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Manuals on methods of estimating population

MANUAL VI

Methods of Measuring Internal Migration

UNITED NATIONS

Department of Economic and Social Affairs

POPULATION STUDIES, No. 47

Manuals on methods of estimating population

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Methods of Measuring Internal Migration

UNITED NATIONS
New York, 1970

NOTE

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FOREWORD

Pursuant to the recommendations of the Population Commission, the Population Division of the United Nations Secretariat has been preparing several manuals describing methods of demographic analysis needed for economic and social policy purposes and suitable for use in many countries, including those where demographic statistics and methods of analysis are not yet adequately developed. Some of those manuals deal with the analysis and evaluation of basic statistics and estimates, and others are concerned with the projection of various population quantities which are needed in diverse fields of economic and social planning. The present Manual, concerned with the analytic study of internal migration, and especially with the use of population census data for such purposes, is part of this longer-range programme.

The following Manuals have been published so far in the series *Manuals on Methods of Estimating Population ; Manual I; Methods of Estimating Total Population for Current Dates;*[1] *Manual II: Methods of Appraisal of Quality of Basic Data for Population Estimates;*[2] *Manual III: Methods for Population Projections by Sex and Age;*[3] *Manual IV: Methods of Estimating Basic Demographic Measures from Incomplete Data;*[4] *Manual V: Methods of Projecting the Economically Active Population;*[5] and related to the series, *Methods of Analysing Census Data on Economic Activities of the Population.*[6] Also, within the context of this coherent and cumulative programme, two other publications should be mentioned, namely, *Estimating Future School Enrolment in Developing Countries; a Manual of Methodology,* published jointly by the United Nations and UNESCO,[7] and the technical report under the title *The Concept of a Stable Population: Application to the Study of Populations of Countries with incomplete Demographic Statistics,*[8] which presents the theoretical background of part of the aforementioned *Manual IV.*

On the occasion of the United Nations World Population Conference, held at Belgrade in 1965, a Committee on Internal Migration was established by the International Union for the Scientific Study of Population (IUSSP),[9] which accepted responsibility for preparing the present Manual. Beginning in 1966, chapters for a first draft were drawn up by Dr. K. C. Zachariah with emphasis on concepts, definitions and sources and the evaluation of various techniques for utilizing census data. This draft was circulated both among members of the Committee and in the United Nations Secretariat for comments and suggestions.[10] A revised version was then prepared by Dr. Zachariah during 1968. Concomitantly, material on population registers was assembled by Dr. S. Kono and Professor D. S. Thomas; and Dr. H. S. Shryock prepared a detailed manuscript on uses of sample survey data. Final editing, including the incorporation of additional material, was accomplished during 1969 by Dr. H. T. Eldridge and Professor Thomas.

In submitting the final draft to the United Nations, the IUSSP Committee on Internal Migration wish to express their appreciation for valuable assistance given them by the staff of the Population Studies Center of the University of Pennsylvania, and especially that provided by Messrs. S. L. N. Rao and K. S. Seetharam, Mesdames A. M. Barbera and L. F. Christaldi, and Miss D. M. Kling.

[1] United Nations publication, Sales No.: 52.XIII.5.
[2] United Nations publication, Sales No.: 56.XIII.2.
[3] United Nations publication, Sales No.: 56.XIII.3.
[4] United Nations publication, Sales No.: 67.XIII.2.
[5] United Nations publication, Sales No.: E.70.XIII.2.
[6] United Nations publication, Sales No.: E.69.XIII.2.
[7] United Nations publication, Sales No.: 66.XIII.3.
[8] United Nations publication, Sales No.: 65.XIII.3.
[9] The Committee consisted of the following members: D. S. Thomas (United States of America), Chairman; J. Arias (Guatemala); R. Bachi (Israel); H. T. Eldridge (United States of America); J. C. Elizaga (Chile); S. Kono (Japan); M. Macura (Yugoslavia); H. S. Shryock (United States of America); T. van den Brink (Netherlands); and K. C. Zachariah (India).
[10] A manuscript on internal migration and population distribution supplied to the United Nations by J. Harewood (Trinidad and Tobago) was also made available to the Committee.

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EXPLANATORY NOTE

The following symbols have been used in the tables throughout the report:

Three dots (...) indicate that data are not available or are not separately reported

A dash (—) indicates that the amount is nil or negligible

A blank in a table indicates that the item is not applicable

A minus sign (−) indicates a deficit or decrease, except as indicated

A full stop (.) is used to indicate decimals

A comma (,) is used to distinguish thousands and millions

A slash (/) indicates a crop year or financial year, e.g., 1960/61.

Use of a hyphen (-) between dates representing years, e.g., 1961-1963, signifies the full period involved, including the beginning and end years.

The term "billion" signifies a thousand million.

Reference to "dollars" indicates United States dollars, unless otherwise stated.

INTRODUCTION

Basic concepts and definitions

The geographic or spatial mobility of a population is a topic of direct interest to the student of human affairs because of its effects upon the distribution of the population and because of its interaction with other demographic forces as well as with other aspects of social and economic change and differentiation.

The movement of population in space is a multifarious phenomenon in which the distance of moves may vary from a few yards to many miles, and in which the duration of stay at destination may vary from a few hours to many years. A considerable part of this movement is incidental to carrying on the activities of daily life—commuting to and from the place of work, shopping, visiting, travel for business or pleasure, to name only a few. These types of mobility are of interest in their own right, and statistics concerning them are useful for many analytical purposes. They are, however, to be distinguished from the type of mobility that involves a sustained or permanent sojourn in the place of destination. It is this latter type of mobility that is envisaged by the concept, *migration*. The essential character of migration is thus that it involves a change in place of abode, or place of "usual" residence—a taking-up of life in a new or different place.

This restriction on the concept of migration eliminates certain other types of spatial mobility that are commonly referred to as "migration" but that, in the interest of scientific precision, should be listed under different categories. These types include nomadism, the movement of population groups that have no fixed place of residence, and the seasonal movements of persons who live in two or more places during the course of a year.

Within the framework of even this restricted concept of migration, there are a number of subsidiary conceptual and procedural problems. Change of residence or residential mobility, like mobility in general, varies along a distance continuum. Highly localized moves—from one apartment to another in the same building, from one house to another in the same neighbourhood or town—are clearly forms of mobility that should not be considered migrations. Indeed, the use of the term "place" in the above definition indicates that such short moves are not so considered. One cannot give this term a wholly precise meaning, but perhaps its intention becomes clearer when the word "locality" is substituted for "place". Locality is itself a somewhat indefinite term, but at least it serves to indicate that migration is conceived as involving a change of *milieu* along with the change of dwelling unit. Since neither change of locality nor change of *milieu* is readily amenable to objective measurement, the more measurable characteristic, distance, is an acceptable substitute. We are thus led to the position that only moves of some reasonable minimum distance should qualify as migrations. If all moves could be classified by distance moved, the minimum could be varied as circumstances dictated, or—and this would be preferable—the distance distribution could be studied in relation to other relevant variables such as origin, destination, duration of stay etc. In practice, the data on residential mobility are seldom recorded in terms of, or directly convertible to, distances spanned. The analyst is forced to deal with approximations thereto; these are at best only rough estimates for broad and overlapping categories of distance.

With exact information on points of origin and points of destination, the tabulation of moves by distance covered would be obtainable. But even under the most favourable conditions, such as those offered by a continuous population register, it is a difficult and laborious process to produce this kind of detail. Under conventional statistical conditions that customarily prevail—the census or the survey—results are necessarily tabulated for the administrative or political units into which the country is divided, and origins and destinations are not specified below this level. A migration is then operationally defined as a change of residence from one civil division to another, and the volume of migration is to a considerable degree a function of the size of areas chosen for compilation. Thus, if the class of areal units chosen is the minor civil division (county, commune, city etc.) a greater proportion of residential mobility will emerge as migration than if the unit chosen is the major civil division (state, province etc.). With either choice, a number of very short moves (e.g., from points close to the boundary of one division to points immediately across the boundary in an adjacent division) will be counted as migration, and a number of longer moves (e.g., from one end of a division to another) will not be so counted. Given that civil divisions of the same class vary widely in size, shape and length of border, it is at once apparent that this criterion for identifying migrants lacks uniformity. It behoves the analyst to exercise caution when he undertakes comparisons of internal mobility either between countries or between the component areas of a single country. It is, of course, desirable that the units be as small as possible. They can then be consolidated for larger units as occasion requires. Also, various combinations of geographic detail are possible, with, for example, small area detail for areas of destination being cross-classified with broader areas of origin.

This problem of comparability of data for areal units of varying size and character is one that nearly always arises in spatial research of whatever kind; it is particularly acute perhaps in migration research. Examples of ap-

proaches to solutions may be found in the works of Hägerstrand and Bachi.[1]

The definitions given below are intended to be applicable to whatever kind of data are being analysed, but they reflect to some degree the compromises that have to be made between the ideal and the feasible in the real world of empirical research. They are intended to be a set of basic terms that should facilitate communication and exchange of knowledge regarding the phenomena with which they deal. These definitions are generally consistent with those given in the *Multilingual Demographic Dictionary*, published by the United Nations.[2] They differ in that they are focused primarily upon the terminology of internal migration and introduce a number of elaborations and refinements.

Migration interval

Migration occurs more or less continuously over time. In order to study its incidence, data have to be compiled with reference to specified periods of time. The interval may be definite, e.g., one year, five years, ten years, the intercensal period, or it may be indefinite, e.g., the lifetime of the population alive at a given date. When the data refer to a definite interval, we may say that they measure *fixed-term* or *period* migration, and thus distinguish them from data on *lifetime* migration or data based on place of last residence that lack a definite time reference.

Migrant and migration

A migration is defined as a move from one migration-defining area to another (or a move of some specified minimum distance) that was made during a given migration interval and that involved a change of residence. A migrant is a person who has changed his usual place of residence from one migration-defining area to another (or who moved some specified minimum distance) at least once during the migration interval. Persons who moved during the interval and died before its end should, strictly speaking, be counted as migrants and their moves should be counted as migrations. However, since information on migration is usually obtained after the end of the interval and with reference to persons still living at that time, both the number and the moves of migrants who died in the interim are likely to be excluded.

For a given migration interval, the number of migrants is rarely, if ever, as large as the number of migrations. Unless the interval is very short (a day, or perhaps a week) some persons are certain to move more than once. In general, the longer the migration interval the more the count of migrants will understate the amount of migration. Conversely, the shorter the migration interval, the more nearly the count of migrants will approach the number of migrations.

Area of origin (departure)

For migration, the area (or place) from which a move is made is the area of origin. For migrants, the area of origin may be either (*a*) the area of residence at the beginning of the migration interval, or (*b*) the area of residence from which the last move was made. The particular way in which the area of origin is defined will depend upon the nature of the information available to the analyst.

Area of destination (arrival)

For migration, the area in which a move terminates is the area of destination. For migrants, the area of destination is the area of residence at the end of the migration interval.

Migration streams

Strictly defined, a migration stream is the total number of moves made during a given migration interval that have a common area of origin and a common area of destination. In practice, it is usually a body of migrants having a common area of origin and a common area of destination.

Data on migrations, or migrants, can be cross-classified by area of origin and area of destination to form a matrix of $n(n-1)$ streams, or a set of $\frac{n(n-1)}{2}$ pairs of streams, each pair representing movements in opposite directions. Thus, if the migration stream from area i to area j is represented by the symbol M_{ij}, the opposing stream is represented by M_{ji}. The larger of any such pair of streams is designated as the *stream* or the *dominant stream* and the smaller as the *counterstream* or the *reverse stream.* The sum of the two members of a pair of streams is called *gross interchange.*

Lifetime migrant and lifetime migration

A person whose area of residence at the census or survey date differs from his area of birth is a lifetime migrant. The number of such persons in a population is commonly referred to as "lifetime migration". This number is, however, a gross understatement of both the amount of migration that has occurred during the lifetime of the living population and of the number of persons who have migrated. It excludes all moves that intervened between departure from the area of birth and arrival in the area of residence as reported at the census date, and it does not count as migrants persons who moved away from and subsequently returned to their areas of birth. Furthermore, it necessarily takes no account of the migration of persons who died before the census date.

[1] Torsten Hägerstrand, "Migration and area; survey of a sample of Swedish migration fields and hypothetical considerations on their genesis", in David Hannerberg, Torsten Hägerstrand and Bruno Odeving (ed.), *Migration in Sweden*, (Lund Studies in Geography, Ser. B., Human Geography, No. 13, (Lund, Royal University of Lund, 1957), pp. 27-158; Roberto Bachi, "Statistical analysis of geographical series", *Bulletin de l'Institut international de la statistique*, Stockholm, 1958, Tome 36, Livraison 2, pp. 229-240.

[2] *Population Studies, No. 29* (United Nations publication, Sales No.: 58.XIII.4). The English and French versions appeared in 1958, the Spanish in 1959, and the Russian in 1964. The *Dictionary* has also been published in at least eleven other languages by various organizations.

When the required information is available, the count of lifetime migrants can be enlarged by the inclusion of persons who have returned to their areas of birth. The result will be the number who have ever migrated and a lifetime migrant is then defined as a person who has ever lived outside his area of birth.

In-migrant and in-migration

Every move is an out-migration with respect to the area of origin and an in-migration with respect to the area of destination. Every migrant is an out-migrant with respect to the area of departure and an in-migrant with respect to the area of arrival. An in-migrant is thus a person who enters a migration-defining area by crossing its boundary from some point outside the area, but within the same country. He is to be distinguished from an "immigrant" who is an international migrant entering the area from a place outside the country.

The number of in-migrants for a migration interval is likely to be less than the number of in-migrations during the same interval as the same person may make more than one in-migration during that period. But regardless of how many in-moves and out-moves he makes during a migration interval, an in-migrant will count as such only if he is living in the area of destination at the end of the interval or if he dies in that area before the end of the interval.

Out-migrant and out-migration

An out-migrant is a person who departs from a migration-defining area by crossing its boundary to a point outside it, but within the same country. He is to be distinguished from an "emigrant" who is an international migrant, departing to another country by crossing an international boundary.

For a given area, the number of out-migrants for a migration interval is likely to be less than the number of out-migrations during the same period, as the same person may make more than one out-migration during that period. As above, regardless of how many out-moves and in-moves he makes during a migration interval, an out-migrant will count as such only if he is living outside the area of origin at the end of the interval or if he dies outside it before the end of the interval.

Gross and net migration

Data that refer to all moves or all migrants, within the specific definition of migration that is being applied, are concerned with *gross migration*. With respect to a given area, the sum of in-migration and out-migration, or of in-migrants and out-migrants, is *turnover*. The term *net migration* refers to the balance of movements in opposing directions. With reference to a specific area, it is the difference between in-migration and out-migration. If in-migration exceeds out-migration, the net gain to the area is classifiable as *net in-migration* and takes a positive sign. In the opposite case, there has been *net out-migration*, which takes a negative sign.

Net migration is equal to the net number of migrants because the difference between in-migrants and in-migration is equal to the difference between out-migrants and out-migration. This is true, however, only if (*a*) the moves of persons who died are included in the migration count and migrants who died are included in the migrant count or (*b*) such moves and such migrants are excluded from the respective counts. Of course, the results of (*a*) will not be the same as the results of (*b*). The former gives the balance due to all migration; the latter gives the balance due to the migration of persons who survived to the end of the interval.

When differences are struck between streams and counterstreams for individual pairs of streams, the balances are *net streams*. The algebraic sum of net streams for a given area is equal to net migration for that area.

PRINCIPAL SOURCES OF DATA

Censuses, population registers and sample surveys are the main source of information on internal migration.

Censuses

Census data have been and still are the major source of information on internal migration in most countries of the world. Until the time when more countries are able to set up efficient systems of population registration, it is likely that censuses will remain the best source of such information. The census data on internal migration are obtained directly by including a question on migration, and indirectly through estimation procedures that use data presumably obtained for other purposes. The usual direct questions on internal migration have to do with: place of birth; place of last residence; duration of residence in the place of enumeration; place of residence on a specific date before the census.

On the basis of the answers to any of these questions, the total population in an area may be classified into two groups: *migrants* and *non-migrants*. As has already been indicated, the criterion for such classification will depend upon the nature of the inquiry. Thus, migrants may be those who are enumerated in a place different from their place of birth, or those whose place of last residence is different from the place of enumeration, or those who resided in the place of enumeration for a period that is less than their age or those who resided x years ago in a place different from their place of residence at the time of the census.

Indirect information on internal migration can be obtained by comparison of total population counts for component areas in two censuses. The difference between the population counts at two censuses gives a measure of the total population change in an area. If this total change cannot be accounted for by births and deaths alone, the balance is attributable to migration. An estimate of net migration for the area is obtained by subtracting natural increase from the total change. Correspondingly, areal

estimates of net intercensal migration can be obtained from the sex-age distributions of two successive censuses.

Surveys

Periodic sample surveys have become an important source of demographic information in many countries; and in a few countries these surveys have been used to collect direct information on internal migration. Where there is no system of population registration, sample surveys provide a means of obtaining current information during the post-censal period. The potential uses of sample surveys for providing migration statistics is enormous. In general, major emphasis in such surveys has been placed on obtaining materials on internal migration that will supplement the information gained from national censuses.

Both censuses and surveys represent a *retrospective* approach to the measurement of migration. That is, they deal with the past behaviour of the population enumerated in the inquiry. The results therefore refer to the migration of only those who survived to the date of inquiry.

Population registers

The practice of recording changes of residence exists in some countries. Where such registrations are made on a routine basis covering the whole country and where these records are used to prepare statistics on population movements, the registration system is potentially an excellent source of data for the study of internal migration. Although, at the present time, there are several countries where accurate statistics on internal migration are obtainable from population registers, published data on internal migration are meagre, being largely confined to the volume of in-migration and out-migration for component areas. The importance of population registers as a source of data on internal migration lies not so much in its widespread use at the present time as in its future potentialities.

In the following chapters, the nature of the data that are available from censuses, the methods of utilizing them for migration analysis, and their accuracy and adequacy are discussed. In addition, some uses of data for migration analysis from population registers and sample surveys are indicated in annexes I and II, respectively.

Chapter I

CENSUS DATA ON INTERNAL MIGRATION

PLACE OF BIRTH

Cost considerations often make it desirable to keep the number of questions on a census schedule to a minimum. Among the questions which have a direct bearing on migration, that on place of birth is perhaps the most widely used. The question is among those given first priority in the United Nations' recommendations for the 1960 and 1970 rounds of censuses; and in fact, about 100 countries did obtain information on birth-place in censuses taken in or around 1960. Most of those lacking such information are newly independent countries which have only recently taken their first census. Such data are obtained by asking a simple question, such as "where was this person born?" for all persons enumerated in the census. The answer to this question may be recorded in a number of ways depending on the degree of detail (with respect to areal units) desired in the migration data. The place of birth may be recorded as the village, town or district in which the person was born, or perhaps a larger unit such as a state, province or governorate. Those born in other countries, separately recorded, can then be singled out as international migrants, not to be included in the study of internal migration.

Lifetime migrants

On the basis of the answer to the place-of-birth question, it is possible to classify the population enumerated into two groups:

1. *Migrants*, defined as persons who were enumerated in a place different from the place where they were born;

2. *Non-migrants*, defined as persons who were enumerated in the place where they were born.

The migrant category may then be subdivided into migration streams on the basis of specific birth-places and specific places of residence. An illustrative compilation of birth-place data is given in table 1, where the population enumerated in each governorate of the United Arab Republic in 1960 is cross-classified by governorate of birth. Column 2 shows that Cairo governorate had in 1960 a total of 1,194,266 lifetime in-migrants (the sum of column 2 minus the figure in the diagonal, that is, 3,273,700 − 2,079,434) of whom 47,220 were born in Alexandria governorate, 9,464 in Port-Said, 216,764 in Menoufia governorate etc. Similarly, the first row of the table shows that Cairo governorate had a total of 241,603 lifetime out-migrants (2,321,037 − 2,079,434) of whom 31,049 were living in Alexandria governorate, 5,293 in Port-Said governorate, 7,038 in Menoufia governorate etc. The diagonal cells of the table give the number of lifetime non-migrants for each governorate.

The streams of lifetime migrants are more conveniently shown in table 2, which gives for the Cairo governorate the numbers of in- and out-migrants, the amount of net migration, the origin and destination of each stream of migration to and from Cairo governorate, and the net balance for each pair of streams.

The number of lifetime in-migrants to Cairo exceeds the number of lifetime out-migrants by 952,663. This difference measures lifetime net migration to Cairo governorate and it can be split up into net streams (i.e., gains and losses resulting from migratory exchanges with each of the other governorates). For example, Cairo had a lifetime net gain of 209,726 persons from Menoufia, a loss of 23,959 to Giza etc.

Cartographic methods are useful for presentation of migration balances or streams, but may not be feasible if the number of areal units is very large. Data for India (with boundaries as of 1931) are shown graphically in map 1, where the direction and magnitude of the major net streams is represented by an arrow whose width is proportional to the size of the balance.

As has been noted about internal migration in general, the sum total of lifetime in-migrants for all the areal units in a country is equal to the sum total of lifetime out-migrants, for each in-migrant to an area is an out-migrant from some other area. The sum of the net balances for all areas is, therefore, necessarily zero. The sum of lifetime in-migrants or lifetime out-migrants gives the number of persons who were enumerated away from their birth-place; that is, the number of lifetime migrants for the country. This total may be obtained from table 1 by subtracting the numbers in the diagonal cells from the corner grand total. Thus, for the United Arab Republic, lifetime migrants numbered 2,697,309, and were 10.5 per cent of the total population. The sum of net lifetime gains (or the sum of net losses) is a measure of redistribution due to lifetime migration for the country as a whole. It is obtained from table 1, by subtracting the horizontal totals from the vertical totals and summing the differences with like sign. For the United Arab Republic, the amount of lifetime redistribution in 1960 was 1,558,452 or 6.0 per cent of the total population.

Estimation of intercensal migration

If place-of-birth statistics are available for the same set of areal units at two consecutive censuses, these data can be used to make an indirect estimate of period, or intercensal net migration for each unit. Thus, if

TABLE 1. POPULATION CLASSIFIED BY GOVERNORATE OF BIRTH AND GOVERNORATE OF ENUMERATION, UNITED ARAB REPUBLIC, 1960

Governorate of birth (1)	*Governorate of enumeration*											
	Cairo (2)	*Alexandria* (3)	*Port-Said* (4)	*Ismailia* (5)	*Kalyubia* (6)	*Gharbia* (7)	*Menoufia* (8)	*Giza* (9)	*Assyiut* (10)	*Souhag* (11)	*All others* (12)	*Total* (13)
Cairo	2,079,434	31,049	5,293	9,813	23,837	10,034	7,038	88,543	4,951	2,569	58,476	2,321,037
Alexandria	47,220	1,085,602	2,641	2,625	2,135	4,921	1,505	6,910	1,355	1,467	29,534	1,185,915
Port-Said	9,464	2,562	168,046	6,461	496	817	323	1,505	326	454	11,184	201,638
Ismailia	9,518	1,395	3,490	171,297	718	910	306	1,593	319	263	10,269	200,078
Kalyubia.....	90,668	4,730	758	3,182	886,464	3,727	3,523	10,279	340	128	18,076	1,021,875
Gharbia	99,179	39,953	1,742	3,347	7,870	1,604,851	6,313	14,529	848	491	64,140	1,843,263
Menoufia	216,764	46,781	1,640	3,338	2,918	29,580	1,308,283	30,915	567	401	47,843	1,689,030
Giza	64,584	4,899	513	2,013	2,887	1,503	2,161	1,040,179	540	433	13,518	1,133,230
Assyiut	100,305	25,497	1,738	2,522	122	2,245	636	13,153	1,290,255	5,955	35,157	1,477,585
Souhag	100,100	63,712	12,087	9,436	295	2,791	1,095	17,958	11,608	1,540,020	53,224	1,812,326
All others	456,464	177,476	43,898	66,973	49,816	47,315	12,179	94,577	14,690	22,375	11,900,302	12,886,065
TOTAL	3,273,700	1,483,656	241,846	281,007	977,558	1,708,694	1,343,362	1,320,141	1,325,799	1,574,556	12,241,723	25,772,042

SOURCE: United Arab Republic, Department of Statistics and Census, *1960 Census of Population* (Cairo, July 1963), vol. II, General tables, table 14, p. 50.

TABLE 2. LIFETIME IN-MIGRANTS BY GOVERNORATE OF ORIGIN, OUT-MIGRANTS BY GOVERNORATE OF DESTINATION AND NET LIFETIME STREAMS OF MIGRATION, CAIRO GOVERNORATE, 1960

Governorate of origin and destination	*Lifetime in-migrants*	*Lifetime out-migrants*	*Net lifetime migration*
Alexandria	47,220	31,049	+16,171
Port Said.....	9,464	5,293	+4,171
Ismailia	9,518	9,813	−295
Kalyubia	90,668	23,837	+66,831
Gharbia	99,179	10,034	+89,145
Menoufia	216,764	7,038	+209,726
Giza.....	64,584	88,543	−23,959
Assyiut	100,305	4,951	+95,354
Souhag	100,100	2,569	+97,531
Other governorates	456,464	58,476	+397,988
TOTAL	1,194,266	241,603	+952,663

SOURCE: Derived from table 1.

I_t and I_{t+n} are the numbers of lifetime in-migrants in a particular area at two censuses at times 't' and '$t+n$' respectively and if O_t and O_{t+n} are the corresponding lifetime out-migrants, then an estimate of intercensal net migration for that area is given by:

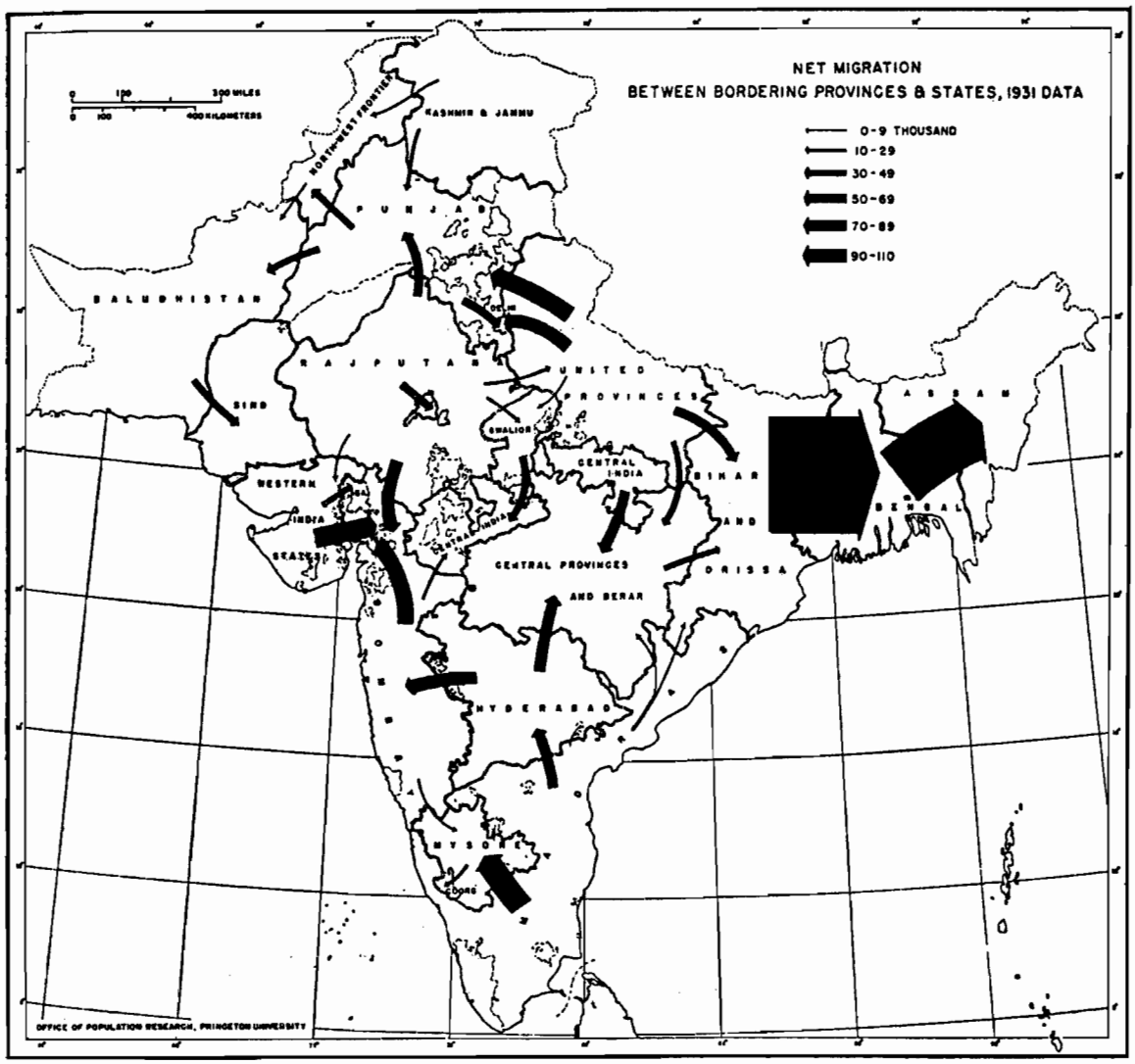
$$\text{Net } M = (I_{t+n} - O_{t+n}) - (S_I I_t - S_o O_t) \qquad (1)$$

where S_I and S_O are the intercensal survival ratios giving the proportions of I_t and O_t that will survive the intercensal period.

The same formula may be rewritten as:

$$\text{Net } M = (I_{t+n} - S_I I_t) + (S_o O_t - O_{t+n}) = M_1 + M_2 \qquad (2)$$

Thus, birth-place data at two censuses not only provide a means of estimating the balance of intercensal migration but they also help to analyse that net balance into two components, namely, net migration among persons born outside the area (M_1) and that among persons born inside the area (M_2).



Map 1. Net lifetime migration streams across state and provincial boundaries, India, 1931

SOURCE: Kingsley Davis, *The Population of India and Pakistan* (Princeton, Princeton University Press, 1951), p. 109.

In practice, the major difficulty in the application of the method is the estimation of S_I and S_O. A considerable amount of data and computations are needed in order to derive accurate estimates of S_I and S_O; such data are not generally available. Several procedures are possible, some elaborate and more accurate, and some simple but approximate. A few of these are discussed below, starting with the simplest and proceeding to more elaborate ones.

Procedure 1

If data on the age distribution of out-born persons are not available, it is virtually impossible to estimate the survival ratios accurately. In this situation, it is recommended that S_I and S_O be both taken as equal to the over-all census survival ratio (ratio of persons aged n years and over in the country at the second census to persons of all ages in the first census, i.e., $P_{n+,t+n}/P_t$) or the over-all life table survival ratio (T_n/T_O) if an appropriate life table covering the entire period is available. These ratios may not measure the probability of survival very accurately, and there will be some error in the migration estimate; but it is certain that an estimate of net migration obtained by using even a roughly approximate survival ratio will be more accurate than one that ignores the mortality factor entirely. If the effect of mortality is ignored, the formula for net migration is reduced to:

$$\text{Net } M' = (I_{t+n} - I_t) + (O_t - O_{t+n}) = M_1' + M_2' \qquad (3)$$

Comparing Net M' and Net M, it is readily seen that if the effect of mortality is ignored, net intercensal migration among out-born and in-born persons will be underestimated by the number of deaths among I_t and O_t during the intercensal period. This can be a serious error for the ordinary intercensal interval of ten years; the population involved is a cohort of lifetime migrants who may have migrated at any time before the first census and who may, therefore, lose substantial numbers through deaths during the period. However, this error will be more serious in the components, M_1' and M_2' than in Net M'. There is some cancellation of error in the estimate of net migration because I_t and O_t have opposite signs in the equation. Nevertheless, the effect of not taking mortality into account is almost certain to be an underestimation of net migration, since the larger of the two components I_t and O_t is likely to lose more through mortality than is the smaller.

A numerical illustration of the application of procedure 1 is given in table 3 using data for the Indian sub-continent, 1921-1931. In this example, the survival ratio is assumed to be the same for the out-born and the in-born; it is estimated from the over-all ten-year census survival ratio, which was approximately 81 per cent. The calculations indicate that the state of Assam had a net gain of 205,000, which was composed of a net inward movement of 211,000 among persons born outside the state and a net outward movement of 6,000 among persons born within the state. The movement to Assam seems to have been virtually a one-way movement. Bombay, on the other hand, shows a net in-migration of 96,000 persons born elsewhere and a net out-migration of 42,000 persons born in Bombay.

TABLE 3. ESTIMATE OF NET MIGRATION FROM BIRTH-PLACE DATA, SELECTED STATES IN THE INDIAN SUB-CONTINENT, MALES, 1921-1931: PROCEDURE 1

State	*Lifetime in-migrants*		*Lifetime out-migrants*		*Net intercensal migration, 1921-1931*		
	1921	*1931*	*1921*	*1931*	*Among out-born*	*Among in-born*	*Total*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Assam	671,195	754,821	44,136	41,785	+211,153	−6,035	+205,118
Madras	97,107	119,621	580,136	723,755	+40,966	−253,845	−212,879
Mysore	187,000	204,260	45,349	54,410	+53,790	−17,677	+35,113
Bombay	474,553	480,557	197,593	202,197	+96,169	−42,147	+54,022

SOURCE: K. C. Zachariah, *A Historical Study of Internal Migration in the Indian Sub-Continent* (Bombay, Asia Publishing House, 1964); derived from table 3.6, pp. 60, 67 and 69.

Note: It is assumed that the ten-year survival ratio of out-born persons is equal to that of in-born persons and that both equal 0.81 column (6) = Col. (3) − 0.81 × col. (2); column (7) = col. (4) × 0.81 − col. (5); column (8) = col. (6) + col. (7).

Procedure 2

If the cross-classification of the population by place of birth and place of residence is available by age in the later of two censuses, but not in both, an over-all survival ratio may be calculated separately for persons born in each of the areal units. Table 4 illustrates the calculation of such area-specific survival ratios for the nine geographic divisions of the United States of America, and table 5 describes and illustrates the steps for estimating net migration among in-born and out-born persons separately for the New England division.

The figures in table 5 for each division were obtained by adding together the numbers of persons born in that division and enumerated in each of the divisions of the country. Ratios of this type are acceptable as survival ratios only if the population native to each area is reasonably "closed", that is, is unaffected by external migration —one of the conditions for the applicability of survival ratio methods. (See chapter II.)

In table 5, these ratios are applied to the 1950 resident population of New England which has been classified by division of birth. The resultant expected numbers (that is, the numbers that would be expected in 1960 in the

TABLE 4. OVER-ALL SURVIVAL RATIOS OF NATIVE WHITE MALES BY GEOGRAPHIC DIVISION OF BIRTH, UNITED STATES OF AMERICA, 1950-1960: PROCEDURE 2

Division of birth	*Native white males born in the division and enumerated anywhere in the United States, 1950*	*Native white males 10 years old and over born in the division and enumerated anywhere in the United States, 1960*	*Ten-year survival ratio, 1950-1960*
(1)	(2)	(3)	(4) = (3)/(2)
New England	4,018,516	3,696,112	0,919770
Middle Atlantic	12,526,609	11,505,221	0.918463
East North Central	13,070,675	11,914,402	0.911537
West North Central ...	7,882,937	7,145,528	0.906455
South Atlantic	7,373,563	6,766,652	0.917691
East South Central	5,183,050	4,677,577	0.902476
West South Central ...	6,015,384	5,640,579	0.937692
Mountain	1,980,217	1,894,899	0.956915
Pacific	3,186,973	3,074,806	0,964805
All divisions	61,237,924	56,315,776	0.919623

SOURCE: For columns (2) and (3), see Hope T. Eldridge, *Net Intercensal Migration for States and Geographic Divisions of the United States, 1950-1960; Methodological and Substantive Aspects.* Analytical and Technical Report No. 5 (Population, Studies Center, University of Pennsylvania, Philadelphia, 1965), table D, pp. 183-191.

absence of change due to migration) are then subtracted from the 1960 enumerated population ten years old and over to estimate net changes due to the migration of each segment of the resident population. The figures in column (5) indicate that during 1950-1960, the New England division experienced a net loss of 65,964 due to the migration of males aged ten years and over in 1960. This net loss is the algebraic sum of a greater net loss of 187,046 due to the migration of males born in New England and a net gain of 121,082 due to the migration of males born in other divisions of the United States of America. The in-migration of 121,082 for males born in other divisions was composed of a gain of 49,781 born in the Middle Atlantic, 21,239 born in the East North Central etc.

Net migration for persons under ten years of age can be obtained directly from the second census, since these were all born during the intercensal period, and any of them living outside their division of birth in 1960 are necessarily intercensal migrants.

Procedure 3

If place-of-birth statistics are tabulated by age for all the areal units of birth and residence separately (that is, for each lifetime stream) and at both the censuses, more accurate estimates of period net migration can be obtained and these estimates can be made in considerable detail —by age, and for in-born and out-born persons separately, with further detail for the out-born by area of birth. The procedure is similar to that described above, but computations are done separately for each age cohort. This procedure is a special application of the Census Survival Ratio Method, the problems and procedures of which are discussed in more detail in chapter II. The steps involved in the calculations are given below, with illustrative materials drawn from data for the United States of America.

TABLE 5. ESTIMATED NET MIGRATION TO NEW ENGLAND BY GEOGRAPHIC DIVSION OF BIRTH, NATIVE WHITE MALES, 1950-1960: PROCEDURE 2 *(continued)*

Division of birth	*Native white males enumerated in New England in 1950*	*Native white males 10 years old and over in 1960*		*Net change due to migration 1950-1960*
		Expected	*Enumerated*	
(1)	(2)	(3)	(4)	(5)
New England	3,448,223	3,171,572	2,984,526	−187,046
Middle Atlantic	223,158	204,962	264,743	+59,781
East North Central	46,661	42,533	63,772	+21,239
West North Central	20,915	18,959	28,311	+9,352
South Atlantic	34,110	31,302	45,401	+14,099
East South Central	10,759	9,710	15,270	+5,560
West South Central	10,293	9,652	15,132	+5,480
Mountain	6,083	5,821	7,856	+2,035
Pacific	10,833	10,452	13,988	+3,536
TOTAL	3,811,035	3,504,963	3,438,999	−65,964

SOURCE: Columns (2) and (4), tables 8 and 10. Column (3) = column (2) multiplied by the survival ratios given in column (4) of table 4; column (5) = column (4) − column (3).

Step 1: Obtain for each area the totals by age of the male (or female) population born in that area and enumerated anywhere in the country. If these data are not directly available in the census, they can be obtained by combining the appropriate figures from the detailed cross-classification. Table 6 illustrates the kind of compilation that is needed for the computation of area-specific survival ratios using data for the nine geographic divisions of the United States. The figures have been adjusted for non-reporting of place of birth on an assumption of proportionality.

Step 2: Calculate a set of survival ratios for each area of birth by dividing the figures for the later census by the corresponding (same area of birth and same age cohort) figures for the earlier census. As in procedure 2, these ratios will be acceptable only if the population native to each area is closed or virtually so. Illustrative survival ratios are worked out in table 7 using the data of table 6.

