

## METHODS AND TECHNIQUES TO MEASURE AND CATEGORIZE MIGRANT MOVEMENTS APPLIED TO BRAZILIAN STATES

Ernesto F. Amaral  
Department of Sociology  
University of Texas at Austin

### Abstract

This paper focuses on 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 migrant movements. Machado (1993) created an estimation of probabilities of emigration, but this technique has some errors. In the denominator, the component of emigration needs to be added. In the numerator, children between zero and five years of age need special weights, adding indirect effects of migration. This correction is an improvement in the migration study. Another objective is to demonstrate results obtained from the 1980, 1991 and 2000 Brazilian Censuses. The main findings suggest higher migration levels from Bahia to São Paulo. More industrialized areas attract more female than male migrants, explained by the existence of labor opportunities for women. Migration to São Paulo is more concentrated around labor ages. Migration to Bahia presents a familiar pattern of probabilities.

### Formulas

“Specific Probabilities of Emigration” were calculated using 1980, 1991 and 2000 Censuses. 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:

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

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.
- 2) 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. On other words, each individual lived, an average, one-half year longer than the amount specified in census.

- 3) 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.
- 4) Emigrants between 0 and 5 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 0 and 5 years of age need to be multiplied by two<sup>1</sup>.

Next formula is the one utilized in this paper to estimate “Specific Probabilities of Emigration” using previous place of residence:

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

“Specific Probabilities of Non-emigration” equal the difference between the number one and “Specific Probabilities of Emigration”:

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

“Total Probability of Non-emigration” is the product of all “Specific Probabilities of Non-emigration”:

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

“Total Probability of Emigration” is the difference between the number one and the “Total Probability of Non-emigration”:

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

The formula below illustrates how to calculate “Specific Probabilities of Emigration” using data at a fixed prior time:

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

---

<sup>1</sup> 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.

### Applying Model Migration Schedules

The estimated probabilities were submitted to Roger and Castro's mathematical model migration schedules (Rogers and Castro, 1981).

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:

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

Another model migration schedule is the "reduced model." This model has a constant value in post-labor ages:

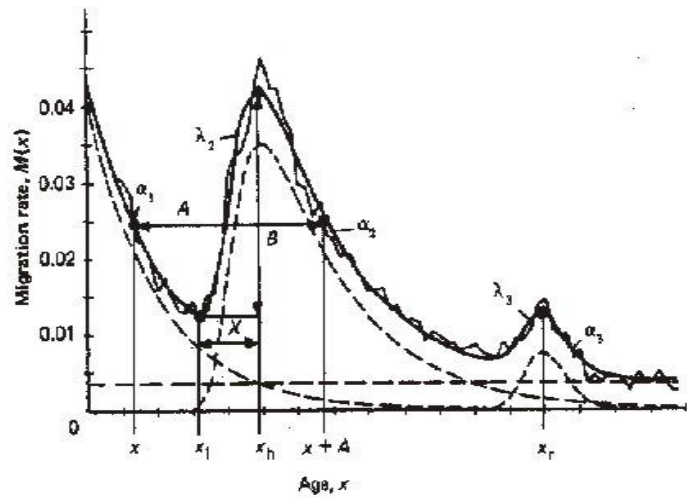
$$M(x) = a_1 * e^{(-\alpha_1 x)} + a_2 * e^{\{-\alpha_2(x-\mu_2) - e^{[-\lambda_2(x-\mu_2)]}\}} + c. \quad (8)$$

The last model is the "migration model with an ascending inclination." This model has a linear function in post-labor ages:

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

Figure 1 better illustrates all parameters in the curve for the "basic migration model":

