A new analysis of tempo, parity and quantum effects based on a new methodology for the reconstruction of Brazilian birth history using the 2000 demographic census.

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This paper presents an innovative methodology for the reconstruction of birth histories, applied to the Brazilian case. We construct a birth history, from 1986 to 2000, based on the 2000 demographic census microdata. This reconstruction is well suited to the application of the Kohler & Ortega method to disentangle tempo, parity, and quantum effects of fertility during the strong fertility decline observed in Brazil.

This type of methodology is important due to the absence of good birth histories in Brazil and other developing countries, the low quality of birth registration, and the usefulness of fertility intensities by parity and age to understand the dynamics of fertility decline. Furthermore, demographic censuses have a large sample size, which allows the estimation of separate intensities by year, education, region of residence, etc.

Methods:

The basic idea of the methodology consists in the reconstruction of birth histories, based on the censuses' family structure. The data requirement from the censuses, conditioned on the allocation of children to their presumable mothers, is the following:

1. Relationship of children to the family head.
2. Sex of children.
3. Age (of mother and children).
4. Parity or number of children ever born.
5. Number of dead children.

A major data limitation prevalent in most demographic censuses in developing countries is the absence of information on birth order and age of dead children. Thus, some restrictions must be applied in order to reconstruct birth histories:

1. Use only women with no dead children (remove women with dead children).
2. Use information about family composition to allocate present children under the age of 15 to the women in the family of ages 15 to 59, keeping only women whose allocation is presumably correct (remove women whose children allocation is not possible).

Removing these women from the analysis could potentially lead to biased estimates. In order to correct for the selection process we use a two-stage Inverse Probability Weight (IPW) procedure. The two subsequent weigth corrections ensure "parity and age", and "temporal" representativity respectively:

1. To ensure representation by parity and age, we correct the original weight by the ratio between two matrixes: the matrix of sum of weight factors of women by parity and age in the original data, divided by the equivalent matrix for the derived data (the data containing only women with no dead children). The matrixes cells values are the sum of the weight factors, by age and parity, for the original sample and the selected sample, respectively. For age *i*, varying from 15 to 59, and parity *j*, varying from 1 to the highest value, the parity and age correction factor, CF_1 is:

$$CF_1 = \frac{\sum_{ij} P_{i,j}^{ORIG}}{\sum_{ij} P_{i,j}^{SEL}} \quad (1),$$

where $\sum_{ij} P_{i,j}^{ORIG}$ is the sum of the original weight factor, P^{ORIG}, by age and parity j and $\sum_{ij} P_{i,j}^{SEL}$ is the sum of the weight factor of the selected sample, P^{SEL}.

2. To ensure temporal representation, we control, within each parity and age category, for the probability of no dead children, based on the characteristics of the women (region of residence) and the children (sex, age and region of residence of each of the allocated children). These probabilities are based on external estimates, derived from life tables (in our case generated by Cedeplar). This correction is important since otherwise women with relatively young children, who would have lower probabilities of having any dead child, would be overrepresented. This would lead to inaccurate time trends. For a woman of age *i,* and parity *j*, with *k* children of age *x* living at home, the probability of having no dead children is:

$$\Pr[noInfMort] = (1-_{x_1} q_0)...(1-_{x_k} q_0)...(1-_{x_{\max}} q_0)^{j-k} \quad (2),$$

where $(1-_x q_0)$ is the probability to survive until age *x*. Each child has an associated survival probability, which depends on sex and age, for those who live with mother. If the parity is over than the number of children ever born, means that *j-k* children don't live with mother. For those j-k children, which are aged over 14, the survival probability depends on the age of mother, *i*, as there is no information about them. Their survival probability is given by $(1-_{x_{\max}} q_0)$, where x_{max} is equal to (*i-15*). The second correction factor (CF_2) is calculated for each woman and is given by the Equation (3):

$$CF_2 = \frac{1}{\sum_{k=1}^{k} \log(1-_x q_0^k) + (j-k)(1-x_{mas} q0)} \quad (3)$$

The final weight factor is given by the Equation (4):

$$P^{FINAL} = P^{ORIG} x CF_1 x CF_2 \quad (4)$$

The next step consists in the application of the Kohler & Ortega method. Based on the weighted birth histories, we obtain the parity and age distribution of women. For every year, we have the number of births by parity and age, and compute the birth intensities. Finally, the computed birth intensities are used to analyze fertility trends. The application of Kohler & Ortega decomposition leads to estimates of tempo, parity, and quantum effects of fertility.

Consistency check-ups

The validation of this methodology will be examined by two exercises:

1. Comparison of rates based on the 2000 Census with rates based on 1996 DHS survey.
2. Comparison of rates for 1986-1991 based on the 2000 Census with those based on the 1991 Census.

Data Sets:

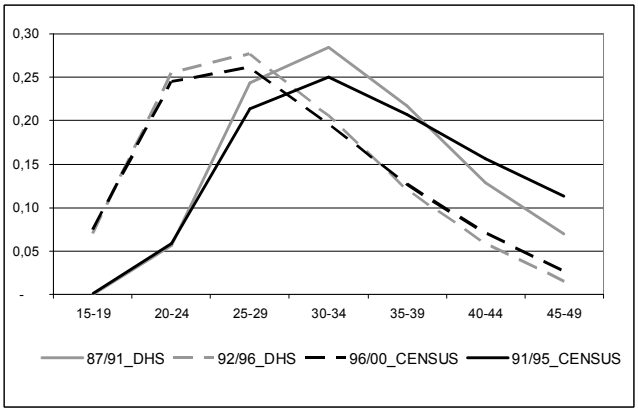
In Brazil, there are two surveys that contain birth histories and that are representative of the whole country: the DHS surveys of 1986 and 1996. The disadvantage of using these databases is associated with the small sample size, it does not allow desegregations, and the rates may present fluctuations. The birth history derived from the 1996 DHS survey will be compared with the one constructed by the proposed methodology.

