Methods and techniques to measure and categorize migrant movements applied to the Brazilian states of São Paulo and Bahia

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The focuses of this paper are the improvement of migration methods and their application to the migration between the Brazilian states of Bahia and São Paulo.There are several techniques used to measure and categorize the level and pattern of migrant movements. Some researchers developed studies about population movements using techniques to build model migration schedules. These studies increased the ability to estimate migration rates. For instance, Rogers and Castro (1981) proposed the measurement of migration using model schedules. This idea is the same applied to fertility and mortality demographic components by previous studies (Brass 1971; Coale and Trussell 1974; Coale and Demeny 1966; Coale 1977; United Nations 1955). Rogers and Castro (1981) were the first demographers to construct model migration schedules by age and sex. This new migration technique was applied to a group of 17 countries: United Kingdom, Finland, Sweden, German Democratic Republic, Netherlands, Canada, Hungary, Soviet Union, Federal Republic of Germany, Austria, Poland, Bulgaria, France, Czechoslovakia, Japan, United States, and Italy.

Another study that tried to use model schedules to correct migration data was conducted by the United Nations (1992). This study focused the analysis on projections for regions, instead of countries. The main objectives of this study were the development of techniques to measure the migration between regions, the estimation of age and sex distribution of migrants, and the preparation of projections of future migration rates. The distribution of migrants by age and sex was estimated using the model age schedules developed by Rogers and Castro (1981).

The model migration schedules technique was applied in Brazilian research to estimate rural and urban population movements (Beltrão and Henriques 1987; Henriques and Beltrão 1986). The main objective of this research was to estimate rural-urban migration in Brazil. This information would be used as an indicator in the new proposal for National Public Health Insurance. Rogers and Castro's methodology was applied in this Brazilian research. This technique provided the estimation of model migration schedules for 1960-1970 and 1970-1980, by sex.

Some recent Brazilian demographic studies developed new techniques and models to measure and correct migration rates. These new methodologies present several advantages to the study of population movements. The first study that developed estimation of model migration schedules is the one elaborated by Jannuzzi (1998, 2000). Jannuzzi analyzes the migration's pattern and level in the Brazilian state of São Paulo. This study is very important to the improvement of migration, introducing new

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information and variables to model schedules. The suggestion is that migration can occur for several reasons and by an individual or group movement.

On the one hand, Jannuzzi categorized the reasons of population movement to estimate different migration models. One reason for migration can be the search for better work conditions. Another reason for migration can be an episode related to family movement. The third reason is the search for a cheaper place to live. Somebody can move to another place because he/she has previous information about that location. Migration can also be explained by the search for better life quality. Finally, Jannuzzi arranges a set of other reasons for human movement. The first is that after retirement a person can decide to move home. Another kind of movement is the returning migration to the original place of residence. Migration can also happen for studying purpose. At the end, the marriage can also cause population movement.

On the other hand, Jannuzzi disaggregates data in four different groups, depending on followers in the migration process. The migrant can move with the nuclear family. Another possibility is that the movement can occur with part of the nuclear family. Relatives or friends can be other followers in the migration process. Finally, migration can also occur by an individual movement.

Other research that tried to improve the estimation of population movements was organized by Machado (1993). Machado's main objective was to project the Brazilian population by regions: North, Northeast, Southeast, South, and Middle-West. To allow the population projection, Machado created a new technique to estimate migration rates by age and sex.

Although these two new studies provided important improvements to estimate migrant models and rates, these techniques still have some problems and limitations. Jannuzzi's methodology used a specific database for the state of São Paulo, which included information about reasons and followers in the migration. This kind of dataset is not common in most countries. Even in Brazil, censuses do not provide these types of variables. In the case of Machado's techniques, there are some problems in the formula used to estimate migration rates. Some corrections will be proposed in this article, with the goal of improving the results obtained.

One objective of this article is to explain previous methods to estimate migration models and rates as well as to show their limitations. Moreover, some changes in migration techniques will be suggested. The intention is to develop those migration estimations. The purpose is to improve techniques, which can be applied to different countries and databases. The Machado (1993) proposition is a good foundation upon which to build new techniques. This methodology can be applied to most censuses available worldwide.

The understanding of technical procedures is made through the use of real migration data. The Brazilian Censuses of 1980, 1991 and 2000 (IBGE 1980, 1991, 2000) were used to replicate previous techniques and to check the new one. More specifically, the new technique was applied to the migration between the Brazilian states of Bahia and São Paulo (IBGE 1980, 1991, 2000).

Technical procedures to develop new migration formulas will be explained in a separate section. This included both previous and new formulas. Previous formulas provide original mathematical thoughts made by Rogers and Castro (1981), Jannuzzi (1998, 2000), and Machado (1993). New formulas provide a better understanding of changes applied in original formulas.

This article is organized in six main sections. First of all, the explanation of previous migration techniques is provided. This furnishes the reader with information about previous important migration studies. After that, an explanation of new migration techniques is presented. This section shows how Brazilian demographers tried to improve those techniques. The third section provides the explanation of technical procedures used to calculate migration rates. Formulas and explanations about migration rates' terms are clarified, in detail, in this section. Following that, several propositions to model and adjust migration rates are analyzed. Explanations are provided to clarify the reason to not use one of those procedures. The fifth section shows the results obtained from Brazilian Censuses. Tables and figures are provided to illustrate migration patterns and levels between the states of Bahia and São Paulo. Finally, the main conclusions are detailed in the last section. A discussion about future uses of migration rates provides an interesting reflection about censuses data.

Model Migration Schedules

In this section the first studies about model migration techniques will be explained. The first research discussed here was conducted by Rogers and Castro (1981). Mortality and fertility models can furnish a suitable foundation to create model migration schedules. Model schedules are important for all demographic components because they arrange different observed data by similarities in level and pattern. Model schedules are made using information from many observed data collected in various populations. The creation of models for demographic variables is possible because mortality, fertility and migration rates behave in some predefined limits.

Former authors created some inflexible schedule models for mortality and fertility (United Nations 1955). These first demographic models are not sophisticated since they have just one parameter. Another problem related to these models is their inflexibility for different population patterns. Latter authors improved model schedules, using more parameters for mortality and fertility components. One case is the study of Coale and Demeny (1966) about mortality model-tables. Another mortality model is the logit system created by Brass (1971). The third one is the fertility model of Coale and Trussell (Coale 1977; Coale and Trussell 1974).

The development of migration models is very important for demographic studies. As in mortality and fertility, model schedules can be built to analyze the migration component. Migration schedules have more applicability when they have different families and several parameters. Rogers & Castro (1981) used propositions of previous mortality and fertility models to summarize regularities of migration variable.

The "correlational" perspective to build migration schedules used ideas from the study of Coale and Demeny (1966). This research developed model life tables, which synthesize indexes of level and several regression equations for different regions in the world (North, South, East, and West). Rates at different ages are associated to an index of level, which is the expected remained life at age 10.

The "relational" perspective used ideas from models that corrected shape and level of observed data, using a standard schedule. Brass (1971) developed the logit system, which relates different mortality schedules by a linear transformation of the logits of their respective survivorship probabilities. Mortality patterns are assumed to have regularity with limited modes of variation, which can be represented by life tables. Coale and Trussell (Coale 1977; Coale and Trussell 1974) improved model fertility schedules using a Swedish standard first-marriage schedule. Moreover, Coale and Trussel adopted a double exponential curve to define the pattern of first-marriage function, which is an analytical perspective of age profiles.

Rogers and Castro (1981) argue that model migration schedules need to have some singularities. Migration rates should be estimated for each single year of age to construct model schedules. However, the estimation for single ages is not usual because the most datasets have information by age groups. Using Swedish data, the authors estimate migration parameters by single years of age. After that, data are aggregated to five-year age groups and then disaggregated to single ages. Estimated parameters are very similar using single years of age or five-year age groups. Therefore, Rogers and Castro (1981) conclude that estimation can be made by age groups data for other countries.