TABLE 6. NATIVE WHITE MALES BORN IN CONTERMINOUS UNITED STATES OF AMERICA ON OR BEFORE 1 APRIL1950, AND LIVING IN CONTERMINOUS UNITED STATES OF AMERICA AT THE CENSUS DATES, BY AGE, COLOUR AND SEX, FOR GEOGRAPHIC DIVISIONS OF BIRTH, 1950 AND 1960: PROCEDURE 3

Division of birth									
					Age				
1950	*0-4*	*5-9*	*10-19*	*20-29*	*30-39*	*40-49*	*50-59*	*60+*	*Total*
NE.....	465,097	378,265	606,335	687,705	656,641	500,240	361,245	362,988	4,018,516
MA	1,361,035	1,116,416	1,866,222	2,133,202	2,121.819	1,624,536	1,150,382	1,152,977	12,526,609
ENC	1,522,349	1,217,854	1,948,213	2,043,774	1,939,167	1,566,433	1,280,657	1,552,228	13,070,675
WNC	743,217	615,227	1,111,939	1,194,264	1,229,910	1,087,393	915,609	985,378	7,882,937
SA	912,414	760,432	1,210,249	1,201,300	1,096,888	869,187	629,687	693,406	7,373,563
ESC	530,776	469,858	837,610	816,074	766,251	661,524	494,251	606,706	5,183,050
WSC	696,278	602,175	1,035,753	1,039,361	957,277	770,893	490,898	422,749	6,015,384
MT	291,411	229,569	372,067	346,454	321,363	205,783	125,936	87,634	1,980,217
PAC	708,837	496,101	571,444	500,986	384,823	246,108	157,064	121,610	3,186,973
1960	*10-14*	*15-19*	*20-29*	*30-39*	*40-49*	*50-59*	*60-69*	*70+*	*Total 10+*
NE.....	467,291	368,524	567,349	691,055	653,776	473,087	297,874	177,156	3,696,112
MA	1,377,499	1,088,482	1,764,197	2,165,949	2,091,434	1,526,770	935,508	555,382	11,505,221
ENC	1,534,186	1,189,741	1,852,268	2,088,048	1,924,846	1,488,806	1,066,126	770,381	11,914,402
WNC	743,690	596,680	1,029,881	1,207,170	1,222,771	1,038,422	767,234	539,680	7,145,528
SA	923,142	742,731	1,124,207	1,221,939	1,075,475	817,850	510,677	350,631	6,766,652
ESC	538,502	453,481	765,768	825,753	751,273	619,881	411,265	311,654	4,677,577
WSC	709,735	587,237	965,535	1,059,754	940,249	731,675	408,601	237,793	5,640,579
MT	297,089	227,040	347,198	355,396	318,240	194,210	104,212	51,514	1,894,899
PAC	719,251	488,011	543,220	508,297	379,598	235,989	132,074	68,366	3,074,806

SOURCE: As for table 4.

Note: For names of divisions, see table 4. "Conterminous" United States of America excludes the states of Alaska and Hawaii in accordance with official United States census usage.

TABLE 7. CENSUS SURVIVAL RATIOS FOR NATIVE WHITE MALES BY DIVISION OF BIRTH AND AGE, CONTERMINOUS UNITED STATES OF AMERICA, 1950-1960: PROCEDURE 3 *(continued)*

Age in 1950	Division of birth								
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*
10-14	1.00472	1.01210	1.00778	1.00064	1.01176	1.01456	1.01933	1.01948	1.01469
15-19	.97425	.97498	.97692	.96985	.97672	.96514	.97519	.98898	.98369
20-29	.93567	.94484	.95070	.92722	.92889	.91421	.93220	.93315	.95060
30-39	1.00487	1.01535	1.02166	1.01081	1.01718	1.01186	1.01962	1.02581	1.01459
40-49	.99564	.98568	.99262	.99420	.98048	.98045	.98221	.99028	.98642
50-59	.94572	.93982	.95044	.95496	.94094	.93705	.94913	.94376	.95888
60-69	.82458	.81322	.83248	.83795	.81100	.83210	.83235	.82750	.84089
70+	.48805	.48169	.49631	.54769	.50566	.51368	.56249	.58783	.56217

SOURCE: Hope T. Eldridge, op. cit., table E, pp. 192-196. Ratios shown here for cohort 20-29 were revised after publication of the report.

Step 3: Multiply the population of a given area at the first census by the survival ratios to obtain expected numbers of survivors at the second census. The expected numbers are obtained separately by age and area of birth, and the process is repeated for each area (and each sex or other sub-category of the population). Tables 8 and 9 illustrate step 3 for the New England division of the United States. The ratios of table 7 are multiplied by the 1950 population shown in table 8 to obtain the expected numbers shown in table 9. (The calculations for other divisions are not shown.)

Step 4: Subtract the expected survivors from the enumerated population at the second census to obtain estimates of net migration by age and area of birth. Repeat this step for each area of residence. The enumerated population in 1960 for New England is given in table 10 and the estimates of net migration for this division, classified by age and division of birth, are given in table 11. They were obtained by subtracting the figures of table 9 from those of table 10.

In table 11, the sum of the figures in the first column gives net out-migration of the in-born and the sum of

TABLE 8. NATIVE WHITE MALES BORN IN CONTERMINOUS UNITED STATES OF AMERICA AND ENUMERATED IN NEW ENGLAND IN 1950, CLASSIFIED BY AGE AND BY DIVISION OF BIRTH: PROCEDURE 3 *(continued)*

Age in 1950	Division of birth									
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*	*Total*
0-4	442,577	7,651	1,831	719	3,451	679	830	533	1,730	460,001
5-9	354,131	10,477	1,966	628	3,735	558	794	352	1,342	373,983
10-19	557,607	27,256	5,488	1,600	3,635	969	949	414	1,494	599,412
20-29	576,161	43,041	13,035	5,647	9,078	3,578	3,507	1,691	2,730	658,468
30-39	540,315	44,449	8,259	4,439	5,734	2,197	2,162	1,487	1,552	610,594
40-49	402,369	35,463	5,980	2,922	3,527	1,130	969	732	934	454,026
50-59	287,577	26,284	4,796	2,479	2,560	873	682	535	535	326,321
60+	287,486	28,537	5,306	2,481	2,390	775	400	339	516	328,230
All ages	3,448,223	223,158	46,661	20,915	34,110	10,759	10,293	6,083	10,833	3,811,035

SOURCE: United States Bureau of the Census, *United States Census of Population: 1950* (Washington, D.C.), vol. IV, *Special Reports*, part 4, chap. A, "State of birth", table 19, pp. 50-55. Persons with place of birth not reported were distributed *pro rata* among those with place of birth reported.

TABLE 9. EXPECTED NUMBERS OF NATIVE WHITE MALES FOR NEW ENGLAND, BY AGE AND DIVISION OF BIRTH, CONTERMINOUS UNITED STATES OF AMERICA, 1960: PROCEDURE 3 *(continued)*

Age in 1950	Division of birth									
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*	*Total*
10-14	444,666	7,744	1,845	719	3,492	689	846	543	1,755	462.299
15-19	345,012	10,215	1,921	609	3,648	539	774	348	1,320	364,386
20-29	512,736	25,753	5,217	1,484	3,377	886	885	386	1,420	561,144
30-39	578,967	43,702	13,317	5,708	9,234	3,620	3,576	1,735	2,770	662,629
40-49	537,959	43,812	8,198	4,413	5,622	2,154	2,124	1,473	1,531	607,286
50-59	380,528	33,329	5,684	2,790	3,319	1,059	920	691	896	429,216
60-69	237,130	21,375	3,993	2,077	2,076	726	568	443	450	268,838
70+	140,308	13,746	2,633	1,359	1,209	398	225	199	290	160,367
10+	3,186,306	199,676	42,808	19,159	31,977	10,071	9,918	5,818	10,432	3,516,165

SOURCE: Computed by multiplying the entries of table 7 by the corresponding entries of table 8.

TABLE 10. NATIVE WHITE MALES BORN IN CONTERMINOUS UNITED STATES OF AMERICA AND ENUMERATED IN NEW ENGLAND IN 1960, CLASSIFIED BY AGE AND BY DIVISION OF BIRTH: PROCEDURE 3 *(continued)*

Age in 1960	Division of birth									
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*	*Total*
10-14	417,069	17,077	4,376	1,313	5,578	960	1,413	819	2,687	451,292
15-19	314,048	24,133	6,934	2,361	6,160	1,417	1,703	845	2,141	359,742
20-29	448,711	51,282	16,789	7,448	11,480	4,753	4,467	1,997	3,482	550,409
30-39	545,014	50,274	13,122	5,921	9,685	3,878	3,746	1,472	2,345	635,457
40-49	517,564	49,548	9,675	4,745	5,822	2,013	2,131	1,371	1,787	594,656
50-59	373,051	35,502	6,182	2,900	3,326	1,049	974	744	820	424,548
60-69	231,804	22,344	3,953	1,971	1,982	785	495	386	459	264,179
70+	137,265	14,583	2,741	1,652	1,368	415	203	222	267	158,716
10+	2,984,526	264,743	63,772	28,311	45,401	15,270	15,132	7,856	13,998	3,438,999

SOURCE: United States Bureau of the Census, *United States Census of Population: 1960; Subject Reports;* "State of birth" (Washington, D.C.), table 25, pp. 61-62. Persons with place of birth not reported were distributed *pro rata* among those with place of birth reported.

TABLE 11. NET CHANGES DUE TO THE MIGRATION OF NATIVE WHITE MALES, BY AGE AND DIVISION OF BIRTH, FOR NEW ENGLAND, 1950-1960: PROCEDURE 3 *(continued)*

Age in 1960	Division of birth									
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*	*Net balance*
10-14	−27,597	+9,333	+2,531	+594	+2,086	+271	+567	+276	+932	−11,007
15-19	−30,964	+13,918	+5,013	+1,752	+2,512	+878	+929	+497	+821	−4,644
20-29	−73,025	+25,529	+11,572	+5,964	+8,103	+3,867	+3,582	+1,611	+2,062	−10,735
30-39	−33,953	+6,572	−195	+213	+451	+258	+170	−263	−425	−27,172
40-49	−20,395	+5,736	+1,477	+332	+200	−141	+7	−102	+256	−12,630
50-59	−7,477	+2,173	+498	+110	+7	−10	+54	+53	−76	−4,668
60-69	−5,326	+969	−40	−106	−94	+59	−73	−57	+9	−4,659
70+	−3,043	+837	+108	+293	+159	+17	−22	+23	−23	−1,651
10+	−201,780	+65,067	+20,964	+9,152	+13,424	+5,199	+5,214	+2,038	+3,556	−77,166

SOURCE: Computed by subtracting table 9 from table 10.

TABLE 12. NET GAINS DUE TO EXCHANGES BETWEEN DIVISIONS, NATIVE WHITE POPULATION 10 YEARS OLD AND OVER IN 1960, GEOGRAPHIC DIVISIONS OF CONTERMINOUS UNITED STATES OF AMERICA, 1950-1960

(Thousands)

Division of gain	Division of loss							
	MT	*SA*	*ENC*	*WSC*	*NE*	*ESC*	*MA*	*WNC*
PAC	145.0	82.2	461.9	270.2	109.8	89.6	270.1	470.6
MT	.	18.1	136.8	79.4	16.3	28.0	60.9	173.0
SA	.	.	126.0	16.2	112.9	199.9	414.4	85.2
ENC	.	.	.	1.9	.	346.0	88.7	48.9
WSC	.	.	.	.	5.7	46.3	33.2	4.3
NE	.	.	7.6	.	.	0.7	52.4	6.1
ESC	.	.	.	.	.	.	5.8	1.2
MA	.	.	.	.	.	.	.	2.7

SOURCE: Eldridge and Kim, op. cit., table 11, p. 61.

the sums of the remaining divisional columns gives net in-migration of the out-born. The sum of the last column gives the net balance of migration for all ages.

Eldridge and Kim were able to evaluate the results obtained from procedure 3 for the United States by adjusting gross data for 1955-1960 in such a way as to make them comparable with the procedure 3 estimates for 1950-1960.[1] They found that net balances were much more accurately estimated by this procedure than were "migration streams". The detail in table 11 both understates the volume of migration streams and causes some distortion of their relative size by area of origin. The last is the result of the attribution of place of origin to place of birth, an attribution that is implicit in procedure 3 or any procedure which attempts to estimate period migration from place-of-birth data. However, when net balances are calculated for all pairs of streams (see table 12 and maps 2 and 3), both the volume and the patterns of net shift are quite accurately estimated.

Problems of accuracy and adequacy

On general principles, it would appear reasonable to expect that a simple question on birth-place would be

[1] Hope T. Eldridge and Yun Kim, *Estimating Intercensal Migration from Birth-Residence Statistics; A Study of Data for the United States, 1950 and 1960*, Analytical and Technical Report No. 7 (Population Studies Center, University of Pennsylvania, Philadelphia, 1967).

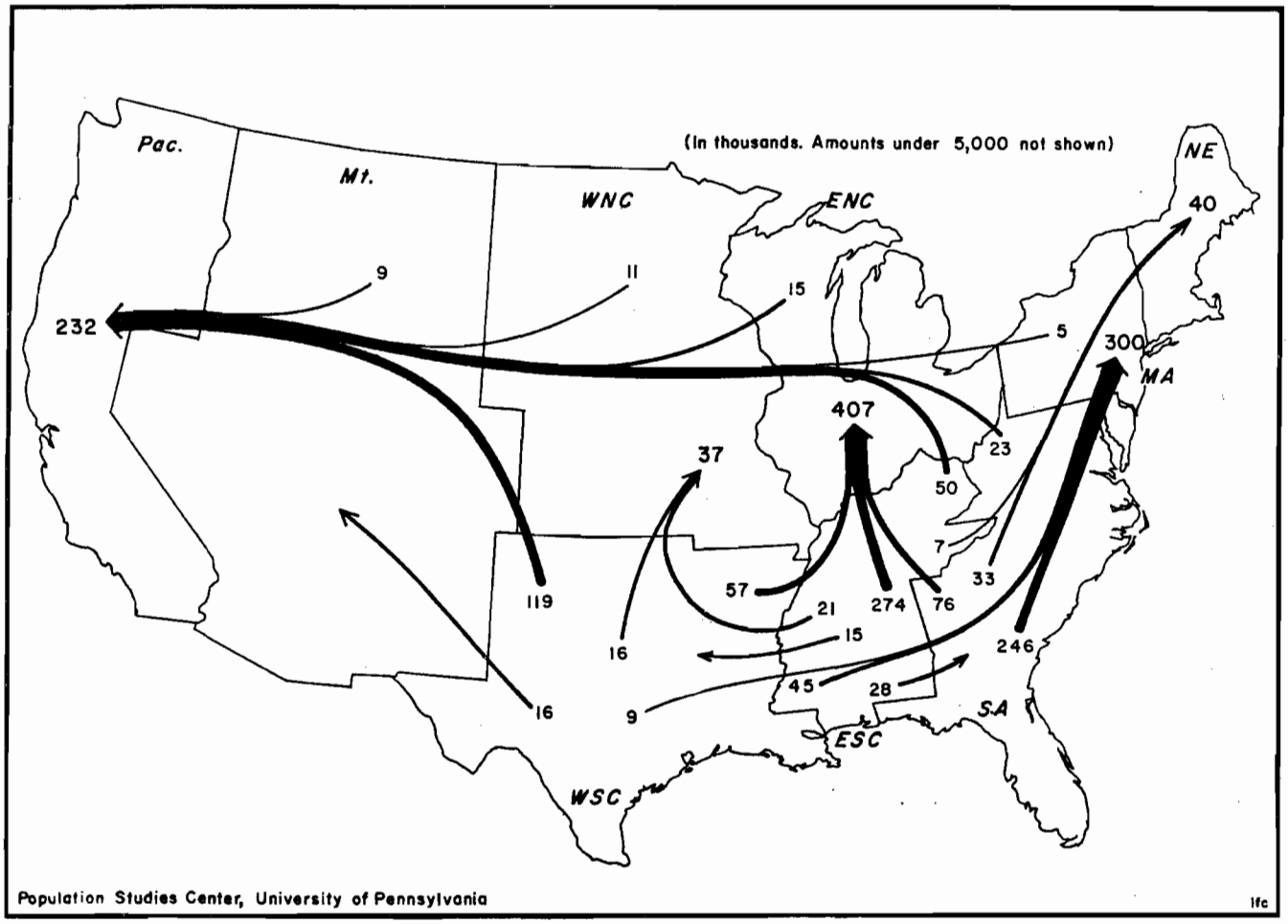
answered with accuracy and completeness. The question is easily understood. Normally, the place where a person was born is fixed in his mind and well known to those close to him. There are, however, possibilities of response error in these data.

The answers to census questions are usually given by one member of the household, ordinarily the head or the housewife, but not always. The respondent may not know the exact birth-place of each person who resides with him or her. If a person has lived in one place for a long time, there may be a tendency to report it as his birth-place. Unintentional mis-statement of place of birth is, therefore, quite possible. There may also be deliberate misreporting of birth-place for political or prestige reasons. The endeavour to identify the area of birth can also introduce a bias in terms of the urban or rural origin of a migrant. A person born in a little-known rural place may prefer to state the name of a better-known nearby town or city, so as to specify his geographic origin more clearly. As a result, many migrants may be reported as having been born in an urban place, though actually they were born in a rural place.

Another factor that can contribute to inaccuracy is associated with boundary changes of geographic units. People are not likely to be aware of such changes, and through ignorance of them may report birth-places incorrectly.

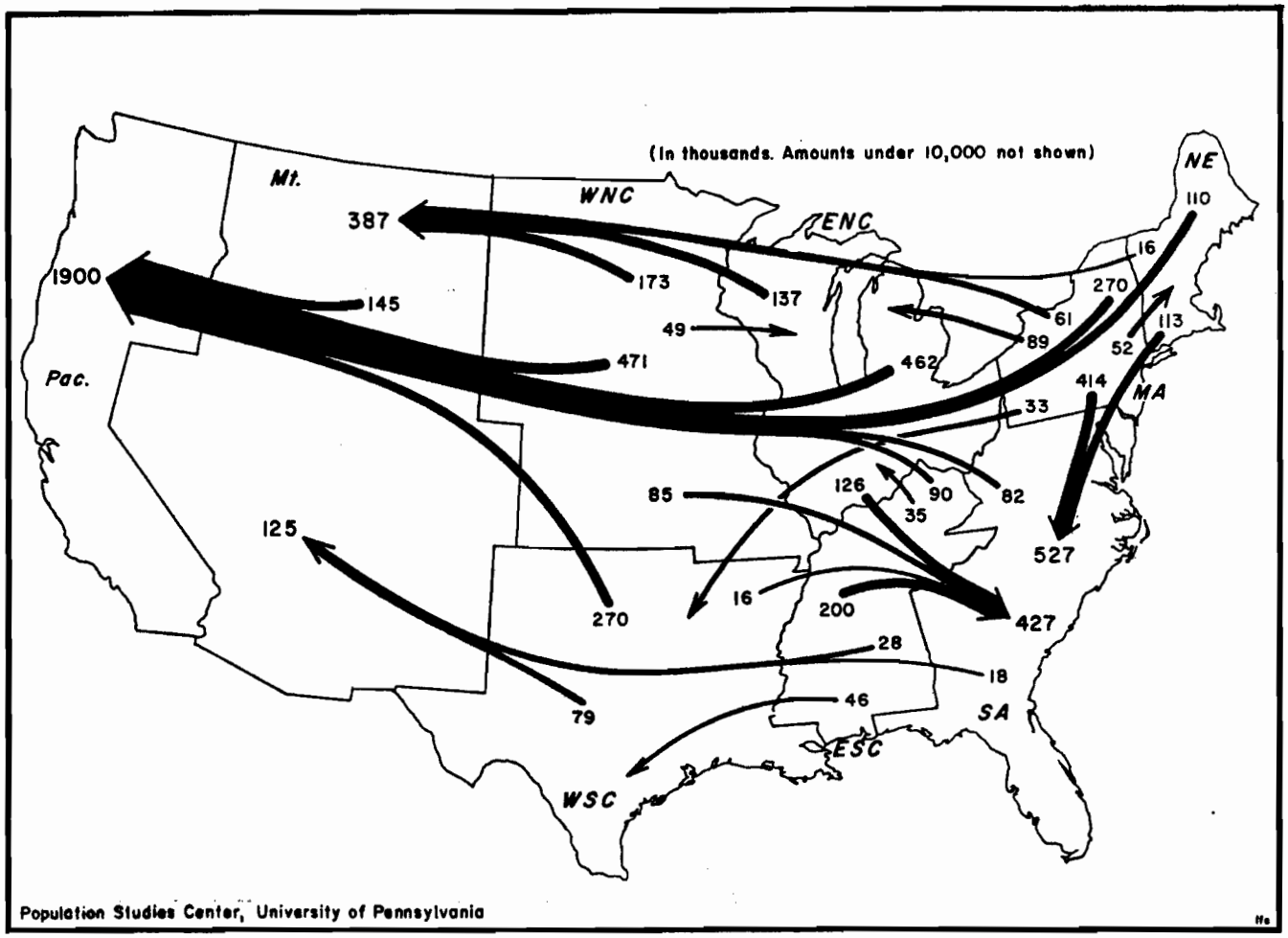
In respect to adequacy, special conditions may render birth-place data unsatisfactory for purposes of migration analysis. In India, for example, it is customary for a woman to return to her father's household to bear the first child and often the second and subsequent children. This custom gives rise to some spurious migration as measured from place-of-birth statistics. It serves to illustrate the desirability, for migration analysis, of identifying the place of birth as the usual place of residence of the parents of a child rather than as the place where the birth actually occurred.

One of the main problems connected with the use of birth-place statistics for migration analysis is that the timing of migrations is unknown. Inasmuch as birth-place statistics reflect migrations, which may have taken place at any time since birth, the category "migrants" includes those who came to the place of enumeration just a few days before the census date as well as those who came a half-century or more earlier. It is to cope with this problem that the procedures described above have been devised. As an illustration of difference between



Map 2. Net streams between divisions, native whites 10 years old and over, conterminous United States of America, 1950-1960

SOURCE: Hope T. Eldridge and Yun Kim, *Estimating Intercensal Migration from Birth-Residence Statistics*, Analytical and Technical Report No. 7 (Population Studies Center, University of Pennsylvania, Philadelphia, December 1967), p. 62.



Map 3. Net streams between divisions, native non-whites 10 years old and over, conterminous United States of America, 1950-1960

SOURCE: Hope T. Eldridge and Yun Kim, *Estimating Intercensal Migration from Birth-Residence Statistics*, Analytical and Technical Report No. 7 (Population Studies Center, University of Pennsylvania, Philadelphia, December 1967), p. 63.

short-term and lifetime migration, consider the migration between Assam and Bihar states in India during the period just before 1931. The net balance of lifetime migration of females between Assam and Bihar was 187,000 in favour of Assam, but an estimate of net intercensal migration during 1921-1931 indicates a gain of about 5,000 females to Bihar.[2] The latter amount, though relatively small, is in the opposite direction from the former. Thus, the impression one gets from the figures on lifetime migration may be quite misleading so far as the more recent period is concerned.

The birth-place definition of migrants assumes a single movement directly from the area of birth to the area of enumeration. Actually some, perhaps a substantial number, of out-born persons enumerated in an area will have moved to it from places other than their places of birth.

The birth-place approach necessarily counts all persons enumerated in their birth-places as non-migrant, even though some of these will have spent most or part of their lives outside the area, having returned to it before the census date. Exclusion of such return migrants from the category of migrants is a serious drawback of birth-place data, but this exclusion need not materially affect estimates of period net migration. These considerations bring out the importance of supplementing direct measures of lifetime migration with indirect measures of period migration.[3]

DURATION OF RESIDENCE

Another approach to the measurement of migration is made possible by including in the census the single question: "How long have you been living in this place?"

[2] India, Census Commissioner, *Census of India*, 1931, vol. I, *India* (Delhi, 1933), part II, "Imperial tables", table VI, pp. 61-62.

[3] Examples of studies that have utilized birth-place statistics in somewhat different ways are: André Beltramone, "Sur la mesure des migrations intérieures au moyen des données fournies par les recensements", *Population* (Paris), 17 Oct.-Dec. 1962, pp. 703-724; Juan C. Elizaga, "Internal migration in Latin America; some methodological aspects and results", *International Social Science Journal* (Paris), vol. 17, No. 2, 1965, pp. 213-231; D. Friedlander and R. J. Roshier, "A study of internal migration in England and Wales, part I: Geographical patterns of internal migration, 1851-1951", *Population Studies* (London), vol. 19, No. 3, March 1966, pp. 239-279.

Persons who have lived in the place of enumeration all their lives would be treated as non-migrants, others as in-migrants. With this approach, persons who were born in a given area but who subsequently moved out and then returned to it would be treated as in-migrants, the duration of residence being taken as the length of time elapsed since they returned to the place of birth. Thus, migrants by the duration-of-residence definition would include all who had ever migrated: (*a*) those born outside the area of enumeration, and (*b*) those born in the area of enumeration who had at some time lived outside it (return migrants). Their number must therefore be more than, though very rarely it may be equal to, the number of lifetime migrants by the birth-place definition.

Although the duration-of-residence approach can, by counting return migrants, fill a gap inherent in the ordinary birth-place approach, the prevailing practice among countries that have included such a question has been to distinguish migrants from non-migrants on the basis of birth-place rather than on the basis of length of residence. This was the practice, for example, in the 1960 census of Peru, the 1961 census of India, and in most censuses which contained a question on duration of residence.

Migration cohorts

The principal value of data on duration of residence is in another direction, namely, in the information it gives on the timing of the last moves of lifetime migrants. An illustrative tabulation of data on duration of residence is given in table 13, where the population born outside each state of Peru is classified by duration of residence in the state in which they were enumerated in 1960. The figures in the rows show the distribution of in-migrants for each state by duration of residence in that state. In other words, these data furnish a distribution of lifetime in-migrants by time of last arrival, or a classification by migration cohorts. This is the unique contribution of the question on duration of residence. The duration of residence can be expressed in time periods as illustrated schematically for a census taken in April 1960.

Duration of residence	*Period of in-migration*
Less than 1 year	After April 1959
One or more but less than 5 years	April 1955 to April 1959
Five years or more but less than 10 years	April 1950 to April 1955
Ten years or more	Before April 1950

Data of this type furnish useful information about the recent migration history of the area. Thus, for Peru as a whole, nearly 16 per cent of lifetime migrants moved to their destinations during the twelve months prior to the census; 42 per cent moved before 1950 (see total line of table 13). In the state of Amazonas, however, 29 per cent of lifetime migrants moved in during the year before the census, and only 22 per cent before 1950. According to these data, the proportion of recent migrants was higher in Amazonas as compared to the average for the country as a whole.

TABLE 13. MIGRANTS CLASSIFIED BY STATE OF ENUMERATION AND DURATION OF RESIDENCE, PERU, 1960

State	*Total*	*Duration of residence (years)*			
		Less than one year	*1-4*	*5-9*	*10+*
Amazonas	26,643	7,770	9,006	4,049	5,818
Ancash	98,589	17,968	30,165	17,499	32,957
Apurimac	15,348	4,007	4,051	1,705	5,585
Arequipa	119,429	24,461	33,295	18,721	42,952
Ayacucho	30,648	7,171	8,105	3,890	11,482
Cajamarca	87,940	13,862	23,051	16,562	34,465
Prov. Const. Del Callao [a]	104,367	11,036	21,451	17,368	54,512
Cuzco	115,484	26,536	30,669	17,747	40,532
Huancavelica	18,783	4,167	5,091	2,164	7,361
Huanuco	44,818	9,606	12,817	6,838	15,557
Ica	71,472	16,594	18,414	12,398	24,066
Junin	123,628	24,602	36,853	22,037	40,136
La Libertad	120,226	15,632	29,606	21,486	53,502
Lambayeque	75,500	10,255	16,995	12,385	35,865
Lima	881,654	99,995	201,539	165,672	414,448
Loreto	73,456	11,694	19,127	13,308	29,327
Madra De Dios	6,150	2,006	1,774	791	1,579
Moquegua	12,913	3,028	5,049	1,802	3,034
Pasco	31,250	6,425	9,701	6,123	9,001
Piura	98,805	17,123	21,653	15,770	44,259
Puno	57,732	12,970	17,396	8,729	18,637
San Martin	21,294	3,153	4,916	3,096	10,129
Tacna	28,511	7,517	10,941	4,044	6,009
Tumbes	15,084	3,483	5,241	1,949	4,411
TOTAL	2,279,724	361,061	567,906	396,133	945,624

SOURCE: Peru, Dirección Nacional de Estadística y Censos, *VI Censo Nacional de Población, República del Perú* (Lima, 1964), Tomo II, cuadro No. 25, pp. 2-9.

[a] Special district.

Duration-of-residence data for Yugoslavia indicate that the proportion of recent migrants (those who moved in during 1958-1961) increased as the distance of migration increased; namely, from 20 per cent for movers within communes to 24 per cent for those who moved between communes within the same state, and to 26 per cent for those who moved between states. Conversely, the proportion of migrants who moved before 1941 decreased as distance increased (see table 14).

TABLE 14. PERCENTAGE DISTRIBUTION OF IN-MIGRANTS BY PERIOD OF MIGRATION AND TYPE OF MIGRATION, YUGOSLAVIA, 1961

Type of migration	*Period of migration*			
	All periods	*Before 1941*	*1941-1957*	*1958-1961*
Within communes	100	34	46	20
Between communes:				
Within states	100	23	53	24
Between states	100	15	59	26

SOURCE: Yugoslavia, *Ukupno i poljoprivredno stanovništvo prema popisu, 1961*, table 7, p. 56.

In interpreting data of these types, it must be remembered that the in-migrants enumerated in any area are the non-mobile survivors of the actual cohorts that migrated during the indicated periods. The cohorts that arrived at the specified places have been decimated by two factors: further migration and deaths. Because the cohorts of migrants who have lived a longer time in the community have been subjected to more years of attrition from mortality and further migration, one would expect rates computed as annual equivalents (number of migrants in the cohort divided by the number of years times the average population) to decrease with increasing duration even though actual rates may not have decreased. Despite these limitations, the data are capable of yielding useful information on differences between areas in the average level for a given period of time and in the pattern of change with increasing duration. Such differences may give some indication of trends in past migration.

A single question on duration of residence does not give any indication of the place of origin of the in-migrants to a given area, and consequently no information on out-migration or on net migration can be derived from it. Nor does it distinguish between immigrants and internal migrants. It follows, therefore, that the data are not of much use for the study of these aspects of migration or for the analysis of migration streams, unless the question on duration of residence is accompanied by another on place of origin or place of birth. If, however, duration-of-residence data become available for two censuses, these can be used to estimate the magnitude of remigration; that is, migration among former in-migrants to an area. A procedure for deriving such estimates is shown schematically in table 15.

TABLE 15. DUMMY TABLE SHOWING METHOD OF ESTIMATING OUT-MIGRATION AMONG FORMER IN-MIGRANTS FROM DURATION OF RESIDENCE DATA FOR AN INTERCENSAL INTERVAL OF 10 YEARS

Age at first census	*In-migrants of duration 0-4 years, first census*	*Expected migrants of duration 10-14 years, second census*	*Enumerated migrants of duration 10-14 years, second census*	*Intercensal out-migration among in-migrants of duration 0-4 years at first census*
(1)	(2)	(3)	(4)	(5)
0-4				
5-9				
10-14				
15-19				
20-24				
. .....				
. .....				
. .....				
. .....				

Note: Columns (2) and (4) are obtained from census data on in-migrants by age and duration or residence in the two censuses. Column (3) is obtained by multiplying column (2) by an appropriate set of survival ratios (national survival ratios if more appropriate ones are not available). Column (5) is obtained by the subtraction of column (3) from column (4).

Problems of accuracy and adequacy

As in the case of birth-place data, the accuracy of duration-of-residence data is affected by the fact that the information is sometimes given by a respondent who does not know the duration of residence of all household members. There may, therefore, be a considerable number reported as "duration unknown". In a study of in-migrants to Greater Bombay[4]—based on data from the census of 1961—the proportion of migrants for whom duration of residence was not reported averaged 9 per 1,000 and proportions varied somewhat from one subgroup of migrants to another. It was greater for females than for males; for the urban-born than for the rural-born; for the single than for the married, widowed or divorced; for male non-workers than for male workers; but, conversely, for female workers than for female non-workers; young children than for most adult groups, and so on.

This study also gives evidence of digit preference, for example, the number reporting duration-of-residence

[4] K. C. Zachariah, *Migrants in Greater Bombay* (Bombay, Asia Publishing House, 1968), pp. 72, 74, 76-77.

as ten years was very much greater than single-year estimates for adjacent durations; and the number reporting fifteen years was much greater than the estimates for thirteen or fourteen years. There is no reason to believe that this pattern reflects variations in period migration. It is therefore a reasonable inference that it reflects the same type of preference for certain integers (like 10 and 15) that is almost universally manifested in age reporting.

Cross-classification by place of birth

As mentioned above, it is becoming a more frequent practice in censuses to include questions on both place of birth and duration of residence. An illustration of the cross-classification of these data is given in table 16, where lifetime in-migrants in Greater Bombay in 1961 are cross-classified by state of birth, and length of residence in the city. The spatial and temporal origin and the effect of variation of one on the other can be studied from these figures. For example, it can be seen that 34 per cent of all lifetime migrants have been in the city for more than fifteen years. In general, the numbers of "survivors" of migrants who came to the city in each year decrease as the interval of time between the year of arrival and the census date (duration of residence) increases; but the rate of decrease declines with increase in length of interval. The distribution of migrants by duration of residence is not the same for all lifetime streams. The highest average is for the Gujarat-born migrants, with more than 41 per cent in the duration interval 15+ years; and the lowest is for those born in Kerala, where the proportion of migrants in the duration interval 15+ was only 20 per cent. The spatial origin of the migrants may be studied by considering the percentage distribution

TABLE 16. PERCENTAGE DISTRIBUTION OF MIGRATION STREAMS BY DURATION OF RESIDENCE, AND OF DURATION COHORTS BY STATE OF ORIGIN, GREATER BOMBAY, 1961: BOTH SEXES

States	*Percentage of total in each duration*						
	All	*0-1*	*1-4*	*5-9*	*10-14*	*15+*	*Not known*
All states	100	7.78	20.17	17.61	19.41	34.14	0.89
Maharashtra	100	7.37	20.13	17.37	16.60	37.64	0.90
Gujarat	100	7.00	15.50	16.26	18.77	41.43	1.04
Mysore	100	7.05	22.29	19.95	17.45	32.54	0.72
Kerala	100	20.01	30.54	21.89	16.92	20.04	0.60
Madras	100	8.21	27.27	23.07	19.65	21.08	0.73
Andhra Pradesh	100	11.61	27.34	19.21	17.25	23.80	0.78
Uttar Pradesh-Bihar	100	10.02	23.94	19.02	18.16	28.01	0.85
West Bengal	100	11.77	25.16	19.88	17.40	24.90	0.87
Rajasthan-Punjab	100	10.92	24.55	20.01	18.97	24.70	0.85
Madhya Pradesh	100	9.47	20.34	18.28	19.32	31.19	1.40

States	*Percentage of total in each state*						
	All	*0-1*	*1-4*	*5-9*	*10-14*	*15+*	*Not known*
All states	100	100	100	100	100	100	100
Maharashtra	42.11	39.85	42.03	41.53	36.01	46.43	42.93
Gujarat	17.10	15.38	13.14	15.78	16.53	20.75	20.11
Mysore	6.51	5.90	7.20	7.38	5.86	6.21	5.29
Kerala	2.79	3.59	4.23	3.47	2.43	1.64	1.89
Madras	3.24	3.42	4.38	4.24	3.28	2.00	2.65
Andhra Pradesh	3.42	5.10	4.63	3.73	3.04	2.98	3.01
Uttar Pradesh-Bihar	12.37	15.93	14.68	13.36	11.57	10.15	11.81
West Bengal	0.62	0.93	0.77	0.70	0.55	0.45	0.61
Rajasthan-Punjab	3.60	5.06	4.38	4.09	3.52	2.61	3.47
Madhya Pradesh	0.88	1.07	0.89	0.92	0.88	0.81	1.39
Others [a]	7.36	3.77	3.67	4.80	16.33	6.58	6.84

SOURCE: K. C. Zachariah, *Migrants in Greater Bombay*, table 3.13, p. 59, and table 3.12, p. 58.
[a] Including all other states, and also Goa, Pakistan and "place of birth not reported".

by columns. For example, it may be seen that 42 per cent of all migrants were born in Maharashtra, the state in which Greater Bombay is located, and 17 per cent were born in the neighbouring state of Gujarat. Uttar Pradesh-Bihar, though physically far from Bombay, is the third in order of importance. Taken together, these three main origins account for no less than 71 per cent of all migrants in the city. The spatial pattern has undergone some change in the past. The neighbouring areas, on the whole, show decreasing importance. For example, the proportion of Maharashtra-born migrants was 46.4 per cent for duration of residence 15+ years, but was only 39.9 per cent for duration less than one year. For the Gujarat-born, the corresponding proportions are 20.7 for duration 15+ years but only 15.4 for duration less than one year. On the other hand, the share of Uttar Pradesh-Bihar is less for the longer duration (10.1 per cent) than for the shorter (15.9 per cent).

PLACE OF LAST PREVIOUS RESIDENCE

Character of the data

One of the limitations of data on place of birth is that, for persons who have migrated more than once, the place of birth gives no indication of residence at the time of last move. In order to get information on direct moves, it is necessary to ask for place of last residence rather than for birth-place. The data will then permit identification of persons as migrants whenever their place of last residence and place of present residence differ. The category "migrants" will thus include all lifetime migrants plus return migrants; that is, all persons who have migrated at any time or all persons who have ever lived outside the area of birth. Non-migrants will be those who have never lived outside the area of birth.

Data derived from the inquiry on place of last residence can be utilized in the same way that place-of-birth data are utilized for obtaining migration measures. From the cross-classification of place of last residence with place of present residence, the places of origin of the in-migrants to an area, the places of destination of out-migrants from an area, and the amount of net migration between any two areas can be derived. The tabulations required and the methods employed in this approach are identical with those described in connexion with place-of-birth data, except that the place of last residence rather than the place of birth is the point of reference.

Advantages and limitations

These data, like those based on birth-place, suffer from the absence of a definite time reference. Persons who migrated fifty years ago or earlier and persons who moved only a few days ago will be grouped together as migrants. Nevertheless, a very important advantage of the place-of-last-residence approach over the place-of-birth approach is that the former reflects direct movement between places, while the latter ignores intervening moves between departure from the first residence and arrival at the last residence.

As to accuracy, there has been little opportunity as yet to assemble data concerning the validity of responses to the question on place of last residence. It is not known whether the place of birth is more likely to be retained in memory than the place of last residence, but this may be true for people who have moved many times. It is therefore possible that not much improvement will occur in the correctness of reporting if the inquiry on birth-place is replaced by one on place of last residence.

