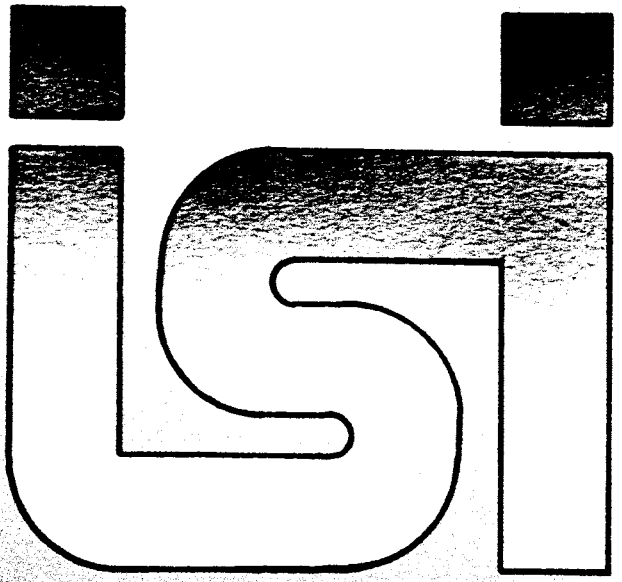

BULLETIN OF THE INTERNATIONAL STATISTICAL INSTITUTE

BULLETIN DE L'INSTITUT INTERNATIONAL DE STATISTIQUE

PROCEEDINGS OF THE 44th SESSION

ACTES DE LA 44ème SESSION

TWO BOOKS — DEUX LIVRAISONS

VOLUME L — BOOK 2
TOME L — LIVRAISON 2

Madrid, 1983

MEASURING FLOWS AND STOCKS OF INTERNAL MIGRANTS : SELECTED STATISTICAL ISSUES

Daniel Courgeau
Institut National d'Etudes Démographiques. France

INTRODUCTION

The continuous locomotion of human beings leads to very complex patterns, when trying to study scientifically changes in population spatial distribution. In view of such a complexity, some crisps but useful concepts emerge as a necessary simplification step to handle geographic mobility.

In many countries, the first mean to get a measure of spatial redistribution was the use of "net migration" concept. Such a concept is a very abstract one, as nobody ever met a net migrant, but a very easy one to measure with widely used data on population. On comparing a local population count from successive censuses with its natural increase during the intercensal period, it is easy to calculate net migration with the use of a balancing equation between these terms. In the past, such a concept was the main used one and is always very useful in developing countries and even in developed ones for its estimation simplicity (Lee, 1957 ; United Nations, 1970).

However to understand the relations between changes in spatial distribution and changes in economic development, it is useful to go beyond this concept. It may be necessary to know the place from which a migrant comes and the place where he goes to assess the effect of economic variables on migrants flows. Such an idea leads to identify a "migrant" as an individual whose place of residence differs at the beginning and the end of a certain interval of time. When the interval is the whole individual lifetime, he will be a "lifetime migrant". Another point of view can be taken when considering only the "latest migration" undertaken by an individual. In this case, the period of observation is variable from an individual to another. Such new concepts lead to add census questions on place of birth, place of residence at a previous date, previous place of residence and duration of residence in the current one. Provisional results from an U.N. survey undertaken in 1975 on 105 countries (United Nations, 1978), gave the following percents of countries by kind of measured concept : 86 percent for lifetime migrants, 76 percent for previous place of residence, 57 percent for duration of residence and 56 percent for migrants.

Again such an approach missed the whole migration process taking place during an individual life history, to pick up a very restricted sequence of events. This leads to a further insight where every "migration" occuring during an individual life is to be taken into account and related to the other ones. In that case the process may be generalized to include more temporary or seasonal moves that may be important steps in an individual life. It will no more be possible to measure all these events through censuses, for the multiplicity of moves to be taken into account. In countries with population registers it may be possible to undertake such a task. However for cost consideration and for purposes of

protecting the privacy of the individual this is mostly impossible. In fact, the use of surveys will be the main way to get such informations. These surveys, rarely undertaken in the past, are now becoming an important approach to migration process as well in developed as in developing countries.

The purpose of this paper (1) is to relate more precisely the previous concepts and to find a general framework that will permit to see easily what are the missing elements connecting these concepts. Then we will try to estimate some of these missing elements to get more comparable results.

1 - CONCEPTS

To have a better understanding of migration phenomena it seems important to recognize first that space and time concepts are not primary ones. Such concepts have been elaborated by mankind as a way to bear some more primary acts. On analysing how the infant constructs an objective space, Piaget and Inhelder (1947) had shown that such a space is not preexistent to this elaboration but created by it. It may then be possible to understand more deeply the elaboration of space and time by men through some more fundemental actions.

