Reconstruction of Brazilian birth history based on the 2000 demographic census: tempo, parity and quantum effects.[∞]

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Introduction

This paper presents a methodology for the reconstruction of birth histories, based on the 2000 Brazilian demographic census microdata. 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 alternative fertility measures to understand the fertility decline dynamics. The use of incidence rates may mislead inferences, as pointed by Ortega and Kohler (2002). Not a great deal is known about some dimensions of fertility in Brazil, such as birth intervals, parity progression rates, tempo effects, and mean age by parity. Thus, this paper aims to: (i) describe the methodology for the reconstruction of birth history based on census microdata; (ii) reconstruct the birth history for the 2000 Brazilian demographic census; (iii) test the application of Ortega & Kohler (2002) methodology to the birth history data.

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. Demographic censuses, otherwise, have a large sample size, which allows the estimation of separate intensities by year, education, region of residence, and other attributes. Although the description is based on the 2000 demographic censuses, the methodology can be applied to most of the Brazilian censuses. This reconstruction is

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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.

The literature registers another methodology of birth history reconstruction, based on census microdata (LUTHER & CHO, 1988), which has some similarities to the one that is presented here: both methodologies are based on the reconstruction of partial birth histories, in order to turn them into complete ones; further, the construction of both partial birth histories is done by the allocation of children to their mothers. The differences are due to the composition of the partial birth histories and the ways to turn them into complete birth histories.

The allocation of children to their mothers is based on the procedure used in the 'Own Children Method' (CHO, RETHERFORD & CHOE, 1986). The 'Own Children Method' uses the variable 'relation to head of household/family' to identify the relation mother-child within the household or family. In LUTHER & CHO's methodology, the partial birth history is composed by women and their allocated children (i.e., their own children). To turn this partial birth history into a complete birth history, a probabilistic procedure is used to assign an age to the omitted children (children not allocated, or dead before the census or survey). For a given woman, the probability of have had an omitted birth, j years before the census or survey, depends on her cohort fertility curve, on the ages of her own-children and on the omitted condition of the child (not allocated or dead).

The present methodology of birth history reconstruction, based on demographic census, also uses the procedure described in the 'Own Children Method' to allocate children to their mothers. In this case, however, the partial birth history is not composed by all women and their own children, but by the women with no dead children at the time of census, and their own children. Then, this partial birth history is corrected by a two stage inverse probability weight (IPW) procedure, which recovery these removed women, by the creation of a new weight factor that ensures "parity and age", and "temporal" representations.

Methods

The basic idea of the methodology consists in the reconstruction of birth histories of women, for a 15 years period, before the census, based on the census' family structure. 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: (a) use only women with no dead children (remove women with dead children); (b) 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).

The data required from the census, conditioned on the allocation of children to their (presumable) mothers, is the following:

- Relationship of women and children to the family head.
- Sex of children.
- Age of mother (15-59) and age of children (0-14).
- Parity or number of children ever born.
- Number of dead children.
- Age of the last child born.

For the 2000 Brazilian Censuses, the variable *'relation to family head'* can assume the following categories:

1- Head of family.

2- Wife/husband.

3- Son/Daughter(including the adopted)/Stepson/Stepdaughter.

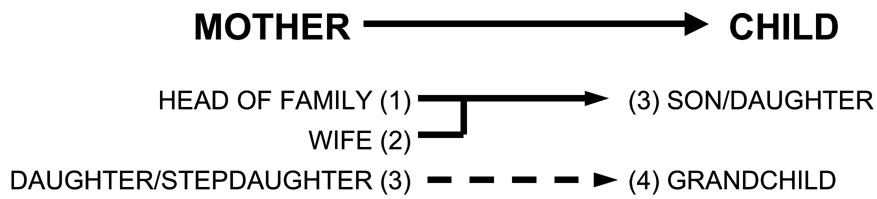
4- Grandchild.

5- Other relatives.

6- Others.

These categories allow the allocation of children to their (presumable) mothers when: mother is (1) and child is (3); mother is (2) and child is (3); mother is (3) and child is (4), as shown on Figure 1.

Figure 1: Arrangements on the variable 'relation to head of family' that allow the identification of the relation mother-child in the Brazilian 2000 census.

