An Application of the Bongaarts Proximate Determinants of Low Fertility for Brazil

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ABSTRACT

More than half of the world’s population lives in a country where fertility is below replacement level. Brazil is one of them. Total Fertility Rate went down from 4.26 children per woman in 1980 to 1.91 in 2010. Some internal disparities exist, however, regardless of the low value at the macro level. We use data from the Demographic and Health Survey from 1986, 1996 and 2006 to decompose and analyze fertility rates using a framework that is especially useful to explore and compare factors associated with low fertility (Bongaarts, 2001). By understanding fertility variation and its components across time in Brazil, this paper illuminates the factors that contribute for low fertility, how they vary by socio-demographic characteristics (birth cohort, race, marital status, religion, education, geographic macro-region, and place of residence), and how these factors combined have formed the total fertility rate throughout the years.

INTRODUCTION

Until recently policymakers in developing countries were concerned about the contribution of high fertility rates to rapid population growth and poor urban and socioeconomic conditions (Bongaarts, 2001). Today, low fertility is a widespread phenomenon. More than half of the world’s population lives in a country where fertility is below replacement level (Morgan, 2003). Brazil is now one of them (Carvalho & Brito, 2005; Potter et al. 2010). Total Fertility Rate went down from 5.8 children per woman in 1960 to 1.91 in 2010 (IBGE, 2011). Some internal disparities exist, however, regardless of the low value at the aggregate level. For example, in 2010, while fertility was 1.24 children per woman for those with more than 12 years of education, those who had between 0 and 3 years of education had a TFR of 3.14 children. Other variations by region, income level and race/ethnicity have also been reported in the last years. White women had a TFR of nearly half a child less than blacks (TFR=1.53 for whites and 1.98 for blacks) in the year 2006. For the same year, women with per capita income equal to 1/4 minimum wage, had a TFR of 4.8 in 2006, while women with per capita income equal to minimum age, already had fertility below replacement in the early 2000’s (Berquó e Cavenaghi, 2006). Other variations such as regional and racial differentials are also
pronounced. White women had a TFR of nearly half a child less than blacks (TFT=1.53 for whites and 1.98 for blacks) in the year 2006. Inhabitants of the north region had a TFR of 2.28 while those of the south had a TRF of 1.69. Even controlling for socio-economic status, research indicate that these differentials exist (Alves e Cavenaghi, 2009) and the most recent Census, in the year 2010, confirms that differences are still remarkable, although the gaps have been narrowing (Miranda-Ribeiro and Garcia, 2012).

Determining the causes and consequences of first, the fertility transition, and second, the fertility decline below replacement, has kept many generations of demographers busy (Mason, 1997). Nevertheless, it is for a good reason. Scholars need to know variations in desired fertility but also how often people are able to implement their fertility preference and the reason why observed fertility departs from desired family size. It is common to find places where desired family size is higher than total fertility rates (Bongaarts, 2001). Besides, the unwanted long term consequences of fertility below replacement, such as population aging and decreasing rates of growth that tends to become negative with time, could be problematic in some countries. Europeans and some Asians, for example, start to feel the first signs of an unbalanced age structure. Lutz et al (2003) demonstrate that the effects have been small so far, but each additional decade that fertility remains below replacement represent a decline from 25 to 40 million people in the absence of immigration or changes in current mortality rates in Europe.

Much of the decline is actually an effect of postponement of fertility as argued by Bongaarts and Feeney (1998), the so called “tempo effect”. If this is true, one might see reversals in fertility rates in the future, when women stop further postponement (Morgan, 2003). However, some of these women might not have time (or the desire) to recuperate their fertility and others might decide to never have children at all, configuring a “quantum effect” that brings harsher consequences on population age distributions (Caldwell and McDonald, 2006; Lesthaeghe and Willems, 1999). In fact, research shows that changes do not seem to be only a timing effect, but a reduction in the number of births, which has severe implications of lowest-low fertility countries (Myrskyla et al. 2012).