To bear such acts the existence of relational systems, composed of individuals in interaction with each other, in certain specified ways, seems to be the rule. Different types of relational systems may be distinguished as family, economic, political, religious, associational or educational ones. Each of these systems can therefore give rise to general categories of culture as space, time, age, sex, occupation... It is then important "to recognize relational systems as the locus within which these categories have their origin and acquire their meaning" (Arensberg and Kimball, 1965 : 269).

Each of these relational systems develop their own space and time, linked with the other ones, that the social scientist will try to decode through different approaches.

Let us take first a mainly political point of view. The consolidation of national states and state bureaucraties tend to attach people to places of residence where they can be registered and enumerated. The definition of such places may be as precise as possible, so that at any time one and only one usual residence can be assigned to each individual. It is then easy to define a permanent migration as a change of residence from a place of origin to a place of destination. However such a concept is only applicable in the case of settled or relatively settled populations. It is no more valid for nomads or semi-nomads. Even for relatively settled populations the definition of one and only one place of residence at one time for every individual, will sometimes be problematic (Courgeau, 1980 : 14-15).

Such a concept, useful for a political point of view, to attach people to residences wher they can be registered, enumerated, taxed and drafted, may be less useful for another point of view, for example an economic one.

Another concept may be related to the dwelling unit, that is a statistical abstraction denoting housing accomodations appropriate for occupation by one household. Change of dwelling - in many cases a temporary or seasonal movement - may be defined. It is a useful concept to know more about potential man-

power available at every time in a given area. It may be adopted for studying nomadic or semi nomadic population, contrary to change of residence.

This concept may also be related to permanent migration. Since at any time a person is attributed no more than one usual residence and one dwelling, sometimes these two places may be the same, at other moments they are different. In some cases, a change of dwelling may be simultaneously a permanent migration. In other cases a change of dwelling may not induce any permanent migration. So that the number of changes of dwelling in an individual life will be more important than the number of permanent migrations.

When changes in dwelling are numerous, some limitations may be made on their definition (Courgeau, 1980, 16-17). However such a concept enables us to see more clearly the importance of temporary moves on the economy of a region or a town : since at any time an individual is attributed no more than one dwelling, the methods of analysis used for permanent migration may also apply to changes in dwelling ; this is an important advantage.

Such a concept mainly useful for an economic analysis, will however miss a more synthetic approach, using the different relational systems.

We will try here to present a more general concept which takes into account these relational systems. We define at any time an individual living space that may include every place with which he may be in relation for family, economic, political, associational, educational reasons. Every change of living space through time can then be considered.

The measurement of such a living space in its whole generality is very difficult, and in many cases we must restrict to some places very often visited during individual's life : dwelling, working place...

The use of this concept will result in a very different analysis from the two preceding ones. It involves following not only one place through time, but many places. Some of these places may disappear and other appear in the living space, or certain may change localization, inducing a very elaborated analysis. Some new concepts may be introduced such as : extension or restriction in living space, partial or total tranfer, in some cases accompanied by extension or restriction etc.

Such concepts are currently very rarely used, but we think they will broaden the analysis of human mobility, replacing man in the context of his entire living space and relational system. But, because they involve very different measurement problems than the two preceding concepts of permanent migration and change of dwelling, we will no longer develop this approach in this paper. However for future research it is important to take this broader point of view.

2 - WHAT IS MEASURABLE

Once the concepts defined we have to see in more detail what is measurable and to try to relate each measurement with other ones. To undertake this comparison we need a general notation that will be fit for use in every kind of measurement. However to simplify the presentation in this paper we make the hypothesis that during the period of observation no more than two moves may be

observed. this hypothesis may easily be relased, without important changes in the results obtained (Courgeau, 1980 : 24-25). Such a notation may also be used for migrations as well as for changes in dwelling.

We represent here the spatial trajectory (2) of an individual by the different successive places of residence (or dwelling) during the studied period, with duration t. Such a period may be the whole individual life, when using place of birth data, or a shorter one. When the successive places are specifically defined they are represented by the letters i, j, k ; when they are only different places in the country, without any specification, they will be represented by the letters a, b, c (3). The foreign countries are represented by the letter f.

With these conventions, the notation (i, j, k) represents the number of individuals living in place i at the beginning of the period t, who undertake a first migration (or move) to area j before going to area k where they live at the end of the period. The notation (a, b, c) represent the number of individuals having three different successive places of residence in the country during the studied period.