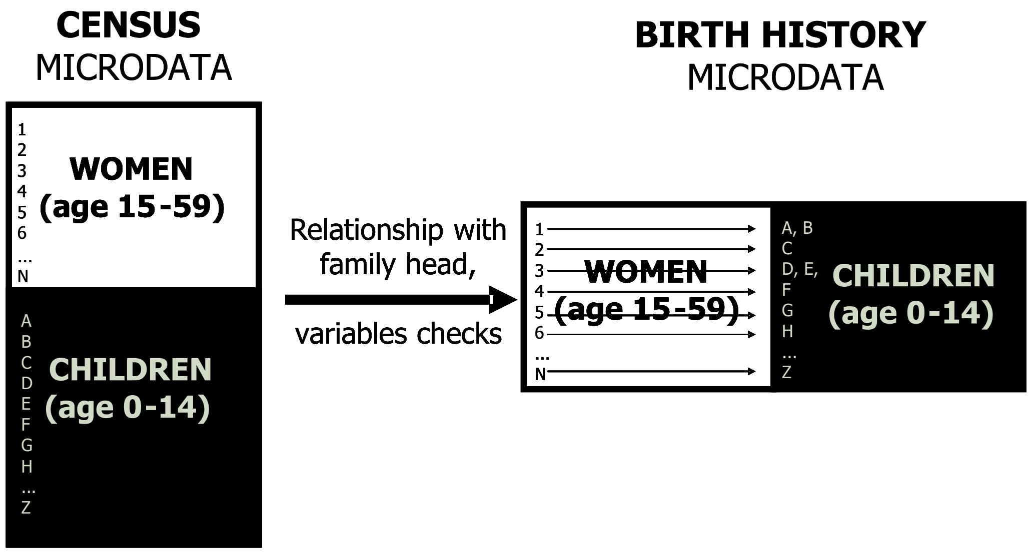


Source: Own elaboration

After the allocation, it's essential to test some variables, in order to eliminate eventual inconsistencies. These inconsistencies are due to confusion in the definition of the category (3) of the variable 'relation to head of family'. If the category included only legitimate sons and daughters, one could certainly allocate children to 'head of family'. Further, when the 'head of family' is a man, there is no guarantee that his sons and daughters are also his wife's. In order to reduce these eventual incorrectness, some alternative variables (ages of mother and child, parity, number of dead children and age of last child born) are used to check: (i) if age of childbearing is coherent to the woman's reproductive period; (ii) if number of allocated children is not higher than the woman's parity; (iii) if age of child is equal or higher than the age of the woman's last child. If any of these conditions are not satisfied, the child is eliminated from the database. In some cases, even when a child is eliminated, at least one of the conditions is not satisfied, what results in the elimination of the woman and all her children. It's important to point out that, even with the checks, there is no absolutely guarantee of the legitimate association 'mother-child' between the remaining women and children.

The result of the allocation process is a database in which each line contains the information of a woman and her children, as shown in Figure 2.

Figure 2: Transformation of Census Microdata into Birth History microdata



Source: Own elaboration

Removing the women with, at least, one dead child, from the database, 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 recovery of these removed women is made by the creation of a new weight factor that ensures "parity and age", and "temporal" representations. The Inverse Probability Weights (IPW) corrects the selection in two stages:

1. To ensure representation by parity and age, we correct the original weight by the ratio between two matrixes. First, a matrix comprised by sum of weight factors of women, by parity and age category, of the original data. Second, a matrix comprised by the sum of weight factors of women, by parity and age category, of the derived data (the data that contains 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, one 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 would be overrepresented, leading 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:

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

where $(1-{}_xq_0)$ 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):

$$CF_2 = \frac{1}{\sum_{k=1}^{k} \log(1-{}_xq_0^k) + (j-k)(1-x_{mas}q0)} \quad (3)$$