**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

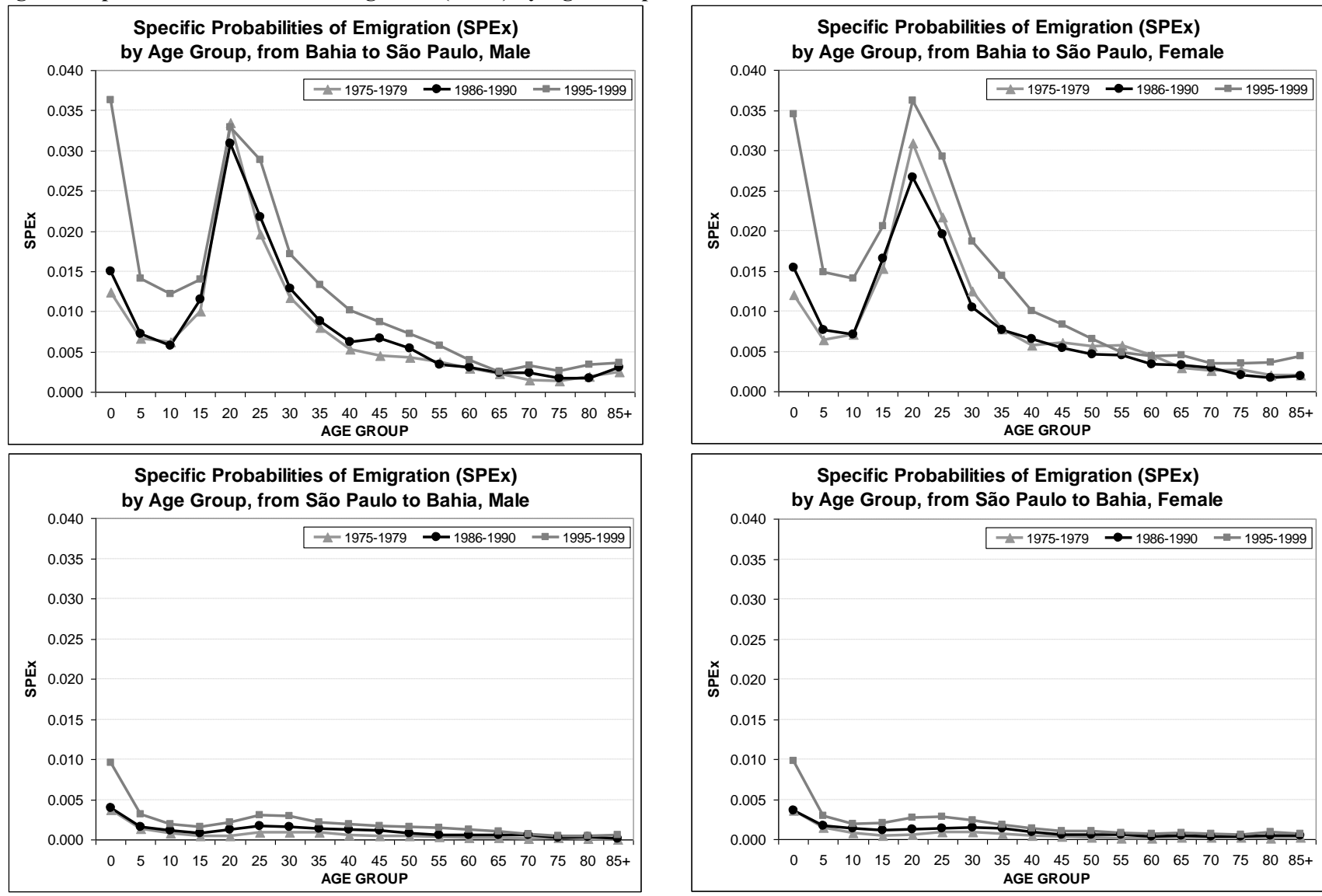
Source: Table constructed by the author, based on IBGE (1980, 1991, 2000).