We are considering here a cohort born before, or at the beginning of the observation period and we suppose first that such a cohort is not open to international migration and that no deaths occur.

A first measure is to consider individual place of residence only at the beginning and at the end of the studied period, whatever the individual path may be. This leads to the definition of <u>migrants</u> from place i to j :

$$m_{ij}(t) = (i,\ldots, j)_t = (i, j)_t + (i, a, j)_t$$

We can see that such a definition blots out the variety of migrations undertaken during the period. Even, when an individual who has moved from place i to j comes back to area i, he will no longer be registered as a migrant between these places. Such a definition, useful to study changes of residence, is of less interest to study temporary moves.

Another kind of measurement is to consider only the last place of residence during the observation period. This leads to the definition of <u>latest migrants</u> from place i to j :

$$\mu_{ij}(t) = (\ldots, i, j)_t = (i, j)_t + (a, i, j)_t + (j, i, j)_t$$

This measure is the same as the preceding one only when every individual undertakes no more than one migration during the period. Such an hypothesis that can be appropriate for very short periods, will be no more true when the duration of observation increases. This measure registers some return migrations $(j, i, j)_t$, not accounted for in the migrant definition. Individuals undertaking multiple migrations will be of different kind from one definition to the other : their numbers are not directly comparable.

A third kind of measurement is to count every registered migration. This leads to the definition of <u>migration</u> from place i to j :

$$M_{ij}(t) = (..,i,j,..)_t = (i,j)_t + (a,i,j)_t + (j,i,j)_t + (i,j,a)_t + (i,j,i,)_t$$

This is a count of events, so that a same individual may be registered as many times as he moved. Such a count of migrations may be easily related to the count of latest migrants :

$$\mu_{ij}(t) \leq M_{ij}(t)$$

Because the count of migrants introduced a term $(i,a,j)_t$ that is not included in the count of migrations or latest migrants, no simple ordinal relation can be found between these counts. When considering internal migrants or migrations, without attending to area of departure or arrival, we can write :

$$m(t) = (a,b)_t + (a,c,b)_t$$

$$\mu(t) = (a,b)_t + (c,a,b)_t + (b,a,b)_t$$

$$M(t) = (a,b)_t + 2(a,c,b)_t + 2(b,a,b)_t$$

As $(a,c,b)_t = (c,a,b)_t$, the following relation is then true :

$$m(t) \leq \mu(t) \leq M(t)$$

Such a relation may be useful when testing the validity of different data sources for the same country.

When measuring net migration or a net number of migrants (or latest migrants) the following relations can be found :

$$m_{ai}(t) - m_{ia}(t) = (a,i)_t - (i,a)_t + (a,b,i)_t - (i,a,b)_t$$

$$\mu_{ai}(t) - \mu_{ia}(t) = (a,i)_t - (i,a)_t + (a,b,i)_t + (i,a,i)_t - (a,i,b)_t$$

$$M_{ai}(t) - M_{ia}(t) = (a,i)_t - (i,a)_t + (a,b,i)_t - (i,a,b)_t$$

In this case, net migration and net number of migrants lead to the same result. It may be shown that this is true whatever the number of observed moves by individual may be. When calculating at net number of latest migrants, the result is quite different. When introducing mortality, these results hold no longer.

Let us now introduce international migration as a disturbing term (5) :

$$m_{ij}(t) = (i,j)_t + (i,a,j)_t + (i,f,j)_t$$

$$\mu_{ij}(t) = (i,j)_t + (a,i,j)_t + (j,i,j)_t + (f,i,j)_t$$

$$M_{ij}(t) = (i,j)_t + (a,i,j)_t + (j,i,j)_t + (f,i,j)_t + (i,j,a)_t + (i,j,i)_t + (i,j,f)_t$$

In countries with an important international emigration inducing a rather short duration for foreign stay, the term $(i,f,j)_t$ may introduce important differences between migrants statistics and latest migrants ones. In this case the only relations remaining true are :

$$\mu_{ij}(t) \leq M_{ij}(t) \qquad \text{and} \qquad \mu(t) \leq M(t)$$

To go further it is necessary to get estimates of the terms differenciating the measurable numbers. Before doing this, let us first present the main data sources on migration.

3 - THE MAIN EXISTING DATA BASES ON MIGRATION

Three main types of data sources are considered here : population registers with other administrative records, population censuses, surveys (retrospective or repeat ones).