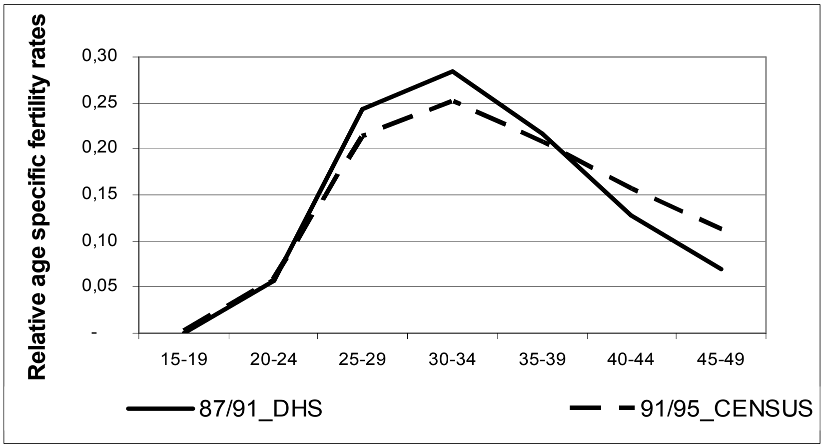
The final weight factor is given by the Equation (4):

$$P^{FINAL} = P^{ORIG} xCF_1 xCF_2 \quad (4)$$

A Consistency Check for the Methodology

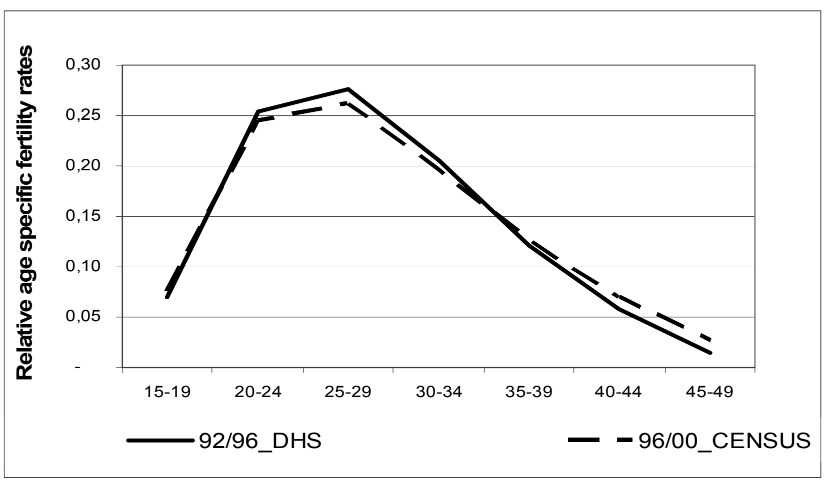
In order to check the methodology regarding the reconstruction of birth histories based on the censuses' family structure, the total fertility rate and the age specific fertility rates were calculated, based on the 1996 DHS and 2000 Census birth histories. The Figures 3 and 4 shows the relative age specific rates for 1987/1991 and 1992/1996, using DHS, and for 1991/1995 and 1996/2000, using Census data.

Figure 3: Brazil: relative age specific fertility rates, based on 1996 DHS and 2000 Demographic Census – 1987/1991, 1991/1995



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

Figure 4: Brazil: relative age specific fertility rates, based on 1996 DHS and 2000 Demographic Census – 1992/1996 and 1996/2000



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

The TFRs calculated with birth histories from DHS and the 2000 demographic census seem to be consistent, as indicated in Table 1. The traditionally calculated TFR for the 1991 and 2000 demographic censuses are also presented for comparison.

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

Sources: BENFAM: Brazilian DHS, 1996 and IBGE: Brazilian Demographic Census, 1991 and 2000
* TFR Tradicional: observed TFR using tradicional Brass techniques.

The next step consists in the application of the Kohler & Ortega method. Based on the weighted birth history, 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.

Some Empirical Results[1]

The birth history reconstruction is, now, combined with the Kohler & Ortegamethod to disentangle the following period effects: tempo, parity composition, and quantum. This exercise will clarify the nature of the strong fertility decline observed in Brazil.

Results presented in Tables 2 and 3 give a small picture of tempo, parity, and quantum effects of Brazilian fertility in 1996 and 2000. The tempo effect observed in 1996 was around 10.2 percent. The adjusted TFR in 1996 was 2.34, contrasted with 2.58 in observed TFR. The size of the negative tempo effect in year 2000 is smaller than in 1996,

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[1] For details of the methodology and application to the Brazilian data, see ORTEGA & KOHLER (2002) and SILVA, MIRANDA-RIBEIRO & RIOS-NETO (2005).

around 8.1 percent, adjusted TFR is near replacement (2.08) while observed TFR is slightly above replacement level.