Different from trends observed in Europe, however, Brazilian fertility remains early, not configuring a general postponement or a positive tempo effect (Rios-Neto, 2005; Alves and Cavenaghi, 2009). Furthermore, research suggests that tempo effect might have been negative for the Brazilian case, as women were having children early in life and that could have inflated the observed TFR (Miranda-Ribeiro et

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1 For more information on Brazil’s fertility decline, see Carvalho & Brito (2005) and Alves & Correa (2003). For complete descriptive data on Brazil’s fertility in the last decade, see Miranda-Ribeiro and Garcia (2012) and Alves e Cavenaghi (2009).
Figure 1 shows that the mean age of childbearing that was 29.5 in 1970 dropped to the minimum low in 1994, 26.5. Part of this decrease is only an effect of the fertility limitation at lower parities (as the mean age at childbearing would be affected by women having children throughout her reproductive life).

When only the mean age at first childbearing is analyzed, one can see that more than half of all women in the 20-25 age group was already a mother in 2006 (BEMFAM, 1987 e 1997; Ministerio da Saude, 2008). The same data for 2006 shows that 25% of the women who got sterilized did so before the age of 25 year old, setting an end to their reproductive period before women in Europe are even starting to have their first child. The only signs of postponement in Brazil were found for women of higher education level\(^2\) (Ministerio da Saude, 2008).

![Figure 1: Mean age at childbearing for selected years](image)


The mean age at childbearing observed a slight recuperation in the last decade, as can be seen in Figure 1. Drawing on Lesthaegue and Willems (1999) and after observing postponements for the second child, Miranda-Ribeiro et al. (2012) suggest that Brazil is entering the second phase of the demographic transition, where after fertility levels decline in all ages and parities, women start postponing fertility. The authors also suggest that there is an unexplored variation in fertility that should be understood if one wishes to predict where Brazil is heading to.

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\(^2\) Among the more educated, the age decreased between the decades 1980 and 2000 and had a slight increase in the following decade, reaching 28.2 in 2010. The same data for 2006 shows that 25% of the women who got sterilized did so before the 25 year old, configuring an end of their reproductive period before many women in Europe are even starting to have their first.
Factors associated with the decline could be different for every country, and the speed of the decline allied to the internal disparities and the substantial differences in regards to the European transition makes studying low fertility in Brazil an opportunity to understand how interactions and changes in social institutions and in preferences might be shaping Brazil’s unique patterns. Thus, this paper explores fertility variation and its components across time in Brazil, shedding light on the factors that contribute for low fertility, how they vary by socio-demographic characteristics (age, race, marital status, religion, education, geographic macro-region, and place of residence), and how these factors combined have formed the total fertility rate throughout the years. In order to do that, we used Demographic and Health Survey data from 1986, 1996 and 2006 to decompose Total Fertility Rates into parameters that represent factors that enhance or reduce its value related to the values of Desired Family Size using the framework provided by Bongaarts (2001) by each year separately. Then, we decomposed the parameters of the TFR by each socio-demographic characteristic.

THEORETICAL FRAMEWORK

The proximate, or direct, determinants of fertility are the biological and behavioral factors through which social, economic and environmental variables, the so called “indirect determinants”, affect fertility (Bongaarts & Potter, 1983, p.1). Generally, they are used to assess fertility in an environment where regulation of fertility is being deliberately practiced, thus total fertility rates departs from natural fertility. They were first described in a theoretical paper by Davis and Blake (1956) and further developed by Bongaarts (1978) who was the first to introduce measurements to the proximate determinants.

In their application of the framework, Bongaarts and Potter (1983) conceptualized the Total fertility Rate as being a results of natural fertility, multiplied by four parameters that would decrease it. The first component of fertility is age at first marriage, which identifies the onset of exposure to the risk of socially sanctioned childbearing, which could also happen during cohabitation depending on the country. This rate is impacted by the mean age at marriage, existence of marital dissolution, and proportion of the population who ever marries. In the past, although there was variation in age at marriage, getting married was almost universal. The second component is contraceptive use. The prevalence, type and effectiveness of the method will affect fertility because some are better effective them others, usually depending on the amount
of human action needed before the sexual act\(^3\). Thus, changes in the pattern of contraceptive behavior with age and with time and cohort will likely have an impact. Rate of induced abortion is the third component. Note that abortion will not only prevent birth, but will make women return to ovulation quicker, so abortion do not avert full birth at population level, but half birth. Duration of Postpartum Infecundability is the fourth element, which is estimated based on the duration of breastfeeding. So, in a context of high fertility, the TFR is expected to be equal to the natural fertility in the absence of any form of regulation, or in other words, in the absence of any parameter. Note that it is possible that two populations with the same TFR will have different values for the parameters, which could help policy makers make better informed decisions.