3.1 - Population registers

We are considering here mainly population registers without assessing the different administrative record, that migth be used to have some information about migration. In these registers every member of the population may indicate any change of residence, for administrative purposes. So that statistical information on migration may have become available as a by-product, without being the main purpose of registration. For example, from U.N. survey (U.N., 1976 : 17) . European countries with registers get data on birth place in 27 percent of them, on duration of residence in 25 percent of them and on place of previous residence in 15 percent of them, from these registers.

However in some countries, as Hungary for example (Szabady, 1974 : 92), every citizen is obliged to report changes in is permanent residence and in his temporary dwelling. Such registers give information on migration and on changes of dwelling. Each individual is allowed to have at each moment a maximum of one permanent residence and a temporary dwelling : it is then possible to compare statistics on the two kinds of moves.

We will focus here on explicit checks on completeness and consistency of such data. A detailed study made in Belgium by Poulain (1978) gives an example on internal consistency check of population registers, another made in Japan by Kono (1971) gives some ideas about completeness of register data in comparison with other census information.

It is possible from such register data to have two different informations for one given move : from place of origin i, it may be registered as an out-migration $E_{ij}(t)$, and from place of destination j, it may be registered as an in-migration $I_{ij}(t)$. If the registration system is entirely consistent, we will have :

$$I_{ij}(t) = E_{ij}(t) = M_{ij}(t)$$

for every period of observation t.

In Belgium, for a one year period, this equality is verified for only 626 flows from a total of 1.892 between 44 districts (arrondissements). Even 253 from these 626 flows are null. On comparing in-migration flows with corresponding out-migration ones a systematical underestimation, around 1 percent, of out-migration flows had been found. Such an underestimation is to be related to legal Belgian dispositions (Poulain, 1978 : 16). However if this cause was the only playing, every differences between $I_{ij}(1)$ and $E_{ij}(1)$ will be positive or zero ones. In 1975, the reverse was true for 526 flows. So that the completeness of registration is to be taken into account. This completeness is depen-

ding on registration errors and on misreporting that were not the same for every place of registration. A third kind of error is to be introduced, due to random fluctuations in registration of $I_{ij}(1)$ and $E_{ij}(1)$. Such a random fluctuation introduces a standard error proportional to the square roots of $M_{ij}(1)$.To place in evidence such an error it is possible to estimate from the data a regression coefficient, a, verifying :

$$\left| I_{ij}(1) - E_{ij}(1) \right| = k \left(I_{ij}(1) + E_{ij}(1) \right)^{a}$$

The experimental values for a were .47 for 1970 data and .43 for 1975 data, what is near to the expected coefficient of .50.

Such a consideration led Poulain to propose a correction of these registration data, introducing two different series of parameters :

α_j : a parameter to correct registered in-migration in area j

β_i : a parameter to correct registered out-migration from area i.

This correction leads to more coherent data, when compared with other sources (latest migrants during last year for the 1970 census, for example).

A similar comparison for census and register data was also undertaken in Japan for the 1960 census, where a question on place of residence one year before was asked. For this period, Kono (1971) found that the ratio between register and census data was 1.013 for interprefectural migration. This result is consistent with theoretical considerations given in previous chapter. However on comparing in-migration or out-migration for every prefecture, such a result holds no more. For in-migration, this ratio lays between .6840 and 1.4023, for out-migration between .6423 and 1.2196. We know than in Japan the migration is recorded by the in-migration area, so that we may consider separately these inflows. First the registration completeness may be related to places of registration. The more industrialized and the more urbanized ones have lower ratios than the prefectures which are remotely located, less industrialized and less urbanized. The correlation coefficient shows + 0.537 between these ratios and the percentage of agriculture among male labour force for each prefecture (Kono, 1971, 2770). Another kind of error is to be introduced, due to random fluctuations in registration and census data, like in Belgium. Let us estimate a regression coefficient, a, verifying :

$$\left| I_{ai}(1) - \dot{i}_{ai}(1) \right| = k \left(I_{ai}(1) + \dot{i}_{ai}(1) \right)^{a}$$

The experimental value for a is 0.40, near to the expected coefficient of 0.50. Again, it might be possible to improve register data on taking into account census data on migrants. We will develop later some more general methods of linking different data sets.

3.2 - Population census The census data on internal migration relate to a little number of questions about previous places of residence. Cost consideration often make it desirable to keep this number to a minimum. These questions are mainly of two kinds.

The first one relates to the place of residence on a specific date before

the census. The length of the interval may vary according to the country considered and even for one country according to the census considered. In France, for example, such intervals were varying from a little more than eight years (1962 census) to six years (1968 census). However the time intervals most commonly selected are one year and five years. Most countries have also a question on place of birth, that will give a lifetime interval variable from an individual to the other. In any case these questions gave a count of migrants.