Cross-classification by duration of residence

The question on place of last residence provides much more useful information, as does the question on place of birth, when it is combined with a question on duration of residence, for then migration cohorts and migration streams can be identified and period migration can be studied. The methods appropriate for analysing these combined data are similar to those described above for use with combined data on place of birth and duration of residence.

If information is obtained on both place of birth and place of last residence, as well as on duration of residence of migrants, not only can the approach be varied, as appropriate to particular studies, but a cross-classification of place of birth by place of last residence can provide

TABLE 17. MIGRANTS, BY TYPE OF MOVE, TYPE OF ORIGIN AND TIME OF MIGRATION, YUGOSLAVIA, 31 MARCH 1961

(*Thousands*)

	Total	*Time of migration*					
		1940 and before	*1941-1945*	*1946-1952*	*1953-1957*	*1958-1961*	*Unknown*
Type of move							
All types	6,884	1,747	536	1,430	1,438	1,556	178
Internal	6,731	1,687	518	1,406	1,428	1,549	144
Same commune	2,111	719	139	392	392	426	43
Other commune of same state	3,297	773	236	704	738	781	65
Other states	1,323	195	143	310	298	342	36
External	112	57	16	22	8	5	4
Unknown	41	3	1	2	2	3	30
Type of origin							
All types	6,884	1,747	536	1,430	1,438	1,556	178
Internal	6,712	1,681	518	1,402	1,425	1,544	142
Rural areas	4,854	1,352	357	998	986	1,067	94
Mixed areas	472	102	38	97	110	116	9
Urban areas	1,386	227	123	307	329	361	39
External	112	57	16	22	8	5	4
Unknown	60	9	2	6	6	7	31

SOURCE: Yugoslavia, Savezni Zavod Za Statistiku, *Statistički Godisnjak SFRJ, 1966*, Thirteenth year (Belgrade, July 1966), pp. 85, 103-105.

Note: The total population, in thousands, was 18,549, of which 11,665 were non-migrants.

methodologically useful information for testing the relative advantages of the two questions. Moreover, with such information it is possible to identify persons moving from areas other than the area of birth (secondary migrants) and persons returning to their areas of birth (return migrants). These measures would, of course, still be only partial because they would not take account of the additional moves made between intermediate places of residence.

Some countries have included a question on place of last residence either alone or in combination with duration of residence (notably a number of Latin American countries and Yugoslavia). In the 1961 census of Yugoslavia, a question on place of last residence was followed by another on the date of arrival at the place of enumeration. Some data drawn from that census are presented in table 17. The total number of migrants was about 6,884,000 (or 37 per cent of the total population of the country) of which 4,854,000 (71 per cent of the latter total) originated in rural areas; 472,000 (7 per cent of the total) in mixed settlements; 1,386,000 (20 per cent) in urban areas; and the balance from outside Yugoslavia. The average duration of residence among internal migrants was longest for migrants from rural areas and shortest for those from urban areas, with the migrants from mixed areas occupying an intermediate position. The external migrants were the group with the longest average duration, 50 per cent having migrated before 1941.

Cross-classification of data like these by specific origins and destinations can yield a wealth of information about the patterns and character of internal migration. Obviously, such detail for all durations would involve extensive tabulations. However, it should be noted that origin-destination tabulations for one migration interval (say "duration five years or less") would yield information closely comparable to that obtained from an inquiry on residence at a fixed past date. The duration-by-place-of-last-residence approach would yield a somewhat larger number of migrants for a given interval, because it would count circular migrants whereas the other approach would not. Stream data would also differ somewhat. For multiple movers, the first approach would designate place of last residence as place of origin; the second approach would designate place of residence at the beginning of the interval as place of origin.

Place of residence at a fixed prior date

Type of measure

Responses to a question concerning residence on a specified past date furnish information that is in many ways the most readily manipulable from the analyst's point of view. The migration interval is clear-cut; migration status is determined by a comparison of residence at two definite points in time; and a migrant is defined as a person whose residence at the census date differs from his residence at the specified prior date. This approach relates strictly to persons who were alive at the beginning of the interval and survived to the end of it. It gives a count of surviving migrants for a single fixed period of time. It understates the number of such migrants in that it does not count as migrants those who moved out of an area during the interval and returned to it before the end of the interval. Information on the migration of persons born during the interval can be obtained only if a supplementary question on birth-place is included.

It differs from the last-residence-by-duration approach just discussed in that (*a*) the place of origin is the place or residence at a fixed prior date rather than the place of residence just before the last move and (*b*) moves made before the specified date are disregarded entirely. Data from these two sources have certain elements in common, provided the migration interval can be equated to a duration interval. Thus, if the fixed prior date is five years before the census in the first instance; and if data are compiled for the duration "five years or less" in the second instance, the two measures are closely comparable except as indicated in (*a*) and (*b*) above.

In asking this question in censuses, an important consideration is the length of the interval. The time intervals most commonly selected are five years (e.g., the United States of America, 1960 and 1940; Greece, 1960) and one year (e.g., Japan, 1960; the United States of America, 1950). Both the total number of moves and the total number of movers are understated to degrees that vary according to the length of the interval. The migration interval should therefore be short enough to obtain a significantly large proportion of all moves. On the other hand, the interval should be long enough to permit the accumulation of enough relatively permanent movements so that the analyst can detect prevailing patterns of migration and can depend upon finding numerical frequencies that are reasonably free from chance variations. It is difficult to designate an optimum length of interval that would be suitable from all points of view; but the balance of a number of factors, such as effective recall, consonance with the census age distribution, attrition due to mortality, as well as those just mentioned, suggest that an interval of five years is perhaps the most serviceable.

Advantages and limitations

Because of its simplicity and specificity, this type of question is considered by some demographers to represent a more worthwhile and useful approach than a question on place of birth or place of last residence, especially if these last two are not accompanied by a question on duration of residence. On the other hand, it can be argued that people have difficulty in recalling where they were living at some arbitrary date in the past and that it is easier for them to recall place of last residence or duration of present residence.

Table 18 shows a cross-classification of migrants by place of enumeration and place of residence five years before the census for each geographic division in the United States of America. Column 1 of this table gives the in-migrant streams to the New England division by their divisions of origin (i.e., residence in 1955). About 440,000 migrants came to New England between 1955 and 1960, of whom 182,000 were living in the Middle Atlantic division in 1955, 58,000 in the East North Central division etc. Correspondingly, from row 1 of the

TABLE 18. INTERDIVISIONAL MIGRANTS IN THE UNITED STATES OF AMERICA FOR THE POPULATION 5 YEARS OLD AND OVER, BY DIVISION OF RESIDENCE IN 1955 AND DIVISION OF ENUMERATION IN 1960

Division of residence in 1955	*Division of enumeration in 1960*									*Out-migrants, 1955-1960*
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*	
NE	.	132,695	51,036	16,477	146,720	11,797	24,073	19,661	94,228	496,687
MA	181,608	.	219,405	41,532	508,737	43,777	62,873	60,850	224,546	1,343,328
ENC	57,641	173,765	.	223,873	434,153	188,044	135,765	150,950	410,097	1,774,288
WNC	20,315	40,881	236,867	.	97,884	35,626	145,205	189,862	332,146	1,098,786
SA	90,673	315,947	274,337	60,425	.	183,613	124,678	60,109	213,545	1,323,327
ESC	15,283	45,558	300,295	40,703	283,376	.	125,123	27,046	88,054	925,438
WSC	22,263	47,490	123,840	135,113	135,227	103,915	.	159,999	305,077	1,032,924
MT	13,325	24,618	55,600	78,629	45,311	16,226	103,717	.	322,936	660,362
PAC	38,946	71,614	120,134	110,999	139,281	39,283	150,902	239,511	.	910,670
In-migrants, 1955-60	440,054	852,568	1,381,514	707,751	1,790,689	622,281	872,336	907,988	1,990,629	9,565,810

SOURCE: United States Bureau of the Census, *United States Census of Population*, 1960, *Final Report*, Pc (2)-2D, *Lifetime and Recent Migration*, table 3, pp. 8-9.

table it is evident that out-migrants from New England numbered 497,000 persons for the same interval. About 133,000 of these went to the Middle Atlantic division, 51,000 to the East North Central division, etc. As a result of these movements, the New England division had a net loss of 57,000 migrants. At the same time, it had net gains, totalling 63,000, that resulted from migratory exchange with the Middle Atlantic, the East North Central, the West North Central and the East South Central divisions. It had net losses, totalling 119,000, as a result of exchanges with the South Atlantic, the West South Central, the Mountain and the Pacific divisions. The streams of in-migrants, out-migrants and the net balances of migration for the New England division are given more conveniently in the first three columns of table 20. Similar tables could be prepared for the other divisions in the same manner, using data from the appropriate rows and columns of table 18.

These data thus permit the calculation of all the conventional measures of migration: in-, out- and net migration. The period in which the migrations took place is well defined; the areas from which the migrants came or to which they went are known, it being understood that a migrant is defined as a person whose residence at the census date differs from his residence at some fixed prior date.

TABLE 19. DIVISION OF RESIDENCE IN 1960, BY DIVISION OF RESIDENCE IN 1955 AND DIVISION OF BIRTH FOR THE POPULATION 5 YEARS OLD AND OVER, UNITED STATES OF AMERICA, 1960

(*Hundreds: totals are sums of rounded numbers*)

Division of residence in 1955 and 1960	*Born in*									
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*	*Total*
NE, 1960	69,114	5,423	1,223	526	1,624	381	338	161	344	79,134
Division of residence in 1955:										
NE	68,103	3,894	712	306	1,071	216	165	88	175	74,730
MA	354	1,263	62	23	69	13	11	6	15	1,816
ENC	102	60	332	22	23	17	10	4	7	577
WNC	36	14	16	111	7	4	8	3	5	204
SA	272	109	41	19	398	28	19	5	17	908
ESC	28	10	7	4	12	85	4	1	2	153
WSC	58	18	13	10	12	7	95	4	6	223
MT	34	14	12	9	8	3	9	38	7	134
PAC	127	41	28	22	24	8	17	12	110	389
MA, 1960	4,863	224,692	4,949	1,606	13,827	2,156	1,136	430	816	254,475
Division of residence in 1955:										
NE	773	408	46	17	49	10	9	5	12	1,329
MA	3,900	221,992	3,739	1,198	11,758	1,708	810	304	539	245,948
ENC	45	519	899	62	97	62	26	9	19	1,738
WNC	9	101	40	205	16	9	13	6	9	408
SA	78	1,001	110	41	1,795	64	34	11	26	3,160
ESC	9	100	21	7	35	268	10	2	4	456
WSC	15	157	26	19	27	18	196	7	10	475
MT	7	107	18	16	11	4	11	63	9	246
PAC	27	307	50	41	39	13	27	23	188	715

TABLE 19 (*continued*)

Division of residence in 1955 and 1960	*Born in*									
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*	*Total*
ENC, 1960	1,527	9,836	230,738	10,206	9,760	20,021	5,076	966	1,270	289,400
Division of residence in 1955:										
NE	274	56	120	13	20	11	7	3	6	510
MA	54	1,531	373	48	97	43	24	8	16	2,194
ENC	1,111	7,905	227,380	8,372	7,898	17,145	4,151	732	888	275,582
WNC.....	13	50	613	1,446	33	79	84	25	26	2,369
SA	34	154	729	67	1,521	163	38	12	26	2,744
ESC	7	32	343	39	93	2,425	47	7	9	3,002
WSC	10	32	337	67	38	80	646	14	15	1,239
MT	6	22	257	55	19	23	25	133	17	557
PAC	18	54	586	99	41	52	54	32	267	1,203
WNC, 1960	375	1,247	7,465	109,122	966	2,230	4,559	1,260	1,082	128,306
Division of residence in 1955:										
NE	85	14	10	38	6	2	5	2	4	166
MA	12	255	30	77	18	7	8	3	5	415
ENC	15	52	1,348	604	37	81	63	17	22	2,239
WNC.....	226	820	5,813	106,749	612	1,788	3,540	932	748	121,228
SA	11	35	46	209	218	31	30	10	15	605
ESC	3	8	24	81	15	248	21	3	3	406
WSC	8	21	64	378	26	44	764	23	22	1,350
MT	5	15	52	379	12	12	54	232	26	787
PAC	10	27	78	607	22	17	74	38	237	1,110
SA, 1960	3,174	12,705	8,298	2,686	174,955	9,221	2,315	581	1,077	215,012
Division of residence in 1955:										
NE	1,021	158	50	23	151	23	15	6	20	1,467
MA	149	3,843	174	59	698	75	40	15	36	5,089
ENC	51	252	2,778	151	719	276	62	19	34	4,342
WNC.....	11	40	94	600	114	38	49	14	19	979
SA	1,835	8,108	3,842	1,597	171,912	6,671	1,305	305	528	197,103
ESC	23	71	100	38	582	1,920	67	12	21	2,834
WSC	23	70	80	62	314	109	644	22	29	1,353
MT	11	37	47	43	104	27	34	130	20	453
PAC	50	126	133	113	361	82	99	58	370	1,392
ESC, 1960	244	859	2,534	832	3,937	92,363	2,076	168	265	103,278
Division of residence in 1955:										
NE	70	8	4	3	7	22	3	1	1	119
MA	12	277	20	7	29	79	8	2	4	438
ENC	8	34	677	37	64	1,013	34	6	9	1,882
WNC.....	2	6	26	179	12	97	25	4	5	356
SA	21	61	68	29	878	710	47	8	14	1,836
ESC	117	435	1,665	510	2,863	89,814	1,438	85	125	97,052
WSC	6	18	34	31	46	413	473	9	10	1,040
MT	2	6	12	12	10	59	15	40	6	162
PAC	6	14	28	24	28	156	33	13	91	393
WSC, 1960	489	1,614	3,366	5,334	2,323	6,096	118,589	1,282	1,240	140,333
Division of residence in 1955:										
NE	142	19	10	7	10	6	40	3	5	242
MA	15	426	25	15	35	15	87	4	7	629
ENC	10	41	736	77	43	87	334	13	15	1,356
WNC.....	6	21	74	797	25	39	445	25	20	1,452
SA	27	76	67	47	593	107	289	15	25	1,246
ESC	6	20	41	30	57	805	275	8	10	1,252
WSC	263	947	2,284	4,160	1,485	4,952	115,847	896	776	131,610
MT	6	23	54	85	27	35	510	263	34	1,037
PAC	14	41	75	116	48	50	762	55	348	1,509

TABLE 19 (*concluded*)

Division of residence in 1955 and 1960	Born in									
	NE	*MA*	*ENC*	*WNC*	*SA*	*ESC*	*WSC*	*MT*	*PAC*	*Total*
MT, 1960	485	1,698	4,301	8,236	1,045	1,067	4,986	30,733	2,553	55,104
Division of residence in 1955:										
NE	132	19	9	7	6	4	4	13	5	199
MA	18	460	30	18	22	7	12	30	11	608
ENC	11	58	1,094	112	43	58	42	68	24	1,510
WNC.....	7	20	92	1,462	18	18	93	153	36	1,899
SA	15	55	53	41	279	36	34	64	24	601
ESC	3	8	17	14	16	164	21	21	7	271
WSC	10	28	64	110	35	47	1,118	150	38	1,600
MT	258	968	2,767	6,151	570	686	3,427	29,626	1,568	46,021
PAC	31	82	175	321	56	47	235	608	840	2,395
PAC, 1960	3,161	8,517	16,230	23,243	4,024	4,035	16,472	10,581	76,771	163,034
Division of residence in 1955:										
NE	662	82	39	28	31	11	18	12	58	941
MA	73	1,694	106	60	94	31	38	24	125	2,245
ENC	41	178	2,927	260	127	189	122	53	204	4,101
WNC.....	17	46	196	2,558	38	42	166	74	185	3,322
SA	90	218	196	137	965	114	115	52	248	2,135
ESC	8	23	48	32	52	598	50	13	56	880
WSC	23	64	119	171	72	93	2,187	77	246	3,052
MT	37	107	239	431	66	53	290	1,516	491	3,230
PAC	2,210	6,105	12,360	19,566	2,579	2,904	13,486	8,760	75,158	143,128

SOURCE: As for table 18.

Cross-classification with place of birth

If data on place of birth and place of residence x years ago are simultaneously available; that is, if place of birth is cross-classified by place of residence x years ago (as in table 19), the analytical potentialities of the data are greatly increased. In the first place, lifetime migration can be compared with fixed-period migration to give some insight into past changes in migration patterns. In table 20, the 1955-1960 streams to and from New England are compared with lifetime streams. The data for streams between New England and the East North Central indicate a net gain of 6,700 for New England between 1955 and 1960 but a net lifetime loss of 30,400. Such contrary patterns are not found in the other pairs of divisions, but the data reveal considerable shift in the relative importance of the various net streams. Thus, New England had a lifetime net gain of 56,000 from the Middle Atlantic and most of the gain occurred during 1955-1960. On the other hand, with respect to the Pacific division, New England had a lifetime net loss of 281,700, but the loss between 1955 and 1960 was only 55,200.

With these data, it is possible to classify 1955-1960 migrants into three meaningful categories:

(1) Primary migrants; that is, those who were living in their division of birth in 1955 and in another division in 1960;

TABLE 20. LIFETIME AND CURRENT MIGRATION STREAMS TO AND FROM NEW ENGLAND AND NET BALANCES FOR ALL PAIRS OF STREAMS

(*Thousands*)

Division of origin or of destination	Recent migration streams, 1955-1960			Lifetime migration streams, 1960		
	To New England	*From New England*	*Net balance*	*To New England*	*From New England*	*Net balance*
MA	181.6	132.9	+48.7	542.3	486.3	+56.0
ENC	57.7	51.0	+6.7	122.3	152.7	−30.4
WNC	20.4	16.6	+3.8	52.6	37.5	+15.1
SA	90.8	146.7	−55.9	162.4	317.4	−155.0
ESC	15.3	11.9	+3.4	38.1	24.4	+13.7
WSC	22.3	24.2	−1.9	33.8	48.9	−15.1
MT	13.4	19.9	−6.5	16.1	48.5	−32.4
PAC	38.9	94.1	−55.2	34.4	316.1	−281.7
TOTAL	440.4	497.3	−56.9	1,002.0	1,431.8	−429.8

SOURCE: Table 19. Totals and balances computed on rounded numbers.

(2) Secondary migrants; that is, those who were living outside the division of birth in 1955 and in a third division in 1960;

(3) Return migrants; that is, those who were living outside the division of birth in 1955 and had returned to it by 1960.

Table 21 gives the figures for these three categories of migrants for the United States (at the national level),

TABLE 21. INTERDIVISIONAL MIGRANTS 5 YEARS OLD AND OVER, BY CATEGORIES OF MIGRATION, UNITED STATES OF AMERICA, 1955-1960

(*Thousands*)

Total migrants	9,556
Primary	5,521
Secondary	1,996
Return	2,049

SOURCE: Hope T. Eldridge and Yun Kim, *Estimating Intercensal Migration from Birth-Residence Statistics*, Analytical and Technical Report, No. 7 (Population Studies Center, University of Pennsylvania, Philadelphia, December 1967), appendix tables 3, 5 and 7.

and table 22 gives such classification of in-migrants and out-migrants for the New England division. The classification of migrants by these types, and an analysis of their differentiating characteristics are important steps in explaining many features of migration in a country. Examples of the analytical uses of these categories can be found in two articles by Hope T. Eldridge.[5]

TABLES 22. IN-MIGRANTS AND OUT-MIGRANTS 5 YEARS OLD AND OVER, BY CATEGORIES OF MIGRATION, NEW ENGLAND, 1955-1960

(*Thousands*)

Types of migration	*In-migrants*	*Out-migrants*
Total	440	497
Primary	243	316
Secondary	96	96
Return	101	85

SOURCE: As for table 21.

SUMMARY APPRAISAL OF THE SEVERAL APPROACHES

In assessing the advantages and disadvantages of alternative approaches, there are two basic considerations: (*a*) the adequacy of the data for migration analysis, and (*b*) the accuracy of the responses. Both these aspects have been touched upon already, but they are drawn together here for an over-all appraisal.

The adequacy of data must be evaluated on the basis of a set of standards acceptable from the point of view of migration analysis. A desirable minimum requirement is that the data be available for reasonably small areal units and that they provide statistics of total in-migration, total out-migration, and net migration for each unit. In addition, it should be possible to show for each areal unit how much of the in-migration came from each of the other areal units in the country and how much of the out-migration went to each of the other areal units. From these points of view, the only question which gives satisfactory data is "place of residence x years ago". Place-of-birth data have no definite time reference, though they do give information on migration streams. The same is true of the question on place of last residence. The question on duration has time reference, but it does not give any information on migration streams, unless the place of last residence is also obtained in the census and the results are cross-tabulated. Consequently, it cannot provide estimates of out-migration and net migration. From all these points of view and on the assumption that only one question on previous residence is to be asked, place of residence x years ago probably represents the most satisfactory approach.

There are, however, certain inadequacies also in these data. If the question on residence x years ago is not equated to the intercensal period, it will not be possible to estimate intercensal migration precisely and the data will not be of much use in determining the components of intercensal population growth; that is, migration and natural increase. Nor do these data overcome the problems of multiple moves during the x-year period prior to the census and circular moves, neither of which are counted in the migration category.

The accuracy of response is likely to vary from one question to another. If, as seems likely, it can be assumed that one of the most important causes of errors in response to these questions would derive from lapses of memory, then it would seem *a priori* that data on place of residence x years ago are likely to be less precise than those based on birth-place or place of last residence. To be sure, the place-of-birth question will yield less accurate results if there have been numerous or important changes in area boundaries during the lifetime of an appreciable proportion of the population. But if the address at some prior date is required, especially if this date is not in the very recent past, many respondents may not be able to remember accurately and easily the required information. A question such as "Where were you living five years ago?" may well tax the memory of persons who have moved more than once during this period. Where a population is highly mobile, the resulting inaccuracies of response may be significant.

In assessing the potential value of these different approaches, it should be kept in mind that the desire to confine the inquiry on migration status to a single question should not be allowed to outweigh considerations of quality and usefulness of the results. Of particular value would be two questions, one covering duration of residence and the other place of last residence. Such a combination can yield at least as much information as the question on residence at a fixed prior date.

[5] "Primary, secondary and return migration in the United States, 1955-60", *Demography* (Chicago), vol. II, 1965, pp. 444-455 and "Patterns of dominance in internal migration, United States, 1955-1960" (WPC/WP/183), paper presented to the United Nations Word Population Conference, 1965.

Chapter II

INDIRECT MEASURES OF NET INTERNAL MIGRATION

Regardless of whether direct questions on migration have been asked in the census, it is possible to estimate net intercensal migration on the basis of census counts of the population of component areas at two successive censuses along with some additional information that is normally available from the censuses or from other sources.

The population increment between any two dates for any given geographic area is the result of natural increase (births minus deaths) and net migratory movement. If the country is a closed one as far as population growth is concerned, i.e., if there has been virtually no migration between the given country and other countries, then the net migratory movement for a given geographic area must be the result of internal migration, i.e., in-migration minus out-migration. Where the population is not closed, problems arise in measuring the effects of internal migration. These are dealt with in the discussion of specific techniques.

Given the population of an area at two points in time and an estimate of natural increase during the interval, we can calculate the number that would be expected at the end of the interval in the absence of migration. The difference between the observed and expected numbers at the end of the interval, or the difference between the observed and the expected change, gives an estimate of net change due to migration.

Approaches to estimating the expected population or the expected change are of two types: (*a*) through vital statistics and (*b*) through the use of estimates of the probability of survival. Applications of these approaches are discussed below.

VITAL STATISTICS METHOD (VS)

Where reliable statistics of births and deaths to the residents of each component area of a country are available, it is possible to estimate the natural increase between two census dates or between any two dates for which the population is known. The estimate of net migration is then obtained by subtracting the natural increase from the total population change. This "balancing equation" can be put in the following simple form:

$$\text{Net } M = (p_{t+n}) - p_t - (B - D) \qquad (4)$$

where for any given area Net M = net migration, p_t is the population at the earlier census, p_{t+n} is the population at the later census, B is the number of births that occurred to residents of the area during the intercensal period, and D is the number of deaths that occurred to residents of the area during the same period. An application of the formula is given in table 23.

TABLE 23. ESTIMATES OF NET MIGRATION TO MADRAS CITY BY THE VITAL STATISTICS METHOD, 1951-1961

1. Population of Madras, 1951 = p_t =	1,416,056
2. Population of Madras, 1961 = p_{t+1} =	1,729,141
3. Increase in population, 1951-1961 = (2)−(1) =	313,085
4. Number of births in Madras, 1951-1961 = B =	653,190
5. Number of deaths in Madras, 1951-1961 = D =	371,286
6. Natural increase in Madras, 1951-1961 = (4)−(5) =	281,904
7. Net migration to Madras, 1951-1961 = (3)−(6) =	31,181

SOURCE: The population figures are taken from *Census of India*, vol. IX, *Madras*, part II-A. The figures of births and deaths are taken from *Vital Statistics of India, 1962*, issued by the Registrar General, India.

This method can, of course, be applied not only to the total population of the area but to particular segments of the population with characteristics which do not change (sex): or for which the change over time is determinable (age).

Thus, if two censuses are taken n years apart, the population aged x years at the earlier census and surviving to the later census will be $x+n$ years old. If the number of deaths in the intercensal period to persons who were x years of age at the time of the earlier census can be determined, then the net migration of persons in this age cohort can be obtained. The balancing equation can then be written in the form:

$$\text{Net } M(x) = p_{x+n,\,t+n} - p_{x,t} + D(x) \qquad (5)$$

where $M(x)$ is the migration among persons who were aged x at the earlier census, $p_{x+n,\,t+n}$ is the population aged $x+n$ years at the later census, $p_{x,\,t}$ is the population aged x at the earlier census, and $D(x)$ is deaths among persons who were aged x at the earlier census.

The problem is that vital statistics (data on births and deaths) are unlikely to be available in the kind of detail required for the cohort approach. Deaths are usually tabulated by age at death rather than by age at a fixed date, for example, the date of the last census. Acceptable estimates of cohort deaths can be made only if the death statistics are tabulated in considerable detail, both by age and by time of death for each geographic area. Few countries are likely to have their data in such detail. Even if they do, there will be problems of incomplete coverage and of misreporting of age in both the census and the death statistics.

From equation (4), it is readily seen that there are several ways in which errors can enter into the net migration estimate. Any uncompensated errors in the enumerated population will be reflected in the estimate. Similarly, errors in vital statistics will affect the accuracy of the estimate. However, it is important to note that some of the error will cancel out in the estimating equation.

Under-enumeration of the total population is probably universal. If the amounts of under-enumeration in the two censuses are equal, there will be no error from this source in the estimate of net migration because p_{t+n} and p_t have opposite signs in the equation. Even if the errors in p_{t+n} and p_t are not equal, the amount of error in Net M is likely to be less than that in either p_{t+n} or p_t. In most countries, relative under-enumeration probably decreases from one census to the next; but since the total population usually increases between censuses, the absolute amount of under-enumeration may increase, decrease or remain more or less the same.

In the developing countries, vital statistics are generally of poor quality, and their errors will be reflected in the migration estimate. But again, a part of the error in the count of births will be cancelled by the error in the count of deaths since B and D have opposite signs in the equation. If the relative undercount is greater for deaths than for births (as in the case in many developing countries) and if the number of deaths is smaller than the number of births (as in almost always the case), there will be a tendency for the error in births to approach the error in deaths. A last point to be noted is that even if the total change $(p_{t+n}-p_t)$ and the natural increase $(B-D)$ are in error, there is some possibility that the migration estimate will be reasonably accurate. The error in natural increase will tend to cancel with the error in total change if the net census error and the natural increase error are both positive or both negative.

The above discussion has assumed that international migration is either nil or negligible. Where this is not so, the estimate of net migration derived by equation (4) will measure the combined effect of both internal and external migration rather than of internal migration only. Thus, if there is appreciable net immigration into a country and if this net immigration tends to concentrate in a particular area, then the net migration for that area as derived from the balancing equation may be principally the result of net immigration; net internal migration may even be negative. One way of partially disentangling internal from external migration would be to use the balancing equation on the native-born population, provided, of course, the natives have not experienced external migration. This procedure would require that not only the census statistics but also the death statistics be available separately for the native and the foreign-born of each area. Since it is unlikely that the death statistics would be classified by nativity, an approximate method might assume that the death rates among natives and non-natives are the same. It would then be possible to start with the native-born population at the earlier census and to deduct from it that portion of the total deaths in the area which can be attributed to the native-born population only. The balancing equation would then include, in addition to these terms, births in the intercensal period and the native population at the time of the second census. This procedure will yield only partial estimates of net internal migration, however, for the internal migration of the foreign-born who were already in the country at the beginning of the interval will be excluded.

If equation (5) is to be used to estimate net migration by age, it should be kept in mind that under-enumeration is likely to vary systemically by age and that biases are thereby introduced into the estimates.

Survival Ratio methods

The second general approach to the estimation of net internal migration for the period between two censuses involves the use of survivorship probabilities. The basic information required is the number of persons classified by age and sex as enumerated in each area at two successive censuses and a set of survival ratios which can be applied to the population at the first census in order to derive an estimate of the number of persons expected to survive to the second census. The difference between the enumerated population at the second census and the expected population is the estimate of net migration. As with the VS method, this approach provides a good measure of net internal migration only when it is applied to a population for which external migration is negligible. The procedure may be expressed symbolically as:

$$\text{Net } M'(x) = p_{x+n,t+n} - S.p_{x,t} \qquad (6)$$

where $M'(x)$ is the net migration of survivors among persons aged x at the first census in a given area (they will be aged $x+n$ at the second census), $P_{x,t}$ is the population aged x in that area at the first census, $p_{x+n,t+n}$ is the population aged $x+n$ years in the same area at the second census separated from the first census by n years, and S is the survival ratio. It yields an estimate of net change due to the migration of persons who survived to the second census.

An alternative to estimating the expected number of persons at the second census by thus applying "forward survival ratios" to the numbers in the first census would be to do the reverse, i.e., to estimate the number of persons that would have been x years of age at the earlier census from the number who are enumerated as $x+n$ years old in the second census by applying "reverse survival ratios" (the reciprocals of forward survival ratios). The rationale here is that the number of persons x years old at the earlier census is equal to the number of persons at the second census who are n years older *plus* the deaths to this cohort. The resulting estimate of net migration thus includes deaths to the migrant cohorts and is equivalent to an assumption that all migration occurred at the beginning of the interval. Symbolically:

$$\text{Net } M''(x) = \frac{1}{S} \cdot p_{x+n,t+n} - p_{x,t} \qquad (7)$$

These two procedures always give different estimates of net migration; but if one of them is known, the other can be calculated. They are related by the equation:

$$\text{Net } M'' = \frac{1}{S} \cdot \text{Net } M' \qquad (8)$$

Since S is positive and usually less than unity, Net M'' always has the same sign as Net M' but is usually greater than Net M'.

The assumption about the timing of migration that is implicit in equation (7) is not realistic. A third procedure, the Average Survival Ratio method, yields an average of Net M' and Net M''. That is:

$$\text{Net } \overline{M} = \frac{(\text{Net } M' + \text{Net } M'')}{2} \tag{9}$$

This estimate, like Net M'', includes migrant deaths but on the assumption that deaths and migrations were evenly distributed over the decade or that all migration occurred at the middle of the interval.[1] It is seen that:

$$\text{Net } \overline{M} = \frac{1+S}{2S} \cdot \text{Net } M' \tag{10}$$

Life Table Survival Ratios (LTSR)

If a life table describing the average mortality conditions of the intercensal period is available for the particular area, survival ratios may be calculated from it and used to estimate net migration for the area. The procedure is evident from the formula given below and the illustrative example given in table 24. If the intercensal period is ten years and the population is classified by five-year age groups, forward survival ratios are given by the formula:

$$_{10}S_x = {}_5L_{x+10}/{}_5L_x \tag{11}$$

where $x = 0, 5, 10\ldots$, $_{10}S_x$ is the 10-year survival ratio from age group (x to $x+4$) to age group ($x+10$ to $x+14$) and $_5L_{x+10}$ and $_5L_x$ are the numbers of persons in the age groups $x+10$ to $x+14$ and x to $x+4$ respectively

TABLE 24. ILLUSTRATION OF PROCEDURES FOR ESTIMATING NET INTERCENSAL MIGRATION BY AGE ACCORDING TO THE FORWARD LIFE TABLE SURVIVAL RATIO METHOD, MALE POPULATION OF GREATER BOMBAY, 1941-1951

Census of 1941		*Ten-year life table survival ratio*	*Census of 1951*		*Expected survivors, 1951*	*Net migration 1941-1951*
Age (1)	*Population* (2)	(3)	*Age* (4)	*Population* (5)	(6) = (2) × (3)	(7) = (5) − (6)
0-4	77,135	.9087	10-14	132,870	70,093	+62,777
5-9	85,134	.9573	15-19	170,227	81,786	+88,441
10-14	79,185	.9471	20-24	263,971	74,996	+188,975
15-19	82,603	.9308	25-29	253,964	76,887	+177,077
20-24	126,247	.9223	30-34	195,373	116,438	+78,935
25-29	155,344	.9161	35-39	151,259	142,311	+8,948
30-34	138,843	.9047	40-44	118,383	125,611	−7,228
35-39	109,356	.8850	45-49	76,421	96,780	−20,359
40-44	81,626	.8548	50-54	65,897	69,774	−3,877
45-49	47,062	.8122	55-59	32,265	38,224	−5,959
50-54	36,908	.7535	60-64	22,248	27,810	−5,562
55-59	15,134	.6726	65-69	9,655	10,179	−524
60+	25,094	.3866	70+	10,100	9,701	+399
All ages	1,059,911	· Total 10+		1,502,633	940,590	+562,043

SOURCE: The age data from the 1941 and 1951 censuses of India have been adjusted for area changes. The survival ratios in column (3) were derived from the United Nations model life table corresponding to a life expectancy at birth of 45 years for males. See *Manual III: Methods for Population Projections by Sex and Age* (United Nations publication, Sales No.: 56.XIII.3).

in the stationary population of the life table. For the terminal age group (say 70+), the survival ratio is given by the formula:

$$_{10}S_{70+} = \frac{T_{80}}{T_{70}} \tag{12}$$

It is important to note that the life table used should measure the average mortality conditions of the intercensal period and should be reasonably applicable to the area for which migration estimates are required. If a life table is not available for the area, but the average mortality level of the period is approximately known, model life tables can be used to calculate the survival ratios.[2]

If an appropriate life table is available and if the census age data are free from error, the LTSR method should give fairly accurate estimates of net migration for persons who were still alive at the time of the second census. But usually the age data are defective, and these defects will be present in the migration estimates. Incompatibility between life table survival ratios and census age data will show itself in an irregular pattern of migration estimates by age and in the failure of the sum of net migration balances for all areal units to add to zero,

[1] For a more detailed discussion, see Jacob S. Siegel and C. Horace Hamilton, "Some considerations in the use of the residual method of estimating net migration", *Journal of the American Statistical Association* (Washington, D.C.), vol. 45, September 1952, pp. 475-500.

[2] See *Manual III: Methods for Population Projections by Sex and Age* (United Nations publication, Sales No.: 56.XIII.3), pp. 72-81, or those prepared by Ansley J. Coale and Paul Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, Princeton University Press, 1966).

which it must do in each age group. Life table survival ratios are smooth, and when a set of smooth survival ratios is applied to a distorted or irregular age distribution, the resulting expected populations and net migration estimates are also distorted; and the sum of net balances for gaining areas probably will not be equal to the sum of net balances for losing areas. The discrepancy may be eliminated by forcing the sum of the positive balances to equal the sum of the negative balances, increasing one and decreasing the other, and prorating the adjustment. The lack of smoothness in the migration estimates by age may be overcome by smoothing either the census age data before applying the estimating formula or the migration estimates themselves. The former procedure is preferable, but there is one precaution that should be taken. The graduation formula should preferably be limited to narrow ranges of age; otherwise, the graduation process may distort estimates of net migration.

If a life table covering the entire intercensal period is not available, estimates of intercensal survival ratios may be obtained by averaging the survival ratios from two life tables, one applicable to the beginning and the other to the end of the intercensal period.

Sometimes it happens that the censuses are not taken at five-year or ten-year intervals, while the age data are tabulated in the usual five-year age groups. In this case, there is need to reconstruct the age distribution of one of the censuses, usually the second census, and to calculate n-year survival ratios for five-year age groups where n is the length of the intercensal period. Calculation of n-year survival ratios from a complete life table is straightforward; but if only an abridged life table is available, some method of interpolation is required.[3] The same method may be used to reconstruct the census age data as well as the survival ratios.

[3] Sprague's multipliers are useful for this purpose. (See *Manual III: Methods for Population Projections by Sex and Age*, table 51, p. 68.)

Census Survival Ratios (CSR)

Where appropriate life tables are lacking, or where use of life table survival ratios is contra-indicated for other reasons, survival ratios can be computed from census age distributions and used instead of life table ratios to estimate the expected population. A census survival ratio is simply the ratio of the population aged $x+n$ at a given census to the population aged x at the census n years earlier. Computed for a nation as a whole, for a "closed" population, the ratio is then multiplied by the population aged x in each component area at the first census; and the expected survivors are subtracted from the corresponding population enumerated at the second census to yield estimates of net migration.

Symbolically, if $p_{i,x,t}$ refers to the population in the i^{th} state in a particular age group x at the first census (time t), $p_{i,x+n,t+n}$ the corresponding population n years older (i.e., $x+n$) at the next census, (time $t+n$) and $P_{x,t}$ and $P_{x+n,t+n}$ refer to the corresponding population of the country as a whole, the estimate of net migration is given by the formula:

$$\text{Net } M_i(x) = p_{i,x+n,t+n} - \frac{P_{x+n,t+n}}{P_{x,t}} \cdot p_{i,x,t} \qquad (13)$$

$$\text{Where } P_x = \sum_i p_{i,x} \text{ for all } x$$

Population data are usually compiled by five-year age groups and the intercensal interval is usually five or ten years. In this situation, no adjustment of the basic age

TABLE 25.A. MALE POPULATION OF KOREA, BY AGE AND HYPOTHETICAL REGIONS, 1930

Age	Hypothetical "regions" A	B	C	D	E	Total
0-4	387,341	345,629	242,593	364,292	321,385	1,661,240
5-9	319,916	280,509	193,967	298,044	269,189	1,361,625
10-14	266,844	238,587	166,124	257,720	224,333	1,153,608
15-19	233,194	219,419	157,457	231,313	216,816	1,058,199
20-24	183,169	181,465	131,730	193,900	170,309	860,573
25-29	145,458	151,066	103,642	159,111	132,877	692,154
30-34	158,072	146,182	104,668	159,828	137,976	706,726
35-39	138,058	128,433	89,348	139,821	123,021	618,681
40-44	127,043	112,876	79,232	117,056	112,034	548,241
45-49	100,143	98,080	71,073	101,291	90,344	460,921
50-54	83,534	79,085	59,826	83,579	73,589	379,603
55-59	68,876	63,371	46,299	65,290	61,758	305,594
60-64	51,951	46,773	37,359	50,041	49,014	235,138
65-69	41,245	33,501	26,025	36,029	34,753	171,553
70-74	25,136	22,482	18,990	25,079	22,832	114,519
75-79	10,873	10,033	8,364	11,080	9,841	50,191
80+	4,300	4,429	3,243	4,526	3,825	20,323
All ages.....	2,345,143	2,161,920	1,539,940	2,297,990	2,053,896	10,398,889

SOURCE: Computed by grouping the data for thirteen provinces into five hypothetical regions. Data for each of the thirteen provinces and for the total country are taken from: Yun Kim, "*The Population of Korea, 1910-1945*" (unpublished Ph.D. dissertation, Australian National University, 1966), tables A1.1 and A2.2, pp. 256-362.