For contexts in which fertility is below replacement, a new equation was put together in Bongaarts (2001). The reason why low fertility needs a separate model is because the main parameters of the Bongaarts and Potter (1983) proximate determinants are not as defining of fertility in a context of universal contraceptive use and abortion access, disregarding marriage and breastfeeding as parameters. So, when low fertility is a result of desire, it is an achievable goal, and thus marital fertility, natural fertility, length of breastfeeding or biological maximum become irrelevant.

This new approach and conceptual framework received the name of the Proximate Determinants of Low Fertility (Bongaarts, 2001). It is calculated in the same way as the one above, but its parameters are different. The intention is to understand what components of a society or structures of the world that “motivate and constrain behavior” could be shaping low fertility (Dharmalingam et al. 2014). There are seven parameters of the Proximate Determinants\(^4\) that are responsible for fertility (TFR) and fertility variation (TFR over time) being different from Desired Family Size (DFS). They can be divided into factors that enhance fertility relative to the desired family size and factors that reduce fertility relatively to desired family size (Morgan et al. 2009). The first group of factors is composed of added fertility due to \textit{unwanted fertility} (\(F_U\)), \textit{replacements for child mortality} (physiological replacement, volitional replacement, hoarding, the \(F_R\)), and \textit{sex preference} (\(F_{SP}\)). The second group is composed of \textit{rising age at childbearing} (tempo effect which would be the number of children that a women would have had if they had not waited, or the

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\(^3\) Condoms and spermicides, which requires action right before the penetration will have worse effectiveness when compared to sterilization, which is a once in a lifetime event, or the pill, which needs to be taken daily but it is not necessarily linked to the sexual act. Intended fertility may also have an impact because choice of contraceptive may depend on the desire to have future children and in the desired birth interval, if any.

\(^4\) For more information on what could affect each determinants and how they affect one another, see Bongaarts (2001).
voluntary infertility (which includes the inability to have a child and also an inability to find a suitable partner, the F_I), and competing preferences for child (set to 1 when childbearing is universal, the F_C). Thus,

\[ TFR = DFS \times (F_U \times F_R \times F_{SP}) \times (F_T \times F_I \times F_C) \]

If woman realizes her fertility intention, TFR=DFS.

The article by Dharmalingam et al. (2014) applies the approach to Indian data. In the case of India, the authors go looking for factors that could account for the differences in desired and observed family size and the schemas that say that low fertility and small families are legit and desirable. They used three waves of DHS to calculate rates and reconstruct family histories, as well as desired family size, fertility preferences, contraceptive use and household economic conditions. As a result, largely cultural factors were found. In the case of India, there is humongous diversity in their TFR ranging from 4 to 1.8 births per women. However, desired fertility has been decreasing over the years, unwanted fertility is still high and the use of reversible contraceptive is still low. They also found decrease in son preference, indication of transition from hoarding to replacement children mortality strategy - which could be a sign of mortality decline in general - , and strong tempo effect (increase of age at childbirth). The authors found that the effect of competing preferences deserves further studies.

In the case of Brazil, some institutional changes that began to appear in the last decades could have played a role in how couples plan their fertilities. For example, religious composition, such as increasing secularization and the decline of the influence of the Vatican\(^5\) could explain the increase in use of contraceptives which could reflect in a decrease in unwanted fertility (F_U). The increasing participation of women in the labor market and increasing participation of women as household heads (37.4% of them were females in the year 2010) (Itaborai, 2003; PNAD 2011) could have made motherhood more complicate, reflecting an increase in the competition (F_C) parameter. Along with that, the possible effects of the expansion of the middle class and the relevant public policies such as cash transfers and increasing opportunities of college admission by means of education quotas for more social disadvantage youth (Rios-
Neto, 2005) deserve further investigation. Increasing education and income might provide new schemas of preferences, that could decrease ideal family sizes, but also improving access to resources that guarantee that those preferences be realized, such as access to contraception, more competing demands, among others.