Brazil has a long list of demographic censuses, the ones with microdata available are 1960, 1970, 1980, 1991, and 2000. The last two censuses will be used in this paper.

Some results:

To check the methodology, we calculated the total fertility rate and the age specific fertility rates, based on the 1996 DHS and 2000 Census birth histories. Graphic 1 shows the relative age specific rates for 1987/1991 and 1992/1996, using DHS, and for 1991/1995 and 1996/2000, using Census data.

Graphic 1: Brazil: relative age specific fertility rates, based on 1996 DHS and 2000 Demographic Census – 1987/1991, 1992/1996, 1991/1995 and 1996/2000



Fonts: BENFAM: Brazilian DHS, 1996
IBGE: Brazilian Demographic Census, 2000

The TFRs for the same periods are also consistent, and consist with the TFR traditionally calculated. Table 1 shows the results.

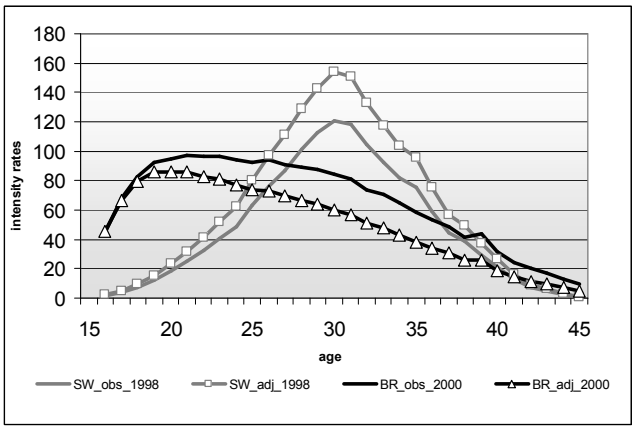
Table 1: Brazil: Birth Histories and Traditional Total Fertility Rates based on 1996 DHS, 1991 and 2000 Demographic Censuses

TFR					
Birth Histories				Traditional	
DHS	CENSUS	DHS	CENSUS	CENSUS	CENSUS
1987/1991	1991/1995	1992/1996	1996/2000	1991	2000
3,10	2,76	2,50	2,36	2,76	2,36

Fonts: BENFAM: Brazilian DHS, 1996
IBGE: Brazilian Demographic Census, 1991 and 2000

The Graphic 2 shows the observed and adjusted intensity rates of the transition to first child, for Brazil and Sweden. While in Sweden the adjusted intensity rates indicate that women are postponing the first child, Brazil is in the opposite situation, what is evident because the observed intensities are higher than the adjusted. In the case of Brazil, the first order childbearing is being anticipated, what inflates the observed intensities.

Graphic 2: Brazil, 2000 and Sweden, 1998: observed and adjusted intensity rates of the transition to first child, based Census data



Fonts: IBGE: Brazilian Demographic Census, 2000
ORTEGA & KOHLER (2002)

Future Applications

The results indicate that, in the aggregate level, the methodology seems to be consistent. If this method proves to be robust, it will be a major advance in the study of tempo, parity, and quantum effects throughout developing countries with good demographic censuses microdata.

A first follow up activity will be the reconstruction of fertility in Brazil since 1946, based on the use of 1960, 1970, 1980, 1991 and 2000 censuses. This can be replicated for other Latin American countries, through the use of IPUMS data basis (it includes Colombia and Mexico) and for other developing countries.

References

FEENEY,G. and J. YU (1987). Period parity progression measures of fertility in China. *Population Studies* 41 (1), 77-102.

CEDEPLAR (1999) Preliminary data for population projections, by sex and five years age groups, for Brazilian Regions, Brazil, 1990/2020. Pronex activities report (Restrictive Use).

KOHLER, H-P and D. PHILIPOV (2001). Variance effects in the Bongaarts-Feeney formula. *Demography* 38(1), 1-16.

KOHLER, H.-P. and J. A. ORTEGA (2002): "Tempo-Adjusted Period Parity Progression Measures, Fertility Postponement and Completed Cohort Fertility", Demographic Research, vol. 6(6), pp. 91-144.

ORTEGA, J.A. and H-P. KOHLER (2002) Measuring low fertility: rethinking demographic methods. Working Paper 2002-001, Max Planck Institute for Demographic Research, Rostock, Germany (Available at http://www.demogr.mpg.de).

ROBINS, J.M, A. ROTNITZKY, L-P ZHAO.(1995). Analysis of semiparametric regression models for repeated outcomes in the presence of missing data. *Journal of the American Statistical Association*, Vol. 90, pp. 106 –121.

WOOLDRIDGE, J. M. (2002), Inverse probability weighted M-estimators for sample selection, attrition and stratification, *Portuguese Economic Journal*, vol. 1(2), pp. 117-139.