The sum of all rates by single years of age equals the "gross migraproduction rate (GMR)," corresponding to fertility's gross reproduction rate. This rate is the average number of movements that a person would migrate from one specific region to another one, during all of his/her life. GMR measures the level of migration and it depends of the size of a specific area. Migration among larger areas has a lower level compared to that among smaller areas.

The crude migration rate is another estimation for residence movements. This rate is "defined as the ratio of the number of migrants, leaving a particular population located in space and time, to the average number of persons (more exactly, the number of person-years) exposed to the risk of becoming migrants" (Rogers and Castro 1981, p.2). This measure is useful in demographic studies, since it provides information about the level of migration between two different regions.

Migration presents selectivity by age and sex, such as argued by Carvalho (1981, 1985) and Rogers and Castro (1981). The notion of selectivity in migration is applied by Rogers and Castro (1981) in their model migration schedules. The shape and level of migration schedules vary depending on the age of analysis. Migrants between 20 and 25 years of age present highest rates. Lowest rates are presented for those people between 10 and 19 years of age. Migration rates between zero and nine years of age are a reflex of rates between 26 and 40 years of age. Migration to metropolitan areas presents high rates around the age of 65 years. Sex has also an influence on the shape and level of population movements. Men's migration rates are higher than women's rates. The highest migration rates for women occur in younger ages because they marry before men. For a longer period of time, return migration presents higher rates (Rogers and Castro 1981; Carvalho 1985).

The main objective of Rogers and Castro (1981) was the estimation of a model migration schedule. This model is advantageous because it can be applied in studies with limited data. The estimated migration curve is composed of four components related to labor market. The pre-labor curve is a negative exponential curve from zero until 19 years of age. The curve for migrants in labor age has a parabola shape. The first ascending half of this parabola represents the migration for those between 20 and 25 years of age. The second descending half of the parabola represents the migration for those between 26 and 40 years of age. The post-labor curve is a small parabola around the age of 65 years. The last parameter of the model schedule is a constant that adjusts the migration rates to the mathematic expression.

Rogers and Castro (1981) created three different model migration schedules. The most complete schedule is the one named as the "basic model migration schedule" (Rogers and Castro 1981, p.40). This schedule has all four labor-migration components listed above. The curve has a total of 11 parameters. The second migration schedule is defined as "reduced form" (Rogers and Castro 1981, p.40). This model does not present the post-labor curve around the age of 65 years. Without this last parabola, the reduced form has seven parameters. "Model migration schedule with an upward slope" is the third schedule presented by Rogers and Castro (1981, p.42). This last schedule has a linear curve in post-labor ages, instead of a parabola. The total number of parameters in this migration curve is nine.

These migration models enable the classification of different migration patterns. There is the possibility to analyze the highest migration rates. Through these schedules, it is possible to analyze the reflex of older migration to younger migration. Detailed explanation about technical procedures to estimate migration schedules will be written in a latter section.

The application of model migration schedules was also made by the United Nations (1992). The main goal of this study is the preparation of migration data for population projections. First of all, sources of data for migration projections are reviewed. Censuses data are qualified to migration projections because they indicate the exact place of residence for all the population. Surveys have the advantage of helping to construct databases with more information about migrants. Moreover, the volume of migration can be measured through different techniques and variables. Information about residence at a fixed prior time provides data to estimate migration rates using direct demographic techniques. Indirect demographic techniques can be applied to estimate migration rates using questions about previous place and duration of residence.

In this research, the distribution of migrants by age and sex is also estimated by several techniques and census data. Migrant distributions by age and sex can be estimated from a question about place of residence at a fixed prior date and the total population for each specific region. Information about place of previous residence and duration of residence can also generate age and sex distributions for population movements. This study emphasized that "model schedules can be used when there are no adequate data on the age distribution of migration, when data in broad age groups need to be divided into smaller groups or when age distributions from sample data need to be smoothed to remove sampling error" (United Nations 1992, p.28). Thus, model schedules provide a way to estimate the age distribution of migration even with limited data.

Some conclusions of this study (United Nations 1992) have important implications to the current paper. Estimated migration pattern follows prepositions presented by Rogers and Castro (1981). If migration is not related to labor market, then the curve can have different shapes and levels across age and sex. Different model migration schedules can be estimated depending on the reasons of population movements. Marriage is one common reason for the increase of migration rates. Another reason for population movements is the search for school activities. Military services are a third reason for people's displacement.

The third body of research that used model migration schedules was conducted by Beltrão and Henriques (Beltrão and Henriques 1987; Henriques and Beltrão 1986). This study is important for the improvement of Public Health Insurance changes in Brazil. The Brazilian government was considering demographic variables to estimate public benefits. However, population movement was not being considered as a variable to estimate the insurance. Beltrão and Henriques affirmed that it is necessary to include rural-urban migration in the new public insurance.

The Brazilian Censuses of 1960, 1970 and 1980 were utilized for estimation of migration rates. Migration rates for the period between 1960 and 1970 were estimated with Censuses of 1960 and 1970. Census of 1970 and 1980 were utilized to estimate migration rates for the period of 1970/1980. Instead of using gross migration rates, authors used net migration of rural area. The first procedure was the estimation of net rural-urban migration. For instance, Beltrão and Henriques estimated the theoretical rural population in 1970 using the Census of 1960. Then, this theoretical population was subtracted from the real population in 1970 using the Census of that year. This technique presumes that migration occurred just from rural to urban areas. The theoretical assumption is that migration from urban to rural areas is not significant in Brazil. Thus, the net migration of rural areas is considered the rural to urban migrants.

The total population that could have migrated from rural areas was also estimated. The rural populations were estimated using the 1960 Census, for 1960/1965 and 1965/1970. These populations were corrected by the survival ratios from the 1970 Census, for 1960/1970 and 1965/1970. Thus, rural-urban migration rates were estimated. The net migration of rural area was divided by the population that could have migrated from rural areas.

Beltrão and Henriques (Beltrão and Henriques 1987; Henriques and Beltrão 1986) applied Rogers and Castro's model schedules (Rogers and Castro 1981) to correct estimated migration rates. The utilization of model schedules was made using net migration rates. However, Rogers and Castro (1981) applied gross migration rates to their model schedules. Even with these limitations, Beltrão and Henriques' research presents important results. Model migration schedules were applied for the first time to the Brazilian context. The shape and level of net rural-urban migration was estimated for the periods of 1960/1970 and 1970/1980.

Methods to Estimate Migration Rates

This section will explain new techniques for the estimation and correction of migration rates. Jannuzzi (1998, 2000) created a new methodology to correct migration rates. The author tried to improve the elaboration of model migration schedules by age. Jannuzzi analyzed population movements according to reasons for migration. Migration is also analyzed in conformity to different kinds of followers in population movements. Migration rates were estimated using the Regional Household Sample (PRAD) of 1993 for the state of São Paulo.

Some problems occurred in Jannuzzi's research (1998, 2000). Migration rates did not adjust to the model proposed by Rogers and Castro (1981). Jannuzzi argued that difficulties in applying model schedules were caused by changes in migration dynamics. Migration is no longer determined just by the relation of migrant to the labor market. New reasons for migration need to be analyzed. If the family has new interests of living, it can decide to move. The search for better income and lower cost of living is another influence of migration. A third migration reason is marriage, which can result in the couple or family changing residences. Entrance in elementary, junior or high school or in college is connected to population movements. Finally, retirement is another variable related to migration. A person can also migrate because he/she is accompanying another member of the family.

Using these analyses, Jannuzzi (1998, 2000) generated new model migration schedules. New model migration rates were developed to adjust observed rates. Moreover, Jannuzzi's study improved the understanding of migration pattern and level in São Paulo.

Another study about estimation of migration rates was developed by Machado (1993). Machado's purpose was to generate emigrant rates that could be used to project Brazilian population. The population projection was made for the five Brazilian regions (North, Northeast, Middle-West, Southeast and South). The Brazilian Census of 1980 does not have data about residence at a fixed prior time. Thus, Machado utilized migration information on previous place and duration of residence. In fact, Machado (1993) created a new methodology to estimate migration rates. The new technique allows researchers to estimate gross migration rates with this kind of migration variable.