After decomposing the parameters, we are able to understand how much of the decrease in TFR is a change of preference possibly driven by ideational changes surrounding the meaning of childbearing (reflected in smaller DFS) or an inability of women to fulfill their reproductive expectations, possibly due to institutional changes or a lack of institutional change to accommodate new necessities of life. In the following paragraphs, we introduce a discussion of the TFT, the DFS and the seven parameters contained in the Bongaarts (2001)’s proximate determinants of low fertility, as well as the methods we will use to estimate and decompose them by socio-demographic factors, or covariates.

CONCEPTUALIZATION, DATA AND MEASUREMENTS

Total Fertility Rate (TFR)

To measure Total Fertility Rate (TFR), we calculate the fertility rates of the last 5 years preceding the Demographic and Health Surveys - DHS, (1986, 1996, 2006). The number of children born in the last 60 months is divided by the women-years lived of exposure age 15-49 by 5 year age group interval. Because in 5 years women might have been part of two different age groups, by using the technique of the Century Month Code, it is possible to take into account the contribution that women gave to each age group; for example, a women age 23 at the time of the interview had spent 4 years of her life at the age group comprised between 20 and 24 and one year in the group of 15-19 year old, so she contributes with her “risk of getting pregnant” to two different ages.

Desired Family Size (DFS)

Desired family size (DFS) is conceptualized as “target fertility” and is measured by the response given to the following questions, which are different for women who had and who had not had any children yet (includes current pregnant): “Se pudesse voltar atrás, para o tempo em que não tinha nenhum filho, e pudesse escolher o número de filhos para ter por toda a vida, que número seria este?”, which translates as

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6 Formulas were based on Dharmalingam et al 2014.
“if you could go back in time to the time when you did not have any children and could choose the number of children you could have throughout your whole life, what number would it be?”, and “Se pudesse escolher exatamente o número de filhos que teria em toda a sua vida, quantos teria?”, which translates “if you could choose the exact number of children to have throughout your whole life, what number would it be?”. Women who answer “up to God” will be excluded together with their births and since they are a small part of the sample, they will not affect the total and do not matter for the analysis since they do not have any target fertility. The desired number of children reported by all women will be averaged and the result will stand as the Desired Family Size (DFS). In the absence of longitudinal data that could capture preferences before the onset of pregnancy, it is important to keep in mind that target family size might be biased due to post ex rationalization. We assume that post ex rationalization, in a context of low fertility and might cancel out its effect at aggregate level.

Unwanted Fertility ($F_U$)

Many women report having more children than they wanted, especially in midtransitional societies. In many developing countries this is the main reason why observed fertility exceeds desired family size. In postransional countries, as couples are increasingly able to implement their fertility preferences, unwanted childbearing is less sizable (Bongaarts, 2001).

Barros and Wong (2012) analyze women of different union types and found that the proportion that has ever used contraception is close to 100%. However, women in unions have lower probability of using contraception, and for those who are low educated it is even lower. Curtis (2012) evaluated Brazil’s contraceptive use and concludes that despite the near universality of contraceptive use, 29.7% of births in the five years before the 2006 PNDS were reported as mistimed (wanted later) and 17.8% were reported as unwanted (Ministerio da Saude, 2008), confirming that this would be an important proximate determinant. This is the pattern found in other low fertility countries, which are a sign of contraceptive failure and inconsistent contraceptive use.

Lacerda et al. (2005) found evidence of unmet need for contraceptive in Brazil in the year 2002. They used the methodology developed by Westoff and Ochoa (1991) in which the group who has unmet need for contraception is composed of sexually active women who were not using contraception at the time of the interview, but had demonstrated desire to postpone or limit their childbearing. That includes pregnant women or women with amenorrhea for which the last pregnancy was unintended or untimed. They found
that there are two diverse profiles of unmet need: while some women do not use contraception because sex is occasional, others do not use because they are already pregnant.