TABLE 25.B. MALE POPULATION OF KOREA, BY AGE AND HYPOTHETICAL REGIONS, 1935

Age	Hypothetical "regions" A	B	C	D	E	Total
4-0	416,072	397,188	273,698	410,782	366,387	1,864,127
5-9	346,195	307,585	209,836	323,481	290,967	1,478,064
10-14	300,455	269,740	186,556	284,260	260,799	1,301,810
15-19	238,336	226,633	157,428	241,441	216,476	1,080,314
20-24	197,798	207,210	145,977	215,981	192,782	959,748
25-29	167,854	174,724	123,879	183,108	161,980	811,545
30-34	136,517	143,037	96,457	147,952	128,605	652,568
35-39	149,797	138,439	97,931	149,768	133,372	669,307
40-44	128,711	118,207	82,142	127,818	115,733	572,611
45-49	118,577	103,943	72,930	107,301	105,963	508,714
50-54	88,760	86,605	63,208	88,696	81,851	409,120
55-59	73,401	69,461	52,903	72,795	65,485	334,045
60-64	55,688	51,773	37,870	52,576	50,298	248,205
65-69	39,538	36,023	28,753	37,797	37,355	179,466
70-74	27,032	22,602	17,027	23,773	22,964	113,398
75-79	13,722	12,786	10,052	13,659	12,364	62,583
80+	5,712	5,407	3,844	5,536	4,881	25,380
All ages	2,504,165	2,371,363	1,660,491	2,486,734	2,248,262	11,271,005
Ages 5+	2,088,093	1,974,175	1,386,793	2,075,942	1,881,875	9,406,878

SOURCE: As for table 25.A.

data is required. But if the number of years in the intercensal interval is not an integral multiple of the number of years in the age group, adjustment procedures like those discussed in the preceding section will be required.

An illustration of the use of census survival ratios for the estimation of net migration by age is given in tables 25 to 28. Tables 25.A and 25.B give the age distribution of the male population in Korea in 1930 and 1935 by arbitrarily formed hypothetical groups of enumerated provincial data. In table 26, the five-year census survival ratios are shown for each age cohort. Table 27 shows the expected population in 1935 obtained by applying age-specific census survival ratios to the 1930 population (table 25.A) of the hypothetical regions. Finally, table 28 gives estimates of net migration obtained by subtracting the expected population from the population enumerated in 1935. These computational procedures for estimating net migration are essentially the same as those given in table 24 except that census survival ratios are used instead of life table survival ratios.

It should be noted that in table 28, the sum of net migration balances of all areal units is zero for each age

TABLE 26. MALE POPULATION OF KOREA, BY AGE, 1930 AND 1935, AND CENSUS SURVIVAL RATIO, 1930-1935

Age in 1930	Enumerated population, 1930	Age in 1935	Enumerated population, 1935	Census survival ratios, 1930-1935
0-4	1,661,240	5-9	1,478,064	0.88973538
5-9	1,361,625	10-14	1,301,810	0.95607087
10-14	1,153,608	15-19	1,080,314	0.93646542
15-19	1,058,199	20-24	959,748	0.90696362
20-24	860,573	25-29	811,545	0.94302866
25-29	692,154	30-34	652,568	0.94280753
30-34	706,726	35-39	669,307	0.94705303
35-39	618,681	40-44	572,611	0.92553513
40-44	548,241	45-49	508,714	0.92790215
45-49	460,921	50-54	409,120	0.88761415
50-54	379,603	55-59	334,045	0.87998514
55-59	305,594	60-64	248,205	0.81220508
60-64	235,138	65-69	179,466	0.76323691
65-69	171,553	70-74	113,398	0.66100855
70-74	114,519	75-79	62,583	0.54648574
75+	70,514	80+	25,380	0.35992852
All ages	10,398,889	Total 5+	9,406,878	

SOURCE: Computed from tables 25.A and 25.B.

Note: Census survival ratios are carried to eight decimal places only because of the correction procedure used for table 31.

TABLE 27. EXPECTED MALE POPULATION OF KOREA, BY AGE AND HYPOTHETICAL REGIONS, 1935

Age	*Hypothetical "regions"* A	B	C	D	E	Total
5-9	344,631	307,518	215,844	324,123	285,948	1,478,064
10-14	305,862	268,187	185,446	284,951	257,364	1,301,810
15-19	249,890	223,429	155,569	241,346	210,080	1,080,314
20-24	211,498	199,005	142,808	209,793	196,644	959,748
25-29	172,734	171,127	124,225	182,853	160,606	811,545
30-34	137,139	142,426	97,715	150,011	125,277	652,568
35-39	149,702	138,442	99,126	151,366	130,671	669,307
40-44	127,778	118,869	82,695	129,409	113,860	572,611
45-49	117,882	104,738	73,520	108,617	103,957	508,714
50-54	88,888	87,057	63,085	89,899	80,191	409,120
55-59	73,500	69,594	52,646	73,548	64,757	334,045
60-64	55,942	51,470	37,604	53,029	50,160	248,205
65-69	39,615	35,699	28,514	38,193	37,409	179,466
70-74	27,263	22,145	17,203	23,815	22,972	113,398
75-79	13,737	12,286	10,378	13,705	12,477	62,583
80+	5,461	5,205	4,178	5,617	4,919	25,380
TOTAL, ages 5+	2,121,558	1,957,197	1,390,556	2,080,275	1,857,292	9,406,878

SOURCE: Computed from tables 25.A and 26.

TABLE 28. NET INTERREGIONAL MIGRATION OF MALE POPULATION OF KOREA, BY AGE AND HYPOTHETICAL REGIONS, 1930-1935

Age	*Hypothetical "regions"* A	B	C	D	E
5-9	+1,564	+67	−6,008	−642	+5,019
10-14	−5,407	+1,553	+1,110	−691	+3,435
15-19	−11,554	+3,204	+1,859	+95	+6,396
20-24	−13,700	+8,205	+3,169	+6,188	−3,862
25-29	−4,880	+3,597	−346	+255	+1,374
30-34	−622	+611	−1,258	−2,059	+3,328
35-39	+95	−3	−1,195	−1,598	+2,701
40-44	+933	−662	−553	−1,591	+1,873
45-49	+695	−795	−590	−1,316	+2,006
50-54	−128	−452	+123	−1,203	+1,660
55-59	−99	−133	+257	−753	+728
60-64	−254	+303	+266	−453	+138
65-69	−113	+324	+239	−396	−54
70-74	−231	+457	−176	−42	−8
75-79	−15	+500	−326	−36	−113
80+	+251	+202	−334	−81	−38
TOTAL, ages 5+ ...	−33,465	+16,978	−3,763	−4,333	+24,583

SOURCE: Computed from tables 25.B and 27.

group. This is always true whatever the nature of error in the age data or survival ratios and is one of the features that distinguishes the Census Survival Ratio method from the Life Table Survival Ratio method.

The CSR method is such that it tends to correct for systematic errors in the age data and thus to compensate for some of the effects of such errors. The age group 0-4 years, for example, may be disproportionately undernumerated. It often happens that this cohort is better enumerated in a later census (say, ten years later when the cohort is aged 10-14 years) and the number is found to be larger than would be expected on the basis of any reasonable estimate of change due to mortality. (CSRs for this cohort sometimes have values greater than unity.) Such ratios do not give accurate measures of survivorship, but they do tend to incorporate net census error in the expected population and to that extent give a better estimate of net migration than would a life table ratio which "expects" no change except that due to mortality. These differentials in the completeness of enumeration of a cohort at successive censuses cause CSRs to fluctuate somewhat rather than to follow the smoothly descending age-pattern characteristic of LTSRs. This feature of the CSR method in one of its advantages over the LTSR method.

But the CSR method has certain disadvantages. These become apparent when one examines the basic assumptions that are implicit in it:

(1) That the national population is closed, i.e., entered only by births and left only by deaths, and therefore is not affected by external migration;

(2) That the specific mortality rates are the same for each areal unit as for the nation;

(3) That the ratio of the degree of "completeness" of enumeration in any age-sex group in each areal unit (i.e., the proportion that any age-sex group bears to the true population) to that of the nation is the same for the same cohort in both censuses.

The accuracy of estimates of net migration will be affected by the extent to which these assumptions are met. Their validity should therefore be examined, as indicated in the following paragraphs.

Assumption (1)

An effort should be made to determine whether the native population was reasonably closed for the period under consideration. Some countries have fairly good data on international migration. These are useful for assessing the amount of international migration and its effect on national and regional population growth. Alternatively, data on country of birth will be helpful. In any case, it is essential to make an assessment of the importance of international migration and to adjust for it to approximate closure before census survival ratios are computed.

Assumption (2)

The matter of geographical uniformity in mortality should also be examined. In countries where the general mortality level is high, there is likely to be considerable variation in the mortality of component areas. The assumption of mortality equality may therefore be seriously violated; and if migration estimates are not corrected for regional differences in mortality, errors will be introduced. The error in the net migration estimates is equal to $\Delta S_i \cdot p_{i,x,t}$ if the estimates are based on the Forward CSR method, where ΔS_i denotes the difference between the survival ratio for the nation and that of the particular areal unit. The error in the net migration rate obtained by the same method, and using the population at the first census as a base, is therefore equal to ΔS_i. An idea of the extent of this error for an intercensal period of ten years is illustrated by the examples in table 29. Thus, if the national expectation of life at birth is 40 years, and if the area expectation of life at birth is 45 years, the error in the net migration rate stemming from this difference is 1.2 per cent for the age group 10-14 years; 1.8 per cent for the age group 20-24 years; 2.4 per cent for the age group 30-34 years, and so on.

As will be shown in the next chapter, there is an advantage in using the population at the second census as a base to calculating the rate of net migration by the Forward CSR method, since the error due to differences in degree of enumeration is cancelled; and the migration rate is thereby freed from enumeration errors.[4] However, the error in the migration rate based on the Forward CSR method, uncorrected for regional differences in mortality and using the population at the second census as a base, is equal to:

$$\Delta S_i \cdot \frac{p_{i,x,t}}{p_{i,x+n,t+n}}$$

As this formula indicates, the error in the migration rate for a given area varies systematically with the magnitude and direction of net migration.

Absence of information on areal differences in mortality is a major difficulty in making such adjustments. Where there is some idea about existing differences, adjustments can be done. The technique of adjustment is illustrated in tables 30-34, where the Korean provincial population age data from tables 25.A and 25.B are combined into five purely hypothetical "regions", each "region" being assigned arbitrarily an expectation of life. The differences between the assigned regional values and the national level of 45 years[5] are as follows:

Regions	e_0^0	*Deviation from* $e_0^0 = 45$
A	40.0	−5.0
B	42.5	−2.5
C	45.0	0.0
D	47.5	+2.5
E	50.0	+5.0

Corrections factors for each "region" were then calculated by dividing the survival ratios of the appropriate model life tables[6] by those that correspond to a life expectancy of 45 years. The correction factors obtained in table 30 were then applied to the census survival ratios of table 26 to obtain the set of adjusted ratios given in table 31. Application of these adjusted ratios to the 1930 population of the "regions" yields expected numbers for 1935 as shown in table 32. The sum of the expected populations for all sub-areas given in table 32 would be equal to the total national population only if the national survival ratios were a weighted average of net survival ratios of sub-areas. This condition would not ordinarily be met, and hence it is necessary to force redistributions by prorating differences, age group by age group. Finally, estimates of net migration were derived by subtracting the expected population of table 33 from the enumerated population in table 25.B. Table 34 gives the estimates of net migration for regions, the algebraic sum of which yields zero age by age.

Assumption (3)

It will rarely be possible to make a direct determination of the validity of the third assumption concerning areal variations in the relative undercount or overcount of age cohorts. The built-in mechanism that corrects for enumeration error will be effective only to the degree that this assumption holds. Moreover, even if this

[4] K. C. Zachariah, "A note on the Census Survival Ratio method of estimating net migration", *Journal of the American Statistical Association* (Washington, D.C.), March 1962, pp. 175-183.

[5] The national e_0^0 of 45 for male is approximately equal to the level given by Yun Kim after investigation of available life tables for the 1930s in his Ph.D. dissertation cited above in table 25.A.

[6] See *Manual III: Methods of Population Projections by Sex and Age.*

TABLE 29. DIFFERENCE IN SURVIVAL RATIOS, BY AGE, NATIONAL EXPECTATION OF LIFE AT BIRTH, AND THE DIFFERENCE IN EXPECTATION OF LIFE AT BIRTH BETWEEN COMPONENT AREAS AND THE NATION

Age	*National* e_0^0 = 40				*National* e_0^0 = 50				*National* e_0^0 = 60.4				*National* e_0^0 = 65.8			
	Area deviations				*Area deviations*				*Area deviations*				*Area deviations*			
	−10	−5	+5	+10	−10	−5	+5	+10.4	−10.4	−5.4	+5.4	+9.8	−10.8	−5.4	+4.4	+8.1
10-14	+.0295	+.0138	−.0119	−.0221	+.0221	+.0102	−.0095	−.0177	+.0177	+.0082	−.0072	−.0141	+.0153	+.0072	−.0069	−.0135
20-24	+.0426	+.0198	−.0175	−.0324	+.0324	+.0149	−.0140	−.0262	+.0262	+.0122	−.0108	−.0206	+.0229	+.0108	−.0099	−.0181
30-34	+.0632	+.0282	−.0237	−.0428	+.0428	+.0191	−.0166	−.0305	+.0305	+.0139	−.0116	−.0215	+.0255	+.0116	−.0099	−.0187
50-54	+.0981	+.0453	−.0387	−.0702	+.0702	+.0315	−.0280	−.0512	+.0512	+.0232	−.0191	−.0360	+.0423	+.0191	−.0169	−.0409

SOURCE: Adapted from K. C. Zachariah, "A note on the Census Survival Ratio method of estimating net migration", *Journal of the American Statistical Association*, vol. 57, March, 1962, p. 182.

TABLE 30. CORRECTION FACTORS FOR MORTALITY ADJUSTMENTS OF CENSUS SURVIVAL RATIOS FOR THE MALE POPULATION OF KOREA, 1930-1935

Age	Deviations from $e_0^0 = 45$			
	−5.0	−2.5	+2.5	+5.0
0-4	0.9796	0.9904	1.0088	1.0170
5-9	0.9939	0.9971	1.0027	1.0050
10-14	0.9945	0.9974	1.0024	1.0045
15-19	0.9929	0.9966	1.0032	1.0062
20-24	0.9912	0.9957	1.0040	1.0076
25-29	0.9898	0.9951	1.0044	1.0084
30-34	0.9881	0.9942	1.0050	1.0097
35-39	0.9855	0.9931	1,0059	1.0113
40-44	0.9827	0.9920	1.0071	1.0134
45-49	0.9797	0.9904	1.0083	1.0157
50-54	0.9760	0.9886	1.0099	1.0189
55-59	0.9718	0.9867	1.0117	1.0224
60-64	0.9667	0.9841	1.0143	1.0274
65-69	0.9584	0.9798	1.0183	1.0353
70-74	0.9468	0.9739	1.0240	1.0463
75+	0.9360	0.9688	1.0285	1.0549

SOURCE: Computed from *Manual III: Methods for Population Projections by Sex and Age* (United Nations publication, Sales No.: 56.XIII.3), table V, pp. 80-81. Correction factors are the ratios of the survival ratios (as denoted by P_x in the Source). For example, column (1) = (P_x corresponding to $e_0^0 = 40/P_x$ corresponding to $e_0^0 = 45$) etc.

TABLE 31. CENSUS SURVIVAL RATIOS FOR THE MALE POPULATION OF KOREA ADJUSTED FOR MORTALITY DIFFERENCES, BY AGE AND HYPOTHETICAL REGIONS, 1930-1935

Age	Hypothetical "regions"				
	A	B	C	D	E
0-4 to 5-9	.87158478	.88119392	.88973538	.89756505	.90486088
5-9 to 10-14	.95023884	.95329826	.95607087	.95865226	.96085122
10-14 to 15-19	.93131486	.93403061	.93646542	.93871294	.94067951
15-19 to 20-24	.90052418	.90387994	.90696362	.90986590	.91258679
20-24 to 25-29	.93473001	.93897364	.94302866	.94680077	.95019568
25-29 to 30-34	.93319089	.93818777	.94280753	.94695588	.95072711
30-34 to 35-39	.93578310	.94156012	.94705303	.95178830	.95623944
35-39 to 40-44	.91211487	.91914894	.92553513	.93099579	.93599368
40-44 to 45-49	.91184944	.92047893	.92790215	.93449026	.94033604
45-49 to 50-54	.86959558	.87909305	.88761415	.89498135	.90154969
50-54 to 55-59	.85886550	.86995331	.87998514	.88869699	.89661686
55-59 to 60-64	.78930090	.80140275	.81220508	.82170788	.83039847
60-64 to 65-69	.73782112	.75110144	.76323691	.77415120	.78414960
65-69 to 70-74	.63351059	.64765618	.66100855	.67310501	.68434215
70-74 to 75-79	.51741270	.53222246	.54648574	.55960140	.57178803
75+ to 80+	.33689309	.34869875	.35992852	.37018648	.37968860

SOURCE: Computed from tables 26 and 30. See Note to table 26.

assumption does hold, the estimated amount of net migration in each age group will differ from the true amount by the same proportion that the enumerated population at the second census differs from the true population of the given age-sex group. If the age distribution is defective only because of mis-statement of age and not because of under-enumeration or over-enumeration, some of the error is eliminated by combining the estimates into broad age groups. If the age distribution is defective because of under-enumeration or over-enumeration of the general population, the total amount of net migration (all ages combined) will tend to be underestimated or overestimated, according to the direction of the enumeration error.

It should be noted here that if the estimate of net migration has the same relative error as the population at the second census (which can happen even if the third assumption is valid), a *rate* of migration based upon the population at the second census will be free of enumeration error.[7]

It should also be noted that the forward CSR method yields an estimate of net migration only for survivors of the initial age cohort. If the number of deaths to in-migrants differs from the number of deaths to out-migrants, the estimated net migration will differ from

[7] See K. C. Zachariah, op.cit., pp. 175-183.

TABLE 32. FIRST APPROXIMATION TO ESTIMATES OF THE EXPECTED MALE POPULATION OF KOREA, BY AGE AND HYPOTHETICAL REGIONS, 1935

Age	*Hypothetical "regions"* A	B	C	D	E	*Total*
5-9	337,600	304,567	215,844	326,976	290,809	1,475,796
10-14	303,996	267,410	185,446	285,721	258,651	1,301,224
15-19	248,515	222,848	155,569	241,926	211,025	1,079,883
20-24	209,997	198,328	142,808	210,463	197,863	959,459
25-29	171,213	170,391	124,226	183,585	161,827	811,242
30-34	135,740	141,729	97,714	150,671	126,329	652,183
35-39	147,921	137,639	99,126	152,122	131,938	668,746
40-44	125,925	118,049	82,694	130,173	115,147	571,988
45-49	115,844	103,899	73,519	109,388	105,349	507,999
50-54	87,084	86,221	63,086	90,645	81,450	408,486
55-59	71,736	68,801	52,646	74,276	65,981	333,440
60-64	54,364	50,786	37,604	53,650	51,284	247,688
65-69	38,330	35,131	28,514	38,739	38,435	179,149
70-74	26,129	21,697	17,203	24,251	23,783	113,063
75-79	13,006	11,965	10,378	14,033	13,055	62,437
80+	5,112	5,043	4,178	5,777	5,189	25,299
TOTAL, ages 5+ .	2,092,512	1,944,504	1,390,555	2,092,396	1,878,115	9,398,082

SOURCE: Tables 25.A and 31. Adjustment is made for mortality differences only.

TABLE 33. FINAL ESTIMATES OF THE EXPECTED MALE POPULATION OF KOREA, BY AGE AND HYPOTHETICAL REGIONS, 1935

Age	*Hypothetical "regions"* A	B	C	D	E	*Total*
5-9	338,208	305,115	215,844	327,565	291,332	1,478,064
10-14	304,156	267,550	185,446	285,871	258,787	1,301,810
15-19	248,631	222,952	155,569	242,039	211,123	1,080,314
20-24	210,071	198,398	142,808	210,538	197,933	959,748
25-29	171,289	170,466	124,226	183,666	161,898	811,545
30-34	135,834	141,827	97,714	150,776	126,417	652,568
35-39	148,067	137,774	99,126	152,272	132,068	669,307
40-44	126,085	118,199	82,694	130,339	115,294	572,611
45-49	116,035	104,070	73,519	109,568	105,522	508,714
50-54	87,244	86,379	63,086	90,811	81,600	409,120
55-59	71,891	68,949	52,646	74,436	66,123	334,045
60-64	54,498	50,911	37,604	53,782	51,410	248,205
65-69	38,411	35,205	28,514	38,820	38,516	179,466
70-74	26,220	21,773	17,203	24,336	23,866	113,398
75-79	13,042	11,999	10,378	14,072	13,092	62,583
80+	5,132	5,062	4,178	5,799	5,209	25,380
TOTAL, ages 5+ .	2,094,814	1,946,629	1,390,555	2,094,690	1,880,190	9,406,878

SOURCE: Tables 32 and 25.B.

Note: Differences between total columns in the two tables are prorated age group by age group for regions A, B, D and E to achieve equality between the observed total population and the expected total population. The data for region C are not prorated because it is assumed that the survival ratios for this region are the same as those of the nation.

the true amount. This follows from the fact that $(1-S)p_{i,t}$ yields the deaths among all those who were enumerated in the first census, including those who migrated out of the area. Moreover, the enumerated population $p_{i,t+n}$ does not include those who migrated to the area after the first census and who died there before the second census. If we denote by D_O the number of deaths among persons who moved out of the area during the intercensal interval and by D_I the number of deaths among those who migrated into the area during the same period, an expression that includes the migration of such persons is given by:

$$\text{Net } M_i = (p_{i,t+n} - Sp_{i,t}) + (D_I - D_O) \qquad (14)$$

If $D_I = D_O$, the error in the estimates from this source is zero. If the death rate is very low, as among those who are in the age group 10-14 or 15-19, D_I and D_O will both be small, and hence $(D_I - D_O)$ will be negligible. Correspondingly, if all migrations (both in and out) took place near the end of the intercensal period, the error will be

TABLE 34. NET INTERREGIONAL MIGRATION OF MALE POPULATION OF KOREA, BY AGE AND HYPOTHETICAL REGIONS, 1930-1935

Age	*Hypothetical "regions"*				
	A	*B*	*C*	*D*	*E*
5-9	7,987	2,470	−6,008	−4,084	−365
10-14	−3,701	2,190	1,110	−1,611	2,012
15-19	−10,295	3,681	1,859	−598	5,353
20-24	−12,273	8,812	3,169	5,443	−5,151
25-29	−3,435	4,258	−347	−558	82
30-34	683	1,210	−1,257	−2,824	2,188
35-39	1,730	665	−1,195	−2,504	1,304
40-44	2,626	8	−552	−2,521	439
45-49	2,542	−127	−589	−2,267	441
50-54	1,516	226	122	−2,115	251
55-59	1,510	512	257	−1,641	−638
60-64	1,190	862	266	−1,206	−1,112
65-69	1,127	818	239	−1,023	−1,161
70-74	812	829	−176	−563	−902
75-79	680	787	−326	−413	−728
80+	580	345	−334	−263	−328
TOTAL, all ages ...	−6,721	25,546	−3,762	−18,748	1,685

SOURCE: Tables 25.B and 33.

small. The error will be greatest when the mortality rates are high, when the amounts of in-migration and out-migration differ considerably and when most of the migration took place near the beginning of the intercensal period. Use of the average CSR method may be indicated when it is specifically desired to include an allowance for the death factor in the measure of net migration.

In summary, it appears that Census Survival Ratio methods furnish a simple and convenient means of estimating net migration where area-specific age data are tabulated in the census. It should, however, be borne in mind that the estimates will be valid only if the assumptions discussed above hold reasonably well for the country and for the period. The validity of all the assumptions (particularly about the absence of international migration and equality of areal mortality levels) should be carefully examined. If the facts are not consistent with these assumptions, every possible attempt should be made to adjust the migration estimates.

It may sometimes happen that indirect evidence shows that the mortality differences are large; but in the absence of any quantitative information about these differences, it is not feasible to make any adjustments. If, however, an independent estimate of the amount of net migration at all ages is obtained by the Vital Statistics method or the Place-of-Birth method, the results of the CSR method are useful for distributing the total amount of net migration by age.

Net migration of children

The Census Survival Ratio method cannot give estimates of net migration for persons born during the intercensal interval. This gap may be filled by various methods. If the birth registration is considered to be complete and numbers of births are available by areal units, these can be used to calculate survival ratios and for computing estimates of net migration. Thus, if data by quinquennial age groups are available from a census taken on 1 January 1960, after an intercensal interval of ten years, survival ratios for quinquennial age groups are given by:

$$S_1 = \frac{\text{National population 0-4 years old in 1960}}{\text{National births during 1955-1959}} \quad (15)$$

$$S_2 = \frac{\text{National population 5-9 years old in 1960}}{\text{National births during 1950-1954}} \quad (16)$$

An estimate of net migration for persons 0-4 years old in 1960 in the $_i{}^{th}$ area is given by:

$$\text{Net } {}_5M_{0,i} = {}_5p_{0,i} - S_1 \cdot B_i \text{ (1955-1959)} \quad (17)$$

and that for persons aged 5-9 years is given by:

$$\text{Net } {}_5M_{5,i} = {}_5p_{5,i} - S_2 \cdot B_i \text{ (1950-1954)} \quad (18)$$

These estimates, like those for the older cohorts, have the property that their total for all areas will automatically be zero.

If reliable birth statistics are not available, the following approximate method, which uses area-specific child-woman ratios, derived from the second census, may be applied.[8] If the ratios of children aged 0-4 to women aged 15-44 and of children aged 5-9 to women aged 20-49 are denoted by CWR_0 and CWR_5 respectively, then estimates of net migration for the age groups 0-4 (denoted by Net $_5M_{0,i}$) and 5-9 (denoted by Net $_5M_{5,i}$) are given by:

$$\text{Net } {}_5M_{0,i} = \tfrac{1}{4}\,\text{CWR}_0\ \text{Net } {}_{30}M^{(f)}_{15,i} \quad (19)$$

$$\text{Net } {}_5M_{5,i} = \tfrac{3}{4}\,\text{CWR}_5\ \text{Net } {}_{30}M^{(f)}_{20,i} \quad (20)$$

[8] This method was devised by Everett S. Lee in *Population Redistribution and Economic Growth, United States, 1870-1950; I. Methodological Considerations and Reference Tables* (Philadelphia, The American Philosophical Society, 1957), p. 65.

where Net ${}_{30}M^{(f)}_{15,i}$ and Net ${}_{30}M^{(f)}_{20,i}$ are the area estimates of net migration for females aged 15-44 and 20-49 respectively. If we assume that the flow of migration was even and fertility ratios constant, then one fourth of the younger and three fourths of the older children would have been born before their mothers migrated. The sum of these net migration estimates for all areas will not necessarily be zero. A zero balance can be obtained by raising the amounts of net loss and lowering the amounts of net gain, or *vice versa*, in proportion to the unadjusted estimates.

Special cases

The detail in which statistics are tabulated may vary from one census to the next. Thus, data by age and sex may not be available from both censuses for all the areas for which it is desired to derive estimates of net internal migration. If the population has been classified by age for the country as a whole at the two censuses and age detail for component areas is available only at the second census, it is possible to derive estimates of net migration, by areas, for ages n years and above combined. This can be done by applying age-specific reverse survival ratios to the age distributions of the second census, summing the expected numbers, and subtracting the observed population at the first census from the expected total. The estimates of total migration so obtained can be made comparable with those that would have resulted from the Forward Survival Ratio method if we multiply them by the over-all forward survival ratio:

$$ {}_nS_{0+} = \frac{P_{n+,t+n}}{P_{0+,t}} \qquad (21) $$

If the age classification is available only at the second census both for the country as a whole and for component areas, it is still possible to derive rough estimates of net migration by the use of an alternative short method. An over-all forward survival ratio for the country as a whole can be applied to the population in the first census for the areas for which the migration estimate is required, thus obtaining an estimate of the "expected" population of that area n years old and over at the second census and deriving an estimate of net migration by subtraction.[9] Symbolically:

$$ \text{Net } M_i(n+) = p_{i,n+,t+n} - \frac{P_{n+,t+n}}{P_{0+,t}} \cdot p_{i,0+,t} \qquad (22) $$

Comparison of indirect measures with other measures

The following types of sources for obtaining estimates of net migration for fixed intervals have been described:

(1) Place of residence at a fixed past date
(2) Duration of residence, by place of last residence
(3) Place of birth statistics (POB)
(4) Vital statistics (VS)
(5) Survival ratios (LTSR or CSR)

The first two yield "direct" measures of net migration. As indicated in previous discussion, the definition of migrants differs slightly as between the two. In (1) a migrant is a person whose place of residence at the time of enumeration differs from his place of residence at the beginning of the interval. In (2) a migrant is a person who has changed his place of residence at least once during the interval.

Sources (3), (4) and (5) yield "indirect" measures of net migration. In all three, the implied definition of a migrant is the same as in (1). Measures derived from (1) are therefore more compatible with the indirect measures than are those derived from (2).

Since the last three methods are designed to measure the same phenomenon, they should provide the same estimate for a given interval. In practice, however, the results obtained differ somewhat and there is need to look into the possible causes of discrepancy among them and to make an assessment of the relative efficiency of each.

The VS method is unique in the sense that it is the only method which measures the balance of all migrations made during the interval. A person who came into the area during the intercensal period and died before the end of the period would be counted in the measure of net migration. Similarly, a person who moved out during the intercensal period and died outside before the second census would be counted in the estimate of net migration. But, as shown earlier, there are sources of errors in this estimate which may be serious in a situation where the errors in the basic data are large. The major points to note in this connexion are:

(1) For the same relative error, the amounts of error in the population data are more important than those in the vital statistics;

(2) Accurate vital statistics in combination with defective population data are likely to give imprecise migration estimates.

It should also be noted that, under prevailing conditions, this method yields estimates only for all ages combined. Detail by age, an important consideration in migration analysis, is not ordinarily obtainable.

The Forward CSR method (the one that is generally preferred) measures net migration, by age, for persons alive at the end of the intercensal period. This measure does not take account of the migration of persons who died during that period. Only in the unlikely event that deaths among out-migrants equal deaths among in-migrants during the intercensal period does the Forward CSR method give net migration among persons alive at the beginning of the intercensal period.[10] Since the number of deaths is likely to be larger in the larger of the two components of net migration (in-migration and out-migration), CSR estimates obtained by the forward method will generally be smaller than those obtained by the VS method.

[9] For examples of the application, of short methods, see D. J. Bogue and K.C. Zachariah, "Urbanization and migration in India" in Roy Turner, ed., *India's Urban Future* (Berkeley, University of California Press, 1962), pp. 27-54.

[10] Although the average CSR method is designed to take account of migrant deaths, it involves assumptions about the distribution of migration and deaths that may not be met. With the VS method, this problem does not arise.

It is difficult to make a general statement, valid in all situations, regarding the relative accuracy of all-ages estimates from the two methods. Estimates from the CSR method have certain theoretical advantages. For a country with a closed population, with a low over-all mortality level, with negligible regional variation in mortality conditions and reasonably good age data, this method is probably preferable to the VS method, if for no other reason than that it yields information by age.[11] On the other hand, if the regional variation in mortality conditions is great and if the age data are highly deficient, the theoretical advantages of the method will not stand up against the errors due to mis-statement of age, under-enumeration or over-enumeration, and most important of all, the error arising from mortality differences among geographic areas. But under these conditions, the vital statistics are also generally poor and the CSR method may be the only one open to the research worker. If no independent estimates are available, one should at least examine the internal consistency of the estimates, particularly the smoothness of the age curve of migration rates, and attempt to evaluate the influence of regional differences in mortality levels.

As between the CSR method and the LTSR method, the former is generally preferable. The reasons have already been stated. However, the situation can arise in which the LTSR method is preferable. For example, if migration estimates are required for only one or two small areas in a country (e.g., one city) and the mortality level is known to be different from that of the country as a whole or if the national population is not sufficiently closed and no satisfactory adjustment can be made for international migration, the LTSR method may be indicated. If a life table is available for the area, it should be used; otherwise one can utilize model life tables. If the age data are defective, it is desirable to smooth them before the life table survival ratios are applied. The range of the smoothing formula should be relatively small, covering not more than 10 years of age at a time (if single-year-age data are available) or not more than three five-year age groups (if only five-year age groups are available).[12]

Not much is known about the validity of responses to the question on birth-place. It seems likely that in a country where the census data and vital statistics are reasonably good and where the assumptions about international migration and mortality differences are satisfactorily met, net migration estimates by the VS method or the CSR method are more accurate than estimates by the POB method (procedure 1). But in some situations, the latter method is definitely to be preferred. Since the VS and the CSR methods have already been compared, we limit the present comparison to the CSR and POB methods. Estimates by these two methods may be written as follows:

$$\text{CSR Method: Net } M'_{CSR} = p_{t+n} - S \cdot p_t \qquad (23)$$

$$\text{POB Method: Net } M'_{POB} = (I_{t+n} - O_{t+n}) - S(I_t - O_t) \qquad (24)$$

It can easily be shown that if the census figures are accurate and if the survival ratio is correctly estimated, Net M'_{CSR} and Net M'_{POB} will be identical. If, however, the above conditions are not met, there will be appreciable differences between the two estimates. For any areal unit, p_t and p_{t+n} will be much larger than $(I_{t+n} - O_{t+n})$ and $(I_t - O_t)$, and Net M'_{CSR} will be the difference between much larger numbers than will Net M'_{POB}. It follows that, for a given percentage error in the survival ratio, the amount of error in Net M'_{CSR} is likely to be much larger than that in Net M'_{POB}. Where regional mortality differences are large and age data are seriously defective, there is additional reason to expect the POB method to give more valid estimates of net migration. This is likely to be true even if the birth-place data are not tabulated by age at all and if only approximate survival ratios are applied to lifetime in-migrants and lifetime out-migrants. If the birth-place data are available also by age for each lifetime stream, the possibility of eliminating the error due to mortality differences is an important consideration operating in favour of the POB method (procedure 3).

There are, however, other considerations which favour the CSR method. In the first place, the survivorship of the populations involved in equation (23) differs from that in equation (24) and unless the birth-place data are available by age, the S in the former is likely to be more accurate than the S in the latter. Secondly, the percentage errors (particularly errors due to under-reporting) in I and O are likely to be greater than those in p_t and p_{t+n} and there is, therefore, a tendency for birth-place data to underestimate migration. These considerations do not invalidate the main points made above, but more information about the validity of the responses on birth-place is necessary before a definitive judgement about the relative accuracy of the POB method can be made for countries where the mortality level is relatively low and census and registration data are reasonably good. Where feasible, evaluation of the two approaches is aided by preparing estimates according to both methods and comparing the results.[13]

[11] For a comparison of results obtained by the VS and Forward CSR methods, see Hope T. Eldridge, *Net Intercensal Migration for States and Geographic Divisions of the United States, 1950-1960: Methodological and Substantive Aspects*, Analytical and Technical Report No. 5 (Population Studies Center, University of Pennsylvania, Philadelphia, 1965), chapter VII. For a comparison of the VS and Average CSR methods, see C. Horace Hamilton, "Effect of census errors on the measurement of net migration", *Demography* (Chicago), vol. 3, No. 2, 1966, pp. 393-415.

[12] A simple moving average formula with equal weights for ten-year coverage may be used for single-year-age data; and a 3-point formula such as [⅓, ⅓, ⅓] may be used for five-year age groups. For a detailed discussion of the reasons for and the assumptions involved in such smoothing procedures, see K. C. Zachariah, op. cit., pp. 149-151.

[13] Such comparisons for the United States of America, 1950-1960, are made in Eldridge and Kim, op. cit., chapter III.

Chapter III

MEASUREMENT OF RURAL-URBAN MIGRATION

Migration estimates are often needed for the rural and urban parts of a country. In the absence of direct inquiry that elicits information on type of previous residence, it is more difficult to make estimates for such areas than for administrative units such as states or provinces.

DIRECT MEASURES

In some censuses, special efforts are made to estimate rural-urban migration with the help of the usual questions on migration. For example, responses to the question on place of birth may be utilized for classifying birth-places as rural or urban. In the 1961 census of India, birth-places were classified on the basis of the status of the area of birth at the time of the census. The results are summarized in table 35, where it is shown that in India lifetime rural-urban migration was 19.7 million, urban-rural migration was 4.8 million and net lifetime migration to urban areas was 15 million. These data have, of course, all the usual characteristics of birth-place data, being non-specific as to time of movement and as to place of last residence. Nevertheless, they give a general picture of the net effect of internal migration over the lifetime of the surviving population, albeit in terms of the urban-rural character of the areas at the time of the census.

If the census data can be classified by duration of residence, they will provide a basis for studying the differential characteristics of rural-urban migrants for specific periods of time. In the 1961 census of India, rural-urban migrants for the twelve-month period prior to the census numbered 2.4 million or 12 per cent of lifetime migrants to such areas.

The data on place of residence x years ago can distinguish rural from urban residence at the initial date, and may be tabulated separately for urban and rural areas of residence at the census date, thus providing information on migration streams between rural and urban areas. The 1961 census of Greece furnishes data of this type for the period 1956-1961 (see table 36). From these data, measures of both gross and net migration can be derived for each of the areas shown or for any combination of them. Data of this type are subject to response error where urban boundary changes have been frequent and a respondent may not know whether his previous residence was inside or outside a given urban place.

TABLE 35. LIFETIME MIGRANTS BY RURAL-URBAN CHARACTER OF PLACE OF BIRTH AND PLACE OF RESIDENCE, INDIA, 1961
(*Thousands*)

Place of birth	*Place of residence*		*Total*
	Rural	*Urban*	
Rural	99,100	19,680	118,780
Urban	4,815	10,819	15,634
TOTAL	103,915	30,499	134,414

SOURCE: India, Registrar General, *Advance Copy of Table D-II*, "Place of birth", p. 16.