Machado did not use other surveys and censuses. Brazilian Household Sample (PNAD) of 1988 and 1990 and Census of 1991 were not available at that time. If Machado had these other datasets, his research would have provided more complete results. Migration rates for other periods could have been estimated with other surveys and censuses. Changes in the Brazilian migration pattern and level would be better understood.

However, Machado's study (1993) is extremely important to this present paper. The new methodology permits the estimation of migration rates using the Census of 1980. Different kinds of rates can be generated by Machado's technique. Migration rates can be estimated for males and females. This calculation can be made by five-year age groups. More over, migration rates can also be produced by states. Finally, migration rates can be estimated by cities.

This methodology developed by Machado can be applied to the Censuses of 1991 and 2000. Migration rates can also be estimated with information on residence at a fixed prior time. Therefore, the two kinds of estimation can be compared for theses two Censuses. Technical details of the methodology elaborated by Machado (1993) will be explained in the following section.

Techniques to Estimate Migration Rates

The explanation of technical procedures to calculate migration rates will be elaborated in this section. Jannuzzi's technique (1998, 2000) will not be utilized in the present study. The migration variable utilized by Jannuzzi is different from those in Brazilian censuses. In this research, the procedure utilized is not applied to emigration rates. This author estimated gross immigration rates. The numerator of the formula is the total number of immigrants. The denominator is the total population in the final place of residence in 1993. Migration rates are estimated per thousand of residents.

In the present paper, rates are calculated for emigrants using Machado's idea (1993) to build formulas. Machado's technique (1993) used the census question on previous place and duration of residence. The intention of the present topic is to improve the methodology proposed by Machado (1993).

The author utilized the term "Specific Rates of Emigration" (Machado 1993, p.81) to qualify the migration estimative. However, the concept adopted by Machado will not be applied. Estimations will be named as "Specific Probabilities of Emigration." The change in the concept was applied for several reasons. First of all, in the denominator, individuals were not calculated in the middle of the period. Moreover, the denominator was the total number of person-years that an individual could have emigrated in the analyzed period. Person-years are the number of years lived by each person in a specific region. If somebody lived in a specific region for five years, he/she could have emigrated from this region for a period of five years. In this case, person-years measure the risk of emigrated from a region to another one. Thus, the correct demographic concept for this kind of estimation is "probability," but not "rates."

Machado (1993) did not utilize the immigration estimative. In his research, he employed the multiregional methodology. This methodology needs to have emigration indicators.

The theory of Machado (1993) had some assumptions. The first one is that population is homogenous with regard to migration risk. Another one assumes that survival ratios for migrants and non-migrants are the same. Finally, each individual migrates just once per year.

"Specific Probabilities of Emigration" were calculated using censuses data from 1980 and 1991. The numerator is the population that migrated from a region i to region j during the five years before a specific census. The denominator for a region of origin (i) is the number of person-years who had a risk to migrate. The following formula is the one applied by Machado (1993) to estimate "Specific Probabilities of Emigration" using information of previous place of residence:

$$SPE_{x,ij} = \frac{\sum_{t=0}^{4} K_{t,ij}}{K_{1,.i} + 2K_{2,.i} + 3K_{3,.i} + 4K_{4,.i} + 5K_{nm,i}} . \qquad (1)$$

For the present paper, Machado's formula (1993) experienced some changes in the denominator[1]. Those people who lived less than one year in a specific region need to be included in the denominator. Another change in the formula concerns the weight for each individual. The weight is not just the number of years of residence in a specific region. The number of years of residence is added by one half to calculate the weight for each individual. This procedure is a common demographic technique when censuses data are used. The reason for this correction is that each individual lived, an average, one-half year longer than the amount specified in census. Furthermore, terms that count the number of person-years lived in the region of origin are added in the denominator. These terms have an opposite weight to those weights of the immigrants (region of destination). The sum of weights of emigrants (origin) and immigrants (destination) equals five years, which is the extension of the analyzed period.

Emigrants between zero and five years of age have weights calculated in a specific manner. This weight is the difference between the real child age and the number of years in the final residence. Because of indirect migration, emigrants between zero and five years of age need to be multiplied by two[2]. Next formula is the one utilized in this paper to estimate "Specific Probabilities of Emigration" using previous place of residence:

$$SPE_{x,ij} = \frac{\sum_{t=0}^{4} K_{t,ij}}{\begin{array}{c} 0.5K_{0,.i} + 1.5K_{1,.i} + 2.5K_{2,.i} + 3.5K_{3,.i} + 4.5K_{4,.i} + \\ 4.5K_{0,i.} + 3.5K_{1,i.} + 2.5K_{2,i.} + 1.5K_{3,i.} + 0.5K_{4,i.} + \\ 5K_{nm,i} \end{array}} . \qquad (2)$$

A sample calculation using the previous formula is a child with three years of age who lived two years in the final residence. This child will have two and a half person-years exposed to the risk of migrating in the actual municipality. The difference between child's age (three years) and the number of years in the final residence (two years) equals the amount of time that this child was exposed to the risk of migrating in the previous municipality. The sum of these two weights (2.5 and 1.0) equals the child's age (three years) added by one half to correct census data. The sum of weights for migrant children equals the single weight for non-migrant children with the same age. For those migrants above five years of age, the sum of weights equals five because they were exposed to the risk of migrating during all period. For all migrants, the two different weights will by applied to distinct regions (origin and destination).

New formulas to estimate migration level are now exhibited and explained. The level of migration is calculated by an estimator called "Total Probability of Emigration." However, "Specific Probabilities of Non-emigration" are calculated before the "Total Probability of Emigration." "Specific Probabilities of Non-emigration" equal the difference between the number one and "Specific Probabilities of Emigration." Following formula shows how to calculate "Specific Probabilities of Non-emigration":

$$SPN_{x,ij} = 1 - SPE_{x,ij} . \qquad (3)$$

After that, the "Total Probability of Non-emigration" is estimated. This probability is the product of all "Specific Probabilities of Non-emigration." The formula below illustrates how the "Total Probability of Non-emigration" is estimated:

$$TPN_{ij} = SPN_{0,ij} * SPN_{5,ij} * SPN_{10,ij} * ... * SPN_{85+,ij} . \qquad (4)$$

Finally, the "Total Probability of Emigration" is calculated. This probability is the difference between the number one and the "Total Probability of Non-emigration." Following formula demonstrates the form to estimate the "Total Probability of Emigration":

$$TPE_{ij} = 1 - TPN_{ij} \ . \qquad (5)$$

The Brazilian Census of 1991 has another variable to estimate migration probabilities. These probabilities are also calculated using census questions on residence at a fixed prior time. In the numerator, the amount of people who lived in another place five years before the census is estimated. In the denominator, the total number of individuals exposed to the risk of migration is computed. The denominator of this formula is multiplied by five. This procedure is applied to furnish an annual average probability.

Two presumptions are considered to calculate migration probabilities using this formula. The probability of emigration is the same between those who died during five years before census and those who survived during this same period. Furthermore, migration probabilities for people between zero and five years of age are the same between those probabilities using previous place of residence and those using residence at a fixed prior time.

Even with this new variable, migration probabilities in the Census of 1991 are also calculated such as in the Census of 1980 using information of previous place of residence. The formula below illustrates how to calculate "Specific Probabilities of Emigration" using data at a fixed prior time:

$$SPE_{x,ij} = \frac{\sum K_{ij}}{t * \sum K_{i.} + K_{ii}} \ . \qquad (6)$$

Applying Model Migration Schedules

In this section, adjusting procedures of migration probabilities are explained. As clarified in the previous section, probabilities of emigration were estimated. The Brazilian Censuses of 1980, 1991 and 2000 (IBGE 1980, 1991, 2000) were utilized. The regions of destination and origin are the states of Bahia and São Paulo.