Another kind of census question may relate to the latest migration. One of these questions may be about the duration of residence in the place of enumeration, and the other about the previous place of residence. Some countries use only one of these questions alone, as others combine the two. It should be observed that two questions are necessary to get the full information about latest migration, whereas only one is useful to get information on migrants. It is also important here to consider only latest migrations between places of enumeration for which they were defined. Contrary to migrants, it is no more possible to have a count of latest migrations to a consolidation of these places of enumeration. Let us take the example of a net number of migrants or latest migrants to a consolidation of two places, i and j :

$$\mu_{a,iuj} - \mu_{iuj,a} = \mu_{a,i} - \mu_{i,a} + \mu_{a,j} - \mu_{j,a} + (a,i,j) + (a,j,i)$$

$$m_{a,iuj} - m_{iuj,a} = m_{a,i} - m_{i,a} + m_{a,j} - m_{j,a}$$

Since the (a,i,j) and (a,j,i) numbers are not registered by a question on previous place of residence, it is no more possible to have a count of $(\mu_{a,iuj} - \mu_{iuj,a})$. This might be an important point when testing the adequacy of the data to migration analysis.

We will first try to check on the accuracy of such counts of migrants or latest migration.

We previously told that such concepts are not appliable to the whole population. Persons without a fixed place of residence, nomads for example, are generally excluded from the count of migrants. In France, for the 1962 census, 257.960 individuals were excluded as nomads, prisoners... Persons who gave no answer to such questions are to be considered. In France, the non-response rate to a question about migrants increased from 2.1 percent in 1962 to 2.7 percent in 1975. They are considered as non-migrants and this might induce an important undercount of migrants.

Such questions being retrospective ones, some remembrance problems may occur. The latest migration change may be inaccurately indicated especially when it is an old one. For migrants inaccurate indication may be given about place of residence at a given previous time from lapses of memory. It might be useful in some cases to use as previous time the date of an important national event or to try to rely this time to some more local events. Some difficulty may arise owing to changes over time in the administrative and other area boundaries. Because people are not likely to be aware of such changes, they may report their previous places of residence incorrectly.

Some other points are linked to the adequacy of such data for migration

analysis. In some cases place of birth statistics may lead to adequacy problems. In India, as it is customary to a woman to return to her father's household to bear children, this gives rise to inadequate migration data when using place of birth statistics. For recent periods, the location of medical facilities may induce some spurious migrations if the place of birth is not clearly defined as the place of usual residence of the mother at the time of the birth.

We said previously that some data on latest migrants may be inadequate for analysis, if the migration defining areas have not been accurately selected. These data may also be inadequate when undertaking population projections for subnational areas introducing migration, as they cannot give a measure of migrants during a precise period.

3.3 - Migration survey Relatively rare in the past, migration and mobility surveys are now overcoming some of the deficiencies of census data on migration. The traditional published census information consider mainly stocks of internal migrants, without a more general approach of a process through individual lifetime. Such a mobility process might include more general forms of mobility than migration : temporary or seasonal mobility, commuting... However tremendous range in the mobility types considered induces some restrictions (see for a more detailed review Goldstein and Goldstein (1981), Findley (1982)).

First the definition of the concepts taken into account need to be very precise. Findley (1982 : 12) found that half of the 155 surveys reviewed in her study, failed to specify the minimum duration of stay qualifying a person as a bona fide mover. Such a lack of specification may lead to important discrepancies between field workers, and may prevent any possibility of comparisons with other sources (censuses, other surveys...). We will see later that this possibility may be necessary to ensure the quality of survey data.

Once the concepts defined, the sampling areas definition may induce some problems. The use of cluster sampling, as in standard household surveys, may lead to an unrepresentative sample of migrants. Such a bias is to be linked to the existence of major migration areas, that may be let aside in a cluster sampling. For example, the elimination of a mining centre, that was a major focus for internal migrants, introduced a systematic bias in an Ugandan Survey (Prothero, 1976 : 122). In such cases a random sampling or a stratified random sampling will give the best coverage for migrants and non-migrants. However if the proportion of migrants is low in the major part of the country and high in a little number of urban centers, this solution may lead to a prohibitive cost of sampling.

In such cases other techniques may be used to increase the probability of interviewing a migrant, in selecting sampling areas with high proportion of migrants. The step survey (enquête par palier) undertaken in Tunisia (Picouet, 1982 : 215) answers to such a consideration. The first step is to interview a sample in the main destination areas (the capital and major towns of the country). From this sample a selection of the main origin areas of migrants will lead to another step of interviews in these areas. This movement to and fro might be continued several times to get a better precision for a given sample size.