TABLE 36. MIGRANTS, BY PLACE OF RESIDENCE IN 1955 AND 1961, GREECE
(*Thousands*)

Residence in 1955	*Residence in 1961*						
	Greater Athens	*Greater Salonika*	*Greater Patras*	*Other urban areas*	*Semi-urban areas*	*Rural areas*	*Total*
Greater Athens	—	3.0	0.9	15.0	9.2	12.3	40.5
Greater Salonika	5.6	—	0.2	4.6	2.0	3.3	15.7
Greater Patras	6.0	0.0	—	0.7	0.4	1.3	8.4
Other urban areas	61.2	12.9	0.8	16.2	11.0	18.8	120.9
Semi-urban areas	37.6	10.8	1.1	15.1	9.0	15.8	89.3
Rural areas	107.8	20.1	6.7	82.1	44.7	108.8	370.0
TOTAL	218.2	46.9	9.7	133.7	76.4	160.0	644.8

SOURCE: Greece, *Results of the Population and Housing Census of 19 March 1961, Sample Elaboration*, vol. V, *Internal Migration* (Athens, 1963), table 2, p. 40.

Because cities expand in space as well as in population and because migration has to be measured in relation to fixed areas, it is often difficult to isolate the contribution of migration to urban growth. Intercensal changes in territory classified as urban create special problems in using data from two censuses for estimating intercensal net migration between rural and urban areas. The change in the size of the urban population from one census to another consists of:

(*a*) Natural increase in areas classified as urban at the first census;

(*b*) Net migration to these areas;

(*c*) Addition at the second census of places newly defined as urban;

(*d*) Deletion at the second census of places newly removed from the urban category; and

(*e*) Additions and deletions of population due to intercensal changes of the boundaries of individual urban places.

The first step in estimating net migration to urban areas, therefore, is to adjust for a constant area; that is, to estimate U_t and U_{t+n} (the urban population in the first and second censuses, respectively) for identical areas. These areas are preferably the urban areas of the second census, but it may be necessary to use those of the first census. The choice will have to be based on the availability of data.

In the Soviet Union, boundaries of areas under an urban administration are adjusted from time to time, and often the administrative status of a locality, owing to its non-agricultural development, is changed from rural (*selsovet*) to urban (*gorsovet*). Local and regional estimates of urban and rural population, aside from registered births, deaths and migrations, take these changes also into account.[1] For the period 1959-1963, for instance, it was estimated that the urban population increased by 18.5 million, a growth which has resulted from a natural increase of 7.5 million, a net migration from rural to urban areas of 7.2 million, and a change of status from village to town involving 3.8 million; corresponding estimates have also been made for the periods 1927-1938 and 1939-1958.[2]

The VS method is particularly adapted for estimating intercensal net migration for individual urban areas, as the annual number of births and deaths are generally published for each urban area. It is, of course, essential for the purpose that the vital statistics be reported on the basis of place of residence rather than place of occurrence of the vital events. The estimating procedure is the same as that discussed for any other areal unit. It depends on the principle that net migration is the difference between the gross change in population and its natural increase.

If the numbers of births and deaths are not available for all of the urban areas, a fairly good estimate of net migration for the urban population as a whole can be made, provided that the urban areas for which vital statistics are missing are relatively unimportant numerically. In this case, birth and death rates may be calculated for the known portion of the urban population and these rates applied to the entire constant-area urban population. Then an estimate of natural increase and, hence, of net migration is obtained. Thus, if b and d are the birth and death rates of the partial urban population:

$$\text{Net } M_U = (U_{t+n} - U_t) - \frac{(U_{t+n} + U_t)}{2} \cdot (b - d) \qquad (25)$$

The CSR method is also applicable. In many censuses, the age tables are prepared separately for urban and rural areas. If such data are available for two censuses, the survival ratio technique may be used. The procedure is as follows:

(1) Obtain or estimate the urban populations U_t and U_{t+n} for a constant area;

(2) Obtain the age distribution of the urban populations U_t and U_{t+n}. If the age distribution applied to a changing area, distribute the control totals from (1) according to the age distribution given by the censuses;

(3) Calculate survival ratios and net migration as indicated in table 37.

Since the mortality conditions in urban areas may sometimes differ appreciably from those in rural areas, it may be advisable to adjust the estimates of net migration for mortality differences. However, rural-urban migration is usually fairly large, and the error due to mortality difference will probably be small relative to the indicated amount of net migration.

Estimates of net migration to urban areas may be calculated for parts of a country such as states or provinces or for individual cities by any of the methods described above.[3] It should be understood that residual methods do not provide estimates of net changes resulting only from migration within the state or province. Thus, net migration to the urban part of a state is the net balance resulting from migratory exchange between the given urban portion and the entire remainder of the country.

[1] The detailed procedures are described in USSR, Tsentralnoye Statisticheskoye Upravlenie, *Posobie po Statistike dlya Rayonnikh i Gorodskikh Inspektur Gosudarstvennoy Statistiki* (Moscow 1961), pp. 312-313.

[2] P. G. Podyachykh, "Population projections in which allowance is made for migration", *World Population Conferenceé 1965*, vol. III (United Nations publication, Sales No.: 66.XIII.7), meeting B.5.

[3] For a detailed illustration of the use of census data for estimating city-ward migration, see Ann R. Miller, *Net Intercensal Migration to Large Urban Areas of the United States, 1930-1940, 1940-1950, 1950-1960*, Analytical and Technical Report, No. 4 (Population Studies Center, University of Pennsylvania, Philadelphia, 1964), pp. 45-71.

TABLE 37. PROCEDURE FOR ESTIMATING NET RURAL-URBAN MIGRATION, 1951-1961, FOR THE MALE POPULATION OF INDIA, BY AGE, AS OF 1961

Age groups		*Urban male population*		*Total male population*		*Estimated net rural-urban migration, 1951-1961*
1951	*1961*	*1951* (1)	*1961* (2)	*1951* (3)	*1961* (4)	(5)
0-4	10-14	4,037	4,820	24,619	26,303	+507
5-9	15-19	3,463	3,908	23,269	18,618	+1,137
10-14	20-24	3,807	4,249	22,914	18,218	+1,222
15-24	25-34	6,604	7,237	31,769	34,557	+53
25-34	35-44	5,717	5,256	28,864	25,717	+162
35-44	45-54	4,122	3,403	22,763	18,887	−17
45-54	55-64	2,782	1,797	16,228	11,001	−89
55-64	65-74	1,455	692	9,360	4,633	−28
65+	75+	829	291	5,686	2,022	−4
All ages	10+	32,816	31,653	185,472	159,956	+2,943

SOURCE: Figures in columns (1) through (4) are taken from K. E. Vaidyanathan, "Population redistribution and economic change, India, 1951-1961", unpublished Ph. D. dissertation, University of Pennsylvania, Philadelphia, 1967, p. 24.

Note : Col. (5)=Col. (2)−[Col. (4)/Col. (3)]. Col. (1).

Chapter IV

RATES, RATIOS AND OTHER INDICES

In migration analysis, there are special problems associated with the construction of rates and other indices. The principal reason for this is that each move involves two areas—origin and destination. The discussion below indicates some guidelines for coping with these problems and gives some illustrations of measures that are useful for the study of migration.

Migration rates and ratios

In considering the various alternatives for rate or ratio computation, it should be understood that much depends upon the nature of the problem. Different problems may call for different kinds of rates. Available alternatives may result in trivial differences (for example, if the migration interval is short), in which case the population base that is the most convenient is the one to be preferred. But where differences are substantial, especially where the pattern of differences either over time or between population groups is affected, careful consideration should be given both to selecting the type of rate that is most suitable for the problem at hand, and to the interpretations that are made of the rates that are used.

In general, a rate expresses the number of events or the number of persons having a given characteristic as a proportion of the population exposed to risk during a specified time interval. A migration rate is, then, the number of migrants (or the number of migrations) related to the population that could have performed the migrations during the given migration interval. The equation is written in algebraic form, as follows:

$$m = \frac{M}{P} \cdot k \qquad (26)$$

where m = the rate of migration for the specified migration interval

M = the number of migrations or the number of persons migrating during the interval

P = the population exposed to the likelihood of migration during the interval

k = a constant, usually 100 or 1,000.

Both the selection of appropriate rate bases and the interpretation of the rates depend in part upon the nature of the available data (e.g., how a migrant is defined) and in part upon the object of the analysis. Thus, in the equation given above, if M refers to migrations, the rate gives a measure of the incidence of moves in P and it must be understood that, since one person may move more than once, some members of the population will appear more than once in the numerator. If, on the other hand, M refers to migrants, M/P becomes a probability rate and gives a measure of the proportion moving *at least once* during a given migration interval. If one had a distribution of migrants by number of migrations, he could calculate separate probabilities (*a*) of migrating once only, (*b*) of migrating more than once, (*c*) of migrating specific numbers of times and (*d*) for migrants, of migrating again after having migrated once. In each case:

$$M/P + N/P = 1$$

where M refers to persons who performed the specified moves, N to persons who did not, and P to persons who could have done so ($M+N = P$). For (*d*) above, P would represent all migrants, M would represent migrants who moved more than once, and N migrants who moved once only.

In most of the discussion to follow, it will be assumed that the data available are of the type obtained in population censuses and surveys; that is, refer to migrants as enumerated at the census or survey date and therefore exclude migrant deaths as well as allowing only one move per migrant.

Migration streams

For migration streams, the population at risk is the population in the area of origin. The equation may be written as:

$$m_{ij} = \frac{M_{ij}}{p_i} \cdot k \qquad (27)$$

where the first subscript refers to the area of origin and the second to the area of destination. This procedure expresses all streams as probabilities of moving from a given origin to a given destination. Such rates may also be said to measure the attraction that the area of destination exerts upon the population at origin. They are useful in various types of analysis and for projections.

The particular form and time reference of p_i that is appropriate depends upon the characteristics of the particular M_{ij}. Thus, for migration data based on residence at a fixed prior date, the exposed population is the population of i at that date who survived to the census date and the rate expresses the probability that persons living in i at the first date (time t) and surviving

to the second date (time $t+n$) will be living in j at the second date. The equation may be written as:

$$m_{ij} = \frac{M_{ij}}{p_{i,t+n} - M_{\cdot i} + M_{i\cdot}} \cdot k \qquad (28)$$

where $M_{\cdot i}$ refers to all in-migrants to i ($\Sigma_j M_{ji}$) and $M_{i\cdot}$ refers to all out-migrants from i ($\Sigma_j M_{ij}$). This procedure confines the measure to persons who were alive at the first date and survived to the second date. For some purposes, it may be considered desirable to base the rate upon the actual population at time t, including persons who died during the interval. In that case, the rate measures the probability that persons living in i at time t will *survive and be living in* j at time $t+n$.

For lifetime migration streams, equation (28) is equally appropriate. Here, M_{ij} refers to persons born in i and living in j, $M_{\cdot i}$ to lifetime in-migrants to i, and $M_{i\cdot}$ to lifetime out-migrants from i. The rate measures the probability that persons born in i and surviving will be living in j at time $t+n$.

For data on duration of present residence cross-classified by place of last residence, rates for specific migration intervals ending at the census date (e.g., durations of five years or less, ten years or less etc.) can be calculated by the same formula. For these, M_{ij} refers to persons whose last moves occurred within the specified interval, originating in i and terminating in j. The base population for this rate does not refer to a specific point in time; it is composed of persons who resided in i throughout the entire interval plus all persons whose last move (made after time t) originated in i, regardless of where they resided between time t and time of last move. This is a genuine probability measure which relates last moves made between time t and $t+n$ to the population at risk.

For some purposes, a measure that expresses the migrant stream as a ratio to the population at destination may be indicated. The ratio may be written as:

$$m_{ij} = \frac{M_{ij}}{p_{j,t+n}} \cdot k \qquad (29)$$

It expresses migrants as a proportion of the population of j at time $t+n$. It is not to be regarded as an "at-risk" rate unless we accept the notion that the population at destination is exposed to the risk of receiving in-migrants. This interpretation of the term diverges from its usual meaning, which implies that the exposed population must be capable of performing the acts or experiencing the events represented in the numerator of the rate, in short, is capable of being in the numerator. Non-migrant persons at destination are incapable of being in-migrants. We must therefore conclude that ratios based on the receiving population are not rates in the probability sense.[1] However they do give a measure of the *impact* of migration upon the receiving population and in this sense may be useful analytical tools. They also permit analysis of the composition of the population with respect to migration status. But in using them, it should be kept in mind that they constitute "a relative frequency statement, which must be handled with caution and whose range of permissible inferences is restricted".[2]

For net streams ($M_{ij} - M_{ji}$) and for gross interchange or turnover ($M_{ij} + M_{ji}$), a rate base that combines the populations of i and j is appropriate. This combination may be the sum or the average of the two populations, preferably the latter, since it will yield a rate level that is comparable with that of its stream components. The composition and time reference of the base population should be the same for both p_i and p_j:

$$m_{(ij-ji)} = \frac{M_{ij} - M_{ji}}{\cdot 5(p_{i,t+n} - M_{\cdot i} + M_{i\cdot}) + \cdot 5(p_{j,t+n} - M_{\cdot j} + M_{j\cdot})} \cdot k \qquad (30)$$

This rate expresses the net stream or net shift as a proportion of the population within which the shift occurred, or as a proportion of the average of their populations.

In-migration, out-migration, net migration

Principles analogous to those discussed above apply with respect to the calculation of rates of in-migration, out-migration and net migration for component areas. Here we consider each area in relation to all other areas combined rather than taking them in pairs. For area i, in-migration is the sum of all incoming streams ($M_{\cdot i} = \Sigma_j M_{ji}$); out-migration is the sum of all outgoing streams ($M_{i\cdot} = \Sigma_j M_{ij}$) and net migration is the difference between the two ($M_{\cdot i} - M_{i\cdot}$). A probability rate of out-migration would relate $M_{i\cdot}$ to the population of the area of origin (p_i). A probability rate of in-migration to i would relate $M_{\cdot i}$ to the population of the remainder of the country ($P - p_i$). These procedures will yield rates of in-migration with a general level that is very much lower than that of rates of out-migration, since the relative difference between the two population bases will be much greater than the relative difference between the two numerators. The two sets of rates would therefore not be directly comparable as to levels, but one could study the two rate distributions and obtain insights into differences between areas as revealed by them.

For rates of net migration, the logically consistent base is the sum of the populations of the two areas concerned, $p_i + (P - p_i)$, i.e., the entire population of the country. For a given migration interval, such rates will bear the same relationship to one another as do the amounts of net migration. They therefore do not have any analytical value for a single migration interval. They are, however, potentially useful for studying time trends for individual areas.

In determining the form and time reference of the population base that is appropriate, the same principles

[1] For a more extended discussion, see C. Horace Hamilton, "Practical and mathematical considerations in the formulation and selection of migration rates", *Demography* (Chicago), vol. 2, 1965, pp. 429-443. See also Ralph Thomlinson, "The determination of a base population for computing migration rates", *Milbank Memorial Fund Quarterly* (New York), vol. XL, 1962, pp. 356-366.

[2] William Haenszel, "Concept, measurement and data in migration analysis", *Demography* (Chicago), vol. 4, No. 1, 1967, p. 255.

as those developed for stream rates are applicable. Thus, rates of out-migration from i would have the same base as equation (28), that is, $(p_{i,t+n}-M_{.i}+M_{i.})$. For in-migration, the base would be the complement of the above: $P_{t+n}-(p_{i,t+n}-M_{.i}+M_{i.})$. The base for the rate of net migration would then be: P_{t+n}.

It should be noted again that it is also possible to take the view that deaths should not be excluded from the base even though they are excluded from the numerator. Thus, Shryock calculates "at-risk" rates of intra-area migration and out-migration based on $p_{i,t}$.[3] Such rates are measures of the probability of *migrating and surviving* to the end of the migration interval. It should also be noted that there may be problems connected with the estimation of $p_{i,t}$ if the migration data refer to a migration interval that does not coincide with the intercensal interval. This will always be the case with data of the duration-by-place-of-last-residence type, which, though susceptible of analysis in terms of migration intervals, do not have an exposed-to-risk population that can be referred to a definite initial date.

The above approach to rate computation for component areas is not the one most commonly used. Instead, it is customary to regard in-migration, out-migration and net migration as "attributes" of the given area and to base all three rates on some measure of that area's population. Such rates would take the following general forms:

$$\text{In-migration: } \frac{M_{.i}}{p_i}\,k \tag{31}$$

$$\text{Out-migration: } \frac{M_{i.}}{p_i}\,k \tag{32}$$

$$\text{Net migration: } \frac{M_{.i}-M_{i.}}{p_i}\,k \tag{33}$$

The particular measure of p_i that should be used is a matter of some disagreement. According to one approach, the first of these rates should be based on the population of i at time $t+n$ (that is, should include in-migrants and exclude out-migrants), that the second should be based on the survivors at time $t+n$ of the population residing in i at time t (that is, should include out-migrants and exclude in-migrants), and that the third should be based on an average of these two quantities.[4] These may be written as follows:

$$m_{.i} = \frac{M_{.i}}{p_{i,t+n}}\,k \tag{34}$$

$$m_{i.} = \frac{M_{i.}}{p_{i,t+n}-M_{.i}+M_{i.}}\,k \tag{35}$$

$$m_{(.i-i.)} = \frac{M_{.i}-M_{i.}}{p_{i,t+n}-.5(M_{.i}-M_{i.})}\,k \tag{36}$$

These procedures give the rate of in-migration the same base as in equation (29), out-migration, the same base as in equation (28), and net migration an average of the two.

Another approach emphasizes the convenience of using the same base for all three rates. In this approach, an average base seems desirable, inasmuch as it contains one half of net migration. This base is identical with that in equation (36) above. Such rates may be regarded as measures of the effects, or of the relative importance of migration with regard to the population of i. They can thus be manipulated in the same way as amounts. Still another approach bases the rates on the non-migrant population: $p_{i,t+n}-M_{.i}$. The resulting ratios give a measure of the impact of migration upon the non-migrant segment of the population.[5]

Indirect measures of net migration

The preceding discussion has assumed the availability of statistics on gross migration. But since most of the migration data currently available are estimates of net migration derived by indirect methods, it is important to examine the special problems that arise in the calculation of rates for data of those types. In this presentation, it is assumed that area rates of migration would not be based on the total population, except for special analysis of historical series, and that what is wanted is a consistent and logically defensible base for computing area-specific rates of net migration, some of which will be positive and some of which will be negative.

VS estimates

As indicated earlier, the Vital Statistics method yields estimates of the net balance of migration (which is the same, whether migrants or migrations are considered) and includes the net balance resulting from the migration of persons who died. An appropriate base for this rate is the average population, usually estimated as $.5(p_{i,t}+p_{i,t+n})$, an approximation to the population at the midpoint of the migration interval. This base contains half of migrants and their deaths, plus non-migrants and half of their deaths.

CSR estimates

Forward census survival ratios yield estimates of the net balance of surviving migrants and are directly comparable with the net balances obtained from census data on residence at a fixed prior date. An appropriate base for them is therefore the same as that given in equation (36), namely: $p_{i,t+n}-.5(M_{.i}-M_{i.})$.

It has been shown that when the relative error in net migration is the same as the relative error in $p_{i,t+n}$ that error will vanish if the rate is based on $p_{i,t+n}$. This holds true also for a population base in the above form, since the relative error in $p_{i,t+n}$ will be the same as that in $p_{i,t+n}-.5(M_{.i}-M_{i.})$.

Estimates of net migration derived by reverse survival ratios contain intercensal deaths to both the components,

[3] Henry S. Shryock, Jr., *Population Mobility Within the United States* (Community and Family Study Center, University of Chicago, 1964), chap. 6.

[4] See C. Horace Hamilton, op. cit., pp. 429-443.

[5] Ratios of this type have been used by Ann R. Miller in "The migration of employed persons to and from metropolitan areas of the United States", *Journal of the American Statistical Association* (Washington, D.C.), vol. 62, December 1967, pp. 1418-1432.

non-migrants and net migration. Net migration thus may be expressed in terms of forward estimates as $(M_{\cdot i}-M_{i\cdot})\,1/S$ where S is the survival ratio. The indicated base is then: $[p_{i,t+n}-.5(M_{\cdot i}-M_{i\cdot})]\,1/S$. It is at once apparent that:

$$\frac{M_{\cdot i}-M_{i\cdot}}{p_{i,t+n}-.5(M_{\cdot i}-M_{i\cdot})} = \frac{(M_{\cdot i}-M_{i\cdot})\frac{1}{S}}{[p_{i,t+n}-.5(M_{\cdot i}-M_{i\cdot})]\frac{1}{S}} \quad (37)$$

and that identical relative errors will still be cancelled.

Estimates of net migration derived by the average method may be expressed in terms of "forward" estimates, as follows:

$$(M_{\cdot i}-M_{i\cdot})\frac{1+S}{2S}$$

and the corresponding estimates, derived by the application of the forward and reverse methods is given by:

$$\frac{(M_{\cdot i}-M_{i\cdot})\frac{1+S}{2S}}{[p_{i,t+n}-.5(M_{\cdot i}-M_{i\cdot})]\frac{1+S}{2S}} \quad (38)$$

and again, identical relative errors will cancel.

Before concluding this chapter, it should be emphasized that although other forms of rate bases may be considered acceptable for rates of net migration from various points of view, the fundamental problem of finding a base is usable for computing both rates of net in-migration and rates of net out-migration seems to be most nearly solved by using a base that is not "weighted" in favour of either in-migration or out-migration, but that contains one half of each. The solution of basing rates on the non-migrant population, a solution that is perhaps the least biased in this respect, is not feasible with estimates derived by indirect methods because the magnitude of this segment of the population cannot be determined.

Specific rates

Because the propensity to migrate varies sharply with age and is likely to differ considerably by sex, it is desirable to calculate rates that are specific for these characteristics and, indeed, for other characteristics if the needed classifications are available. The principles and procedures to be followed in selecting suitable population bases are the same as those given above in general terms. The chief concern here is to maintain cohort identity between numerator and denominator. Thus, equation (28) may be rewritten to indicate age-specificity, as follows:

$$m_{ij}(x) = \frac{M_{ij}(x)}{p_{i,x+n,t+n}-[M_{\cdot i}(x)-M_{i\cdot}(x)]} \cdot k \quad (39)$$

where $M(x)$ refers to migrants who were x years of age at time t (aged $x+n$ at time $t+n$). The other symbols are as previously defined.

Problems of annualizing period rates

It is a common practice to express amounts or rates of change as annual averages when the period to which the data refer is more than one year. In general, this practice renders data for time periods of differing lengths reasonably comparable. It is not, however, an appropriate procedure for most types of migration data. Unless the migration measure is a count, or estimate, of all moves of the given type made during the given interval, an average obtained by dividing the amount or the rate for an interval longer than a year by the number of years in the interval will understate the actual annual amounts to a degree that tends to increase as the length of interval increases. The census approach to the measurement of migration identifies migrants on the basis of one past residence only, and allows only one move per migrant. As a result, the count of migrants for a long interval (for example, ten years) will be less than the sum of the numbers that would be obtained if the count were made at the end of each one-year interval that forms part of the longer period. In this respect, migration data differ from statistics of births and deaths in which events are additive and the sums of the numbers for individual years are equal to the numbers for the period as a whole. (Averaging migration data for a series of one-year migration intervals is, of course, not subject to the objections indicated.)

These observations apply to statistics of gross migration (migration streams, in-migrants, out-migrants, total migrants within an area or a country etc.). Measures of net migration may be averaged without danger of understatement provided the balance of migrant deaths is included in the estimate. This is true because, as indicated earlier, the balance of migrations equals the balance of migrants for any given migration interval.

But the calculation of annual averages in the attempt to render comparable the measures for intervals of differing lengths must be approached with caution, no matter what the nature of the migration data. Precautions are especially necessary in the comparison of age-specific rates of migration. Because the propensity to migrate differs strongly with age, the rate obtained for any age groups is closely linked to the exposure interval. If, for example, one wishes to compare rates of the age group 20-24 years (age at end of interval) for two migration intervals, one ten years in length and the other five years in length, he will not achieve comparability by dividing the first rate by 10 and the second rate by 5 (or by using some more elaborate technique) to arrive at an annual average. The reasons are that, in the first case, he is averaging the experience of a cohort that was moving from ages 10-14 to ages 20-24, while, in the second, he is averaging the experience of a cohort moving from 15-19 to 20-24 years. Rates between ages 10-14 and 15-19 are likely to be much lower than rates between 15-19 and 20-24. Before comparisons are undertaken, the ages should be adjusted to reflect the average age during the interval and perhaps some interpolative procedures will be called for in order to approximate identical age groups. With these manipulations, it should not be lost to sight that possibly doubtful assumptions are being made about the regularity of change in migration behaviour over the interval and that fine comparisons are probably not justifiable.

For migration intervals significantly longer than a decade, it is doubtful that "annualization" of migration data should be attempted at all.

INDEX OF REDISTRIBUTION

Net migration and natural increase or natural change are the components of population growth and redistribution. Their effects are not always synchronous nor are they mutually exclusive. The contribution of natural change to area growth is usually positive. The contribution of migration may be either positive or negative. Furthermore, natural change affects the contribution that migration makes to population change; migration, in turn, has an effect upon the contribution of natural change. In short, there is interaction between migration and natural change. To develop the complexities of this interaction by factoring population change would, however, take us beyond the scope of this Manual.[6] The present chapter is, therefore, limited to the contribution of internal migration to population redistribution.

Inasmuch as the algebraic sum of areal gains and losses through internal migration is zero, measures of redistribution due to migration (R_M) are obtained by summing net changes of like sign, which is the same as taking one half the sum of all changes without regard to sign. Thus:

$$R_M = \sum_{+}(M_{.i}-M_{i.}) = \frac{\sum_{i}|M_{.i}-M_{i.}|}{2} \qquad (40)$$

where $(M_{.i}-M_{i.})$ refers to the measure of net change due to migration and the symbol $\sum_{+}$ indicates the summation of those net changes having a positive sign. This number can be expressed as a rate of redistribution, or a rate of displacement due to migration, by relating it to the total population within which the displacement occurred. An appropriate base is the average population. The rate (r_M) may be written as:

$$r_M = \frac{R_M}{.5(P_t+P_{t+n})} \cdot k \qquad (41)$$

An illustration of the application of equations (40) and (41) is given in table 38. Appropriate modification of the above formulae will yield measures of redistribution due to natural increase and also total net redistribution.

The measure of redistribution is specific for the class of area to which the data apply, as interprovincial, interstate, intercounty etc. Different systems of areas yield different amounts and different rates. Smaller areas will yield indices at least as high as do larger areas, but generally higher. This characteristic of the measure means that international comparisons are hazardous.

Bachi has demonstrated that if all mobility is taken into account—movement within component areas as well as between them—the resultant measures of redistribution will be unaffected, or almost unaffected, by the class of geographical unit used. His techniques represent a centrographic approach to the measurement of redistribution. He makes use of measures of central tendency (the "mean centre" or "centre of gravity" of the population) and dispersion (the "standard distance" of the population from its centre). Briefly, the basic procedures are as follows:

(*a*) The location of the centres of the smallest areal units for which data are available is expressed in degree of latitude on the horizontal co-ordinate (X_i) and, in degrees of longitude, on a vertical co-ordinate (Y_i);

[6] See K. C. Zachariah, op. cit., pp. 191-196. Also, K. E. Vaidyanathan, op. cit., pp. 113-125.

TABLE 38. ILLUSTRATION OF COMPUTATION OF INDEX OF REDISTRIBUTION: NATIVES, UNITED STATES OF AMERICA, 1940-1950

Subregions	*Intercensal net migration (thousands)*	
North East		
N-1	−91	
N-2	+7	
N-3	−310	
N-4	+334	R_M = 3,948,00
South		
S-1	−322	Average population = 0.5 $(P_{1940}+P_{1950})$
S-2	−1,249	
S-3	−877	= 129,535,000
North Central		
C-1	+373	
C-2	+590	$r_M = \frac{3,948,000}{129,535,000}$ = 3.1 per cent
C-3	−453	
West		
W-1	−56	
W-2	+160	
W-3	+3,074	
Sum of net gains (or losses)	±3,948	

SOURCE: H. T. Eldridge and D. S. Thomas, *Population Redistribution and Economic Growth, United States, 1870-1950*, vol. III, *Demographic Analysis and Interrelations* (Philadelphia, American Philosophical Society, 1964), tables 1.33, p. 111, A1.12, p. 252.

(*b*) The centre of population ($\bar{X}$, $\bar{Y}$) is determined by the means of X and Y weighted by the population (p_i) of the areal units. Thus:

$$\bar{X} = \frac{\sum_i p_i X_i}{\sum_i p_i} \tag{42}$$

$$\bar{Y} = \frac{\sum_i p_i Y_i}{\sum_i p_i} \tag{43}$$

(*c*) The standard distance (d) is obtained as follows:

$$d = \sqrt{\frac{\sum_i p_i (X_i - \bar{X})^2}{\sum_i p_i} + \frac{\sum_i p_i (Y_i - \bar{Y})^2}{\sum_i p_i}} \tag{44}$$

These measures can be calculated for the migrant population before and after migration, or for migrants and non-migrants (or the general population) at various points in time. Comparison of the results yields information on the prevailing directions of migration and its effect upon population spread.[7]

Indices of migration differentials and selectivity

One of the advantages of census data on migration is that all characteristics required in the census for the general population of the country are available for migrant segments. It is, therefore, potentially possible to analyse such characteristics of the migrants as sex, age, marital status, educational attainment, occupation, industry, and in fact all personal and household characteristics that were covered in the census. These data open up the broad field of analysis of migration selectivity and differentials.

Migrants tend to be different from the parent population in a number of characteristics; that is, they are not a random sample. For example, there may be an unduly large proportion of young adults among migrants. Such differences between characteristics of migrants (at the time of out-migration) and of the population from which they originate are called migration selectivity or *origin differentials*. They arise from the fact that the rate of out-migration is not the same in all the population subgroups.

Even if migrants were not different from the parent population, they might still be different from the population which they enter. The differences between the characteristics of migrants and non-migrants at the destination are called *destination differentials*. They arise because of the fact that the rate of in-migration at the place of destination is not the same for all population subgroups.

Following are some procedures that are developed for the measurement of migration differentials.

[7] See Roberto Bachi, "Standard distance measures and related methods for spatial analysis", Regional Science Association, *Papers*, vol. X, *Zurich Congress*, 1962, pp. 83-132; also "Statistical analysis of geographical series", *Bulletin de l'Institut international de la statistique* (The Hague), vol. 36, No. 2, 1958, pp. 229-240 (reprinted in Brain J. L. Berry and Duane F. Marble, *Spatial Analysis* (Englewood Cliffs, N.J., Prentice-Hall, Inc., 1968), pp. 101-109).

Migration differentials may be measured in a number of ways, but all the methods are based on the frequency distributions of migrants and non-migrants at the place of destination with respect to the particular characteristic under investigation. The differences in the patterns of the two distributions measure the magnitude of the differentials. Two common procedures are: (1) in terms of differential proportions and (2) in terms of differential ratios (or rates).

The two methods cited yield different measures of differentials but identical indices.

Let:

$M_1, M_2, \ldots M_n$ represent the distribution of migrants at the place of destination with respect to some characteristic, and

$N_1, N_2, \ldots N_n$ represent the distribution of non-migrants in the same area with respect to the same characteristic.

A measure of migration differentials by the differential proportions method is given by:

$$\left(\frac{M_i}{M} - \frac{N_i}{N}\right)$$

where $M = \sum_i M_i$ and $N = \sum_i N_i$ $\Big\}$ $i(= 1, 2 \ldots n)$ denotes the category under investigation

An index of migration differentials by this method is obtained by dividing the differences in the proportions between migrants and non-migrants by the proportion for the non-migrants. Thus, we have:

$$IMD_i \text{ (procedure 1)} = \left[\left(\frac{M_i}{M} - \frac{N_i}{N}\right) \Big/ \frac{N_i}{N}\right] \cdot k \tag{45}$$

A measure of the differential by the ratio method is given by:

$$\left(\frac{M_i}{N_i} - \frac{M}{N}\right)$$

where M, N, M_i, and N_i have the same meaning as above.

An index of migration differentials by this method is given by:

$$IMD_i \text{ (procedure 2)} = \left[\left(\frac{M_i}{N_i} - \frac{M}{N}\right) \Big/ \frac{M}{N}\right] \cdot k \tag{46}$$

It can easily be shown that equations (45) and (46) are identical.

$$\left[\left(\frac{M_i}{M} - \frac{N_i}{N}\right) \Big/ \frac{N_i}{N}\right] \cdot k = [(M_i N - N_i M)/MN_i] \cdot k \tag{45}$$

$$\left[\left(\frac{M_i}{N_i} - \frac{M}{N}\right) \Big/ \frac{M}{N}\right] \cdot k = [(M_i N - N_i M)/MN_i] \cdot k \tag{46}$$

However, if we express the difference between the proportions of migrants and non-migrants as a ratio to the proportion for the total population (i.e., P_i/P)

instead of to the proportion for the non-migrants (as in equation (45)), the resulting index is given by:

$$IMD_i \text{ (procedure 3)} = \left[\left(\frac{M_i}{M} - \frac{N_i}{N}\right)\Big/\frac{P_i}{P}\right] \cdot k \quad (47)$$

where P_i is the total population in category i and $P = \sum_i P_i$.

An example illustrating the computational procedures for the measurement of destination differentials with respect to industrial affiliation of male migrant workers in Greater Bombay is given in table 39. The proportions of migrant male workers in each industry category in column (5) are compared with those of non-migrants in column (6) to derive measure of migration differentials in column (8). In calculating the indices of migration differentials, the denominators may be taken as proportions of non-migrant male workers in each industry category (procedure 1), which yield indices given in column (9). On the other hand, we may take as denominators the proportions of total male workers in Bombay in each industry category (procedure 3), which yield the indices shown in column (12). The latter procedure is preferable when the non-migrants form a small proportion of the total population, as they do for Greater Bombay.

The indices by the first two methods for each industry category, shown in columns (9) and (11), are identical.

TABLE 39. PROCEDURE FOR MEASURING DESTINATION DIFFERENTIALS: AN EXAMPLE WITH RESPECT TO INDUSTRY GROUPS, MALE WORKERS IN GREATER BOMBAY, 1961

Industry group (1)	Number (thousands) Migrants (2)	Non-migrants (3)	Total (4)	Percentage distribution Migrants (5)	Non-migrants (6)	Total (7)	Differential (5)-(6) (8)	Index (procedure 1) (8)/(6) (9)	Index Ratio (2)/(3) (10)	Index (procedure 2) (11)	Index (procedure 3) (8)/(7) (12)
Agriculture and mining	19.2	7.3	26.5	1.46	3.24	1.72	−1.78	−55	2.62	−55	−103
Manufacture of textiles	303.0	41.7	344.8	23.05	18.45	22.37	4.60	25	7.26	25	21
Manufacture of metals and chemicals	249.5	54.2	303.7	18.98	23.95	19.71	−4.97	−21	4.61	−21	−25
Construction	36.0	4.2	40.2	2.74	1.87	2.61	.87	46	8.51	46	33
Utilities	19.2	5.2	24.4	1.46	2.31	1.59	−.85	−37	3.67	−37	−53
Commerce	240.9	45.8	286.7	18.32	20.23	18.60	−1.91	−9	5.26	−9	−10
Transport	152.2	28.2	180.3	11.57	12.45	11.70	−.88	−7	5.40	−7	−8
Services	292.1	39.0	331.1	22.21	17.25	21.48	4.96	29	7.49	29	23
Activities not adequately described	2.6	0.6	3.2	.20	.26	.21	− .06	.	.	.	.
TOTAL	1,314.7	226.2	1,540.9	100	100	100			5.81		

SOURCE: Computed from data in K. C. Zachariah, op. cit., table 12.1, p. 241.

Note: Index (procedure 2) in column (11) is obtained as follows:

$$\left(\frac{\text{Specific industry ratio}}{\text{All industry ratio}} - 1\right) \cdot 100$$

To give a numerical example: the index of migration differentials for the service industry by the differential proportions method, shown in column (9), is:

$$\left[\left(\frac{M_i}{M} - \frac{N_i}{N}\right)\Big/\frac{N_i}{N}\right] \cdot k$$

$$= [(22.21 - 17.25)/17.25] \cdot 100 = 29$$

and the index of migration differentials for the same industry group by the ratio (or rate) method shown in column (11) is:

$$\left[\left(\frac{M_i}{N_i} - \frac{M}{N}\right)\Big/\frac{M}{N}\right] \cdot k$$

$$= [(7.48 - 5.81)/5.81] \cdot 100 = 29$$

If, however, the proportion of total male workers in each industry is used as the denominator (as in procedure 3) the resulting index for the service industry will be:

$$\left[\left(\frac{M_i}{M} - \frac{N_i}{N}\right)\Big/\frac{P_i}{P}\right] \cdot k$$

$$= [(22.21 - 17.25)/21.48] \cdot 100 = 23$$

as shown in column (12).

In accordance with our discussion earlier in this chapter an example is in table 40 illustrating the measurement of age selectivity of migrants in Japan (defined as those who, a year ago, resided in a place different from the place of enumeration in the 1960 census), by comparing the age composition of migrants with that of the total population of the country in 1960.

The formulae for the indices of migration selectivity or origin differentials by the differential proportions method and differential ratio method are the same as those given in equation (45) and (46). However, in this context:

$M_1, M_2, \ldots M_n$ represent the distribution of total migrants in the country with respect to some characteristic.

$M = \sum_i M_i$

$N_1, N_2, \ldots N_n$ are replaced by $P_1, P_2, \ldots P_n$ to represent the distribution of total population of the country with respect to the same characteristic, and

$P = \sum_i P_i$

The computational procedure for deriving indices of

TABLE 40. PROCEDURE FOR MEASURING MIGRATION SELECTIVITY WITH RESPECT TO AGE, JAPAN, 1959-1960

Age in 1960 (1)	Interprefectural migrants, 1959-60		Total population, Japan, 1960		Procedure 1		Procedure 2	
	Number (2)	Percentage (3)	Number (4)	Percentage (5)	Difference (3)-(5) (6)	Index of selectivity (6)/(5).100 (7)	Ratio (2)/(4).100 (8)	Index[a] of selectivity (9)
1-14	316,900	12.3	26,434,600	28.8	−16.5	−57.3	1.1988	−57.3
15-19	684,900	26.5	9,257,500	10.1	+16.4	+162.4	7.3983	+162.4
20-24	588,400	22.8	8,286,400	9.0	+13.8	+153.3	7.1007	+153.3
25-29	394,800	15.3	8,220,700	9.0	+6.3	+70.0	4.8025	+70.0
30-39	315,600	12.2	13,529,800	14.7	−2.5	−17.0	2.3326	−17.0
40-49	137,700	5.3	9,839,100	10.7	−5.4	−50.5	1.3995	−50.5
50-59	78,900	3.1	7,861,600	8.6	−5.5	−64.0	1.0036	−64.0
60-69	41,400	1.6	5,105,600	5.6	−4.0	−71.4	0.8108	−71.4
70-79	19,200	0.7	2,545,600	2.8	−2.1	−75.0	0.7542	−75.0
80+	4,100	0.2	677,800	0.7	−0.5	−71.4	0.6048	−71.4
TOTAL 1+	2,581,900	100.0	91,758,700	100.0	.	.	2.8137	.