The estimated probabilities were submitted to Roger and Castro's mathematical model migration schedules (Rogers and Castro, 1981). The model was defined as the sum of four components. The first component is an exponential negative curve. This curve is located in pre-labor ages until 19 years of age and has a descendent indicator called α_1. Another component is a parabola located in labor ages. μ_2 is the age mean indicator for this curve. This component has also the ascendant indicator called λ_2 and the descendent indicator named α_2. The third component of model migration schedule is a small parabola located in post-labor ages. The age mean indicator is represented by μ_3. λ_3 is the ascendant indicator for this curve and α_3 is the descendent one. Finally, the constant curve is the fourth component of model schedules. This component is the adjustment to the mathematical expression. Its indicator is the constant value named *c*.

Three different model migration schedules were constructed by Rogers and Castro (1981). The first model is the "basic migration model." This model has a parabola in post-labor ages. Following equation shows the mathematical form of this family of schedules (Rogers and Castro 1981):

$$M(x) = a_1 * e^{(-\alpha_1 x)} + a_2 * e^{\{-\alpha_2(x-\mu_2) - e^{[-\lambda_2(x-\mu_2)]}\}} + a_3 * e^{\{-\alpha_3(x-\mu_3) - e^{[-\lambda_3(x-\mu_3)]}\}} + c\,. \quad (7)$$

Another model migration schedule is the "reduced model." This model has a constant value in post-labor ages. The next equation details the mathematical form of this model (Rogers and Castro 1981):

$$M(x) = a_1 * e^{(-\alpha_1 x)} + a_2 * e^{\{-\alpha_2(x-\mu_2) - e^{[-\lambda_2(x-\mu_2)]}\}} + c\,. \quad (8)$$

The last model is the "migration model with an ascending inclination." This model has a linear function in post-labor ages. The following equation illustrates the mathematical form of this model (Rogers and Castro 1981):

$$M(x) = a_1 * e^{(-\alpha_1 x)} + a_2 * e^{\{-\alpha_2(x-\mu_2) - e^{[-\lambda_2(x-\mu_2)]}\}} + a_3 * e^{(\alpha_3 x)} + c\,. \quad (9)$$

The appropriate model migration schedule is selected after the analysis of some questions. The shape of migration probabilities among regions needs to be evaluated. The level of probabilities of migration has to be examined among all regions. The Figure 1 better illustrates all parameters in the curve for the "basic migration model" (Rogers and Castro 1981).

<<< FIGURE 1 >>>

In the migration model, basic measures are divided in two different groups. The first group includes the fundamental parameters. Levels of migration probabilities are measured by different indicators. The first indicator is the level of migration in pre-labor ages (a_1). The level of migration in labor ages is estimated by a_2. The level of migration in post-labor ages is called a_3. The constant (c) is the last level estimator. Placements of migration probabilities are calculated using two means. The age mean in labor ages (μ_2) is one indicator of placement. The other placement indicator is the age mean in post-labor ages (μ_3). Model migration schedules have some parameters to estimate inclinations of curve. The negative inclination of pre-labor curve is named as α_1. Another parameter is the negative inclination of labor curve (α_2). The third indicator is the negative inclination of post-labor curve (α_3). λ_2 is the positive inclination of labor curve. Finally, the positive inclination of post-labor curve is estimated by λ_3.

The second group of basic measures includes ratios of parameters. The labor force dependency of population is measured by $\delta_{1c}=a_1/c$. The measure $\delta_{12}=a_1/a_2$ is the youth ratio dependency of population. Old-aged ratio dependency of population is the following $\delta_{32}=a_3/a_2$. The relationship between child migration and adult migration is calculated by $\beta_{12}=\alpha_1/\alpha_2$. The ratio $\sigma_2=\lambda_2/\alpha_2$ originates likeness between the first and the second-half of labor curve. Finally, similarity between the first and the second-half of post-labor curve is estimated by $\sigma_3=\lambda_3/\alpha_3$.

Derivative measures are divided into two groups to analyze the migration pattern. The first group is the calculation of areas below the migration curve. The total area below the curve is the Gross Migraproduction Rate (GMR). The area below age zero to fourteen is the percentage of migrants in pre-labor ages. The area below 15 until 64 years of age is the percentage of migrants in labor ages. The area below age of 65 until the last one is the percentage of migrants in post-labor ages.

The second group of derivative measures is the horizontal distance among parameters. The distance between lowest pre-labor rate and highest labor rate is calculated by *X*. The distance between middle pre-labor rate and middle labor rate is represented by the parameter *A*.

The estimation method Levenberg-Marquardt was used to correct observed migration data. This method was applied by Rogers and Castro (1981). In this present paper, the statistical software SPSS was utilized.

Some problems occurred in the application of this model migration schedule. The iterative algorithms of minimization did not converge the observed migration data. Different criteria were utilized to calculate the initial parameters. These problems obstruct the utilization of model migration schedules developed by Rogers and Castro (1981).

Problems in the use of migration schedules are caused by several reasons. Methodological and technical reasons are important to understand these difficulties. There are differences in the definition of migration probabilities between Rogers and Castro's study (1981) and this present paper. The high variance of migration probabilities among ages, in this paper, decreases the possibility of adjustment. The statistical software could not fit the parameters for model migration schedules.

Theoretical and substantive reasons are also related to the problems of modeling migration data. Migration is no longer related just to labor market changes across ages. Because of new reasons of population movements, Rogers and Castro's model cannot fit migration probabilities.

In another study, Jannuzzi (1998, 2000) developed some methodological procedures creating new models of migration rates. He tried to insert new motives of migration in his models. New models were not just based in economic variables. Different reasons for population movements were considered. Family followers in the migration were considered in the construction of new models. Jannuzzi's model has fourteen different categories. The formula below illustrates migration rate developed by the author:

$$T_i = \frac{M}{N} * \sum_k s_{ik} p_k \ . \qquad (10)$$

Jannuzzi argues that some factors can affect the quality of modeling migration rates. The definition of migrant can affect the quality of estimated rates. In utilizing his model, it is necessary to calculate migration rates as he did. His rates were calculated using some rules. If the leader of the family was a migrant, everybody in the household was also considered a migrant. The period of analyses equals thirteen years, from 1980 until 1993. In the denominator, the population in the region of destination was calculated.

In the present research, rules to estimate migration probabilities were not similar to those followed by Jannuzzi (1998, 2000). Individuals were considered migrants after the analysis of census variables. Those people who lived less than five years in the actual municipality were considered migrants. Another case of migrants includes people who lived in another city exactly five years before the census. This information does not depend on the information of the leader of the family. Furthermore, the period of analysis equals five years, from 1975 until 1979 (IBGE 1980), from 1986 until 1990 (IBGE 1991) and from 1995 until 1999 (IBGE 2000). In the denominator, the number of person-years in the region of origin was estimated. Because of these differences, migration models proposed by Jannuzzi (1998, 2000) were not utilized. Moreover, migration models to shape observed curves were not used in this paper.

Since procedures to model migration probabilities were not successful, a statistical procedure was applied to adjust probabilities. This procedure was applied to decrease the influence of outlier migration probabilities. These outlier observations exist because of deficiencies in migration variables. In Brazilian censuses, migration variables are not collected for the entire population. Thus, the amount of observations in censuses is not large enough for migration information. Migration is a demographic variable that does not occur as often as other population components. Fertility and mortality occur more often than population movements. For this reason, migration probabilities present a considerably oscillating shape across ages.

The technique utilized to adjust observed migration curves is called Loess. This kind of technique is more flexible than the model migration schedules discussed above (Rogers and Castro 1981; Jannuzzi 1998, 2000). Initial parameters to the curve are not required to initiate the adjusting process. The statistical software SAS was utilized to the adjustment of migration probabilities.

Because of several reasons, adjusting procedures were not applied to correct probabilities. Since the present study is utilizing five-year age groups, the Loess technique generates patterns that are too linear. These adjusted probabilities do not have enough information about oscillations on the shape of migration across ages. Therefore, migration probabilities were not modeled or adjusted.

