# Fertility decline in Brazil and México: tempo, quantum and parity composition effects.

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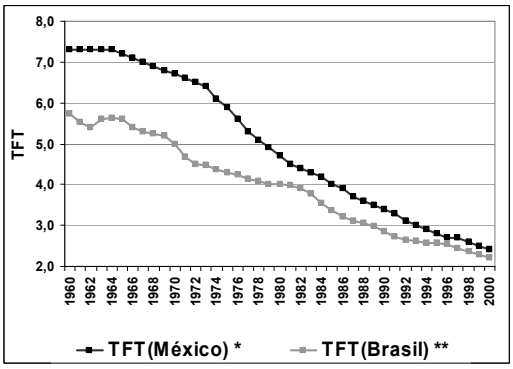
## I- Introduction

Fertility in Brazil and Mexico declined strongly during the last 40 years. In 1960, TFR in Mexico was around 7.3 and, in 2000, reached 2.4. In Brazil, the decline was less intense but also expressive, declining from 5.7 in 1960 to 2.1 in 2000. Figure 1 shows that the decline in both countries started in the midle 1960's, from a different level and in a different pace and that, at the end of the 1990's, Brazil's and Mexico's fertility was near the replacement level.

**Figure 1**
**Brasil and México, 1960/2000: TFR series.**




Sources: * Consejo Nacional de Población, México.
** IBGE, Brasil: Censos Demográficos, 1970, 1980, 1991 e 2000.

Fertility studies in Brazil and Mexico are in general limited to the analysis of the traditional measures (TFR, ASFR and mean age of childbearing), most because of the low quality of birth registration and the absence of good birth histories. It's known that the traditional measures are distorted and, although very useful, lead to a misunderstanding of the overall process of fertility decline. The investigation of alternative measures is becoming more important as the fertility level reaches lower levels.

After the 1980's the technological advances allow the development of new techniques – or methodologies – that produce, from census and survey data, a data set from which it is possible to obtain some alternative fertility measures. Examples are the methodologies that reconstruct birth histories from census and survey data. Miranda-Ribeiro & Rios-Neto (2006) present two birth histories reconstruction methodologies and determine the one that produces better results to the Brazilian case. This methodology also produced good results when applied to the 2000 Mexican Census (Miranda-Ribeiro, Rios-Neto & Ortega, 2006).

The birth histories data allow the measurement of the childbearing intensities. Childbearing intensities are obtained by dividing the number of births occurring to

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mothers in a specific category by a measure of exposure in this specific category. A series of intensities allow the application of Köhler & Ortega method (described in Ortega & Köhler, 2002), which leads to estimates of tempo, parity, and quantum effects of fertility.

The main objective of this paper is to apply the Köhler & Ortega method to the last two editions of the Brazilian and Mexican Censuses (1991 and 2000 for Brazil; 1990 and 2000 for Mexico) to disentangle tempo, parity, and quantum effects of fertility during the fertility decline in both countries. Other purpose of the paper is to apply the birth history reconstruction methodology to the censuses data (the methodology is described in Miranda-Ribeiro & Rios-Neto, 2006).

**II- The Köhler & Ortega Method (K-O)**

Basically, the method consists in four steps, as shown in Diagram 1: (1) calculation of incidence and intensity rates and TFR; (2) estimation of the parameters gamma and delta, by an iterative process; gamma and delta allow the estimation of $r_j(a)$, the annual variation of the mean age of childbearing, by birth order and age of mother; (3) $r_j(a)$ is used to estimate the adjusted intensities, incidences and TFR (measures that are free from tempo effects); (4) a fertility table is used to disentangle the parity composition effect of fertility, by using the adjusted intensities, and producing the adjusted PATFR, a pure quantum measure.

Birth intensities are defined as the number of births of order "i" divided by the number of women of parity "ï-1", as defined in (1):

$m_c(a) = \frac{B_c(a)}{E_c(a)}$ **(1),** where $B_c(a)$ are births of women aged *a* and class *c* and $E_c(a)$ are women aged a and class c (parity "ï-1"). Incidence rates generate the age specific fertility rates: $f_c(a) = \frac{B_c(a)}{E\ (a)}$ (**2**), where $B_c(a)$ are births of women aged *a* and class *c* and $E\ (a)$ are women aged *a*. The annual variation $r_j(a)$ of parity "*j*" at age *a* is: $r_j(a) = \gamma_j + \delta_j(a - \overline{a}_j)$ (**3**), where $\gamma_j$ and $\delta_j$ are the parameters gamma and delta, calculated interactively following Kohler e Philipov (2001). Gamma is the change in the mean age at childbearing, while delta is the proportional change in the standard deviation and $\overline{a}_j$ é the mean age at the adjusted fertility function. The adjusted functions follow the two formulas below.