The first thing one has to have in mind when calculating unwanted pregnancy is the fact that the number might be underestimated because of ex post rationalization of children, and the stigma associated with reporting a child as unwanted (Dharmalingam et al. 2012). In the lack of longitudinal data that would allow for the capturing of ex post rationalization, the strategy used will be to consider as unwanted any birth of a living child in the last 60 months where the women responds that prior to getting pregnant she wished to have no more children/ a birth is considered as wanted if the number of living children at the time of conception is less than the desired number of children. The question posed to the respondents in the DHS is: “Quando ficou grávida do <name of child>, estava querendo engravidar naquele momento, queria esperar mais, ou não queria ter (mais) filhos?”, which translates as “At the time you became pregnant with <name of child>, did you want to become pregnant then, did you want to wait until later, or did not want more (children) at all?”. In other words, we are calculating an unwanted fertility rate (UFR).

The ratio between the TFR and UFR gives an estimate of the percentages of births that were unwanted and will become an index. So, if 15% of the births were unwanted, the index will be \( F_U = 1.15 \).

**Replacement Effect of Child Mortality (F_R)**

So, parents “bear children not for the rewards accruing from the birth itself, but principally for the rewards expected to accrue from surviving children” (Preston, 1978, p. 9). Replacements for child mortality usually take three strategies: physiological replacement – refers to the rapid return to ovulation after death of child; volitional replacement – refers to having an additional giving that one has died; and hoarding – having a high number anticipating child loss). Preston (1978) discusses whether improvements in life expectancy and lower mortality contributed to the decrease in fertility given that the survival of more children motivated parents to control fertility and also because in most developed countries the decline in mortality preceded the decline in fertility. One of the possible mechanisms were breastfeeding (delay return of ovulation, improve survival and reduce of uncertainty, and increase birth spacing (Knodel and van de Walle, 1967). Given that mortality rate of children in late-transitional societies are small, the impact on fertility is not remarkable (Bongaarts, 2001).
Following Dharmalingam et al. (2014), the Total Replacement Effect (FR) of child mortality on fertility is estimated by a technique proposed by Olsen (1980) and Trussell and Olsen (1983). First, they selected women aged 35-49 years, who, according to them, have already completed or are close to completing their fertility. This might be problematic in an analysis with different groups in the population, when different age ranges might be chosen. Second, they estimated the proportion of dead children: \( P_{\text{dead}} = \frac{C_D}{C_E B} \), where \( C_D \) is children dead per woman \( i \), \( C_E B \) is children ever born per woman. Then they regressed \( C_D \) on \( P_{\text{dead}} \) and estimated the predicted values \( E[C_D] \). After they regressed the predicted values on \( C_E B \). The result is an estimate of the replacement rate. The effect of the rate of replacement on fertility at the aggregate level is given by the replacement rate multiplied by the infant mortality rate (IMR). The IMR was estimated with Census data for the years of 1980, 1991, 2000 and 2010. The values for 1986, 1996 and 2006 were obtained by exponential interpolation based on these values. If the replacement of fertility takes on a number of 10%, for example, the Index of FR=1.10.

**Sex Preference (F\(_{SP}\))**

Parents may have a preference for a family of a particular size, and also of a specific sex composition. For instance, a commonly chosen family of two children with one son and one daughter. In such a family, if the number is achieved but the composition is not, parents may continue to have births, therefore leading to higher fertility (Bongaarts, 2001). Gender preferences are a tricky phenomenon because they usually make fertility higher in order to go toward one’s compositional goals. However, in contexts of low fertility, one cannot proceed to endless parities in order to compose a household. Besides, that might include selective abortion, which could lead to longer spacing between children, and consequently, a lower fertility.

According to Dharmalingam et al (2014), in traditional patriarchal institutions, as in India, sons are more valued than daughters for their greater economic utility and due to sociocultural logic. In Latin America, as emphasized by Bongaarts (2001), this effect might be smaller, non-significant or even favorable to females. Souza et al. 2011 found evidence that the probability of having a third child is higher for women whose first two children are the same sex as described by literature in Angrist and Evans (1998 in Souza et al 2011). While women who had two children of difference sex the likelihood of having a third was 47.04% in 1990, the ones who had only one sex in the household have 51.16% probability of having a
third child. In 2000, the probabilities were 38.50% and 42.12%, respectively. We have to keep in mind that 1990 and 2000 was still too early in the fertility transition when fertility was still high, so a new analyzes deserve an update.