As discussed before, "Specific Probabilities of Migration" were estimated for two regions of destination and by sex using Censuses of 1980, 1991 and 2000. Thus, 12 migration curves were generated.

Results

The techniques discussed in the previous sections were applied to the population movements between the Brazilian states of Bahia and São Paulo. During the 1960s and 1970s, the migration from Bahia to São Paulo was characterized by a rural to urban migration. Lower classes people migrated and still migrate from Northeast to São Paulo, since this state has the most industries and job opportunities in Brazil. Before show the results for these specific areas, a discussion about the main migration patterns in Latin America will be made.

Roberts (1995) discusses about the relationship between the process of industrialization and the migration flows in underdeveloped countries, mainly in Latin America. Changes in the agricultural areas were important in the process of internal migration. However, recent migration patterns seem to show that rural-urban population movements are decreasing in developing countries. This new pattern needs to be analyzed as a broad process, including its indirect effects in the destination areas. Children of migrants born in the urban area are an important aspect in this discussion.

In previous centuries, Latin American countries had economies based on exportation of agricultural products. The industrialization changed this process. Investments on urban areas developed those areas and made other areas more dependent to the large cities. However, since the 1980s, the rural-urban migration has lower importance. Some reasons are the declining of people living in rural areas and the flourishing of medium urban centers as new destination areas.

Roberts (1995) explains four different types of agrarian structures in Latin America. The first one is characterized by a large-scale commercial production. The second type is the one with an economy based on mining or plantation agriculture, such as banana and sugar plantations. The labor force comes from areas of subsistence farming. The third type of agrarian structure is a small-scale farming, oriented to some market activities, encountered in many Latin American countries. The fourth kind is the subsistence farming combined with low productive stages, common in most countries. These agrarian structures can explain the rural-urban migration in those countries.

Moreover, Roberts argues that industrialization increases the diversification and commercialization of rural areas, expanding the peasant sector. Industrialization and migration have a complex relation in the development of capitalism. Thus, internal migration can be seen as the incorporation of provincial areas by the dominant national urban economy.

Cerrutti and Bertoncello (2003) show that the Import Substitution Industrialization (IS) model had a crisis since the 1970s. This economic process created a new dynamic in Latin American countries, changing the patterns of population distribution and mobility. On previous decades, the rural-urban flow contributed to a fast urban growth. On recent decades, the population dynamic has changed. “On the one hand, migration rates from rural to urban areas have decreased; on the other, urban natural growth rate continued being significantly lower than rural” (Cerrutti and Bertoncello 2003, p.6). Nowadays, the most important flow is the urban-urban migration. Two aspects of this new pattern is the increasing significance of middle size cities and the intra-metropolitan migration.

The intra-metropolitan migration occurs from central urban areas to peripheral territories. On one hand, the “peripherialization” process segregates the upper classes in gated communities isolated from lower classes. On the other hand, the “gentrification” process concentrates poor people in deteriorated urban areas. Internal migration became more complex, with a widely variety of places of origin and destination and a change in the socio-economic characteristics of migrants.

Following, some data will be presented, such as the number of migrants between Bahia and São Paulo, the proportion of migrants in the population of origin, the “Total Probability of Emigration” (TPE), and the curves of estimated and proportional “Specific Probabilities of Emigration” (SPEx). Those data cannot verify the hypothesis that migration from rural to urban areas has been substituted by urban to urban migration. The intention is to analyze the levels and patterns of migration flows between those Brazilian states, showing that the previous techniques are an important tool in the explanation of population movements.

The Table 1 shows that the number of migrants from Bahia to São Paulo increased from 1975-1979 to 1995-1999. For instance, the female migration increased 116.3% (from 249,618 to 539,862) in the first period to the last one. Moreover, the migration from São Paulo to Bahia improved significantly. The male migration augmented 333.1% (44,736 to 193,734) from 1975-1979 to 1995-1999. Analyzing the proportion of those migrants on the population of region of origin, the numbers show a decrease from 1975-1979 to 1986-1990, and a increase from 1986-1990 to 1995-1999. These proportions are a good migration measure, because the size of population that had the risk to migrate was taking into account.

<<< TABLE 1 >>>

The “Total Probabilities of Emigration” (TPE) between Bahia and São Paulo and Northeast and Southeast are presented in Table 2.

<<< TABLE 2 >>>

In general, the level of migration from Northeast to Southeast and from Bahia to São Paulo decreased from 1975-1979 to 1986-1990 and increased from 1986-1990 to 1995-1999.

On the one hand, the interesting information is that in the first and third periods, the probabilities of migration are higher for women. This result is opposite to the assessment made by Rogers and Castro (1981), in which the selectivity of migration would present higher probabilities to men than to women. In the case of Table 2, these data might be showing that areas with more opportunities of insertion into the labor market attract women from rural areas or small cities in Northeast and Bahia to more industrialized and modern areas in Southeast and São Paulo. On the other hand, the migration probabilities from Southeast to Northeast and from São Paulo to Bahia present higher levels for men than for women, in all periods. In this case, areas with fewer opportunities for women to enter into the labor market attract more male migrants.

The Figure 2 is another form to analyze the level of migrants between Bahia and São Paulo. These probabilities are reported in Tables 1 and 2 in the Appendix. First of all, the "Specific Probabilities of Emigration" (SPEx) show that migration from Bahia to São Paulo is much greater than from São Paulo to Bahia. Moreover, the level of migrants from Bahia to São Paulo increased in 1995-1999, comparing to the previous periods. For women, this raise is greater than for men, related to the data analyzed in Table 2.

The Figure 3 illustrates the proportional SPEx between Bahia and São Paulo. Those probabilities provide information to understand the migration patterns. The estimation of proportional probabilities was made using the SPEx in Figure 2, making the sum across age groups equals one unit. These results are reported in Tables 3 and 4 in the Appendix. These curves show that migration from Bahia to São Paulo is concentrated between the age groups 10-14 and 35-39. This is a typical migration caused by persons looking for job opportunities, since these probabilities aggregate individuals in labor ages. For the case of migration from São Paulo to Bahia, the importance of probabilities in earlier ages is higher. This is consistent with the assessment that this migration is more related to familiar movements. Thus, the migration movements between those areas have different patterns. The data are reinforcing the considerations that São Paulo has more job opportunities to persons in labor ages, and Bahia is more attractive to the whole family moving together.

<<< FIGURE 2 >>>

<<< FIGURE 3 >>>

Discussion

The technique developed by Machado (1993) is very important for migration research. The estimation of migration probabilities was conducted in two different ways. One estimation utilized questions on previous place and duration of residence. This procedure is the technique developed by Machado (1993). This kind of migration information is furnished by Censuses of 1980, 1991 and 2000.

The other estimative of migration probabilities utilized questions about residence at a fixed prior time. This technique is a direct way to estimate migration probabilities. This information was first gathered in the Census of 1991 and following in the Census of 2000. However the migration probabilities were not estimated using this direct technique. Machado's technique is very important for demographic analysis. Migrant patterns can be evaluated through the shape of proportional estimated curves. Migrant levels are examined by the "Total Probability of Emigration."

However, some corrections need to be applied to Machado's technique (1993). The formula created by Machado (1993) presented some errors. In the denominator of the formula, some changes were applied. It is essential that the component of emigration be added in the denominator. Moreover, weights need to be changed to improve results. In the numerator, a specific change must be realized. Children between zero and five years of age need to have special weights. This correction adds the indirect effect of migration. This procedure prevents the underestimation of migration probabilities on these early ages. The correction of Machado's technique is an improvement in the study of migration.

Some limitations are encountered in Brazilian Census of 2000. Questions on previous place and duration of residence will have limitations. Information about municipality of previous residence will not be available. The information will just be about state or country of residence. Therefore, it will not be possible to estimate intra-state probabilities of emigration. In Census of 2000, intra-state analyzes can be made using information of residence at a fixed prior time. Another technique to estimate the intra-state probabilities between zero and five years of age will be necessary.