Some problems, unusual with other kinds of surveys, may become prominent with migration surveys. It might be important for such surveys to follow one individual from its place of departure to subsequent places of residence. Usually, the place of departure may be known, but the following ones are to be found. Different ways may be taken to find these places of residence. The multiplicity method relying upon social networks may permit a better identification of migrant's actual place of residence. This method will select respondents that may give the better information on migrants' destination (Goldstein, 1981 : 49-50). Collomb (1982) extended such a method on using a tracer concept. From censuses data, he identified a number of out-migrants from a French region during the period 1954-1962. During the first stage, he got the localization of 79 percent of these migrants on using a multiplicity method in the commune of departure, 19 years later. Field-workers interviewed in these rural communes out-migrants family (when some of them still live there), village constable, game-keeper, postman, mayor or secretary of the commune. The second stage took place when interviewing these localized migrants. Field-workers asked them about the place of actual residence of some of the 21 percent others, coming from the same commune than themselves. The localization of the first out-migrant's group was generally perfect, and they gave the localization of the major part for the preceding unidentified out-migrants. With this method, he finds 98.2 percent of his sample. Further assesments of the multiplicity approach need to be made using larger samples and covering a broader range of moves. However the first results seem to give it considerable potential value for studying out-migration.

When such a survey has a retrospective part it might be useful to assess the memory recall errors, especially for old events. Several kind of errors may occur. The first one will be only a dating error, letting the sequence of events unchanged. An other error may change the sequence of events and we can also have the omission of some of these events. These last errors are the more serious ones. To assess the validity of retrospectively reported migration histories in a French survey (Courgeau, 1982), the same questionnaire had been used in French speaking Belgium where there exists a population register (Poulain, 1982). Such a test not yet completed will give further insight in these memory problems.

4 - METHODS OF LINKING DIFFERENT DATA BASES TO IMPROVE MIGRATION STATISTICS

In previous parts of this paper we used several times different data bases to get or to improve migration statistics. We will develop here such a methodology in two different directions. First we will review some methods not presented in the United Nations Manual (1970) that might be useful for developing countries having few migration data, mainly place of birth statistics. The other direction will be to use some results from migration surveys to get some estimates of the unknows elements when comparing migrants, latest migration and migration statistics.

4.1 - Use of place of birth data from different censuses to get intercensal migration statistics

Such a methodology was first presented by Friedlander and Roshier (1966) and then developed by Tugault (1973) to give migration estimates in past England and France. We think that it might be useful in developing countries where the only migration statistics relate to place of birth. However it might be necessary to have a more detailed view of the hypotheses on which to rely.

We shall use the previous notation, with slight modifications. Let (a,b,c) be the number of individuals born in place a, living in place b at the time of the first considered census and living in place c at the second one (6).

We are working on a cohort borne at the first census. Let us first consider the whole number of migrants in a country without specifying origin or destination areas. The deaths during the intercensal period are represented by the letter d.

The first census will give the numbers :

$$(a,b,.) = (a,b,b) + (a,b,a) + (a,b,c) + (a,b,f) + (a,b,d)$$

while the second one gives :

$$(a,.,b) = (a,b,b) + (a,a,b) + (a,c,b) + (a,f,b)$$

where a point indicates no information about place of residence at this time. From these equations we can write the following relation :

$$(a,.,b) - (a,b,.) + (a,b,d) = (a,a,b) - (a,b,a) + (a,f,b) - (a,b,f)$$

If we have an estimation of survival probability of migrants (a,b,.) during the intercensal period, ${}_np$, anf if we suppose that multiple migrations are negligible, we can then write :

$$\widehat{(a,a,b)} = (a,.,b) - {}_np(a,b,.) \qquad [1]$$

We have an estimation of first migrants during the intercensal period from place of birth statistics at the two censuses.