In the Brazilian DHS, women also respond the exact number of daughters and sons they would like to have in an ideal situation, or the ideal sex composition of the household. They get asked: “Quantos destes filhos (as) você gostaria que fossem homens, quantos que fossem mulheres, e quantos não importaria o sexo?”, which translates as “how many of these children [desired number cited above] would you like to be male, how many to be female and how many you would not care about the sex?”. Technically, this is an indication of sex selection however, because desires not always translate into accomplishments, sex ratios at birth and parity progression are better indicators of the impact of sex selection on fertility than desired sex ratio (Bongaarts, 2013). Sex ratios can tell whether women have been using any sort of sex selection mechanism, as for example selective abortion. Parity progression, or Sex Ratio at Last Birth (SRLB), shows if the progression to the next birth depends on the sex composition of preceding births, a proxy for sex-selective stopping behavior. They are estimated by calculating the probability of having a second child giving the sex of the first, and the probability of having a third child giving that the sex of the first two children are the same (a boy or a girl).

Although Bongaarts (2013) finds evidence of strong sex selection for male offspring’s in Asia, this is not the case in Brazil where any kind of abortion practice is forbidden by the law and where sex ratio at birth is considered at normal level, around 104 in 2010. Sex selection in Brazil, if there is any, reflects in higher parities births with the intention of household composition and increasing the TFR when comparing with the DFS.

Dharmalingam et al (2014) operationalized this enhancing effect on fertility using the following procedure, which was based on estimating the counterfactual, “What would happen to fertility if all sex preferences were to disappear suddenly?” The authors propose to estimate whether or not a respondent wants an additional child by parity and sex composition of existing children. The measure is defined by the following relationship:

$$\frac{\sum C_i P_i}{\sum P_i}$$

where $$C_i$$ is the highest proportion of individuals among the different

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7 Analysis indicate daughter preference in Brazil and high ex post rationalization. Due to space constrains, this variable won’t be explored in this paper. But this is the topic of one of the dissertation papers of the first author.
composition who do not want any more children at each parity $i$, and $P_i$ is the number of persons at each parity. The result of this division demonstrates the percentage of increase in TFR due to sex preferences.

**Tempo Effect ($F_T$)**

Historically, in the beginning on the twenty century, the relative participation of women age 40 and over on childbearing is high since natural fertility would not control high parities. Thus, it was not unusual to see 45 year old having babies, but it used to be of much higher parity. When birth control is intensified and fertility declines, women stop childbearing at early ages because they have already fulfilled their reproductive goals (Morgan, 1991). So, births of women age 45 and over goes from 10% to 3-4% (Billari et al. 2007) in the United States. But then, when women start to delay fertility, the rates of births at age 40 more than doubled between 1971 and 2000, becoming more common, especially for first births (Billari et al. 2007).

Menken (1985) discusses the issue of delaying childbearing. She cites as sources for the problem the fact that women many times delay entrance into marriage, or wait until they achieve their personal goals before having a child. However, “some of those who do expect to have a child eventually will surely change their intentions, either voluntarily or involuntarily because divorce precedes the time they planned to have a first birth or because their hopes for establishing a family unit are not met. As discussed above, postponements of fertility (tempo effect which would be the number of children that a women would have had if they had not waited) affect fertility rates negatively and the reason why this happens is because despite the apparent simplicity of the TFR, it is subject to misinterpretation. The indicator is estimated with data from a specific period, i.e., from women aged 15 to 49 in the same year. If there is a rising age at childbearing, the estimates decrease the TFR because births of successive cohorts are spread over a longer time period, the tempo effect (Bongaarts, 2001).

The tempo (FT) effect on fertility is calculated with the Bongaarts and Feeney (1998) method. The result is an adjusted TFR without postponement of fertility and done by parity specific rates.

$$TFR^*_i = TFR_i \frac{1}{1-m_i}$$
Where $TFR_i$ is the adjusted TFR for birth order $i$, $TFR$ is the observed TFR by birth order, and

$m_i$ is the annualized rate of change in mean age at childbearing at order $i$ between the beginning and end of the period.

The total fertility rate is the sum of the specific rates (see below).

$$TFR = \sum_i TFR_i$$

The ratio between the TFR and the $TFR'$ will provide a percentage that represents the effect of postponing fertility (by pushing the mean age at childbearing) on the observed TFR.