Even with these difficulties using the Census of 2000, Machado's technique is highly useful. This kind of research can be utilized by several researchers around the world. The development of migration techniques will be possible by using real data. New techniques might arise to increase the results obtained by research in this area.

The main results for the migration between Bahia and São Paulo suggest higher migration levels from Bahia to São Paulo than the opposite direction. More industrialized areas attract more female than male migrants, which might be explained by the existence of more opportunities of insertion into the labor market for women. The patterns of migration are different between those states. On the one hand, migration to São Paulo is more concentrated in labor ages. On the other hand, migration to Bahia presents probabilities more uniform across all age groups, which suggest a familiar migration.

References

Beltrão, Kaizô I. and Maria H. F. T. Henriques. 1987. "Modelagem da Migração Líquida Rural-Urbana no Brasil: Décadas de 1960/1970 e 1970/1980." Previdência em Dados 2(3):23-36. Rio de Janeiro, RJ, Brazil.

Brass, William. 1971. “On the Scale of Mortality.” Pp. 69-110 in Biological Aspects of Demography, edited by W. Brass. London, England: Taylor and Francis, Ltd.

Carvalho, José A. M. 1981. “Migrações Internas: Mensuração Direta e Indireta.” II Encontro Nacional de Estudos Populacionais 1:533-577. Belo Horizonte, MG, Brazil.

_____. 1985. “Estimativas Indiretas e Dados Sobre Migrações: uma Avaliação Conceitual e Metodológica das Informações Censitárias Recentes.” Revista Brasileira de Estudos de População 2(1):31-73. Campinas, SP, Brazil.

Carvalho, José A. M. and Cláudio C. Machado. 1992. “Quesitos sobre Migrações no Censo Demográfico de 1991.” Revista Brasileira de Estudos de População 9(1):22-34. Campinas, SP, Brazil.

Carvalho, José A. M., Diana O. Sawyer and Roberto N. Rodrigues. 1998. Introdução a Alguns Conceitos Básicos e Medidas em Demografia. São Paulo, SP, Brazil: ABEP.

Cerrutti, Marcela and Rodolfo Bertoncello. 2003. “Urbanization and Internal Migration Patterns in Latin America.” Paper presented in the Conference on African Migration in Comparative Perspective. Johannesburg, South Africa, 4-7 June.

Coale, Ansley and James Trussell. 1974. “Model Fertility Schedules: Variations in the Age Structure of Childbearing in Human Populations.” Population Index 40(2):185-206.

Coale, Ansley and Paul Demeny. 1966. Regional Model Life Tables and Stable Populations. Princeton, New Jersey: Princeton University Press.

Coale, Ansley. 1977. “The Development of New Models of Nuptiality and Fertility.” Population, special issue: 131-154.

Henriques, Maria H. F. T. and Kaizô I. Beltrão. 1986. As Migrações Internas e a Previdência Social. Rio de Janeiro, RJ, Brazil: IPEA/INPES.

Instituto Brasileiro de Geografia e Estatística (IBGE). 1980. Censo Demografico 1980: Microdados. Rio de Janeiro, RJ, Brazil: IBGE. (Media source)

_____. 1991. Censo Demografico 1991: Microdados. Rio de Janeiro, RJ, Brazil: IBGE. (Media source)

_____. 2000. Censo Demografico 2000: Microdados. Rio de Janeiro, RJ, Brazil: IBGE. (Media source)

Jannuzzi, Paulo M. 1998. “Interpretação e Modelagem de Perfis Etários da Migração: uma Contribuição a Partir da Análise de Taxas Migratórias Específicas por Motivos e Específicas por Acompanhantes da Mudança.” I Encontro Nacional sobre Migração 1:229-271. Curitiba, PR, Brazil.

_____. 2000. “Tasas Específicas por Motivos y Acompañantes de la Migración: una Contribución a la Interpretación y al Uso de Modelos de Patrones Etarios de Migración.” Notas de Población 28(70):33-85. Santiago de Chile, Chile.

Machado, Cláudio C. 1993. "Projeções Multirregionais de População: o Caso Brasileiro (1980-2020)." Ph.D. Dissertation in Centro de Desenvolvimento e Planejamento Regional, Universidade Federal de Minas Gerais. Belo Horizonte, MG, Brazil.

Roberts, Bryan. 1995. The Making of Citizens. London, United Kingdom: Edward Arnold.

Rogers, Andrei and Luis J. Castro. 1981. Model Migration Schedules. Laxenburg, Austria: International Institute for Applied Systems Analysis.

United Nations. 1955. Age and Sex Patterns of Mortality: Model Life Tables for Underdeveloped Countries. New York: United Nations.

_____. 1992. Preparing Migration Data for Subnational Population Projections. New York: United Nations Publication.

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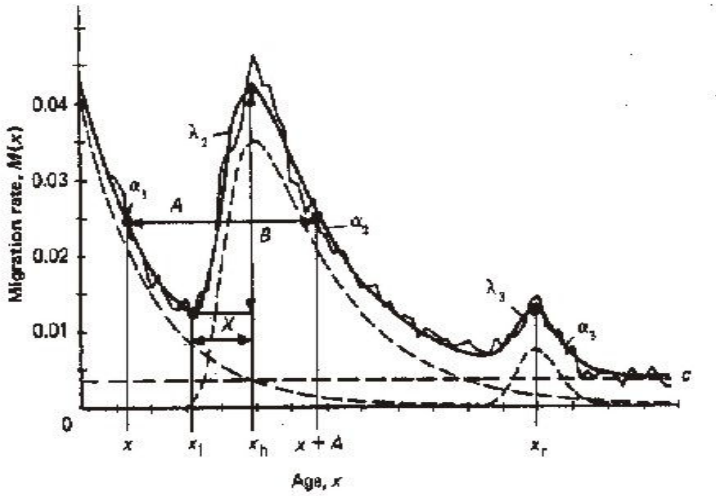
[1] All these changes were applied by suggestion of the professor Dr. José Alberto Magno de Carvalho from the Center of Regional Development and Planning (CEDEPLAR) of the Federal University of Minas Gerais (UFMG) in Brazil.

[2] In a period of five years, children born in the region of destination of emigrant mothers equal, approximately, the same amount of children born in the region of origin.

Figure 1. The model migration schedule elaborated by Rogers and Castro



Source: Rogers and Castro 1981.

Table 1. TOTAL NUMBER OF EMIGRANTS AND PROPORTION IN THE POPULATION OF ORIGIN BY REGION AND SEX, 1975-1979, 1986-1990, 1995-1999

Region	1975-1979		1986-1990		1995-1999	
	Male	Female	Male	Female	Male	Female
Northeast to Southeast	1,039,548	1,081,717	1,190,793	1,194,996	1,664,949	1,812,730
Bahia to São Paulo	219,893	249,618	304,146	314,272	482,972	539,862
Southeast to Northeast	260,073	244,602	514,962	478,956	841,201	763,012
São Paulo to Bahia	44,736	42,921	91,893	87,865	193,734	182,099
Proportion in the population of origin						
Northeast to Southeast	0.060994	0.060867	0.057301	0.055037	0.071058	0.074440
Bahia to São Paulo	0.047097	0.052151	0.051924	0.052293	0.074656	0.081593
Southeast to Northeast	0.010105	0.009407	0.016669	0.015039	0.023742	0.020622
Sao Paulo to Bahia	0.011349	0.010481	0.021563	0.019127	0.033596	0.028894