However we will see that these hypotheses usually are not true. As in France we have a question on place of birth and place of residence at the last census, we can got some estimates of the missing terms. Let us consider the cohort aged from 15 years to 24 years in 1975. The observed numbers are in each case for changes of departments :

$(a,a,b) = 611,870$

$(a,b,a) = 116,540$

$(a,.,b) = 2,198,510$

${}_np.(a,b,.) = 1,703,180$

From equation [1] we estimate :

$\widehat{(a,a,b)} = 495,330$

that gives an underestimation of the real value around 19 percent. We can see in that case that we cannot estimate first migration separately from place of birth data, but only the difference between first migration and return migration

$$(a,a,b) - (a,b,a) = 495,330$$

We can also compare such an estimate with the number of born in France migrants during the same intercensal period (7) :

$$(.,a,b) = (a,a,b) + (b,a,b) + (c,a,b) = 1,087,610$$

Again such a number is different from the previous ones : the return migrants are, in this case, added not substracted as previously and the number of migrants during the intercensal period, born in a third department is :

$$(a,a,b) = 359,200$$

Under these restrictions, the estimates from place of birth data may give a somewhat complex but very useful view of the evolution of migration in a country (Tugault, 1973).

Such a method may also be used to estimate flows between two areas i and j. It can be shown (Courgeau, 1980 : 55) that the following number may be estimated :

$$(i,.,j) - {}_n p(i,j,.) = (i,i,j) - (i,j,i) + (i,a,j) - (i,j,a) + (i,f,j) - (i,j,f)$$

The signification of such an estimate is more complex than the previous one, because we have other correcting terms for multiple moves added to the return ones.

4.2 - Some models to relate different measures

On using some hypotheses that may be tested from survey data on migration process, one might be able to relate more precisely the different proposed measures.

Let us first consider the simple case where an individual's migratory behaviour may be represented by a Markov process (Rogers et Willekens, 1978). The underlying hypotheses are that each move is independent from previous ones, and that the probability of a move is independent from the duration of residence in the area. Let us call m_{ij} this annual flow between areas i and j, the observed initial population for area i being $N_i(0)$.

With these hypotheses we can have estimates for every terms given in chapter 3. For example, if we are working on a two-year period, we can write :

$$(i,j,i)_2 = m_{ij}\, m_{ji}\, N_i(0)$$

$$(i,j)_2 = \left[m_{ij} \left(1 - \sum_{a \neq j} m_{ja}\right) + \left(1 - \sum_{a \neq i} m_{ai}\right) m_{ij} \right] N_i(0)$$

In that case, it is possible to calculate the number of migrations, latest migrations and migrants for a two-year period (Courgeau, 1982 : 15) :

$$M_{ij}(2) = m_{ij} \left[\left(2 - \sum_{a \neq i} m_{ia}\right) N_i(0) + \sum_{a \neq i} m_{ai}\, N_a(0) \right] \qquad [2]$$

$$\mu_{ij}(2) = m_{ij} \left[\left(2 - \sum_{a \neq j} m_{ja} - \sum_{a \neq i} m_{ia}\right) N_i(0) + \sum_{a \neq i} m_{ai}\, N_a(0) \right] \qquad [3]$$

$$m_{ij}(2) = \left[m_{ij} \left(1 - \sum_{a \neq j} m_{ja}\right) + \left(1 - \sum_{a \neq i} m_{ia}\right) m_{ij} + \sum_{\substack{a \neq i \\ a \neq j}} m_{ia}\, m_{aj} \right] N_i(0) \qquad [4]$$

Such relations may be generalized for every duration t. It can be shown that in matrix form the equation [4] may be written :

$$N(0) + m(t) = \left[I + M \right]^t N(0)$$

where N(o) is a diagonal matrix of the initial populations, M(t) the matrix of migrant's flows during the period t (8), and M the annual migration flows matrix. So that the matrix M may be calculated as :

$$M = \left(I + m\,(t)\, N(0)^{-1} \right)^{\frac{1}{t}} - I$$

when knowing such a matrix, every flow $M_{ij}(t)$ or $\mu_{ij}(t)$ can then be calculated.

However it had been verified that such an hypothesis is often far from reality. It may be useful to construct models that will permit to relate with a higher security some measures to others. A mover-stayer model is often more adequate to describe migration processes. In this model only a certain part of the population, k, has a non zero probability of undertaking a migration (movers) while the rest of the population has a zero probability of migration (stayers). Under these assumptions we will have two independent Markov processes whose mixture is itself no more markovian. For example, we can again calculate the number of migrations, latest migrants and migrants after a two-year period:

$$M_{ij}(2) = m_{ij} \left[\left(2 - \frac{1}{k} \sum_{a \neq i} m_{ia}\right) N_i(0) + \frac{1}{k} \sum_{a \neq i} m_{ai}\, N_a(0) \right]$$

$$\mu_{ij}(2) = m_{ij} \left[\left(2 - \frac{1}{k} \sum_{a \neq j} m_{ja} - \frac{1}{k} \sum_{a \neq i} m_{ia}\right) N_i(0) + \frac{1}{k} \sum_{a \neq i} m_{ai}\, N_a(0) \right]$$

$$m_{ij}(2) = \left[m_{ij} \left(2 - \frac{1}{k} \sum_{a \neq j} m_{ja} - \frac{1}{k} \sum_{a \neq i} m_{ia}\right) + \frac{1}{k} \sum_{\substack{a \neq i \\ a \neq j}} m_{ia}\, m_{aj} \right] N_i(0)$$