**Involuntary infertility (F_i)**

Sub-fecundity or infecundity stands for the effect of the inability to have a child (physiological or disease-induced), the effect of union disruption on fertility, and also the inability to find a suitable partner. I need to take this measure with caution, however. One problem with this measure is that perceived sterility might be higher than actual and the exaggeration of infertility might be a myth we have to break. Menken (1985) explain how the couples nowadays are not trying long enough before they consider themselves infertile. In fact, if they had tried for at least two years, a large proportion of them would have got pregnant.

Another problem is that Dharmalingam et al (2014) estimates this parameter by looking at the percentage of women in their last age group (45-49) who were childless (2%). Differently from India, marriage is not universal in Brazil, childbearing is often nonmarital, and unmarried women are not expected to bear children so many of them might not know if they could ever bear children. Thus this estimator might not fully represent the involuntary childlessness in Brazil and might not fully capture the socio-economic nuances that could impact involuntary infertility.

Assuming that involuntary infertility has no selectivity factor, spite of age, women who have tried to have children and women who have not tried have equal chance of getting pregnant in case they were both trying. So, we will estimate the involuntary infertility based on the proportion of women aged 45-49 who have never conceived and responded that they have problems to have children. This is based on the
answer to the question “Por que voce nunca engravidou?”, which translates as “Why didn’t you ever got pregnant?”. The answers to be considered are “is infertile” and “can’t get pregnant”.

The proportion of women in the sample who fall into this category will be used as a parameter in the equation to decrease the value of TFR.

**Competing Preferences (F<sub>c</sub>)**

Competing preferences, or the feeling that something gets in the way of motherhood, seem to be an important factors shaping Brazilian fertility rates.

Several studies have documented the differences between mothers and non-mothers in terms of wage, type of occupation and labor participation. Paulo (2012) models the female hourly wage comparing mothers and non-mothers aged 22 to 34. Independently of education, non-mothers have much higher wage in the three periods analyzed (1984, 1988 and 2009), but the difference is higher for women of high education which suggest that the penalties and cost of opportunities is higher for these women. Junior (2008) found associations between occupation and fertility. Women who worked in positions of direction and manager, as well as women with bachelor degree in general, postpone fertility and tend to control fertility by parity much more. Women with low skill occupation tend to have a more “flexible” relationship with work, with worse pay and no benefits or formal contract of work. Those types of work do not improve wage with experience and women can leave for maternity and return with apparently low penalty given that their pay do not change too much (England, 1991 in Junior 2008). Santiago also found that high educated have lower odds of having three children when compared to low educated, suggesting, once again, that women might think about the costs of opportunities.

Interestingly, Souza et al. (2011) researched the effect of having children on the female labor participation by parity (1, 2, and 3) and found that children impact participation at every order, but the negative effect of first and second child became weaker with time, but the effect of high birth order (3) increased. This shows that women will have one or two regardless of her labor participation because this number could be associated with ideal family size.

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8 Estimating the effects of involuntary fertility on fertility rates due to biological (physiological or disease-induced), and social reasons, like the effect of union disruption and inability to find a suitable partner, is the focus of one of the dissertation papers of the first author. For the simplicity of this paper, only the biological reasons will be captured here.
The article by Dharmalingam et al (2014) estimate that because marriage is universal in India, this parameter should not influence fertility rates, so they set the value to the parameter to be equal to 1. However, we have enough evidence to believe that Brazilian women are feeling constrained by their other responsibilities and foregoing maternity more often than in the past. Because these are behavior of especially young cohorts for whom it is still early to estimate family preferences, the parameter of competing preferences is calculated as follows. We observed the proportion of women who did not have children before their 30th birthday due to reasons such as personal investments and human capital achievement. Women age 30 and over got asked “Hoje em dia é cada vez mais comum que as mulheres adiem a maternidade por que tem outros projetos de vida. Quais das seguintes razões explicam melhor por que você não teve filhos nascidos vivos antes dos 30 anos?”, which translates as “Nowadays it is every time more common that women postpone motherhood because they have other life projects. Which of the following reasons best explain why you did not have any children born alive before you reached 30?”. Below, I list the categories of answers that will be utilized for the composition of this parameter, followed by their English translation in parenthesis: nunca quis ter filhos (never wanted to have children), Ainda não quis ter filhos (did not want to have children yet), Queria estudar/ ter profissão antes de ter filhos (wanted to study/have a profession before having children), Queria aproveitar outras coisas da vida antes de ser mãe (wanted to enjoy other things in life before becoming a mother).9

The proportion of women in the sample who fall into this category will be used as a parameter in the equation to decrease the value of TFR.