Table 2: Tempo and Parity Composition Effects on Fertility – Brazil 1996

	Parities					
	0	1	2	3	4+	Total
TFR	0,875	0,703	0,407	0,206	0,391	2,582
TFR Adjusted	0,844	0,710	0,328	0,157	0,304	2,344
Mean Tempo Effect (%)	(3,57)	0,93	(24,02)	(31,03)	(28,59)	(10,16)
PATFR	0,901	0,749	0,394	0,160	0,012	2,216
PATFR Adjusted	0,837	0,611	0,227	0,070	0,002	1,747
Parity Composition Effect (%)	0,92	16,05	44,51	124,69	13.234,57	34,12
Mean Age Stable Dist.	23,93	26,93	28,96	30,68	34,73	-
Mean Age Frequency Sched.	24,59	28,70	30,38	31,41	35,12	-

Source: Birth History Reconstruction from the Brazilian Demographic Census, 2000.

Table 3: Tempo and Parity Composition Effects on Fertility – Brazil 2000

	Parities					
	0	1	2	3	4+	Total
TFR	0,824	0,630	0,354	0,168	0,273	2,249
TFR Adjusted	0,748	0,612	0,347	0,152	0,221	2,081
Mean Tempo Effect (%)	(10,15)	(3,06)	(1,98)	(10,33)	(23,10)	(8,09)
PATFR	0,870	0,670	0,316	0,122	0,007	1,984
PATFR Adjusted	0,823	0,556	0,228	0,077	0,003	1,687
Parity Composition Effect (%)	(9,10)	9,94	52,52	98,00	8.010,51	23,35
Mean Age Stable Dist.	23,48	26,74	28,46	29,81	33,91	-
Mean Age Frequency Sched.	24,12	27,89	28,92	29,93	33,31	-

Source: Birth History Reconstruction from the Brazilian Demographic Census, 2000.

Ortega and Kohler (2002) remind that adjusted PATFR is the pure index of fertility, since it is free from tempo and compositional distortions. This index of fertility is the pure quantum effect, free from all non-behavioral effects. Results from Tables 2 and 3 shows that the "pure quantum component" was already below replacement in 1996, and declined from 1.74 to 1.68, in 2000. What makes adjusted TFR different from the pure quantum index (adjusted PATFR) is the parity and age distribution of fertility.

Considerations

This paper presented a methodology to reconstruct a birth history from the 2000 Brazilian demographic census microdata, and tested the application of the Ortega and Kohler methodology to the resulting birth history database. To what concerns the reconstruction of birth history, it is important to point out that the methodology is still under construction. Although Figures 3 and 4 show a consistent distribution of the relative age specific fertility rates, comparing the birth history, DHS and 2000 census data, some inconsistencies were found, during the application of Ortega and Kohler methodology. These inconsistencies occur especially for periods over 5 years, from the time of the census. Because of this, other alternatives of correction are being tested, including improvements in the mortality data. Even with some problems, the results seem reasonable for the period 1996-2000. The replication of the methodology to other Brazilian censuses (1960, 1970, 1980 and 1991) would establish a Brazilian fertility time series, by year, from 1946 to 2000.

To what concerns the results of the application of Ortega & Kohler methodology, it is obvious that only two points in time do not say much about tendencies. The reconstruction of birth histories based on other Brazilian census microdata could the results, however, allows some inferences. They suggest, for example, that the tempo effect was small and negative (as opposed to the large and positive effect found in developed countries); that the parity distribution was large and positive (favoring high TFR, as opposed to the negative parity distribution effect found in developed countries); and finally, that the pure fertility index (quantum fertility) was the factor responsible for the observed fertility decline in Brazil. The quantum fertility in Brazil is already well below replacement, almost approaching the lowest-low fertility level. The main question now is whether the country will entry the postponement transition. If Brazil enters the postponement transition, the consequence may be a positive tempo effect and levels of observed TFR well below the lowest-low fertility threshold. Although this may be undesirable in macroeconomic terms (it may be a negative externality), it is clearly desirable on universal rights grounds to the extent that it is enhanced by an increase in schooling, a decline in adolescent fertility, and a more diverse supply of contraceptives. The Brazilian Government has just launched a new family planning program, promoting women sexual and reproductive rights in light of Cairo´s propositions. If the program succeeds, it is almost sure that Brazil will be among the first developing countries entering the lowest-low fertility category.

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