,

Again the last relation may be easily generalized in matrix form :

$$N(0) + m(t) = k \left[I + \frac{1}{k} M \right]^t N(0) + (1 - k)\, N(0)$$

whose solution M is :

$$M = k \left\{ \left[I + \frac{1}{k} m(t)\, N(0)^{-1} \right]^{\frac{1}{t}} - I \right\}$$

Again when such a matrix is known every flow $M_{ij}(t)$ or $\mu_{ij}(t)$ can be calculated.

More complex models have been developed, introducing new parameters, as probability of return moves that are nearer to reality (Courgeau, 1981 : 24-28). The research in this way will be very useful for a deeper understanding of such complex processes.

CONCLUSIONS

Since it was not possible, in such a contribution, to deal thoroughly every statistical issue related to the measurement of internal migration, we had to select some of them, that seemed to be of main interest in the current research on this topic.

At the present time new methods of measurement using mainly survey approach introduce a more detailed view of the migration process through individual life. Such an approach broadens the view of migration to more temporary or seasonal moves that might be useful to introduce for a better understanding of mobility processes. However the previous methods of measurement, mainly through censuses, may be related each other with this more synthetic approach.

We tried here to present a general notation that seems to be very useful to relate each kind of measurement (migrants, latest migrants, migration...) with the others and to develop from survey results some links existing between these measurements. Such a method gave also a new approach to ascertain the accuracy of different data sets.

For future research on these measurement problems, we think that a more general use of surveys will induce a better knowledge of migration processes and improve mainly the first results presented here. Such an use may be conducted in relation with other data sources (censuses, other surveys...) (Teller, 1982) to ascertain the quality of data and to permit a more general view of the migration process through family, economic, political... systems. The attemps presented here will be entirely fruitful if in a near future a larger team of research workers can investigate and develop their consequences.

NOTES

1 - This paper emerged from our participation to a ISI/IUSSP joint Ad Hoc Working Group on Internal Migration whose chairman was K.T. de Graft-Johnson and whose other members were J. Arevalo, S. Goldstein, M. Termote, K.C. Zachariah.

2 - To be more comprehensive it might be useful to add the times at which the changes occur.

3 - When considering together specifically defined places and not specifically defined others, these latest will always be different from the previous ones.

4 - This is the case for retrospective data obtained from censuses or surveys.

5 - As migrants or latest migrants are measured from retrospective census question, it is not useful to introduce death here.

6 - To be wrightly comparable with the previous notation, we should have used here (a,...,b,...,c) as there might be other different places of residence during the two considered periods.

7 - We have also to eliminate individuals born in France, living in foreign countries at first census, coming back to France at the last one.

8 - The diagonal term being $M_{ii}(t) = - \sum_{j \neq i} M_{ij}(t)$.

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RESUME

Une nouvelle étape dans l'étude des migrations humaines vient d'être franchie grâce, en particulier, au développement récent d'enquêtes sur la mobilité spatiale. Une réflexion approfondie sur les concepts montre que la mobilité est liée à l'inscription spatiale des systèmes de relations familiales, économiques, politiques... en interaction les uns avec les autres. Il est, dès lors, nécessaire d'introduire des concepts plus souples tels que le changement de logement ou d'espace de vie pour mieux saisir cette complexité. D'un autre côté, l'utilisation de diverses mesures ne doit pas faire perdre de vue l'unité du phénomène étudié. C'est pourquoi nous avons développé une notation synthétique qui permette de relier de façon quantitative les divers effectifs mesurés. Certains modèles ont enfin été présentés comme une première étape de cette synthèse.

SUMMARY

A new stage in the study of human migration has occured, linked to the recent development of spatial mobility surveys. When going deeply into the concepts used, we can recognize relational systems (family, economic, political... ones) to be the locus within which mobility processes took place. It is then useful to introduce some new concepts as change in dwelling or in living space to take into account this complexity. In another way, the use of different measurements will not leave out the consistency of the phenomenon under consideration. So that we bring in a synthetic notation that will permit to relate quantitatively these different measurements. Some more general models are then developed as a first step for such a synthesis.