**Covariates**

The covariates come from the three waves of the DHS (1986, 1996, 2006) and are factors that shape fertility intentions and outcomes: age (age groups), race (White=1, Black=2, Brown=3, Yellow=4, Native Indian=5), marital status (married or cohabiting=1, single=2, divorced/separated=3, widow=4), religion (Catholic=1, Mainline Protestant=2, Pentecostal=3, Spiritist=4, Afro-Brazilian=5, None=6), years of formal education (None=1, 1-3=2, 4=3, 5-8=4, 9-11=5, 12 or more=6), geographic macro-region (North-East=1, Southeast =2, South=3, South=4, Central-West=5), and place of residence (Urban=1, Rural=2). The TFR and the DF, as well as the 6 parameters utilized in the framework were explored according to socio-demographic variable.

9 Exploring Competing Preferences more in depth is the topic of one of the dissertation papers of the first author.
Data

We used data from the three most recent waves of the Brazilian DHS of 1986, 1996 and 2006. These databases are nationally representative, cross-sectional, and have the following sample sizes respectively: 5892, 12612 and 15575. The focus of the interviews was on women (15-49) and their children born in the last 5 years. The DHS Program has developed standard procedures, methodologies, and manuals to guide the survey process and make countries and years comparable. Sample procedure for the DHS followed specifications of the equal probability of selection method (EPSEM) and the probability proportion to size (PPS). More information about sampling procedure for the DHS can be found at http://dhsprogram.com/pubs/pdf/AISM5/DHS_III_Sampling_Manual.pdf.

The DHS 1986 was coordinated by Sociedade Civil Bem-Estar Familiar no Brasil (BEMFAM), and was inserted in the research conducted by the Demographic Health Surveys (Macro International Inc) and the Center for Disease Control (CDD, US). The DHS 1996 was coordinated by BEMFAM with the help of the Instituto Brasileiro de Geografia e Estatistica (IBGE), Macro International Inc., Agência Norte Americana para o Desenvolvimento, UN Population Fund and UNICEF. The DHS 2006, officially called Pesquisa Nacional de Demografia e Saude (PNDS 2006), was coordinated by the Brazilian Center for Analysis and Planning and the Brazilian Health Ministry and funded by UNESCO. Data were collected in the five Brazilian geographic regions (four regions for 1986) and in urban and rural areas, as well as urban slums. Original survey databases have already been published and are available at http://bvsms.saude.gov.br/bvs/pnds, and at http://dhsprogram.com/data/available-datasets.cfm.

We applied weights (v005) to expand the sample size. Missing data for covariates was treated as random and deleted from the analyses.
PRELIMINARY RESULTS

The preliminary results for the parameters according to DHS year are found below. The following table will be further stratified to observe the differences among the socio-demographic characteristics (birth cohort, race, marital status, religion, education, geographic macro-region, and place of residence).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1986</th>
<th>1996</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFR</td>
<td>3.4</td>
<td>2.5</td>
<td>1.8</td>
</tr>
<tr>
<td>DFS</td>
<td>2.8</td>
<td>2.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Tempo</td>
<td>1.06</td>
<td>1.005</td>
<td>0.998</td>
</tr>
<tr>
<td>Involuntary Infertility</td>
<td>0.92</td>
<td>0.92</td>
<td>0.89</td>
</tr>
<tr>
<td>Competing preferences</td>
<td>0.77</td>
<td>0.79</td>
<td>0.68</td>
</tr>
<tr>
<td>Child Replacement</td>
<td>1.07</td>
<td>1.04</td>
<td>1.03</td>
</tr>
<tr>
<td>Sex Preferences</td>
<td>1.01</td>
<td>1.02</td>
<td>1.03</td>
</tr>
<tr>
<td>Unwanted fertility</td>
<td>1.50</td>
<td>1.37</td>
<td>1.27</td>
</tr>
</tbody>
</table>