SOURCE: Japan, Bureau of Statistics, Office of the Prime Minister, *Population of Japan, 1960, Summary of results* (Tokyo, 1963), table 60, p. 542.

[a] Derived as follows: (computed before rounding)

$$\left(\frac{\text{age-specific ratio}}{\text{all-ages ratio}} - 1\right)100 \qquad \text{Example: } \left(\frac{1.1988}{2.8137} - 1\right)100 = -57.3$$

selectivity is shown in table 40. In columns (3) and (5) are given the percentage distributions of migrants and of the total population in Japan as of 1960, by age group. In columns (7) and (9), the indices of selectivity are shown by the two methods described above. These indices reflect the highly selective nature of migration in the prime age groups.

An important point, which is sometime overlooked in the analysis of migration differentials and selectivity, is that these phenomena vary in magnitude as well as in direction in population subgroups, and consequently the over-all measures of differentials (that is, for the population as a whole) is as much a function of differentials within population subgroups as of the distribution of the total population among subgroups. Following the practice in other branches of demography, we may call the over-all measure *the crude index of migration differentials* and that for population subgroups, *the specific indices of migration differentials*. The fact that the specific indices can be quite different from the crude index is evident from the data given in table 41 where measures of migration differentials with respect to occupational groups in Greater Bombay are given for the male workers as a whole (column 2) and for subgroups by age and

TABLE 41. DESTINATION DIFFERENTIALS, BY OCCUPATIONAL GROUPS, MALE WORKERS, BY EDUCATIONAL CATEGORIES AND AGE, GREATER BOMBAY, 1961

Occupational group	Educational category and age group														
	Total		Illiterate all ages	Literate without educational level			Primary or junior basic			Matriculation higher secondary			Degree or diploma		
	Standardized (1)	Crude (2)	(3)	15-34 (4)	35-59 (5)	60+ (6)	15-34 (7)	35-59 (8)	60+ (9)	15-34 (10)	35-59 (11)	60+ (12)	15-34 (13)	35-59 (14)	60+ (15)
1. Professional	0.0	−1.9	0.4	−0.2	−0.2	0.6	−1.1	0.4	2.4	0.3	0.2	−0.4	−0.1	−2.0	−1.9
2. Administrative	0.5	−1.1	0.5	−0.5	0.3	−1.1	0.0	0.4	2.0	3.0	−1.5	−0.5	2.6	3.1	1.1
3. Clerical	−19.8	−15.5	−55.7	−1.5	−2.6	−2.7	−2.0	−8.3	−7.8	−4.1	−2.0	−3.3	0.2	1.8	−1.3
4. Sales	3.1	1.6	7.8	−1.1	1.8	5.3	1.2	6.8	5.1	−1.3	−1.0	3.7	−3.0	−1.8	1.9
5. Farmers	−1.2	−1.1	0.8	−4.8	−3.1	−3.5	−1.1	−1.5	−1.5	—	—	—	—	—	—
6. Transport	−1.7	−1.1	−6.3	0.2	0.1	1.8	0.2	0.6	1.3	2.0	0.6	0.0	0.5	−0.6	0.7
7. Craftsmen and labourers	9.4	9.8	32.8	0.1	0.0	−6.8	−4.6	−2.2	−4.1	−1.1	2.6	0.1	−0.3	−0.3	−0.2
8. Service	9.7	9.3	19.7	7.8	3.7	6.4	7.4	3.8	2.6	1.2	1.1	0.4	0.1	−0.2	−0.3
9. Coefficient of dissimilarity	22.7	20.7	62.0	8.1	5.9	14.1	8.8	12.0	13.4	6.5	4.5	4.2	3.4	4.9	3.7
10. Percentage distribution of migrant workers	.	100	32.0	16.7	8.9	1.4	16.6	7.7	1.3	7.8	2.8	0.6	3.3	0.9	0.2

SOURCE: Computed from *Census of India, 1961, Greater Bombay*, tables D-IV and B-VI.

Note: The figures in the table show the difference between the percentage of workers in an occupation among migrants, and that among non-migrants. Positive values indicate that there were relatively more migrants in a specified occupational group. Negative figures indicate that there were relatively fewer migrants.

education (columns 3 to 15). These differentials were derived from a series of percentage distributions by occupational group for male migrant workers and for male non-migrant workers in each of the categories shown in the headings of the table. It should be noted that in the census tables illiterate workers are not cross-classified by age.

A summary measure of migration differentials may be obtained by the coefficient of dissimilarity (comparable to the index of redistribution discussed in the preceding section). It is obtained by computing the differences between the percentage distribution of migrants and non-migrants and summing those of like signs.

The coefficients of dissimilarity given in row 9 show that the magnitude of differentials varies considerably from one subgroup to another. In general, the differentials in occupational composition decrease as the level of education increases. Maximum differentials are observed among illiterates and minimum among highly educated. The direction of differentials is not the same in all population subgroups. In row 5, for example, the crude differential of -1.1 indicates that there are relatively fewer farmers among migrants than among non-migrants in Greater Bombay. But for illiterate workers, the reverse relation holds. In this group, there are relatively more farmers among migrants than among non-migrants. Similar tendencies of conflicting differentials in population subgroups may be observed for other occupational divisions. The most striking example of variation in the magnitude of the differentials is given by the clerical workers among whom the crude differential is -15.5 percentage points, but the specific occupational differential ranges from $+1.8$ to -55.7.

Following the practice in other branches of demography, we may calculate from the specific differentials, standardized indices. These indices for each occupational division, computed on the basis of the percentage distribution of male migrant workers (shown in row 10) are given in column 1. Thus, for transport workers the standardized differential (-1.7) is obtained by the algebraic summation of the product of row 6 (columns 3-15) and row 10, divided by 100. The coefficient of dissimilarity for the standardized differentials is 22.7, which may be taken as a more refined measure of over-all migration differentials.

Let us now examine how far census data are useful in analysing migration selectivity and differentials. Broadly speaking, all types of measure (birth-place, place of last residence, duration of residence and place of residence x years ago) provide materials for such study, but those which separate fixed-term migrants from lifetime or all-time migrants are the most satisfactory. Many of the characteristics of migrants tend to vary rather significantly by length of residence at destination. The sex or the race of a migrant does not change, of course, but his age increases by the same amount as the length of his residence. These are "fixed" characteristics which either do not change or, if they do, the amount and direction of change can be exactly calculated when the length of residence is known. This is not the case with social and economic characteristics such as marital status, education, economic status, industry, occupation etc. For these characteristics, census data are not satisfactory for the analysis of migration selectivity or origin differentials. It is the characteristics of migrants, as of the census date, that are recorded in the census. These characteristics will often be different from those existing at the time of out-migration from communities of origin. Information on characteristics before migration are a pressing need for refined analysis of the selectivity and concomitants of migration. In annex II, an example is given of how, under favourable survey conditions, selectivity can be measured for streams of migrants.

Some other indices

In migration analysis, as in other fields of demographic research, it is often desirable to calculate relative rates or relative indices of various kinds which reflect variations in the intensity of migration while holding constant certain disturbing factors or certain characteristics of the populations involved. In general, these procedures yield expected frequencies or rates, which represent the stated assumptions and which may be compared with observed frequencies or rates, or from which may be calculated standardized measures that permit comparisons between population groups without the interference of the disturbing factors. An obvious example is standardization for age, a procedure which permits comparisons of all-ages rates of migration while holding constant the contribution that variations in age structure make to variations in levels of mobility.

There are various possible bases of varying degrees of specificity and complexity that may be used for the derivation of expected numbers. A few of the more common procedures are presented here by way of illustration.

Index of preference

If migration propensities were uniform, the number of out-migrants from i would be $M(p_i/P)$. Similarly, the number of in-migrants to j would be $M(p_j/P)$, where M represents total migrants. The expected number of migrants from i to j will be $M \cdot (p_i/P \cdot p_j/P)$ and an index of preference or relative intensity (IPR) is:[8]

$$IPR = \frac{M_{ij}}{M\left(\frac{p_i}{P} \cdot \frac{p_j}{P}\right)} \cdot k \qquad (48)$$

This procedure takes M as given even though it is known that the magnitude of M is determined by varying propensities as observed in the population.

Index of velocity

Bogue, Shryock and Hoermann proposed a similar

[8] Several indices of "preference" are discussed in Henry S. Shryock, Jr., *Population Mobility Within the United States* (Community and Family Study Center, University of Chicago, 1964), pp. 267-269.

measure, which they called the "velocity" of migration streams, and which may be written as:[9]

$$IGV = \left(\frac{M_{ij}}{p_i \cdot p_j} \cdot P\right) \cdot k \qquad (49)$$

This gives the total rate of out-migration that i will have if:

$$\frac{M_{i.}}{M_{ij}} = \frac{P}{p_j}$$

When this rate is expressed as a ratio to the general rate M/P, the resulting index is identical with (48) above and gives a measure of the relative intensity of M_{ij}, or the relation of M_{ij} to the number that would be expected if migration were determined by population size at origin and destination.

Index of net velocity

Kono and Shio[10] have used a variant of the index of velocity, which is based on net streams between areal units. This is called the index of net migration velocity.

$$INV = (M_{ji} - M_{ij}) \frac{P}{p_i p_j} \qquad (50)$$

They have also used another measure taking distance into account:

$$\Delta_{ij} \cdot INV = (M_{ji} - M_{ij}) \frac{P}{p_i p_j} \Delta_{ij} \qquad (51)$$

Where Δ_{ij} stands for a measure of distance between areal units.

Index of effectiveness

An index used by both Thomas and Shryock,[11] which relates net migration to turnover, and is called by the latter an "effectiveness index", can be written as follows:

$$IE = \frac{|M_{.i} - M_{i.}|}{M_{.i} + M_{i.}} \cdot k \qquad (52)$$

Similar measures have been calculated for pairs of streams:

$$Ie = \frac{|M_{ij} - M_{ji}|}{M_{ij} + M_{ji}} \cdot k \qquad (53)$$

The "expected" value here is unity or k, if migration is completely effective; that is, if migration is all in one direction.

In using measures such as those described above, thought should be given to the degree to which they may defeat the purpose of understanding the causes and concomitants of migration by building into the measure assumptions that may themselves need testing, or that may obscure other relationships that need to be examined.

[9] See Donald J. Bogue, Henry S. Shryock, Jr. and Siegfried A. Hoermann, *Subregional Migration in the United States, 1935-1940*, vol. I, *Streams of Migration Between Subregions*, Scripps Foundation Studies in Population Distribution, No. 5, 1957, pp. 48-49. Also, see Donald J. Bogue, "Internal migration", in Philip M. Hauser and Otis Dudley Duncan (eds.), *The Study of Population* (Chicago, University of Chicago Press, 1959), pp. 503-504.

[10] Shigemi Kono and Mitsuru Shio, *Inter-Prefectural Migration in Japan, 1956 and 1961: Migration Stream Analysis* (New York, Asia Publishing House, 1965), p. 9.

[11] Dorothy S. Thomas, *Social and Economic Aspects of Swedish Population Movements, 1750-1933*, (New York, Macmillan Co., 1941), chap. 7; Henry S. Shryock, Jr., op. cit., chap. 9.

ANNEX I

USES OF CONTINUOUS POPULATION REGISTERS IN MIGRATION ANALYSIS

Introduction

Following a recommendation in 1956 of the Statistical Commission of the United Nations, "a study and evaluation of continuous population registers [was] undertaken with a view to an examination of their usefulness as a statistical mechanism both in statistically developed countries and in those less advanced". The latest report available of an inquiry organized to implement this recommendation is contained in a document issued in 1962. Here, "a true population register system [is] defined as a mechanism which will provide for the continuous recording of information about the population in such a manner that data on particular events that occur to each individual, as well as selected characteristics describing him, are maintained on a current basis".[a]

This system of population accounting requires, as its point of departure, a census of the inhabitants of a country by administrative units or localities at a given point in time. To each areal stock, so determined are added, continuously, all new inhabitants of the area; that is, births, immigrants and in-migrants and, correspondingly, subtractions or areal reallocations are made, as they occur, of deaths, emigrants and out-migrants. The usefulness of the registers for analyses of internal migration depends upon the way in which they are designed, the safeguards that are established to ensure completeness, the checks with subsequent censuses or other "stock" records, and, of course, the periodic assembling and compilation of statistical data on the migration "flows".

[a] "Methodology and evaluation of continuous population registers"; (report of the Secretary-General, (E/CN.3/293, 7 February 1962). See also Council of Europe, *European Population Conference*, Strasbourg, 30 August-6 September 1966 (*Official Documents*, vol. II, C-26).

In the United Nations document (E/CN.3/293), "information" was received concerning such systems in forty-six countries and "indications" of the functioning of systems in "at least eleven other countries". It was emphasized, however, that:

> "The traditional function of population registers has always been to provide information for the administrative purposes of governments. Statistical information, such as demographic data, may have become available as a by-product but... the larger number of systems... appear to be used solely for administrative purposes, including, *inter alia*, the legal identification of individuals, the preparation of electoral rolls, the control of selection for military service, indications of each person's status in respect of various social security benefits and the preparation of tax lists."

Of the fifty-seven presumable "systems" listed as of 1962, only nine reported that they provided statistical data on internal migration. Examples from three of these (Japan, Netherlands and Sweden) are given in the following sections to indicate some of the uses of such data from these registers for measuring internal migration, and some of the explicit checks on completeness and consistency.

Problems of definition

As indicated, registers are concerned with the event of migration. It follows, therefore, that there will be systematic differences between data derived from censuses, where migrants are defined either by birth-place in relation to current residence, current residence in relation to residence at a prior fixed date, or duration of current residence. Since at least some migrants, by census definition, will have been involved, by registration definition, in more than one migratory event, counts from registers should normally exceed those from censuses. Only with Japanese data has it so far been

Table 42. Comparison of migration by sex and type based on the population registers and the census for the one-year period between October 1959 and 1 October 1960, Japan

Sex and type of migration	*Register data* (1)	*Census data* (2)	*Ratio:* $\frac{(1)}{(2)} \times 100$ (3)
Both sexes			
Intra-prefectural	2,966,621	1,998,171	148.47
Interprefectural	2,625,135	2,590,751	101.33
Males			
Intra-prefectural	1,488,935	1,001,745	148.63
Interprefectural	1,450,817	1,466,898	98.90
Females			
Intra-prefectural	1,477,686	996,426	148.30
Interprefectural	1,174,318	1,123,853	104.49

Source: Register data, Japan Bureau of Statistics, Office of the Prime Minister, *Jumin Toroku Jinko Ido Hokoku Nempo, 1960* (*Annual Report of Migration Based on Resident Population Registers, Tokyo, 1960*) (Tokyo, 1962), table 2, pp. 32-33; census data, Bureau of Statistics, Office of the Prime Minister, *1960 Census of Japan*, vol. 3, *All Japan*, part 1 (Tokyo 1964), p. 198.

Note: "Intra-prefectural" migration means migration between different minor civil divisions, namely *shi* (city), *ku* (ward), *machi* (town) or *mura* (village) within the same *ken* (prefecture), while "interprefectural" migration denotes migration between different prefectures.

TABLE 43.A. COMPARISON OF IN-MIGRATION, BY PREFECTURES OF DESTINATION, BASED ON THE POPULATION REGISTERS AND THE CENSUS FOR THE ONE-YEAR PERIOD BETWEEN 1 OCTOBER 1959 AND 1 OCTOBER 1960, JAPAN

Ken (prefecture) of destination	*Register data* (1)	*Census data* (2)	*Ratio:* $\frac{(1)}{(2)} \times 100$ (3)
All Japan	2,625,135	2,590,751	101.33
1. Hokkaido	54,741	80,033	68.40
2. Aomori	18,673	17,340	107.69
3. Iwate	17,796	16,650	106.88
4. Miyagi	29,778	29,769	100.03
5. Akita	15,142	13,763	110.02
6. Yamagata	19,119	12,885	148.38
7. Fukushima	28,535	23,283	122.56
8. Ibaraki	36,388	30,671	118.64
9. Tochigi	23,395	20,462	144.33
10. Gunma	23,835	19,676	121.14
11. Saitama	98,259	89,062	110.33
12. Chiba	79,665	74,183	107.39
13. Tokyo	591,711	578,526	102.28
14. Kanagawa	192,148	199,217	96.45
15. Niigata	30,635	25,655	119.41
16. Toyama	12,705	15,107	84.10
17. Ishikawa	14,384	16,067	89.53
18. Fukui	10,612	10,593	100.18
19. Yamanashi	12,528	16,340	76.67
20. Nagano	27,775	26,827	103.53
21. Gifu	39,950	42,008	95.10
22. Shizuoka	56,999	67,192	84.83
23. Aichi	151,563	167,168	90.67
24. Mie	28,640	31,232	91.70
25. Shiga	21,688	18,100	119.82
26. Kyoto	51,268	57,094	89.80
27. Osaka	291,276	298,730	97.51
28. Hyogo	137,770	136,279	101.09
29. Nara	18,124	26,851	67.50
30. Wakayama	18,623	17,324	107.50
31. Tottori	10,809	9,017	119.87
32. Shimane	14,228	14,021	101.48
33. Okayama	29,243	26,158	111.79
34. Hiroshima	46,349	46,349	100.00
35. Yamaguchi	34,277	29,925	114.54
36. Tokushima	11,944	10,043	118.93
37. Kagawa	16,830	14,361	117.19
38. Ehime	24,130	19,628	122.94
39. Kochi	12,355	10,167	121.52
40. Fukuoka	98,867	91,036	108.60
41. Saga	21,644	17,359	124.69
42. Nagasaki	34,583	31,891	108.44
43. Kumamoto	31,541	24,285	129.88
44. Oita	23,181	20,166	114.95
45. Miyazaki	24,474	21,900	111.75
46. Kagoshima	36,955	26,354	140.23

TABLE 43.B. COMPARISON OF OUT-MIGRATION, BY PREFECTURES OF ORIGIN, BASED ON THE POPULATION REGISTERS AND THE CENSUS FOR THE ONE-YEAR PERIOD BETWEEN 1 OCTOBER 1959 AND 1 OCTOBER 1960, JAPAN

Ken (prefecture) of origin	*Register data* (1)	*Census data* (2)	*Ratio:* $\frac{(1)}{(2)} \times 100$ (3)
All Japan	2,625,135	2,590,751	101.33
1. Hokkaido	65,222	67,294	96.92
2. Aomori	30,386	47,312	64.23
3. Iwate	32,156	42,488	75.68
4. Miyagi	48,725	56,113	86.83
5. Akita	34.410	45,181	76.16
6. Yamagata	36,711	40,036	91.70
7. Fukushima	63,662	70,256	90.61
8. Ibaraki	53,718	53,989	99.50
9. Tochigi	40,911	42,089	97.20
10. Gunma	40,748	41,105	99.13
11. Saitama	65,307	56,444	115.70
12. Chiba	68,354	63,554	107.55
13. Tokyo	377,019	319,420	118.03
14. Kanagawa	102,963	88,183	116.76
15. Niigata	63,619	60,696	104.82
16. Toyama	20,479	24,019	85.26
17. Ishikawa	19,259	20,449	94.18
18. Fukui	16,455	17,016	96.70
19. Yamanashi	24,209	25,163	96.21
20. Nagano	50,213	50,140	100.15
21. Gifu	40,723	38,874	104.76
22. Shizuoka	61,214	62,254	98.33
23. Aichi	87,330	71,605	121.96
24. Mie	37,627	37,711	99.78
25. Shiga	23,699	21,974	107.85
26. Kyoto	56,550	52,777	107.15
27. Osaka	146,833	129,083	113.75
28. Hyogo	103,844	93,573	110.98
29. Nara	24,265	23,722	102.29
30. Wakayama	24,262	25,798	94.05
31. Tottori	18,526	18,470	100.30
32. Shimane	27,846	28,801	96.68
33. Okayama	41,446	41,282	100.40
34. Hiroshima	52,883	52,852	100.06
35. Yamaguchi	49,848	52,443	95.05
36. Tokushima	24,960	28,194	88.53
37. Kagawa	28,710	28,932	99.23
38. Ehime	46,063	48,760	94.47
39. Kochi	24,779	28,158	88.00
40. Fukuoka	126,188	127,430	99.03
41. Saga	41,992	40,605	103.42
42. Nagasaki	62,435	67,900	91.95
43. Kumamoto	60,466	67,637	89.40
44. Oita	40,531	45,668	88.75
45. Miyazaki	40,127	43,427	92.40
46. Kagoshima	77,462	81,874	94.61

SOURCE: Register data, Japan Bureau of Statistics, Office of the Prime Minister, *Annual Report of Migration Based on Resident Population Registers, 1959* (Tokyo, 1961) and *Annual Report of Migration Based on Resident Population Registers, 1960* (Tokyo, 1962); Census data, Japan Bureau of Statistics, *1960 Census of Japan*, vol. 3, *All Japan*, part 1, (Tokyo 1964), pp. 198-217.

possible to test the correspondence between migrations, as registered during a one-year period and migrants enumerated in the census in terms of fixed-period change of residence. Kono gives the relevant comparisons from the two sources in a paper prepared for the London Conference of IUSSP,[b] for migrants recorded in the registers during a one-year period extending from 1 October 1959 to 1 October 1960, and persons enumerated in the census as of 1 October 1960, who reported a different residence as of 1 October 1959. Table 42 shows these data in parallel columns for the whole of Japan, by sex of migrants and by distance spanned in the migration (intra-prefectural *versus* interprefectural) and in table 43.A interprefectural detail is presented for in-migrants, and in table 43.B for out-migrants.

[b] Shigemi Kono, "Evaluation of the Japanese population register data on internal migration"; paper presented to the London Conference of IUSSP, session 10.1, September 1969.

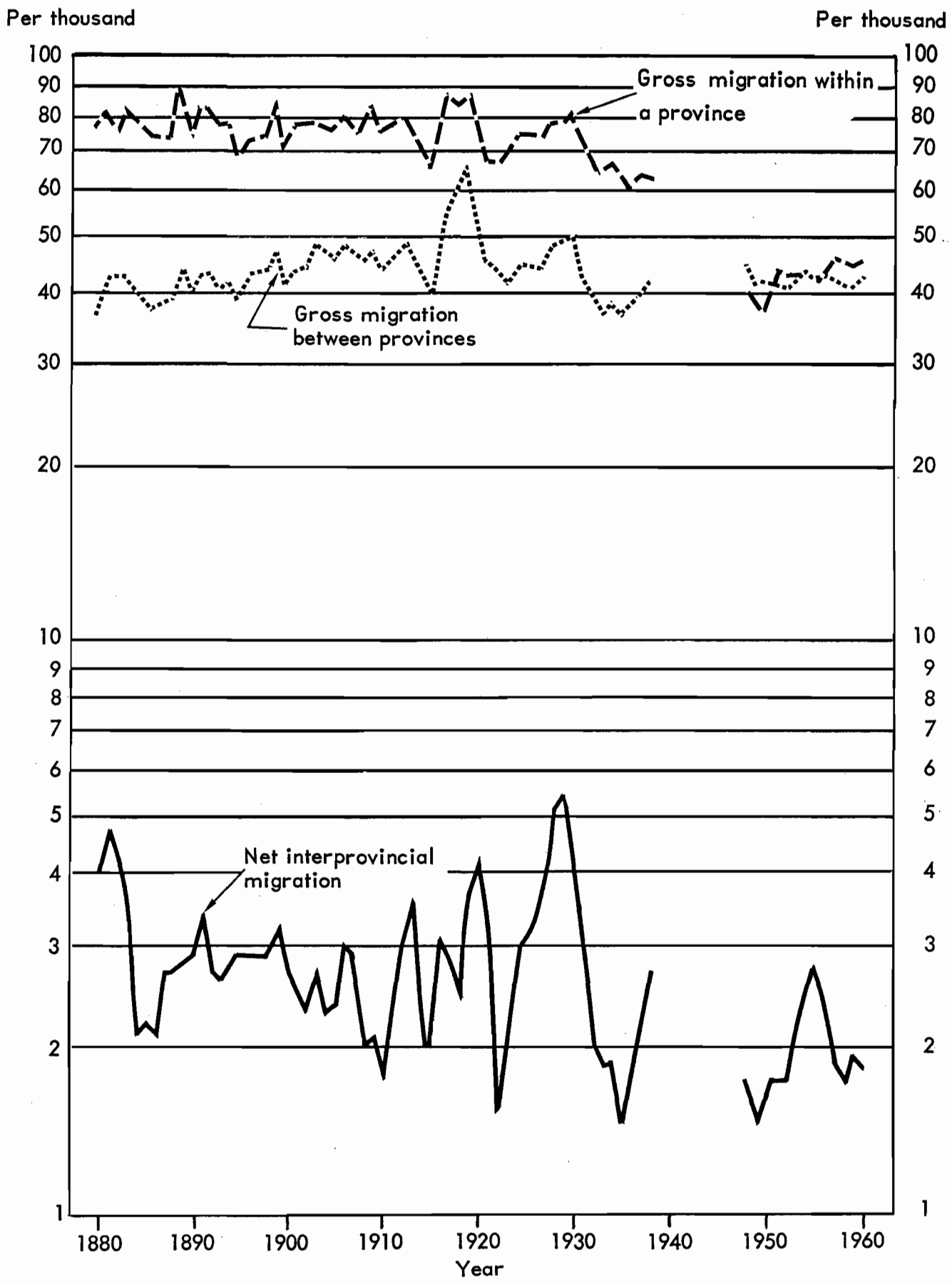


Figure I. Gross and net internal migration in the Netherlands, per 1,000 of the population as of 1 January of each year, 1880-1960

SOURCE: H. Ter Heide, *Binnenlandse Migratie in Nederland*, Staatsuitgeverij (s'Gravenhage, 1965), pp. 463-471.

As shown in table 42, the differences are very large indeed for intra-prefectural migrants, and surprisingly small for those migrating between prefectures. For the latter, the direction of differences is in the expected direction for females (excess in the registration data); but for males, on the contrary, there is a somewhat greater number of migrants reported in the census than that recorded in the registers. The prefectural patterns of in-migration and out-migration (tables 43.A and B) indicate appreciable variability with, in general, greater discrepancies for the former than for the latter. Kono attributes these discrepancies partly to definitional problems and time lags in reporting, but he points out also that some of the irregularities are probably attributable to labour-force transfers, to suburbanization, and to the movement of school-age populations.

Time series

Substantively, an important use of continuous registers is in the historical time series they provide. Two examples are given.

Figure I charts for the Netherlands rates of gross internal migration (the sum of gains and losses within and between provinces) along with rates of "net" interprovincial migration (the sum of the gains and losses, disregarding signs) annually from 1880 to 1960, with omission of the years of invasion and occupation during the 1940s.[c]

Figure II shows a similar series for Sweden from 1895 to 1950, in terms of absolute net gains of towns from rural areas.[d]

Migration time series, so derived, are useful for analytical purposes, for example, for correlation with economic time series, but, as Ahlberg has emphatically pointed out, special care must be exercised in such cases to free the register series from accumulations of errors and to distribute discrepancies that appear when periodical external checks are made.

[c] H. Ter Heide, *Binnenlandse Migratie in Nederland*, Staatsuitgeverij (s'Gravenhage, 1965), pp. 463-471.

[d] Gösta Ahlberg, *Befolkningsutvecklingen och Urbaniseringen* (Stockholm, 1953), p. 151, spliced a series for 1895-1933 assembled from primary materials by Dorothy S. Thomas, *Social and Economic Aspects of Swedish Population Movements, 1750-1933* (New York, 1941), p. 428, with a series derived, after corrections for procedural changes, from the Swedish Central Statistical Bureau.

Ecological comparisons

Of substantive interest, as well as considerable use in planning operations, are compilations of internal migration of data in terms of the structure of sending and receiving areas. A useful cross-classification of this sort has, for some time, been provided annually by the Central Bureau of Statistics in the Netherlands. Tables 44.A and B show for the City of Utrecht, the detail that is available for each large city and each province. The data are cross-classified for in-migrants by origin and out-migrants by destination according to a typology representing seven "degrees of urbanization" (from rural municipalities through intermediate categories to large towns), and also by distance (contiguous and non-contiguous municipalities). These data are also cross-classified for both in-migrants and out-migrants by certain socio-demographic characteristics at the time of migration, namely, sex by family status (family heads, family members and persons migrating alone).

Inasmuch as these data are limited to the migrating classes, they are suitable for analysis of migration differentials only when comparable data are available for the general population from the census. Ter Heide[e] has, indeed, analysed some of these data by comparing percentage distributions of migrants and total populations as of the census years 1947 and 1960 by age, sex, marital status, economic activity and occupation.

Quality of the data

A few examples of how useful data, obtainable routinely from continuous population registers, can be for time series and ecological comparisons have been indicated.

It must be emphasized, however, that effective analytical use of registration data depends, in large measure, upon the completeness and accuracy of the registers. The mechanism of continuous registration means that errors will not only be cumulative but can involve serious biases. It is, therefore, desirable to indicate the nature of these problems.

In the Netherlands, both direct and indirect checks on accuracy and completeness are described by van den Brink as follows:

[e] Ter Heide, op. cit., chap. 13.

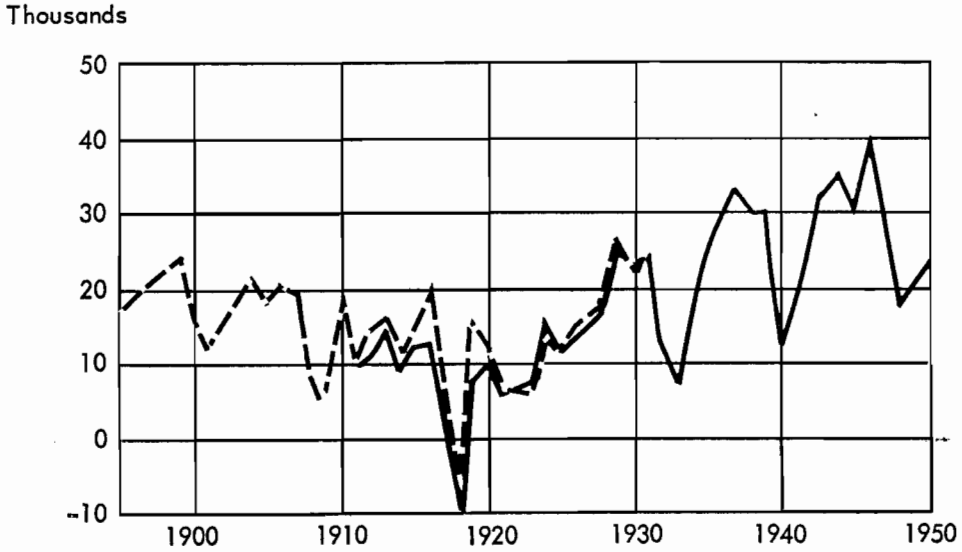


Figure II. Migration losses of rural areas to towns, Sweden, 1895-1950

SOURCE: Gösta Ahlberg, *Befolkningsutvecklingen och Urbaniseringen* (Stockholm, K. L. Beckmans Boktryckeri, 1953), p. 125.

TABLE 44.A. IN-MIGRANTS TO UTRECHT CITY, BY PROVINCE OR ORIGIN, FAMILY STATUS AND SEX, 1963

	Family heads		*Family members*		*Persons migrating alone*		*Total persons*
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	
Provinces							
Groningen	21	7	45	54	69	79	247
Friesland	19	6	39	40	68	89	236
Drenthe	11	5	25	36	62	45	168
Overijssel	35	12	81	83	163	179	506
Gelderland	86	31	183	213	447	477	1,320
Utrecht	304	41	560	572	744	822	2,698
Noordholland	162	44	301	340	453	540	1,634
Zuidholland	161	29	318	351	503	594	1,766
Zeeland	7	2	14	19	44	46	123
Noodbrabant	46	10	98	108	301	262	769
Limburg	31	8	68	76	227	122	493
Not reported	2	1	10	12	4	—	26
TOTAL	885	196	1,742	1,904	3,085	3,255	9,986
Groups of municipalities, by degree of urbanization [a]							
0	160	39	301	350	552	655	1,858
1, 2	57	15	102	118	216	235	671
3	196	25	370	371	556	608	1,905
4	20	6	38	56	82	80	256
5, 6	68	19	142	158	357	330	987
7, 8	151	32	320	322	593	567	1,802
9	231	59	459	517	725	780	2,481
Not reported	2	1	10	12	4	—	26
TOTAL	885	196	1,742	1,904	3,085	3,255	9,986
Contiguous municipalities	209	22	386	386	524	532	1,828
All other municipalities	676	174	1,356	1,518	2,561	2,723	8,158
TOTAL	885	196	1,742	1,904	3,085	3,255	9,986

[a] See the table 44.B.

"The direct method consists firstly in a measure which the municipal councils are legally required to carry out, viz., periodical house-to-house checks conducted either personally by population registry officials or by mail. In addition, with each periodical General Population Census, the census questionnaires are compared with the personal cards in the municipal population registers. This is done to check both the completeness of the population census and the accuracy of the population registers. Any disparities revealed are investigated.

"The indirect checks are altogether different in character. All contact between the population registry and the population is also utilized to trace and correct any omissions in the notification of changes of residence, removal from and domiciliation in the municipality. The effectiveness of the method depends, obviously, on the frequency of that contact. In the Netherlands, where population registration forms an integral part of government administration, this is extremely high. First, there is the contact on the attainment of certain ages: e.g. in the first year of life (vaccinations); on reaching the age of 6 (compulsory school attendance); at 18 (military conscription); at 21 (suffrage); and at 65 (old-age pension). There are also numerous incidental opportunities for checking (such as payments of maternity benefits, children's allowances, disablement pensions; passport application etc.). In addition, the population registry receives notification of changes of address from various other government agencies."[f]

A complete two-way check made just after the general census of 31 May 1960 gave the following reassuring results:[g]

"The census showed that 2,000 persons who had been living in the country since before 1 June 1960, had not yet been entered in any population register. Conversely, some 6,500 persons who had left the country prior to that date were still listed in the population registers. In view of the total population as at 31 May 1960 (11,462,000), these discrepancies are of negligible dimensions. Moreover, it was possible to ascertain that a large number of the persons involved had immigrated or emigrated only a short time before (between 1 January and 31 May 1960). In addition, some 29,000 persons were listed in municipal registers other than the register of the municipality in which they resided at the date of the census... This category consisted largely of lodgers and boarders."

In Sweden, there has for a number of years been a systematic annual check of the registers.

"The accuracy of both the parish and the county registers are checked once a year through a special procedure, the *mantalsskrivning*, by which every real estate owner is responsible for information being supplied about all persons living on the estate. On this occasion every head of a household must fill in a form giving particulars for the household and its members. This procedure implies in fact that Sweden has an annual population census, although the data collected are on the whole not used for statistical purposes.

[f] T. van den Brink, "The Netherlands population registers"; reprinted from *Sociologica Neerlandica* (Assen), vol. III, No. II, 1966, pp. 36-37.

[g] *Ibid.*, pp. 37-38.

TABLE 44.B. OUT-MIGRANTS FROM UTRECHT CITY, BY PROVINCE OF DESTINATION, FAMILY STATUS AND SEX, 1963

	Family heads		*Family members*		*Persons migrating alone*		*Total persons*
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	
Province							
Groningen	30	5	59	60	54	59	232
Friesland	19	3	29	42	62	58	191
Drenthe	26	2	36	60	62	32	190
Overijssel	51	13	106	115	129	120	470
Gelderland	166	21	306	317	465	383	1,471
Utrecht	455	45	837	805	694	815	3,151
Noordholland	160	30	294	334	532	586	1,746
Zuidholland	233	32	451	450	537	523	1,961
Zeeland	5	2	13	14	36	29	92
Noordbrabant	107	25	221	223	264	210	918
Limburg	28	18	64	92	141	96	393
Not reported	—	—	—	—	2	—	2
TOTAL	1,281	196	2,416	2,512	2,978	2,911	10,817
Groups of municiplalities, by degree of urbanization [a]							
0	327	37	615	591	537	538	2,281
1, 2	121	27	221	252	236	217	926
3	253	27	469	457	501	629	2,056
4	28	4	58	67	84	47	256
5, 6	143	27	287	302	320	256	1,165
7, 8	164	35	306	334	499	504	1,643
9	245	39	460	509	799	720	2,488
Not reported	—	—	—	—	2	—	2
TOTAL	1,281	196	2,416	2,512	2,978	2,911	10,817
Contiguous municipalities	330	26	617	575	491	533	2,216
All other municipalities	951	170	1,799	1,937	2,487	2,378	8,601
TOTAL	1,281	196	2,416	2,512	2,978	2,911	10,817

SOURCE: Netherlands, Central Bureau of Statistics, manuscript tables.

[a] 0 ..... Rural municipalities
1,2 ..... Industrialized rural municipalities
3 ..... Specific resident municipalities of commuters
4 ..... Some municipalities of heterogeneous character
5,6 ..... Country towns and small towns (2,000-30,000 population in built-up area)
7,8 ..... Medium-size towns (30,000-100,000 population in built-up area)
9 ..... Large towns (100,000 and more population in built-up area)

"When a population census takes place the Swede does not notice anything different, apart from the fact that the annual form for the *mantalsskrivning* is somewhat more detailed than in other years. The frame for the census is the *mantalsskrivning*, and the census is taken wholly through self-enumeration.

"The lists of persons arrived at as a result of the *mantalsskrivning* are checked every year against the parish registers. If it is then discovered that a person according to the *mantalsskrivning* lives in a place where he is not registered, action is taken in order to have his [registration card] transferred from his old to his new parish. If a person in a parish register does not turn up at all at the *mantalsskrivning*, he remains for the time being in the parish register. If he does not turn up at the *mantalsskrivning* of the following year, he will be transferred to a special Register of persons with residence unknown. There is one such register at each parish but when a person is transferred to it his [card] is forwarded to [Stockholm], which keeps a central register of all such persons."[h]

The basic safeguard in the Swedish system is the "register of persons with residence unknown:[i]

"This register is a testimony of the accuracy of the registration system. According to present rules a person who has once been included in the register remains there, until he turns up again or until he is 100 years old. In a previous period when the registration system was less accurate many persons were annually transferred to this register. An important category were the then numerous emigrants. There were also many duplicates of persons who were properly registered in some other place in the country. For this reason it is not surprising that as a result of a stocktaking in 1960 it was discovered that in the register of persons with residence unknown there were included 139,761 persons or 1.9 per cent of the then Swedish population of 7.5 millions. However, this is not a comparison which can be used in order to assert that the accuracy of the registration system is low. By far the majority of these 139,761 persons are no doubt dead or living in some other country. The persons included in the register of persons with residence unknown are, of course, not included in the population statistics for Sweden.

[h] E. v. Hofsten, "Population registers and computers; new possibilities for the production of demographic data", *Review of the International Statistical Institute* (The Hague), vol. 34(2), 1966, p. 187.

[i] The Swedish word for this register (*obefintliga*) has previously been translated as the register of the statistically "non-existent" (by Thomas, op. cit., and others).