**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

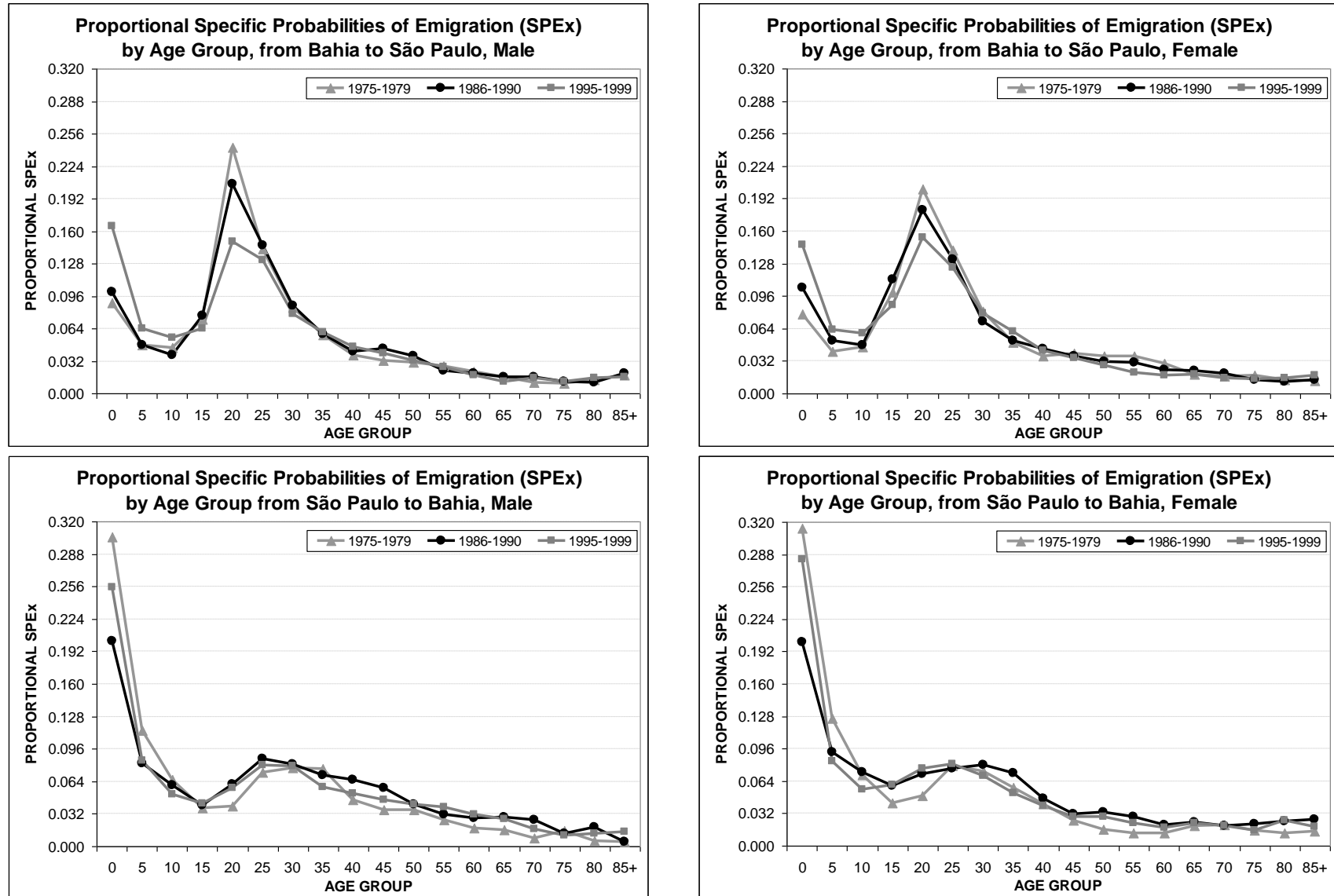
Source: Table constructed by the author, based on IBGE (1980, 1991, 2000).

Figure 2. Specific Probabilities of Emigration (SPE<sub>x</sub>) 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).