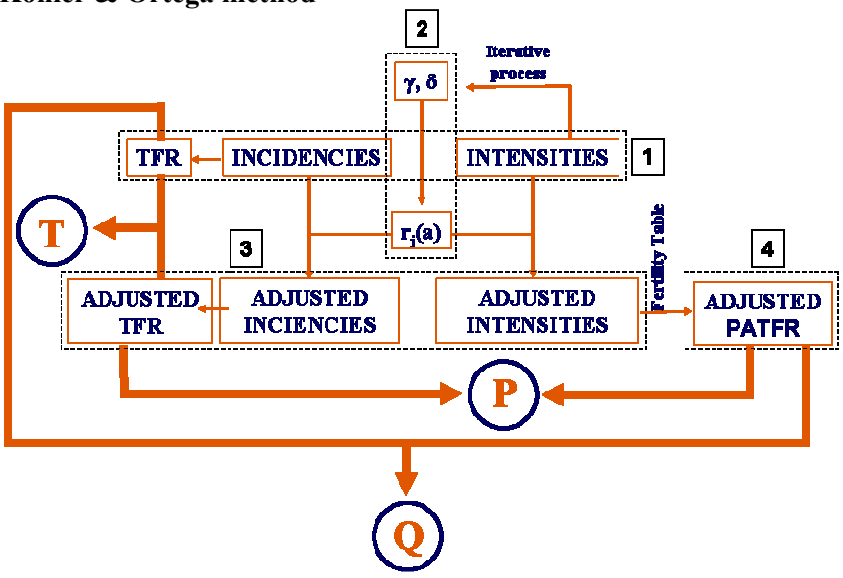
For intensities, $m_j'(a) = \frac{m_j(a)}{1 - r_j(a)}$ (**4**) and for incidences, $f_j'(a) = \frac{f_j(a)}{1 - r_j(a)}$ (**5**). TFR e $TFR_C$ (class c) are calculated by the formulas (6) and (7): $TFR_C = \sum_a f_c(a)$ (**6**) and $TFR = \sum_c TFRc = \sum_a f(a)$ (**7**).

A fertility table is built following the formulas below. The age and parity specific probability of birth: $q_j(a) = 1 - \exp[-m_j(a)]$ (**8**). The birth probabilities are the basis for the other measures of the table: the number of births of order *j*, from women aged *a*, $b_j(a) = D_j(a).q_j(a)$ (**9**), where $D_j(a)$ is the number of women of parity *j* and exact age *a*. An iteractive procedure using formulas (9) and (10) allows the calculation of the number of women and births ( $D_j(a+1) = D_j(a) - b_j(a) + b_{j-1}(a)$ (**10**). For parity *J*, the last parity, including parities *J* and above, the two interactive formulas are: $b_J(a) = D_j(a) f_J(a)$ (**11**) and $D_J(a+1) = D_J(a) + b_{J-1}(a)$ (**12**).

The number of women at the initial condition of the table (radix), that is to say age "$\alpha$" and parity "j=0", is N. At the exact age "$\alpha$" and parity "j>0" the number of women is null. The mean number of births for women in the synthetic cohort is defined by $b_{j1,j2}(a_0,a_1)=\sum_{a=a0}^{a1}\sum_{j=j1}^{j2}b_j(a)$ **(13)**.

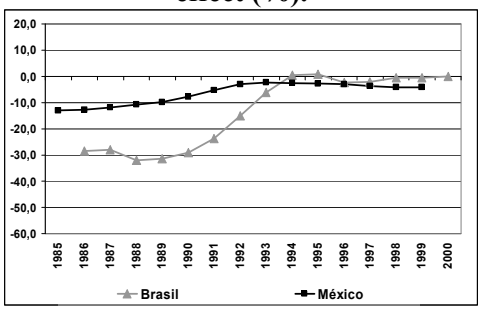
The completed fertility of the fertility table corresponds to (13) and is also called Parity and Age Total Fertility Rate (PATFR) as in Rally and Toulemon (1993). When PATFR is built based on tempo adjusted intensities, it is free from both tempo and parity compositional effects (PATFRadjusted).

**Diagram 2**
**Köhler & Ortega method**



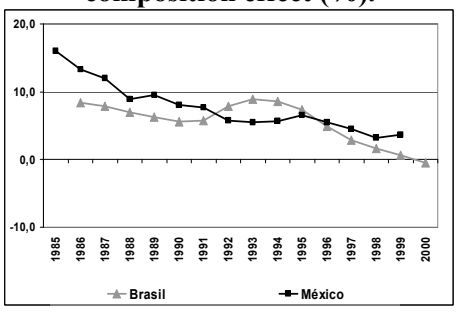

## III- Some results

**Figure 2**
**Brazil and México, 1985-2000: tempo effect (%).**




Sources: IBGE: Brazilian Demographic Census, 2000.
*IPUMS-International*: Mexican Demographic Census, 2000.

**Figure 3**
**Brazil and México, 1985-2000: parity composition effect (%).**




Sources: IBGE: Brazilian Demographic Census, 2000.
*IPUMS-International*: Mexican Demographic Census, 2000.

Figures 2 and 3 show that Brazil and México have similar trends, regarding tempo and parity effects. Tempo effect is negative during part of the analisys period and very small at the end of the period. Parity composition effect is positive during the period. For Mexico, at the end of the period there is still some parity composition effect (4%), while for Brazil it is null.

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