"The persons actually alive and living in the country who are registered in the register of persons with residence unknown, must be subject to mortality. The [Central Bureau of Statistics] annually receives about 75,000 death certificates, of which nearly all refer to persons who are properly registered. The remaining cases are mostly foreigners who have died while on a temporary visit to Sweden. Only a very few cases refer to persons who can be traced in the register of persons with residence unknown (in both 1963 and 1964, 14 cases).

"The deceased persons who thus turn up in the register are mostly vagabonds and are all in the age groups between 20 and 60. No children are found, nor any old persons; for both categories the social security benefits are [an important safeguard]. If it is assumed that mortality for the group included in the register is the same as that for the rest of the population between 20 and 60, the total number of persons included in the register and living in Sweden without being registered anywhere else would amount to some 3,000. As it could be assumed that mortality for this category is considerably higher, the actual number may be much smaller.

"It may be added that in 1964 there were 1,931 persons transferred to the register of persons with residence unknown, whereas 992 persons were transferred from that register to the registered population. The latter category mainly consisted of persons who had left the country some years before without notifying the parish and who were discovered when they returned to the country."[j]

The Dutch and Swedish registers are historically based, with more than a century of experience in the former, and more than two centuries in the latter. Realistic applications of the quality safeguards discussed above, however, were effectuated only in recent decades. As the cited United Nations document indicates, the practice of establishing registers is now spreading with some rapidity throughout the world and their potentialities for scientific research are becoming very great indeed. But, as van den Brink warns:

"Those potentialities will largely depend on the completeness and accuracy of the registration, i.e., the extent to which the population register is kept up to date (both as regards the persons registered and the particulars concerning them), for in itself the establishment of such a register is not so difficult. It can be started with, or based on, census enumeration forms. Considerable disappointment will ensue, however, if there is no guarantee that it can be kept up to date."[k]

Other limitatons and other uses

Aside from quality control, which has clearly attained a high level in the Netherlands and Sweden, the chief limitation of continuous registers as sources for data on internal migration is their weakness with respect to records of changing population characteristics in contrast to their strength with respect to records of fixed characteristics. Thus, van den Brink raises a very pertinent question when he asks:

"Whether by a well balanced system of continuous population bookkeeping on base of population registers the system of periodic population censuses may be dropped. The answer to this question depends on the nature of the information which is available in the population register and that which one wants to collect at the population census. In general it may be observed that at the population censuses an ever-increasing number of details is asked for, of which a continuous registration in the population registers will never be possible. This applies, e.g., to the occupation, for although in the Netherlands population registers it is attempted to verify the occupation stated on the personal card at each contact with the individual, still the personal card will never present an up-to-date picture of all particulars, which e.g., were asked at the Netherlands census of 1947 about the occupation (nature of occupation, nature of the establishment in which employed, industrial status, social status, employment status, place of work if done outside the municipality of residence, means of transport from home to working place etc.).

"Therefore it is not likely that in the future population registers will be able to replace fully periodic censuses. They are, however, eminently suited as a starting point for partial censuses by limiting the number of data and for the number of enumeration-units (by sampling)."[l]

Hofsten tends to answer the same question differently because of pending plans in Sweden "to have information about employment and occupations reported to the county [registration] offices", which he believes might in the future make it "possible to eliminate the taking of complete censuses"[m] Hofsten refers also to the fact that "for a number of years there has been a central register of a sample of the population, consisting of those born on the 15th of any month of the year".[n] This brings up a final consideration for this section, namely, the development from registers of frames for population sampling, adaptable to analyses of migration differentials. The imaginatively conceived "sample of the 15th day born"[o] has however, up to the present, yielded little information on internal migration, and, since its establishment, first in the frame of the 1950 census, and later in that of the 1960 census and updated each year on the basis of continuous register data, has been beset by programming difficulties.

Ways in which migration data can be linked from register and other sources are illustrated in Kono's paper and Ter Heide's monograph, refered to above, and especially in Neymark's study (discussed below in annex II) where a cohort of 21-year old males, drawn from population register lists for the central conscription authorities, were traced backward to age 14 and forward to age 28, with clear identification of successive migrations in relation to socio-demographic and ecological characteristics. The possibilities of drawing unbiased samples and thus differentiating types of migrations and of migrants are among the most important potentials of continuous population registers.

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[j] E. v. Hofsten, op.cit., pp. 189-190.

[k] T. van den Brink, op. cit., p. 47.

[l] T. van den Brink, "Population registers and their significance for demographic statistics", *Proceedings of the World Population Conference, 1954* (United Nations publication, Sales No.: 55.XIII.8/vol. 4), pp. 917-918.

[m] E. v. Hofsten, op. cit., p. 188.

[n] *Ibid.*

[o] See L. Widén, "Registret över femtondefödda", in *Statistisk Tidskrift*, (Stockholm), 1966, No. 5 (summary in English, pp. 408-411).

ANNEX II

USES OF SAMPLE SURVEYS IN MIGRATION ANALYSIS

Introduction

A small but growing number of national statistical offices have collected data about internal migration in their national sample surveys. These data are rarely, if ever, collected monthly; but the same questions may be asked periodically or a special *ad hoc* supplement may be devoted to this topic. In addition, data may be collected by other agencies, public or private. Their surveys are usually restricted to a particular area such as a city or community.

Unless otherwise indicated, the sample surveys discussed here are thought to represent probability samples with the data collected through household interviews. Some sample surveys on internal migration have been conducted by mail, but the non-response rates are then relatively high and the results biased unless intensive efforts are made to follow up on the non-respondents. An intermediate procedure that consists of an initial household interview and the leaving of a second questionnaire to be returned by mail is easier to administer satisfactorily.

Advantages and disadvantages

The specific questions on internal migration that are asked in sample surveys can be the same as those asked in censuses. There are circumstances, however, that make it expedient for the survey questions to be more restricted in some respects, but feasible for them to be more expansive in others.

The size of the sample is usually such that reliable statistics can be shown in only very limited geographical detail. Hence, it is not worthwhile to attempt to collect very much geographical detail on place of origin. It is true that detailed areas of origin can be coded to produce reliable statistics on former type of residence, using such broad classifications as urban-rural, size of locality, and metropolitan-non-metropolitan; but the added costs of enumeration and of coding must be weighed against the value of data for the few resulting categories. "Reliable" is used here in the sense of having a tolerable sampling error.

It is essential that the detail tabulated in cross-classifications of migration status with personal, social and economic characteristics take account of sampling error. Reliability can be increased, however, by accumulating the statistics for several years and then analysing the averaged rates, percentage distributions etc. Such averaging is more defensible when the true rates are nearly equal for all years within the chosen period so that the observed rates differ among themselves mainly because of sampling fluctuations.

Advantages

When the survey data on migration are collected at frequent and regular intervals (annually, quarterly etc.), then better time series are available for analysis than are available from censuses. This generalization is particularly true of fixed-period migration since there are very few instances, so far, of comparable fixed-period questions in successive national censuses.

Observations at more frequent intervals permit the analyst to delineate cyclical movements more precisely, to locate more accurately any turning points in trends, and to study more effectively the response of internal migration to business cycles and to key political events (wars, legislation, new gevernment programmes etc.). One example of the study of the interrrelations between migration and economic changes is contained in an article by Thomas.[a] She dealt with interstate migration as measured for the United States of America in ten annual supplements to the *Current Population Survey* from 1947/48 to 1956/57.

One of the greatest advantages of the sample survey for the collection of data on migration is the opportunity to experiment with novel questions and to explore the subject in greater depth by means of a larger set of questions. The fact that a new question is not altogether successful is less critical in the case of a sample survey than in that of a census where the investment is much larger and where failure cannot be remedied until after the lapse of perhaps five or ten years. New features can be introduced not only in the questions proper but also in the instructions to the canvassers, the coding, the editing and the tabulations. Since a national population census is a multipurpose statistical project, a fairly large number of different topics must be investigated and no one of them can be explored in any great depth. In a survey, on the other hand, even when there is a nucleus of items that has to be included on the form every time, in supplements or occasional rounds, it is feasible to probe a particular topic with a "battery" of related questions, with the added cost being relatively moderate. One device is to ask enough questions in the regular survey interview to identify those persons or households who had migrated in a given period of time or who met some similar qualifying condition and then to collect additional information about them in a revisit or by leaving a form to be filled and mailed to the office. This device protects the regular survey activities from undue delay. For example, in March 1963, the United States Bureau of Labor Statistics sponsored a supplement to the *Current Population Survey* on the employment status of migrants.[b] Male movers 18 to 64 years old identified in the *Current Population Survey* of that month were left a form containing questions relating to reason for moving; occupation, industry and status one year earlier; and economic activity just prior to move. Some *ad hoc* surveys have investigated migration in even more detail.

One interrelationship between sample surveys and censuses has already been touched on. The sample survey can be used to *pre-test* questions (as well as changes in question wording, instructions etc.) that are being considered for inclusion on the census schedule. Reversing the sequence, the census or population register can provide a sampling frame for a subsequent survey on migration. Again, the sampling can be restricted to a particular population subclass, such as those persons who migrated in a given period. The "simplified" census taken in the Republic of Korea in 1966 collected no information on migration, but a subsequent survey of 1/600 of all households included a number of items on that

[a] Dorothy Swaine Thomas, "Age and economic differentials in interstate migration", *Population Index* (Princeton, N.J.), vol. 24, No. 4, October 1958, pp. 319-325.

[b] Samuel Saben, "Geographic mobility and employment status, March 1962-March 1963", *Special Labor Force Report*, No. 44, United States Bureau of Labor Statistics (Washington, D.C. August 1964).

subject. A much more complex interplay among data sources was required to produce Neymark's Swedish study[c] described later in this annex.

The statistics on migration from the two sources (census or register; and survey) may also supplement each other analytically. For example, if they cover different periods, the statistics may be used to describe changing migration patterns in terms of differentials and of relative sizes of streams. The United States Bureau of the Census matched the records of the March 1960 *Current Population Survey* with those of the 25 per cent sample of the 1960 census. Thus, for the same persons, it was possible to make a tabulation of migration status, 1959-1960, against migration status, 1955-1960.[d] Some statistics on migration histories can be inferred from such a tabulation.

Disadvantages

Concerning the disadvantages, little remains to be added beyond what was mentioned above. Sampling error is probably the main handicap. There is also usually some sampling bias arising from the design of the survey or from failure to carry out the design exactly. Moreover, it may not be practical to sample the entire population even when that is desirable so that coverage is not extended to certain population subgroups (nomadic or tribal populations, persons living in group quarters etc.). The public may not co-operate as well in a sample survey as in a national census, which receives a great deal of publicity with attendant patriotic appeal. On the other hand, the data from a regular survey programme may be superior in some respects to those from a census because the field staff of the former has more training and experience. These matters are explored in more detial in the following subsection

QUALITY OF THE STATISTICS

Sampling error

Some indications of the level of sampling error from national sample surveys are available. It is desirable, of course, that this kind of information be made available in all reports giving statistics on internal migration that were collected in sample surveys.

The Current Population Survey (CPS) of the United States of America now interviews about 50,000 households every month. Text tables in the reports give the standard errors of estimated numbers and percentages; the estimated numbers are inflated numbers. Tables 45 and 46 are taken from a recent report on internal migration.[e] To illustrate the use of these tables, the report shows that 12,032,000 males age 14 and over moved to a different house in the United States between March 1966 and March 1967. By linear interpolation of the values in table 45, the standard error of an estimate of this size is approximately 252,000. The chances are therefore 68 out of 100 that a complete census would have shown a figure differing from the estimate by less than 252,000.

TABLE 45. STANDARD ERRORS OF ESTIMATED NUMBERS, UNITED STATES CURRENT POPULATION SURVEY

(68 chances out of 100)

Size of estimate	*Standard error*	*Size of estimate*	*Standard error*
25,000	12,000	2,500,000	121,000
50,000	17,000	5,000,000	170,000
100,000	24,000	10,000,000	236,000
250,000	38,000	25,000,000	357,000
500,000	54,000	50,000,000	462,000
1,000,000	77,000	100,000,000	513,000

SOURCE: United States Bureau of the Census, *Current Population Reports*, Series P-20, No. 171, *Mobility of the Population of the United States: March 1966 to March 1967* (Washington, D.C., Government Printing Office, 1968), table A.

Non-response and other sources of error

In most publications of the results of national sample surveys, what is given about non-sampling types of error (non-response, sample bias, response error, processing error etc.) is of an essentially qualitative nature.

In the United States, a subsample of CPS households was re-interviewed over a period of several years on a number of items, including population mobility; but the results have not yet been published. Moreover, information on mobility status in the year 1949/50 was obtained from both the census and the CPS; and the distributions obtained from these two sources are compared in table 47. The percentage of migrants among persons 1 year old and over is seen to be nearly the same from the census and the Current Survey. Where the distributions differed more markedly, the figure from the survey was deemed to be more valid.[f]

Among persons in households interviewed in the Current Population Survey, the proportion failing to answer the question on residence one year ago is quite low—of the order of a fraction of 1 per cent. Of households eligible for interview, however, about

[c] Ejnar Neymark, *Selektiv Rörlighet* (Stockholm, Personal-administrativa Rådet, 1961), 529 pp. (in Swedish, with English summary).

[d] Henry S. Shryock, Jr. and Elizabeth A. Larmon, "Some longitudinal data on internal migration", *Demography* (Chicago), 1965, No. 2, pp. 581-583.

[e] United States Bureau of the Census, *Current Population Reports*, Series P-20, No. 171, *Mobility of the Population of the United States: March 1966 to March 1967* (Washington, D. C., Government Printing Office, 1968).

[f] Henry S. Shryock, Jr., *Population Mobility Within the United States* (Chicago, Community and Family Study Center, University of Chicago, 1964), pp. 57-58.

TABLE 46. STANDARD ERRORS OF ESTIMATED PERCENTAGES, UNITED STATES CURRENT POPULATION SURVEY

(68 chances out of 100)

Estimated percentage	*Base of percentage (thousands)*								
	250	*500*	*1,000*	*2,500*	*5,000*	*10,000*	*25,000*	*50,000*	*100,000*
2 or 98	2.2	1.5	1.1	0.7	0.5	0.3	0.2	0.2	0.1
5 or 95	3.4	2.4	1.7	1.1	0.7	0.5	0.3	0.2	0.2
10 or 90	4.6	3.3	2.3	1.5	1.0	0.7	0.5	0.3	0.2
25 or 75	6.7	4.7	3.3	2.1	1.5	1.1	0.7	0.5	0.3
50	7.7	5.4	3.8	2.4	1.7	1.2	0.8	0.5	0.4

SOURCE: As for table 45, table B.

TABLE 47. PERCENTAGE DISTRIBUTION OF PERSONS 1 YEAR OLD AND OVER IN THE UNITED STATES OF AMERICA, BY MOBILITY STATUS: 1950 CENSUS AND MARCH 1950 CURRENT POPULATION SURVEY

Mobility status	*Census*	*Current Population Survey*
Total reporting mobility status	100.0	100.0
Same house as in 1950	82.6	80.9
Different house in the United States (movers)	17.1	18.7
Intra-county movers	11.4	13.1
Intercounty migrants	5.7	5.6
Intra-state migrants	3.0	3.0
Interstate migrants	2.7	2.6
Abroad in 1949	0.4	0.3

SOURCE: Henry S. Shryock, Jr., *Population Mobility Within the United States* (Chicago, Community and Family Study Center, University of Chicago, 1964), p. 58.

5 per cent are not interviewed at all in an average month. The members of these households are also non-respondents on the migration questions, of course. Inflating the sample data to control totals by age, sex etc. gives these non-respondents the same characteristics as those persons in the specific age-sex group who reported, although actually they may have had a somewhat different distribution on such a characteristic as mobility. Thus, the published statistics do not show any "unknowns" on migration.

In the 1962 sample survey of Greater Santiago conducted by the United Nations Latin American Demographic Centre (CELADE), the non-interview rate was 7 per cent for both the households and the in-migrants.[g] Non-response rates on specific migration items are not shown, but a more detailed report gives both (1) comparisons of percentage distributions by commune of residence and by age between the survey and the 1960 census, and (2) tables of standard errors for the migration survey.[h]

TYPES OF STATISTICS

The basic statistics on internal migration that have been tabulated from sample surveys and the measures that have been derived from these statistics are, in large part, of the same type as those from censuses that were discussed earlier in this Manual. The novel features derive, in the main, from the frequency of some of the surveys and from the additional aspects of migration that are investigated.

Volumes and rates

The ways of presenting absolute numbers on migration status, in, out, and net migration, and migration streams and the percentage distributions and rates derived from these numbers are fairly well standardized. What is good practice for census data should be good practice for survey data. Table 48 is an example drawn from the CPS which indicates the mobility status of the United States population 1 year old and over as on March 1967.

[g] Juan C. Elizaga, "A study of migration to Greater Santiago (Chile)," *Demography* (Chicago), vol. 3, No. 2, 1966, p. 354.

[h] United Nations, Centro Latinoamericano de Demografía, *Encuesta sobre Immigración en el Gran Santiago, Informe General*, part 1 (edición provisional), Series A, No. 15 (Santiago, 1964), pp. 43-52.

TABLE 48. AGE OF THE POPULATION 1 YEAR OLD AND OVER, BY MOBILITY STATUS, FOR THE UNITED STATES OF AMERICA, MARCH 1967
(*Numbers in thousands*)

Age, and sex	*Total*	*Same house (non-movers)*	*Different house in the United States (movers)*							*Abroad on 1 March 1966*
			Total	*Same county*	*Different county (migrants)*					
					Total	*Within a state*	*Between states*			
							Total	*Contiguous*	*Non-contiguous*	
Both sexes										
TOTAL	*192,233*	*155,710*	*35,200*	*22,339*	*12,861*	*6,308*	*6,553*	*2,198*	*4,355*	*1,323*
1 to 4 years	15,843	11,361	4,356	2,769	1,587	704	883	303	580	127
5 to 13 years	36,797	30,222	6,345	4,027	2,318	1,072	1,246	384	862	231
5 and 6 years	8,493	6,669	1,764	1,104	660	307	353	114	239	61
7 to 13 years	28,304	23,553	4,581	2,923	1,658	765	893	270	623	170
14 to 17 years	14,473	12,462	1,946	1,321	625	353	272	94	178	65
18 and 19 years	6.691	5,082	1,560	992	568	280	288	97	191	49
20 to 24 years	13,565	7,737	5,566	3,291	2,275	1,003	1,272	431	841	260
20 and 21 years	5,411	3,321	2,002	1,194	808	368	440	150	290	87
22 to 24 years	8,154	4,416	3,564	2,097	1,467	635	832	281	551	173
25 to 34 years	22,388	15,814	6,255	3,871	2,384	1,077	1,307	444	863	318
25 to 29 years	11,634	7,620	3,839	2,392	1,447	655	792	287	505	174
30 to 34 years	10,754	8,194	2,416	1,479	937	422	515	157	358	144
35 to 44 years	23,865	20,081	3,609	2,261	1,348	693	655	201	454	175
45 to 64 years	39,922	35,875	3,965	2,719	1,246	759	487	192	295	83
65 years and over	18,689	17,079	1,596	1,086	510	366	144	52	92	14
65 to 74 years	11,792	10,808	972	653	319	235	84	30	54	12
75 years and over	6,897	6,271	624	433	191	131	60	22	38	2
Median age (years)	28.8	32.1	23.2	23.2	23.1	23.8	22.5	22.8	22.4	23.8

SOURCE: United States Bureau of the Census, *Current Population Reports*, Series P-20, No. 171, *Mobility of the Population of the United States: March 1966 to March 1967*, p. 11.

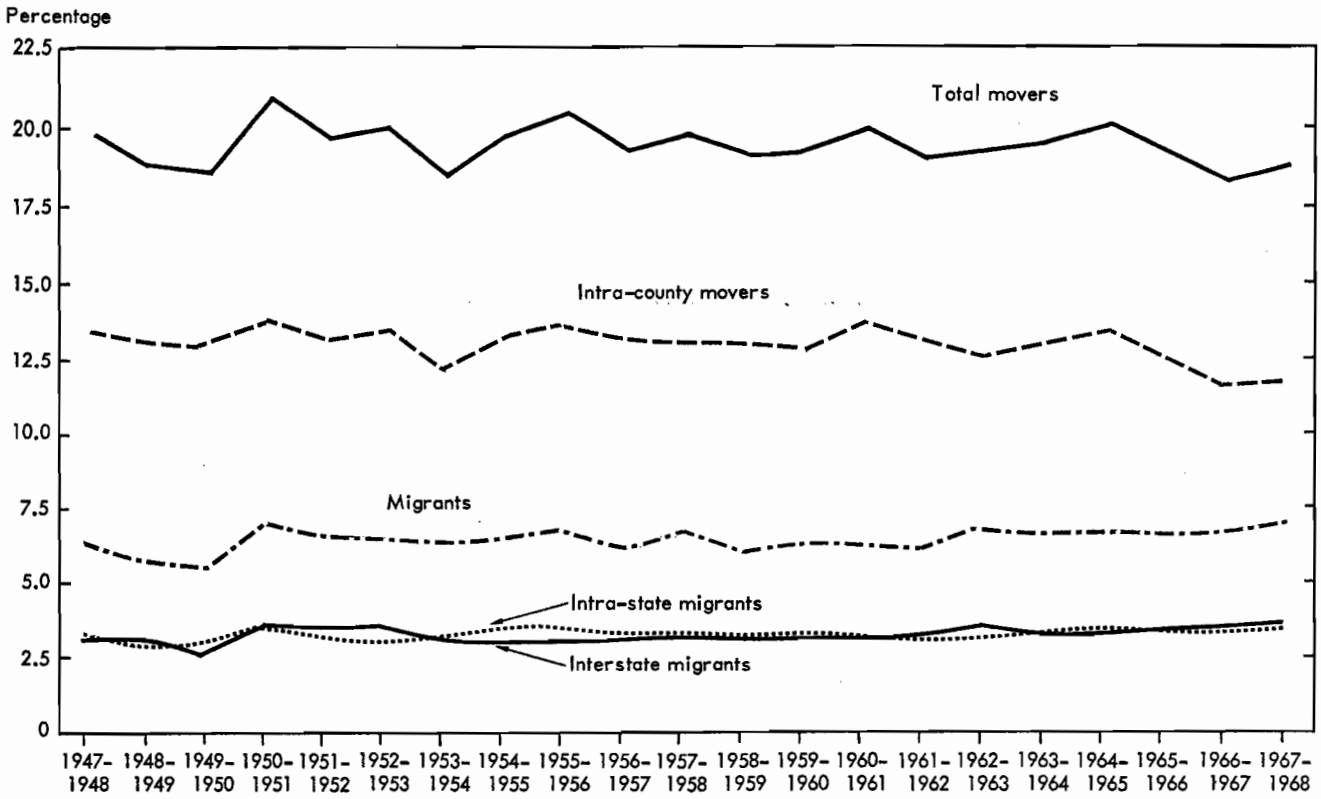

Figure III. Movers, by type of mobility as percentage of the population 1 year old and over, for the United States of America April 1948-March 1968

SOURCE: United States Bureau of the Census, *Current Population Reports*, Series P-20, No. 188, *Mobility of the Population of the United States: March 1967 to March 1968* (Washington, D.C., Government Printing Office, 1969).

Time series

Repetition of the survey at fairly frequent and fixed intervals, such as an annual survey covering the preceding 12-month period, also provides statistics that are more satisfactory for analysing cyclical and occasional variations and, in time, even long swings and trends. The occasional variations may not be purely random but may reflect political events rather than economic changes.

Figure III illustrates the graphic presentation of mobility rates of various types. Some of the peaks and troughs are associated with the outbreak of the Korean conflict and three post-war business cycles.[i] The downturn of the intra-county mobility rate in the last year or so presumably reflects the low volume of construction of new residential housing.

Differentials: status at the time of survey

Distributions and migration rates specific for various characteristics are also derived from the survey data, as illustrated in tables 48 and 49.A and B and figure IV. The characteristics are as of the time of the survey, although some are invariant. This is the usual, but not necessarily the best way of displaying the characteristics. Certain characteristics may change during the migration period as a matter of maturation (age itself, educational attainment etc.); others may change in connexion with the time of the move (marital status, employer, industry). Of course, some changes in characteristics are associated with *both* the life cycle and the event of migration. One reaches a certain stage of life at which it is customary to marry, and one changes one's residence at the time of marriage. One also tends to command more income with increasing age (up to a point) and may accomplish this by changing one's job and residence area. The next subsection treats classifications by characteristics as of the time of migration or at the beginning of the migration period.

Differentials: status at the beginning of the period or time of migration

To obtain a person's current characteristics, the demographer may make use of questions that are a regular part of a general-purpose survey. To obtain the characteristics at the beginning of the period or at the time of migration, extra questions must be added. Fortunately, this procedure is being followed in a growing number of surveys. Classifications according to status prior to migration form the logical bases for measuring differential propensities to migrate. This kind of information also indicates important temporal sequences, and answers such questions as, "Did the unemployment of a given worker precede or follow his move?" These temporal sequences, in turn, yield some insights as to causal relationships.

Questions concerning previous status have been included in a number of surveys. As an illustration, the 1963-based attempt to relate migration to employment status one year earlier by supplementing a CPS survey may be cited.[j]

Many annual surveys had already shown that, age for age, males unemployed at the end of the migration period had had higher migration rates than those employed. The 1963 study showed that the *propensity* of the unemployed to migrate in a subsequent period was also greater than that of the employed (see table 50).

[i] Shryock, op cit., p. 65.

[j] Samual Saben, op. cit.

TABLE 49.A. YEARS OF SCHOOL COMPLETED BY THE MALE POPULATION 25 YEARS OLD AND OVER, BY MOBILITY STATUS AND AGE FOR THE UNITED STATES OF AMERICA, MARCH 1967

(Percentage distribution)

Age, and years of school completed	Total	Same house (non-movers)	Different house in the United States (movers)							Abroad on 1 March 1966
			Total	Same county	Different county (migrants)					
					Total	Within a state	Between states			
							Total	Contiguous	Non-contiguous	
TOTAL, *25 years old and over*	*100.0*	*83.3*	*16.0*	*10.2*	*5.8*	*3.1*	*2.7*	*0.9*	*1.7*	*0.7*
Elementary: 0 to 8 years	100.0	86.2	13.5	9.5	3.9	2.6	1.3	0.5	0.8	0.3
High school: 1 to 3 years	100.0	84.3	15.4	10.6	4.8	3.0	1.8	0.8	1.0	0.2
4 years	100.0	82.7	16.4	10.4	5.9	3.1	2.9	0.9	1.9	0.9
College: 1 year or more	100.0	78.9	19.7	10.7	9.1	4.0	5.1	1.7	3.3	1.4
25 to 34 years	100.0	67.5	30.7	19.1	11.6	5.4	6.2	2.1	4.1	1.8
Elementary: 0 to 8 years	100.0	67.1	32.0	22.9	9.1	4.7	4.3	1.6	2.8	0.9
High school: 1 to 3 years	100.0	68.4	30.8	20.9	9.9	5.3	4.5	1.8	2.7	0.8
4 years	100.0	70.6	27.7	18.0	9.6	4.4	5.2	1.7	3.6	1.7
College: 1 year or more	100.0	63.6	33.7	18.0	15.7	6.8	8.9	2.9	6.0	2.7
35 to 44 years	100.0	82.4	16.7	10.2	6.5	3.2	3.2	1.0	2.2	0.9
Elementary: 0 to 8 years	100.0	80.2	19.1	13.5	5.6	3.0	2.6	0.7	1.9	0.6
High school: 1 to 3 years	100.0	83.4	16.6	11.2	5.4	3.2	2.1	0.9	1.3	0.1
4 years	100.0	84.7	14.0	8.3	5.7	3.1	2.6	0.7	2.0	1.2
College: 1 year or more	100.0	80.6	18.1	9.3	8.8	3.6	5.1	1.8	3.4	1.3
45 to 64 years	100.0	89.2	10.6	7.2	3.4	2.1	1.2	0.6	0.7	0.2
Elementary: 0 to 8 years	100.0	88.2	11.5	8.4	3.1	2.1	1.0	0.5	0.5	0.2
High school: 1 to 3 years	100.0	90.9	9.3	6.5	2.8	2.0	0.9	0.4	0.4	0.1
4 years	100.0	89.4	10.4	6.9	3.5	2.2	1.3	0.6	0.7	0.1
College: 1 year or more	100.0	89.1	10.4	5.9	4.5	2.1	2.3	1.0	1.3	0.5
65 years and over	100.0	91.7	8.3	5.4	2.9	2.3	0.5	0.2	0.4	0.1
Elementary: 0 to 8 years	100.0	91.3	8.7	5.7	2.9	2.6	0.3	0.1	0.2	0.1
High school: 1 to 3 years	100.0	93.2	6.8	4.5	2.3	2.0	0.3	—	0.3	—
4 years	100.0	92.4	7.5	4.2	3.2	1.6	1.6	0.8	0.8	0.1
College: 1 year or more	100.0	91.6	8.2	5.7	2.5	1.8	0.7	—	0.7	0.1

SOURCE: See table 49.B.

The 1965 supplement to the monthly Labour Force Survey of Canada[k] was similar to the CPS study in a number of respects including the determination of labour force status one year earlier. Changes in labour force status from October 1964 to October 1965 for migrant and non-migrant males aged 17-64 years are given in table 51. It would be possible to compute migration rates for persons with and without status change. For example, among the 106,000 unemployed at the beginning of the interval, 11 per cent migrated during the interval.[l]

When the survey is limited to a particular part of a country, such as a city, the conventional in-migration rates are frequently presented for population subgroups defined in terms of characteristics at the time of the survey. It seems much less logical to compute such rates for subgroups defined in terms of characteristics at a past date, particularly when that is not a fixed date. If the status is that at the time of in-migration, then there seems to be no appropriate population base to serve as the denominator. Accordingly, we find that in-migration rates are not computed from survey data of this general type; instead the percentage distribution by the characteristic is given for the in-migrants. Such descriptive statistics do not, of course, measure the selectivity of migration.

A few examples can be cited here. Labour force status and occupation in the area of origin, as reported in the survey of Greater Santiago, are analysed for in-migrants by the Centro Latino-americano de Demografía and by Elizaga. Table 52 presents some of the published statistics.

Reasons for migration

Questions on reasons for migration are among the more popular items in recent sample surveys on internal migration. These questions represent an attempt to determine motivation by asking migrants why they moved. This approach is quite different from trying to draw inferences on the causes of migration from data on migration differentials or on the comparative characteristics of sending and receiving areas.

There has been little standardization of categories of reasons among the various surveys that have included this topic. Although there has been some repetition of categories used in earlier surveys, the topic seems to be essentially in its exploratory stage with meaningful categories and classifications being developed partly by trial and error. The respondent is often allowed to give more than one reason so that the sum of reasons given may exceed the number of persons reporting. There is frequently an attempt, either in the questions

[k] Canada, Dominion Bureau of Statistics, *Special Labour Force Studies*, No. 4, *Geographic Mobility in Canada: October 1964-October 1965*, by May Nickson (Ottawa, April 1967).

[l] Detailed migration rates could be computed from appendix table C.3 given on page 21 of Canada, Dominion Bureau of Statistics, *Special Labour Force Studies*, No. 4.

TABLE 49.B. YEARS OF SCHOOL COMPLETED BY THE FEMALE POPULATION 25 YEARS OLD AND OVER, BY MOBILITY STATUS AND AGE FOR THE UNITED STATES OF AMERICA, MARCH 1967

(Percentage distribution)

Age, and years of school completed		Total	Same house (non-movers)	Different house in the United States (movers)							Abroad on 1 March 1966
				Total	Different county (migrants)						
					Same county	Total	Within a state	Between states			
								Total	Contiguous	Non-contiguous	
TOTAL, *25 years old and over*		*100.0*	*86.0*	*13.5*	*8.8*	*4.7*	*2.4*	*2.3*	*0.8*	*1.5*	*0.4*
Elementary:	0 to 8 years	100.0	87.6	12.0	8.8	3.2	2.1	1.1	0.5	0.7	0.4
High school:	1 to 3 years	100.0	85.3	14.5	10.4	4.1	2.1	2.0	0.7	1.3	0.2
	4 years	100.0	86.2	13.3	8.5	4.9	2.4	2.4	0.7	1.7	0.4
College:	1 year or more	100.0	83.8	15.5	7.7	7.8	3.4	4.3	1.4	2.9	0.8
25 to 34 years		100.0	73.5	25.3	15.5	9.8	4.3	5.5	1.9	3.6	1.1
Elementary:	0 to 8 years	100.0	71.3	26.5	18.9	7.6	4.4	3.2	1.7	1.5	2.0
High school:	1 to 3 years	100.0	72.3	27.0	19.0	8.0	3.3	4.7	1.9	2.9	0.8
	4 years	100.0	76.7	22.4	14.2	8.2	3.6	4.7	1.3	3.3	0.9
College:	1 year or more	100.0	69.0	29.6	14.0	15.6	6.6	9.0	3.1	5.9	1.3
35 to 44 years		100.0	85.8	13.6	8.8	4.9	2.6	2.3	0.7	1.6	0.6
Elementary:	0 to 8 years	100.0	82.9	16.2	12.0	4.2	2.3	1.9	0.7	1.2	0.9
High school:	1 to 3 years	100.0	83.4	16.6	11.7	4.8	2.9	1.9	0.6	1.4	—
	4 years	100.0	88.2	11.3	7.1	4.2	2.4	1.8	0.5	1.3	0.5
College:	1 year or more	100.0	85.3	13.5	6.4	7.1	3.0	4.1	1.2	2.9	1.2
45 to 64 years		100.0	90.5	9.3	6.4	2.9	1.7	1.2	0.4	0.8	0.2
Elementary:	0 to 8 years	100.0	89.1	10.7	7.9	2.8	2.0	0.8	0.3	0.5	0.3
High school:	1 to 3 years	100.0	91.1	8.8	6.5	2.3	1.2	1.1	0.3	0.7	—
	4 years	100.0	91.1	8.9	5.8	3.1	1.8	1.3	0.4	0.9	0.1
College:	1 year or more	100.0	91.4	8.3	4.8	3.5	1.6	1.9	0.6	1.3	0.3
65 years and over		100.0	91.2	8.7	6.1	2.6	1.7	0.9	0.4	0.6	0.1
Elementary:	0 to 8 years	100.0	90.7	9.2	6.7	2.5	1.7	0.8	0.3	0.5	—
High school:	1 to 3 years	100.0	92.0	8.0	6.2	1.8	0.9	0.9	0.5	0.4	—
	4 years	100.0	91.5	8.3	5.0	3.3	1.8	1.5	0.5	1.1	0.2
College:	1 year or more	100.0	92.2	7.8	4.5	3.3	2.3	0.9	0.3	0.6	0.1

SOURCE: United States Bureau of the Census, *Current Population Reports*, Series P-20, No. 171, *Mobility of the Population of the United States: March 1966 to March 1967*, table 5.

TABLE 50. MIGRATION RATES,[a] BY LABOUR FORCE STATUS IN MARCH 1962, MALES 18 TO 64 YEARS OLD BY AGE FOR THE UNITED STATES OF AMERICA, MARCH 1963

Labour force status in March 1962	Total, 18 to 64 years	18 to 24 years	25 to 64 years		
			Total	25 to 44 years	45 to 64 years
TOTAL population	6.9	12.4	5.9	7.9	3.5
Labour force status					
Civilian labour force	6.0	11.1	5.4	7.1	3.3
Employed	5.7	11.0	5.1	6.8	3.1
Unemployed	10.9	16.3	10.8	11.1	7.9
Not in civilian labour force	15.2	14.6	15.8	28.8	6.1

SOURCE: Adapted from table 2 in Samuel Saben, "Geographic mobility and employment status, March 1962-March 1963", *Special Labor Force Report*, No. 44, United States Bureau of Labor Statistics (Reprint No. 2443 from *Monthly Labor Review* (Washington, D.C.), August 1964).

[a] Migrants as a percentage of all males in group.

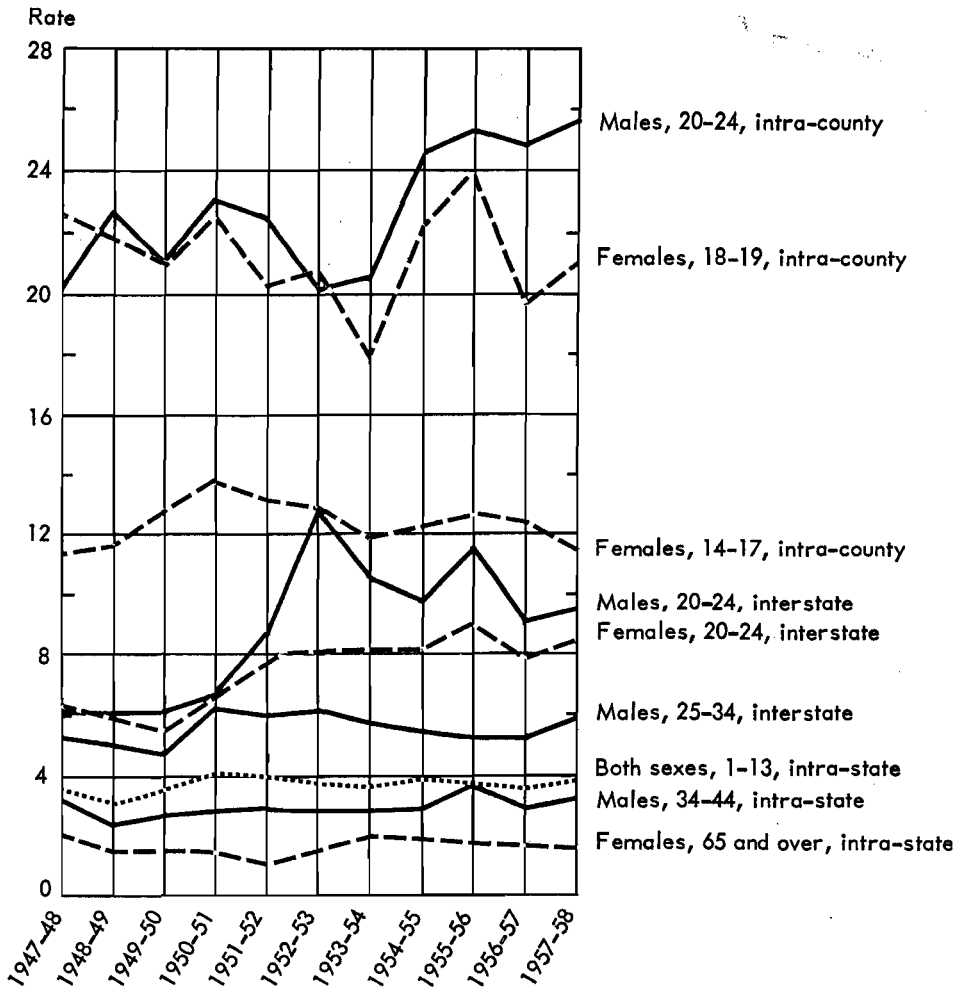

Figure IV. Selected mobility rates, by age and sex, United States of America, 1947/48-1957/58

SOURCE: Henry S. Shryock, Jr., *Population Mobility within the United States* (Chicago, Community and Family Study Center, University of Chicago, 1964), p. 353.