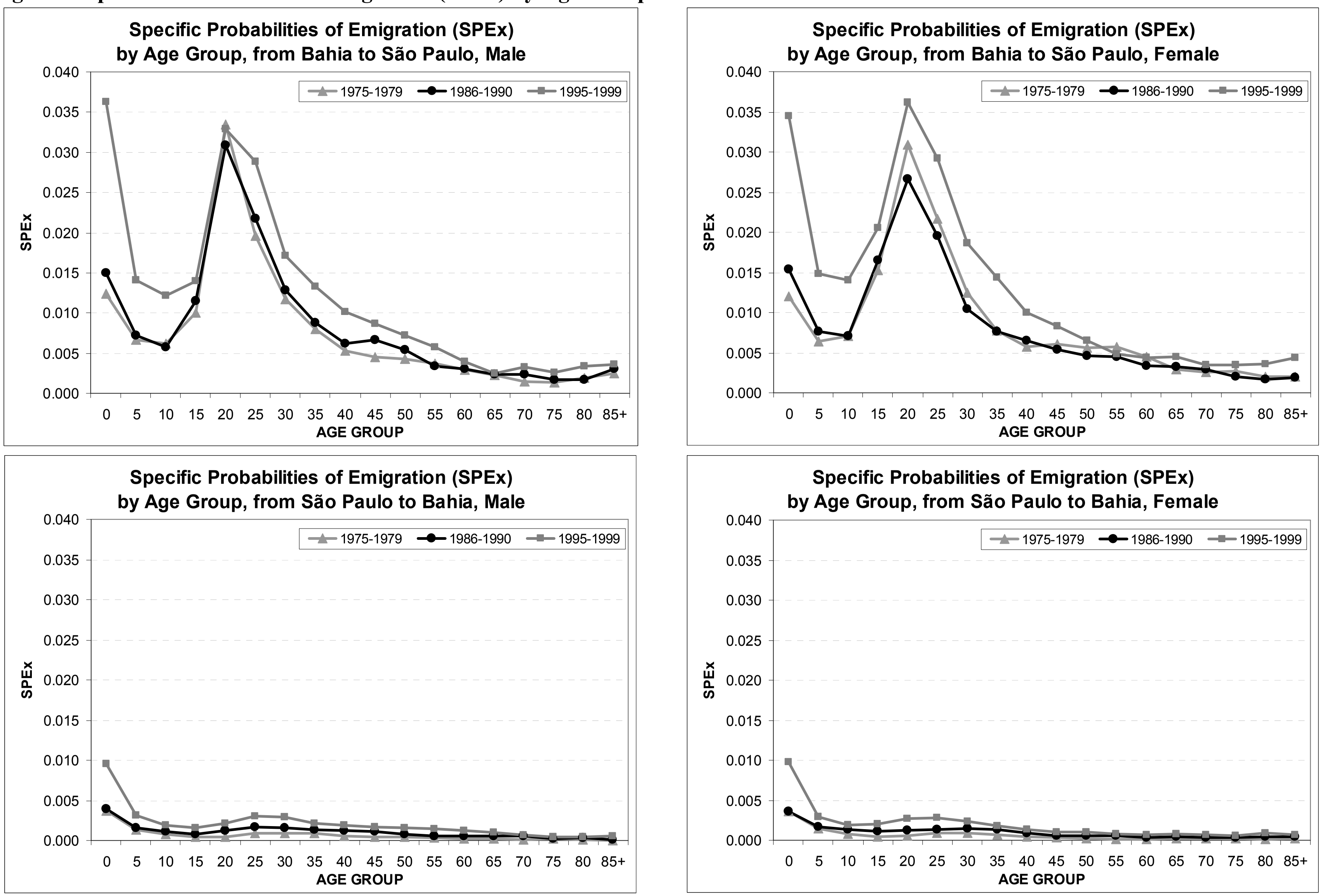
Source: Table constructed by the author, based on IBGE (1980, 1991, 2000).

Table 2. TOTAL PROBABILITY OF EMIGRATION (TPE) BY REGION AND SEX, 1975-1979, 1986-1990, 1995-1999

Region	1975-1979		1986-1990		1995-1999	
	Male	Female	Male	Female	Male	Female
Northeast to Southeast	0.166779	0.168524	0.154852	0.148777	0.193040	0.201819
Bahia to São Paulo	0.130010	0.143407	0.139747	0.137829	0.199146	0.212118
Southeast to Northeast	0.033909	0.031315	0.053048	0.048379	0.080175	0.070546
São Paulo to Bahia	0.011994	0.011532	0.019264	0.017927	0.036925	0.034099

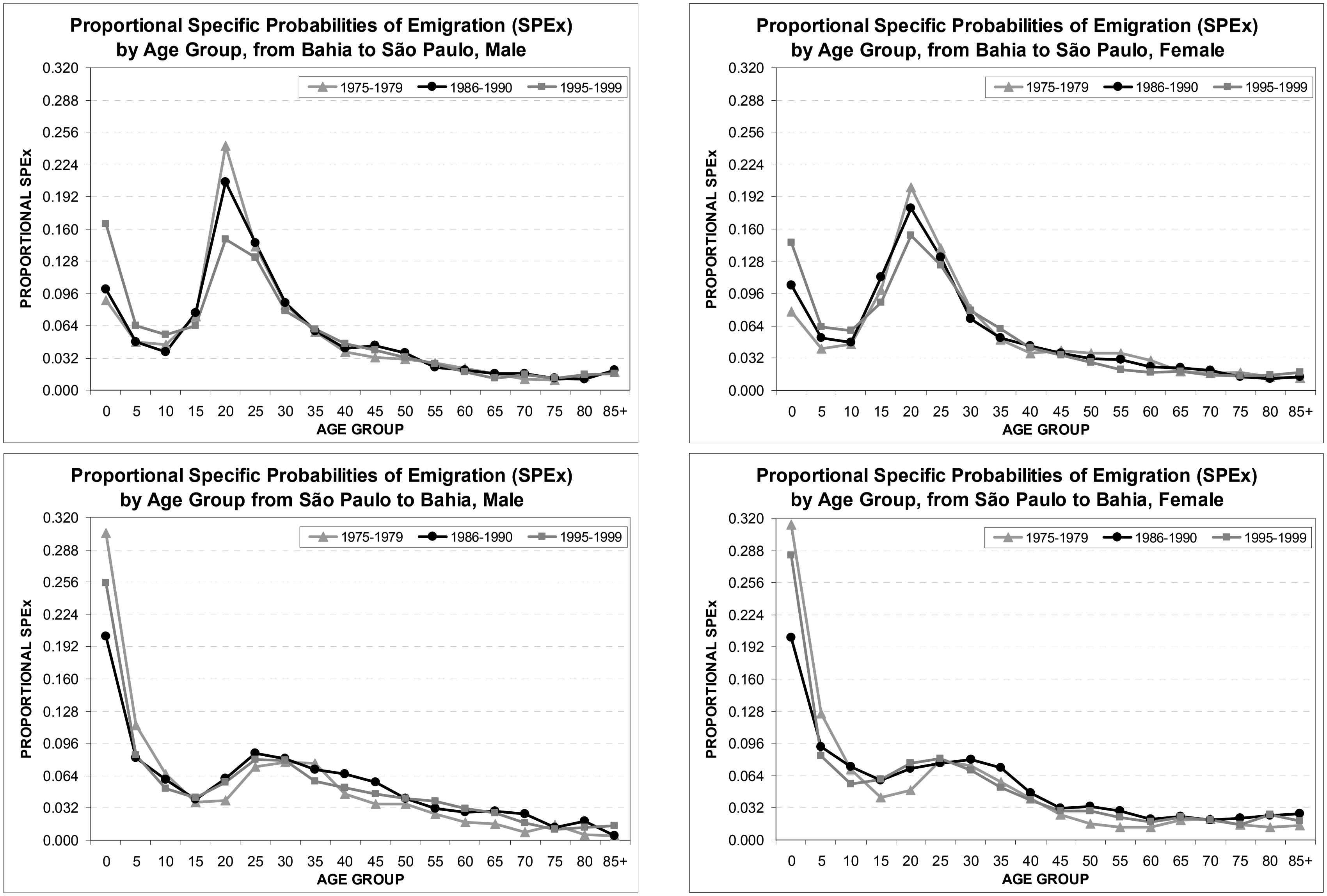
Source: Table constructed by the author, based on IBGE (1980, 1991, 2000).

Figure 2. Specific Probabilities of Emigration (SPEx) by Age Group and Sex between Bahia and São Paulo



Source: 1980, 1991 and 2000 Brazilian Censuses (IBGE 1980, 1991, 2000).

Figure 3. Proportional Specific Probabilities of Emigration (SPEx) by Age Group and Sex between Bahia and São Paulo



Source: 1980, 1991 and 2000 Brazilian Censuses (IBGE 1980, 1991, 2000).

Appendix

Table 1. SPECIFIC PROBABILITIES OF EMIGRATION BY AGE GROUP FROM BAHIA TO SAO PAULO

Age group	1975-1979		1986-1990		1995-1999	
	Male	Female	Male	Female	Male	Female
0	0.012364	0.012048	0.014939	0.015398	0.036297	0.034546
5	0.006606	0.006415	0.007192	0.007681	0.014118	0.014804
10	0.006250	0.007054	0.005715	0.007038	0.012141	0.014094
15	0.010059	0.015337	0.011449	0.016549	0.013993	0.020545
20	0.033453	0.030884	0.030840	0.026651	0.032877	0.036210
25	0.019651	0.021724	0.021772	0.019508	0.028851	0.029260
30	0.011708	0.012493	0.012883	0.010436	0.017183	0.018622
35	0.008005	0.007706	0.008797	0.007683	0.013290	0.014356
40	0.005257	0.005715	0.006174	0.006474	0.010113	0.010009
45	0.004517	0.006072	0.006633	0.005384	0.008635	0.008265
50	0.004230	0.005661	0.005459	0.004662	0.007214	0.006551
55	0.003745	0.005726	0.003406	0.004496	0.005772	0.004816
60	0.002960	0.004513	0.002989	0.003412	0.003897	0.004330
65	0.002230	0.002956	0.002398	0.003311	0.002511	0.004440
70	0.001472	0.002596	0.002374	0.002889	0.003286	0.003505
75	0.001328	0.002725	0.001706	0.002033	0.002544	0.003490
80	0.001883	0.002017	0.001645	0.001741	0.003407	0.003630
85+	0.002463	0.001985	0.003008	0.001926	0.003620	0.004345
TPE	**0.130010**	**0.143407**	**0.139747**	**0.137829**	**0.199146**	**0.212118**

TPE is the Total Probability of Emigration.
Source: Table constructed by the author, based on IBGE (1980, 1991, 2000).

Table 2. SPECIFIC PROBABILITIES OF EMIGRATION BY AGE GROUP FROM SAO PAULO TO BAHIA

Age group	1975-1979		1986-1990		1995-1999	
	Male	Female	Male	Female	Male	Female
0	0.003673	0.003631	0.003927	0.003644	0.009602	0.009794
5	0.001378	0.001461	0.001598	0.001669	0.003175	0.002897
10	0.000796	0.000813	0.001172	0.001318	0.001924	0.001918
15	0.000458	0.000485	0.000789	0.001072	0.001573	0.002071
20	0.000480	0.000576	0.001184	0.001278	0.002145	0.002657
25	0.000876	0.000912	0.001673	0.001389	0.002997	0.002807
30	0.000928	0.000852	0.001580	0.001440	0.002960	0.002404
35	0.000922	0.000668	0.001367	0.001294	0.002189	0.001795
40	0.000555	0.000474	0.001278	0.000848	0.001956	0.001358
45	0.000434	0.000289	0.001114	0.000564	0.001730	0.000987
50	0.000431	0.000185	0.000811	0.000594	0.001537	0.001005
55	0.000310	0.000143	0.000615	0.000519	0.001446	0.000776
60	0.000221	0.000144	0.000548	0.000370	0.001196	0.000636
65	0.000199	0.000233	0.000567	0.000417	0.001020	0.000768
70	0.000099	0.000238	0.000511	0.000358	0.000641	0.000689
75	0.000184	0.000175	0.000243	0.000384	0.000416	0.000537
80	0.000060	0.000141	0.000367	0.000440	0.000485	0.000884
85+	0.000053	0.000169	0.000091	0.000477	0.000556	0.000639
TPE	**0.011994**	**0.011532**	**0.019264**	**0.017927**	**0.036925**	**0.034099**

TPE is the Total Probability of Emigration.
Source: Table constructed by the author, based on IBGE (1980, 1991, 2000).

Table 3. PROPORTIONAL SPECIFIC PROBABILITIES OF EMIGRATION BY AGE GROUP FROM BAHIA TO SAO PAULO

Age group	1975-1979		1986-1990		1995-1999	
	Male	Female	Male	Female	Male	Female
0	0.089477	0.100007	0.165175	0.078424	0.104555	0.146494
5	0.047807	0.048146	0.064246	0.041757	0.052155	0.062777
10	0.045231	0.038258	0.055249	0.045916	0.047789	0.059766
15	0.072796	0.076644	0.063677	0.099833	0.112370	0.087122
20	0.242096	0.206455	0.149612	0.201032	0.180964	0.153551
25	0.142212	0.145750	0.131291	0.141407	0.132462	0.124079
30	0.084729	0.086244	0.078194	0.081320	0.070862	0.078968
35	0.057931	0.058890	0.060478	0.050160	0.052169	0.060877
40	0.038044	0.041331	0.046021	0.037200	0.043959	0.042444
45	0.032689	0.044404	0.039295	0.039524	0.036558	0.035048
50	0.030612	0.036545	0.032828	0.036849	0.031656	0.027780
55	0.027102	0.022801	0.026266	0.037272	0.030529	0.020423
60	0.021421	0.020010	0.017734	0.029376	0.023168	0.018362
65	0.016138	0.016053	0.011427	0.019241	0.022482	0.018828
70	0.010653	0.015892	0.014953	0.016898	0.019617	0.014863
75	0.009611	0.011421	0.011577	0.017738	0.013804	0.014800
80	0.013627	0.011012	0.015504	0.013129	0.011822	0.015393
85+	0.017824	0.020137	0.016473	0.012921	0.013078	0.018425
TOTAL	**1.000000**	**1.000000**	**1.000000**	**1.000000**	**1.000000**	**1.000000**

Source: Table constructed by the author, based on IBGE (1980, 1991, 2000).

Table 4. PROPORTIONAL SPECIFIC PROBABILITIES OF EMIGRATION BY AGE GROUP FROM SAO PAULO TO BAHIA

Age group	1975-1979		1986-1990		1995-1999	
	Male	Female	Male	Female	Male	Female
0	0.304636	0.202058	0.255726	0.313314	0.201604	0.282884
5	0.114290	0.082223	0.084558	0.126068	0.092337	0.083675
10	0.066020	0.060304	0.051241	0.070153	0.072918	0.055398
15	0.037986	0.040597	0.041893	0.041850	0.059308	0.059817
20	0.039811	0.060921	0.057127	0.049702	0.070705	0.076743
25	0.072655	0.086082	0.079818	0.078695	0.076846	0.081076
30	0.076968	0.081297	0.078832	0.073518	0.079668	0.069436
35	0.076470	0.070337	0.058299	0.057641	0.071591	0.051846
40	0.046031	0.065758	0.052093	0.040901	0.046916	0.039224
45	0.035996	0.057319	0.046074	0.024937	0.031203	0.028508
50	0.035747	0.041729	0.040934	0.015963	0.032863	0.029028
55	0.025711	0.031644	0.038511	0.012339	0.028714	0.022413
60	0.018330	0.028197	0.031853	0.012426	0.020470	0.018370
65	0.016505	0.029174	0.027165	0.020105	0.023071	0.022182
70	0.008211	0.026293	0.017071	0.020537	0.019806	0.019901
75	0.015261	0.012503	0.011079	0.015101	0.021245	0.015510
80	0.004976	0.018883	0.012917	0.012167	0.024343	0.025533
85+	0.004396	0.004682	0.014808	0.014583	0.026390	0.018456
TOTAL	**1.000000**	**1.000000**	**1.000000**	**1.000000**	**1.000000**	**1.000000**

Source: Table constructed by the author, based on IBGE (1980, 1991, 2000).