TABLE 51. MALES 17-64, BY LABOUR FORCE STATUS, OCTOBER 1964, DISTRIBUTED BY LABOUR FORCE STATUS, CANADA, OCTOBER 1965

Labour force status, October 1964	*Total males, 17-64 (thousands)*	*Labour force status, October 1965 (percentage distribution)*				*Total with status change* [a]	
		Total	*Employed*	*Unemployed*	*Non-labour*	*Number (thousands)*	*Percentage*
Non-migrants, totals	4,895	100.0	87.9	2.1	10.0	343	7.1
Employed	4,168	100.0	97.7	1.4	0.9	96	2.3
Unemployed	94	100.0	66.7	31.3	[b]	65	68.7
Non-labour force	633	100.0	26.7	2.1	71.2	182	28.8
Migrants, totals	399	100.0	88.8	2.6	8.6	69	17.3
Employed	323	100.0	94.5	[b]	3.1	18	5.6
Unemployed	12	100.0	94.1	[b]	[b]	11	94.1
Non-labour force	64	100.0	59.1	[b]	38.5	40	61.5

SOURCE: Canada, Dominion Bureau of Statistics, *Special Labour Force Studies*, No. 4, *Geographic Mobility in Canada: October 1964-October 1965*, by May Nickson (Ottawa, April 1967), table 7, p. 12.

[a] Including moves between employment, and unemployment as well as men entering or leaving the labour force.

[b] Based on estimates of less than 10,000.

TABLE 52. MALE IN-MIGRANTS TO GREATER SANTIAGO, BY SIZE OF PLACE, LABOUR FORCE STATUS, AND BROAD OCCUPATION GROUP AT ORIGIN, 1962

(Uninflated sample cases)

Labour force status and broad occupation group	*Total*	*Type of origin*		
		Places of 5,000 inhabitants or more	*Smaller places and rural*	*Abroad and not reported*
Total males	553	351	168	34
Total reporting	482	301	151	30
Not reporting	71	50	17	4
Percentage of total reporting	100.0	100.0	100.0	—
All workers except unpaid family workers	74.3	75.4	70.2	—
Unpaid family workers	4.1	2.7	6.6	—
Looking for work for the first time	4.8	5.0	5.3	—
Not in labour force	16.8	16.9	17.9	—
All workers except unpaid family workers	358	227	106	25
Percentage of subtotal	100.0	100.0	100.0	
White collar	27.4	31.3	11.3	—
Manual	42.7	52.0	27.4	—
Agricultural	27.9	14.5	61.3	—
Other [a]	2.0	2.2	—	—

SOURCE: Adapted from: United Nations, Centro Latinoamericano de Demografía, *Encuesta sobre Inmigración en el Gran Santiago, Informe General*, part 1 (edición provisional), Series A, No. 15 (Santiago, 1964), p. 164.

[a] Members of armed forces, foreign diplomatic personnel, and occupation not reported.

themselves or in the tabular classification of the replies, to distinguish job-related from other (personal or social) reasons.

The main problems of measurement for this topic seem to be: (1) choice of meaningful universes in the coverage of the survey and of sub-universes in the tabulations; (2) choice of a reasonable number of predesignated reasons that are mutually exclusive and exhaustive; and (3) choice of analytically relevant classifications of reasons.

In the United States of America, two CPS surveys[m] approached this problem. In both, more than one "reason" for the move could be recorded, and in the second, priorities were assigned, following a predetermined order. In the earlier report, an attempt was made to determine "reasons" for every member of the sampled households (including children), with cross-classification by age and sex. In the second, reasons were obtained only for males in the age range 18-64 years, but, again, cross-classification was carried through by broad age groups and by marital status; and the job-related reasons were analysed separately by labour force status, occupation and industry (as indicated in Saben, op. cit., pages 876-878). Moreover, the earlier report was limited to migrant categories i.e., persons crossing county lines, whereas the later report included information on intra-county movers and cross-classified migrants by origin, by contiguous and non-contiguous states, respectively. Tables 53.A and B show the maximum detail published on reasons.

The Canadian survey covering the period 1964 to 1965 related to an almost identical universe—males 17 to 64—but gave an abridged set of reasons for migration. It should be noted that their primary interest was in job-related reasons, which were divided into three categories (job transfer, to take a job, to look for a job), and hence all other reasons were combined into a single category.

The study conducted by Lansing and Mueller at the Survey Research Center of the University of Michigan[n] also stresses the economic factor in migration for heads of families. The economic reasons in their classification are:

Transfer; reassignment of head;

Unemployment; desire for more or steadier work; to enter labour force;

Higher rate of pay; better prospects or chance for advancement;

Other.

These "other economic reasons" are essentially job-related reasons, since they included "...moving to a place which has a lower cost of living or lower taxes, which is nearer to one's job or has better transportation to work, which offers a good opportunity to open a business, and the like". Table 54 shows the results obtained in their study. They also provide tables of reasons for moving, cross-classified by broad groupings of age, of education, of family income, and of occupation separately.

A survey in the city of Krasnoyarsk, USSR, covered workers who voluntarily left the industrial enterprises of that city in the second quarter of 1960.[o] Job mobility and geographical mobility are covered simultaneously. The percentage distribution of the reasons given for leaving are shown in table 55 separately for job leavers who did and did not also leave the city.

An elaborate classification of reasons for migration was developed by Yoon[p] with a basic differentiation among economic, socio-cultural and psychological motives. Table 56 shows his list of reasons for migration, classified by sex in terms of whether or not the migrants were "unaccompanied" or "accompanied" and showing percentage

[m] United States Bureau of the Census, *Current Population Reports*, Series P-20, No. 4, *Postwar Migration and its Causes in the United States: August 1945 to October 1946* (Washington, D.C., October 1947), and Series P-20, No. 154, *Reasons for Moving: March 1962 to March 1963* (Washington, D.C., August 1966), table E.

[n] John B. Lansing and Eva Mueller, *The Geographic Mobility of Labour* (University of Michigan, Survey Research Center, Ann Arbor, Michigan, 1967), pp. 57-67.

[o] V. I. Perevedentsev, *Migratsiya Naseleniya i Trudovye Problemy Sibiri*, Izdatelstvo "Nauka", Sibirskoye Otdelenie (Novosibirsk, 1966), pp. 115-124.

[p] Jong-Joo Yoon, "A study on the migration motives of Seoul", *The Institute of Population Problems* (Seoul, 1966), table 7.

TABLE 53.A. MALE MOVERS 18 TO 64 YEARS OLD, BY REASON FOR MOVE AND TYPE OF MOBILITY, OF THE UNITED STATES OF AMERICA, MARCH 1963
(Thousands)

Reason for moving	Intra-county movers				Migrants			
	All reasons	One reason only	Two or more reasons	Primary reason[a]	All reasons	One reason only	Two or more reason	Primary reason[a]
TOTAL persons	6,292	5,754	538	6,292	3,519	2,974	545	3,519
All reasons	*6,857*	*5,754*	*1,103*	*6,292*	*4,101*	*2,974*	*1,127*	*3,519*
Related to job	794	488	306	780	2,374	1,838	536	2,287
To take a job	188	126	62	190	964	772	192	966
To look for work	65	42	23	66	394	269	125	389
Job transfer	29	25	4	28	297	254	43	268
Commuting and armed forces	512	295	217	496	719	543	176	664
Easier commuting	459	264	195	...	272	174	98	...
Enter or leave armed forces	53	31	22	...	447	369	78	...
Not related to job	6,044	5,247	797	5,512	1,709	1,118	591	1,232
Housing	4,127	3,704	423	3,895	461	324	137	362
Better housing	3,783	3,398	385	...	435	304	131	...
Forced move	344	306	38	...	26	20	6	...
Family status	1,304	1,081	223	1,143	664	419	245	480
Change in marital status	751	659	92	...	165	133	32	...
Join or move with family	553	422	131	...	499	286	213	...
Other	614	462	152	485	583	375	208	398
Health	77	47	30	...	116	71	45	...
All other reasons	537	415	122	...	467	304	163	...
Not reported	19	19	...	...	18	18	...	...

SOURCE and footnote *a*: See table 53.B.

TABLE 53.B. MALE MOVERS 18 TO 64 YEARS OLD, BY REASON FOR MOVE AND TYPE OF MOBILITY, OF THE UNITED STATES OF AMERICA, MARCH 1963
Percentage distribution

Reason for moving	Intra-county movers				Migrants			
	All reasons	One reason only	Two or more reasons	Primary reason[a]	All reasons	One reason only	Two or more reasons	Primary reason[a]
All reasons	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
Related to job	11.6	8.5	27.7	12.4	58.1	62.2	47.6	65.0
To take a job	2.7	2.2	5.6	3.0	23.6	26.1	17.0	27.5
To look for work	1.0	0.7	2.1	1.0	9.6	9.1	11.1	11.1
Job transfer	0.4	0.4	0,4	0.4	7.3	8.6	3.8	7.6
Commuting and armed forces	7.5	5.1	19.7	7.9	17.6	18.4	15.6	18.9
Easier commuting	6.7	4.6	17.7	...	6.7	5.9	8.7	...
Enter or leave armed forces	0.8	0.5	2.0	...	10.9	12.5	6.9	...
Not related to job	88.1	91.5	72.3	87.6	41.9	37.8	52.4	35.0
Housing	60.4	64.6	38.3	61.9	11.3	11.0	12.2	10.3
Better housing	55.3	59.3	34.9	...	10.7	10.3	11.6	...
Forced move	5.0	5.3	3.4	...	0.6	0.7	0.5	...
Family status	19.1	18.8	20.2	18.2	16.3	14.2	21.7	13.6
Change in marital status	11.0	11.5	8.3	...	4.0	4.5	2.8	...
Join or move with family	8.1	7.4	11.9	...	12.2	9.7	18.9	...
Other	9.0	8.1	13.8	7.7	14.3	12.7	18.5	11.3
Health	1.1	0.8	2.7	...	2.8	2.4	4.0	...
All other reasons	7.9	7.3	11.1	...	11.5	10.3	14.5	...

SOURCE: United States Bureau of the Census, *Current Population Reports*, Series P-20, No. 154, *Reasons for Moving: March 1962 to March 1963* (Washington, D.C., August 1966) table E.

[a] Persons reporting more than one reason were assigned a single reason on the basis of the order in which reasons appeared in the stub. At the same time the detail was consolidated into the subtotals indicated.

[b] Based on reported cases.

TABLE 54. REASONS FOR MOVING, BY WORK STATUS AND SELECTED OCCUPATIONS

(Percentage distribution of heads of families who moved in the past five years)

Work status	Reasons for moving: Economic reasons only	Both economic and non-economic reasons mentioned	Non economic reasons only	No reasons mentioned	Total	Number of cases
All	58	14	23	5	100	583
In the labour force						
Total in labour force	61	16	18	5	100	502
Professional, technical	74	13	11	2	100	140
Other white collar	67	15	16	2	100	117
Blue collar	51	18	25	6	100	203
Not in the labour force	19	4	68	9	100	70

SOURCE: John B. Lansing and Eva Mueller, *The Geographic Mobility of Labor* (University of Michigan, Survey Research Center, Ann Arbor, Michigan, 1967), p. 60.

TABLE 55. REASONS FOR JOB MOBILITY AND MIGRATION OF WORKERS LEAVING INDUSTRIAL ENTERPRISES IN KRASNOYARSK, USSR, 1960

(The data relate to about 4,700 persons who voluntarily left the industrial enterprises in Krasnoyarsk in the second quarter of 1960)

Main reasons for leaving jobs previously occupied	Percentage distribution by reason for leaving job: All separations	Those who also left the city	Percentage of persons separated for given reason who: Also left the city	Remained in the city
TOTAL covered by survey	100.0	100.0	49	51
Dissatisfaction with amount of wage	17.5	9.5	27	73
Dissatisfaction with kind of work	13.9	6.4	23	77
Dissatisfaction with housing conditions	11.2	12.7	57	43
Excessive distance between home and work and poor transportation	4.2	1.9	23	77
Impossibility of sending children to kindergarten or nursery school	4.0	1.4	18	82
Desire to go to vicinity of relatives	17.5	34.0	96	4
Unsuitable climate	0.6	1.1	86	14
Health reasons	4.9	2.8	28	72
Illness of relatives	4.3	6.3	73	27
Wish to continue schooling	5.2	3.8	37	63
Other reasons	11.3	12.4	55	45
Reasons unstated	5.4	7.7	71	29

SOURCE: Adapted from V. I. Perevedentsev, *Migratsiya Naseleniya i Trudovye Problemy Sibiri*, Izdatelstvo "Nauka", Sibirskoye Otdelenie (Novosibirsk, 1966), p. 120, table 58.

distribution separately by economic and socio-cultural and by psychological categories.

In a number of studies on reasons for migration, attempts have been made to identify more specifically those migrants who were the principal decision makers from those who moved primarily as dependents of heads of their families. For example, Elizaga[q] first classified migrants in Greater Santiago into those who moved "independently" and those who came as dependent family members. The former were subdivided into those with reasons relating to (*a*) work; (*b*) education; (*c*) family problems; and (*d*) "other" (including insufficient information). Data basic to his study published by the Centro Latinamericano de Demografía (op. cit., p. 172), indicate that the dependent migrants in the period 1942-1962 amounted to 11 per cent of the males and 37 per cent of the females 14 years old and over upon arrival.

[q] See Elizaga, op. cit., p. 365.

In analysing the 1946 data from the Current Population Survey, Shryock[r] divided the migrants into those "who made the basic decisions either for themselves alone or for their families" and "those whose migration was merely derivative from a decision made by the head of the family". This dichotomization was made on the basis of the reason itself. The percentage of decision makers among the migrants by age and sex was as follows:

Age	Male	Female
Under 14 years	4.6	3.3
14 to 24 years	71.6	36.2
25 to 44 years	98.3	23.2
45 years and over	95.5	43.0

As a final example, a multilevel classification developed by Das Gupta[s] is noted. In its most elaborate form, it attempts classification of "reasons" as follows:

[r] Shryock, op. cit., pp. 404-405.

[s] Ajit Das Gupta, "Types and measures of internal migration", *International Population Conference, Vienna 1959*, pp. 619-624.

TABLE 56. PERCENTAGE DISTRIBUTION OF UNACCOMPANIED AND ACCOMPANIED MIGRANTS, BY REASON FOR MIGRATION AND SEX, FOR SEOUL, REPUBLIC OF KOREA, 1961-1966

(Only one respondent tabulated for each group—Household etc.— of migrants. "Psychological" reasons recorded as secondary reasons)

Reason for migration	Unaccompanied (lone) migrants			Accompanied (household and part-household) migrants		
	Both sexes	Male	Female	Both sexes	Male	Female
Total economic and socio-cultural						
Number (uninflated)	405	120	285	346	283	63
Percentage	100	100	100	100	100	100
Economic	68	63	71	77	88	27
Looking for job	46	37	50	38	43	16
Taking or changing job	18	18	17	17	20	3
Transfer	—	2	—	11	13	3
Starting new business	1	3	—	9	10	5
Other	3	2	3	1	2	—
Socio-cultural	32	37	29	23	12	73
Own education	16	33	8	3	2	3
Child's education	—	—	—	8	5	21
Marriage	7	—	10	1	1	3
Joining family	8	2	10	10	2	46
Military	—	—	—	1	1	—
Other	1	1	1	1	1	—
Total psychological						
Number (uninflated)	99	23	76	113	85	28
Percentage	100	100	100	100	100	100
Attraction of Seoul	45	26	51	19	19	21
Dislike of previous place	8	—	11	12	13	7
Better life	43	74	34	69	68	71
Other	3	—	4	—	—	—

SOURCE: Adapted from Republic of Korea, Institute of Population Problems, "The survey report on fertility and mortality of Seoul city", *Journal of Population Studies* (Seoul), No. 3, 1966 tables 3-14.

Voluntary
  For employment
    In search of a job
    In search of a better job
  For studies
  Other
Obligatory
  Under transfer on service or business contract
Sequential, as of dependents
  Upon marriage
  Upon the move of another household member
  Upon political change (refugee)
  Other

The National Sample Survey of India has used the classification in its reports on internal migration[f] with some modifications. The explicit provision for refugee movements in this taxonomy illustrates the importance of historical or cultural reasons that may be unique to a few countries.

Possibilities of longitudinal analysis

Survey data offer a number of possibilities for the longitudinal analysis of internal migration. Some of these methods are not readily possible, or even possible at all, from multipurpose complete censuses that are taken at intervals of five or ten years. There is considerable interest in knowing the migration histories, or parts of them, for persons, families or cohorts. From this information, one could compile statistics on total number of migrations since birth or during a fixed period of time, the extent of migration by stages and of return migration, the effect of earlier migration on the probability of migration in a subsequent period, and so on.

There are several ways in which data of these sorts can be produced from surveys. These include (*a*) tabulation of age cohorts from successive surveys, (*b*) matching cases between successive surveys, and (*c*) the collection of migration histories. The retrospective data of lifetime migration histories are especially subject to bias—errors of recall, lack of knowledge, attrition of cohorts over time etc. On the other hand, surveys here, as elsewhere, have the potentialities of collecting a rich variety of social and economic characteristics for the study of differentials, whereas registers are limited to a relatively few standard items. An integration of the two sources, survey and register, is an especially promising means of securing longitudinal data. Neymark's study[g] was formulated in terms of selective aspects of Swedish internal migration and social factors associated with occupational shifts.

A 10 per cent sample of the 1928 male birth cohort was chosen serially in 1948/49 at the time of the compulsory registration of this cohort to determine fitness for military service. Neymark traced these 21-year olds back in time to approximately 1942, when, at the age of 14, they had completed their elementary education, and

[f] India, Directorate of National Sample Survey, *The National Sample Survey, Ninth, Eleventh, Twelfth and Thirteenth Rounds, May 1955-1958*, No. 53 (Delhi, 1962).

[g] E. Neymark, op. cit. (especially part I). The English summary used here is adapted from Dorothy S. Thomas, "Internal migration in Sweden; a recent study", *Population Index* (Princeton, N.J.), vol. 29, No. 2, April 1963, pp. 125-129.

forward to 1956, when they were 28 years of age. The original sample of 4,590 was reduced to 4,487 by excluding those who had immigrated to Sweden after 1942, and those who had emigrated or died between 1942 and 1956. Of the target sample of 4,590 only 3 were untraceable. By collating data from the central conscription register with information from the local population registers, from two waves of questionnaires, from interviews and field investigations, Neymark obtained the following coverage:

	Percentage completeness
Community of residence in 1942, 1949 and 1956	100
Father's (or father surrogate's) occupation and status in 1942	100
Level in schooling by 1949 and by 1956	100
Vocational training by 1949 and by 1956	100
School "grades" achieved by students who did not proceed direct from elementary to secondary schools in 1942	98
Intelligence test score on Swedish induction test, in 1948	94
Height in 1948	95
Occupation and status in 1949 and 1956	100

Migration status of each member of the cohort sample was defined in terms of the community (the smallest Swedish administrative unit), of which there are several thousand. "Non-migrants" were those residing in the same community at successive reference dates; migrants, those who changed residence from one community to another. Migration streams were delineated according to the urban or rural character of each community of origin and destination, following in general the administrative classification of such communities as of 1952. The distance factor was taken into account by further classifying streams as intra-county and intercounty, counties being Sweden's largest administrative units and numbering only 25. Thus, for analysis of migration differentials, there were two main classes of "non-migrants", that is, persons resident in the same rural or the same urban community at successive reference dates; and eight main classes of migrants, namely:

Origin	*Destination*
A rural community	1. Another rural community in the same county
	2. Another rural community in a different county
	3. A town in the same county
	4. A town in a different county
A town	5. Another town in the same county
	6. Another town in a different county
	7. A rural community in the same county
	8. A rural community in a different county

In some analyses, the total experience over the fourteen-year period (1942 to 1956) was utilized; in others, "early" migrants (that is, those whose change of residence occurred by 1949) were isolated from "late" migrants (that is, those, who had not migrated by 1949, but had changed residence by 1956), as were small numbers of "return" migrants (that is, those who lived in different communities in 1942 and 1949 but had returned to the 1942 residence by 1956). In still other analyses, rural origins and destinations were differentiated by agglomeration level (that is, the proportion of the population living in administratively defined "clusters"), and by occupational structure (that is, the proportion of the economically active population engaged in agricultural and non-agricultural pursuits, respectively). Similarly, town origins and destinations were subdivided by size classes, from small towns of less than 10,000 inhabitants through intermediate classes to the three metropolises and their suburban rings. As with rural communities, the town classification was held constant at the 1952 level.

Some idea of the richness of the analysis is shown in the following summary of various types of migrants classified by Stanine ("Standard nine") Scores on intelligence tests.[9]

Migration status as of 1956	*Score*
Rural non-migrants	4.19
Rural to rural, same county	4.20
Rural to rural, different county	4.93
Rural to town, same county	4.71
Rural to town, different county	5.48
Town non-migrants	5.50
Town to rural, same county	4.88
Town to rural, different county	5.88
Town to town, same county	6.16
Town to town, different county	6.55

Cohort tabulation

Let us assume that data on migration are collected annually and relate to a one-year period. Each year these data could be tabulated by single years of age. No periodic survey has a sample large enough to support reliable migration data in such fine age detail, but the age data could be combined into five-year groupings on the basis of birth cohorts. Thus, for the first year, a grouping would be 15-19 years, for the second, 16-20, for the third, 17-21, and so on.

In lieu of a tabulation by single years of age, published statistics for five-year age groups could be arranged so as to show the experience of cohorts at five-year intervals. Ideally, for this purpose, the migration question should relate to residence five years ago. If it relates instead to residence one year ago, as in the Current Population Survey of the United States, the arraying of the statistics is more complicated. There is a choice between: (1) limiting the table to every fifth survey year, thereby omitting four fifths of the migration history, or (2) showing all the survey years with considerable overlap of the five-year cohorts.

For an illustration of the first procedure, table 57 has been constructed. The choice of age groups was limited by the tabulated detail. These fragmentary statistics suggest the methods of analysis. Within the age range shown, each cohort's migration rate declines with age just as is found in cross-sectional data. The next question would be whether some cohorts had higher rates than others at each age. To compare rates for this purpose, one reads along the diagonal. Has the 1931 to 1935 cohort, for example, been characterized by relatively high migration rates during its lifetime? More plausible, perhaps, is the hypothesis that cohorts will have different "profiles" of rates with relatively high rates at one age being partially compensated by relatively low rates at other.

Matched cases

In the Current Population Survey, three quarters of the housing units designated at any given time are supposed to be in the panel again one month later and half are included twelve months later. In such circumstances, checks can be made in a given survey on persons listed in the preceding survey of the same panel to find out whether they had moved away during the interval. Again, there can be procedures for finding out where the respondents have gone and hence for determining whether or not they qualify as migrants. These efforts do not of themselves generate longitudinal data, but, if the panel members when interviewed had been asked about residence one year ago, five years ago, at birth etc., data on mobility in at least two successive periods would have resulted. Still another possibility is the matching of persons included in a current survey with those listed in a census, especially if different migration periods were covered in the two sources. Such a matching study was carried out in the United States in connexion with the 1960 census.[10]

[9] E. Neymark, op. cit., pp. 207-208.

[10] Shryock and Larmon, op. cit., pp. 581-853.

TABLE 57. AVAILABLE MIGRATION RATES FOR SELECTED MALE COHORTS, FOR THE UNITED STATES OF AMERICA, 1950/51 TO 1965/66

Survey year	Birth cohort					
	1941 to 1945 [a]	*1936 to 1940*	*1931 to 1935*	*1926 to 1930*	*1921 to 1925*	*1916 to 1920*
(a) *Age at time of survey*						
1965/66	20 to 24	25 to 29	30 to 34			
1960/61		20 to 24	25 to 29	30 to 34		
1955/56			20 to 24	25 to 29	30 to 34	
1950/51				20 to 24	25 to 29	30 to 34
(b) *Migration rate*						
1965/66	16.4	13.6	9.6			
1960/61		17.1	13.8	8.3		
1955/56			18.9	11.7	9.5	
1950/51				13.3	13.1	10.3

SOURCE: United States Bureau of the Census, *Current Population Reports*, Series P-20 (Washington, D.C., Government Printing Office).

[a] More precisely, April 1941 to March 1964 etc., for a survey taken in March. Moreover, some of the earlier surveys were conducted in April.

Migration histories

Finally, there are the migration histories (or rather the listing) of past areas of usual residence) that have been collected in a number of sample surveys around the world. These are not limited to national sample surveys. Since a relatively small proportion of the population may be casual drifters who change residence very frequently, the surveys do not usually attempt to record *all* formers residences (or all moves) but only the last "k" residences and perhaps also the area of residence at birth. Furthermore, the exact address is usually not recorded but only the area of residence, and there may be other restrictions on the information recorded. Thus, for example, the May 1958 supplement to the United States *Current Population Survey* recorded three previous residences; and, if these did not account for all previous residences, the area of birth was also requested.

> "A minimum stay of one year was required for an area (other than that of birth) to be recorded in the list of previous residences. Moves within a county were not recorded unless they involved a change in type of residence, e.g., from farm to non-farm. Furthermore, migration connected with service in the Armed Forces was not recorded."[k]

On the other hand, a survey conducted in France in 1961 obtained information on all residences after the age of 15 from a sample of persons of voting age.[y] The areal unit was the commune, except that changes of residence between communes within the larger agglomerations were not counted.

One of the earliest, if not the earliest, collections of migration histories in a scientific sample survey was in the Michigan Population and Unemployment Census of 1935. This sample "census" of a state obtained a history of the occupation, employment status and place of employment of every person 15 years old and over for the period from April 1930 to January 1935.[z]

A few more details may be given about the May 1958 Current Population Survey. From the individual places or counties recorded as former residences, codes and recodes were established for such items as size of place, region, number of migrations and distance-type of first migration. These items have been tabulated by size of place and region at the time of the survey, age, sex and colour; and the resulting set of tables has been published as a special report by the United States Bureau of the Census (cited in footnote *x* above) Figure V is taken from that source.

Analyses by the Public Health Service of other tabulations from the same survey have tended to focus on duration of residence rather than directly on migration in view of that agency's interest in environmental exposure to air pollution etc.[aa] In studying migration streams, K. Taeuber assigns each move to a specific cohort and to the age group at which the move occurred. For each cell, he tabulates size of place of residence at origin and destination, and points out that additional available characteristics can be introduced as controls.

> "One way to handle these data is to percentage each row across and regard each table as a stochastic transition matrix. A variety of methods for handling social mobility data as transition matrices has been elaborated recently."[bb]

Other types of analysis by Taeuber of these migration histories collected in 1958 are illustrated in figure VI and table 58. The indices of dissimilarity given in table 59 are computed by the method described in connexion with census data in this Manual (see chapter IV).

The tables from the study by Lansing and Mueller are brief and closely integrated into the textual discussion. Table 59 illustrates

[x] United States Bureau of the Census, *Current Population Reports*, Series P-23, No. 25, "Lifetime migration histories of the American people" (Washington, D.C., Government Printing Office, 1968), p. 1.

[y] Guy Pourcher, *Le peuplement de Paris*, Institut national d'études démographiques, Travaux et documents, Cahier No. 43 (Paris, Presses Universitaires de France, 1964). See also Alain Girard, Henri Bastide and Guy Pourcher, "Mobilité géographique et concentration urbaine en France; une enquête en province", *Population* (Paris), vol. 19, No. 2, 1964, pp. 227-266; and Guy Pourcher, "Un essai d'analyse par cohorte de la mobilité géographique et professionnelle", *Population*, vol. 21, No. 2, 1966, pp. 357-378.

[z] Michigan State Emergency Relief Administration, *Mobility of Labor in Michigan* (Lansing, May 1937), by John N. Webb, Albert Westefeld and Albert H. Huntingdon, Jr.

[aa] From the standpoint of migration analysis, the most definitive report on this study is: Karl E. Taeuber, Leonard Chiazze, Jr. and William Haenszel, *Migration in the United States: An Analysis of Residence Histories*, Public Health Monograph, No. 77, United States Department of Health, Education and Welfare (Washington, D.C., 1968).

[bb] Karl E. Taeuber, "Cohort migration", *Demography* (Chicago), vol. 3, No. 2, 1966, pp. 420-421.

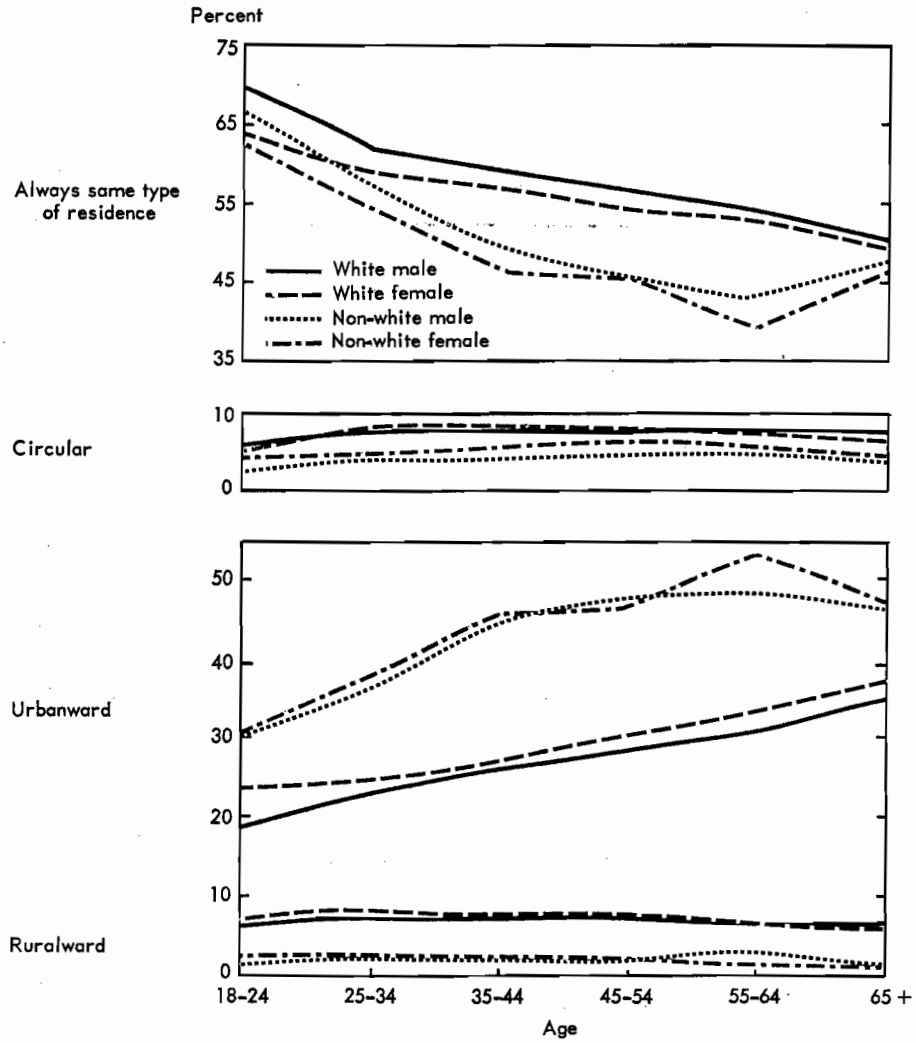

Figure V. Lifetime migration histories of the people of the United States of America

SOURCE: United States Bureau of the Census, *Current Population Reports*, Technical Studies, Series P-23, No. 35, 8 March 1968 (Washington, D.C., Government Printing Office). This figure originally appeared in Shryock and Larmon, "Some longitudinal data on internal migration", *Demography* (Chicago), 1965, No. 2.

how they abstracted facts from their migration histories to present a picture of cumulative mobility since birth and since leaving high school.

Other uses of sample surveys

The principal uses of sample surveys have been described in the preceding sections. Where surveys have been repeated at irregular intervals and are thus unsuitable for conventional time series analysis, they may still serve an important function in indicating trends and patterns of change. For example, in the six surveys conducted between 1951 and 1962 in the Tokyo Metropolitan Area[cc] (in connexion with the rice-rationing prógramme), heads of migrant households were required to register at both the old and new local offices and to fill in questionnaires for themselves and their family members. The questionnaires thus yielded data on area of origin and destination and occupation both before and after migration along with data on characteristics of the migrants (age, sex, relation to head, marital status, income, school attendance and educational status).

Sample surveys are especially useful in experimenting with meaningful reference dates for the migration interval, on the assumption that important historical events may be more readily remembered than an arbitrary point of time such as five years before the survey date. Examples are the reference date, of the "military coup" of 1961, in the special demographic survey of the Republic of Korea in 1966; and those in the CPS Survey of February 1946,[dd] which included residence both at the time of the 1940 census and

[cc] Reports on the Migration Survey of Tokyo, published in November 1951, February 1952, May 1956, October 1956, April 1957 and July 1962 by the Tokyo Metropolitan Government.

[dd] See the questionnaire for the special demographic survey of the Republic of Korea, 1966, and also United States Bureau of the Census, *Current Population Reports*, Series P-20, No. 4.

TABLE 58. INDICES OF DISSIMILARITY COMPARING SIZE-OF-PLACE DISTRIBUTION OF EACH COHORT AT EACH AGE WITH DISTRIBUTION AT PRECEDING AGE

Cohort		*Index comparing:*				
Years of birth	*Age in 1958*	*Birth and 18*	*18 and 24*	*24 and 34*	*34 and 44*	*44 and age in 1958*
1933-1940	18-24	7.5 (1945)	6.9 (1954)	—	—	—
1923-1933	25-34	5.7 (1937)	6.6 (1949)	5.7 (1952)	—	—
1913-1923	35-44	6.6 (1927)	5.9 (1939)	8.2 (1947)	3.2 (1952)	—
1903-1913	45-54	7.7 (1917)	4.9 (1929)	4.1 (1937)	3.3 (1947)	3.1 (1952)
1893-1903	55-64	5.9 (1907)	6.1 (1919)	4.1 (1927)	1.8 (1937)	6.0 (1947)
To 1893	65 and over	5.7 (1892)	4.8 (1904)	6.1 (1912)	0.5 (1922)	11.6 (1932)

SOURCE: Karl E. Taeuber, "Cohort population redistribution and urban hierarchy", *The Milbank Memorial Fund Quarterly* (New York), vol. 43, No. 4, October 1965, part 1, p. 453.

Note: Years shown in parenthese are medians of approximate corresponding calendar-year intervals.

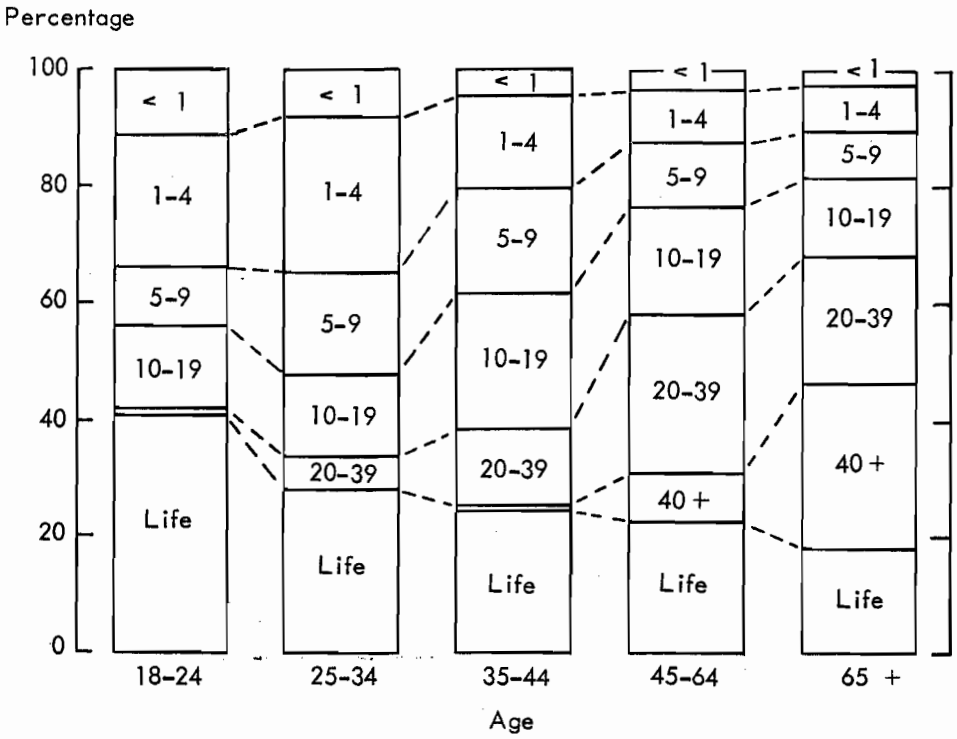

Figure VI. Duration of residence in current place; percentage with specified years or longer, by age, United States of America, 1958

SOURCE: Karl E. Taeuber, "Duration of residence analysis of internal migration in the United States", *The Milbank Memorial Fund Quarterly* (New York), vol. 39, No. 1, January 1961, page 124, figure 3.

TABLE 59. CUMULATIVE MOBILITY OF FAMILY HEADS
(Percentage distribution of heads of families)

	Percentage of heads of families
Lifetime mobility	
Moved to present area within last 5 years	16.0
Moved to present area since 1950 but not in last 5 years	14.0
Lived in present area since 1950 but born elsewhere	38.0
Lived in present area since 1950, born there, but once lived somewhere else	5.0
Lived in present area since 1950, born there, never lived anywhere else	27.0
TOTAL	100.0

TABLE 59. *(continued)*

	Percentage of heads of families
Mobility since high school	
No longer live in area where graduated or left high school	57.0
Live in area where graduated or left school, once lived away in service	4.0
Live in area where graduated or left school, once lived elsewhere (other than service)	8.0
Live in area where graduated or left school, never lived elsewhere	31.0
TOTAL	100.0
Number of heads of families	3,991

SOURCE: University of Michigan, Survey Research Center, *The Geographic Mobility of Labor*, by John B. Lansing and Eva Mueller (Ann Arbor, Michigan, 1967), table 2.

also as of 14 August 1945 (V-J Day). A variant of this procedure is in terms of key stages in the informants' life cycle, as in the British survey described by Friedlander and Roshier,[ee] where the reference dates for informants and their spouses were "at birth and at the time of first meeting their future spouses". Correspondingly, in the Canadian National Sample Survey of January 1966, each respondent was asked where he had obtained most of his (or her) elementary education, high school or secondary education, college or university education. It has already been noted that in Neymark's Swedish study a chief reference point was place of residence at the time of completing elementary education.

Finally, the importance of detailed cross-classification of characteristics of migrants (especially to control for variations in underlying demographic factors such as age and sex) must be re-emphasized. This is only possible when the sample is quite large, as in recent CPS surveys where almost 50,000 households are interviewed. Large samples also make it possible to introduce some regional detail and to determine stream differentials.

[ee] D. Friedlander and R. J. Roshier, "A study of internal migration in England and Wales; part II, recent internal migrants: their movements and characteristics", *Population Studies* (London), vol. 20, No. 1, July 1966, pp. 45-59.

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