An Application of the Bongaarts Proximate Determinants of Low Fertility for Brazil: [1]

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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 5.8 children per women in 1960 to 1.8 in 2006 (Ministerio da Saude 2008). Some internal disparities exist, however, regardless of the low value at the macro level. For example, in 2006, while fertility was 1 child per women for those with more than 12 years of education, those who were illiterate had a TFR of 4.24 children. For women with per capita income equal to 1/4 minimum wage, TFR was 4.8, while women with per capita income equal to minimum age, TFR was already 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. The Bongaarts Proximate Determinants of low Fertility (Bongaarts, 2001) is especially useful to analyze and compare factors associated with low fertility. Thus, this research proposal aims at understanding 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 formed the total fertility rate throughout the years. In order to do that, I will use Demographic and Health Survey data from 1986, 1996 and 2006 to decompose fertility rates using the framework of the Bongaarts Proximate Determinants of Low Fertility for each socio-demographic characteristic. I ultimately expect to be able to extend the literature on the Brazilian fertility transition and elaborate informed suggestions of public policies to address unmet fertility outcomes.

INTRODUCTION

Low fertility is today a wide spread phenomenon. More than half of the world's population lives in a country where fertility is below replacement level (Morgan, 2003). Brazil is one of them, and is known for having a fast fertility transition (Carvalho & Brito, 2005; Potter et al. 2010). Total Fertility Rate went down from 5.8

[1] Proposal presented as a partial fulfillment of the requirements for the course SOCI 833 - Fertility. The actual Results section of this paper only brings an exploratory analysis to evaluate the feasibility of this project.

children per women in 1960 to 1.8 in 2006 (Ministerio da Saude 2008). Some internal disparities exist, however, regardless of the low value at the macro level. For example, in 2006, while fertility was 1 child per women for those with more than 12 years of education, those who were illiterate had a TFR of 4.24 children. For women with per capita income equal to 1/4 minimum wage, TFR was 4.8, while women with per capita income equal to minimum age, TFR was already 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). Spite of the differences, no one disputes the remarkable general decline[2].

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). 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, can be overwhelming for most countries. Europeans and some Asians countries, 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.

[2] 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).

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 might pick up their fertility (Morgan, 2003). However, some of these women might not ever have time 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 age structure 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 al. 2006). The mean age at first childbearing in Brazil for women aged 20-25 use to be 22 in 1986. In 2006, it went down to 19. That means half of the women in this age group is a mother (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. The only signs of postponement in Brazil were found for women of higher education[3] (Ministerio da Saude, 2008).

The mean age at childbearing, however, has been increasing throughout the years (Ministerio da Saude, 2008). Drawing on Lesthaegue and Willems (1999) and after observing postponements for the second child, Miranda-Ribeiro et al. (2012) suggest that some Brazilian women are entering the second

[3] 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.

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. 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 might be shaping Brazil's unique patterns. Some institutional changes that began to appear in the last decades that could play a role in how couples plan their fertilities, are the changes in religious composition[4], increasing participation of women in the labor market, and increasing participation of women as household heads - 37.4% were females in the year 2010 (Itaborai, 2003; PNAD 2011). 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 deserve further investigation (Rios-Neto, 2005).

Given that consequences of low fertility can be severe, it is never too early to research programs and policies that propose institutional changes or other strategies that in the future might have to be put into effect to secure the sustainability of social security system, infra-structure, health services, labor market, education system and demand for services and products (Caldwell and McDonald, 2006; Lutz et al 2003). Because people adapt in the way that produces minimum institutional adjustments (Morgan 1991, p. 802), it is necessary to keep in mind that the best way to guarantee that these institutional changes and

[4] The number of self-declared Catholics in Brazil has declined precipitously in the past half-century. According to the Census, the percentage dropped from 95% in 1940 to 74% in 2000. The reduction in Catholics is attributed to an increase in the growth of Pentecostal churches, as well as an increase in the number of people without religious affiliation (Decol, 1999; Costa et al, 2005; Alves & Novellino, 2003; McKinnon et al, 2008). In the same 60 year period, the proportion of Protestants increased from 3% to 15%, while those who self-reported themselves as without religious affiliation increased from 1% to 7% of the total (Mariano, 2004; Costa et al, 2005; McKinnon et al, 2008; Alves & Novellino, 2006). People who declared themselves as "other religions" increased from 2% to 3% during 60 years.

arrangements will be respectful to the diversity of human being's experiences and preferences and to their human rights - that includes the respect to citizens and sovereign of countries that could provide labor supply to countries in need - is to first understand how fertility is determined and what factors are associated with fertility decline (Carvalho & Brito, 2005, Caldwell and McDonald, 2006; Potter et al 2010). It is especially important to control and look for interactions that could reveal how costs and opportunities are considered.

The Bongaarts Proximate Determinants of low Fertility is especially useful to analyze and compare the components. Thus, this research proposal aims at understanding 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 formed the total fertility rate throughout the years. In order to do that, I will use Demographic and Health Survey data from 1986, 1996 and 2006 to decompose fertility rates using the framework of the Bongaarts Proximate Determinants of Low Fertility for each socio-demographic characteristic. I ultimately expect to be able to extend the literature on the Brazilian fertility transition and elaborate informed suggestions of public policies to address unmet fertility outcomes.

THEORETICAL FRAMEWORK

What is behind low fertility

The motivation for low fertility, which is focus of passionate debates, revolves around two major themes[5]. On one hand, economic explanations driven by either institutional changes or a lack of institutional change to accommodate new necessities of modern life are the focus of the debate. On the

[5] For more information on fertility decline, see Mason (1997). The theories she presents will not be discussed here because they are more relevant for the decline of fertility up to the replacement level.

other hand, cultural changes surrounding the meaning of parenthood and of having children are responsible for the fertility decline. I will further explore these two dimensions below, followed by the introduction of a third and more embracing body of theory called Theory of Conjunctural Action.

Among the economic explanations driven by institutions, one find increasing investments in higher education, career and personal goals to overcome economic hardship that causes women to respond by postponing fertility until they have accumulated enough social capital (Billari and Kohler, 2002; Myrskyla et al. 2012). Postponements due to unanticipated union dissolution, delays in finding suitable partner, miscarriages, or longer-than-expected waiting times to pregnancy are also other reasons for low fertility associated with delay in childbearing are postponement (Billari et al. 2007).

Family policies, child care system, and welfare typologies are responsible for the relationships between career and motherhood, and in some countries that relationships is incompatible (Brewster and Rindfuss, 2000). According to McDonald (2000), there is a mismatch between high gender equity in individual-oriented institutions and low gender equity in family oriented institutions. He noticed that in countries where gender equality is high and institutions support child care and maternity, fertility tends to be higher than countries where there is major gender inequality and no support for child care. As a result, women have to choose between working or having children. If they prefer the first, fertility falls. Esping-Andersen (2007; Bonke & Esping-Andersen, 2009) also adds that when women's education increase, the state has to increase incentives for childbearing, just like Sweden and France. If the state does not adapt, fertility drops below replacement level, as the case of Italy and Germany.

Another source of impact relates to the life course process of transition into adulthood and the role that institutions play in regulating life transitions. In places where young adulthood has been prolonged with people living with parents until later ages, especially due to the financial burden of establishing a household

and an independent life in early adulthood, fertility is postponed. “Italians have the highest share of young people co-residing with parents during early adulthood, and together with Spain had the latest age separation from parental home (Corijn, 1999 in Billari and Kohler, 2002)”.

The examples above suggest that fertility remains closely affected by institutions. However, a second major theory to explain fertility decline moves toward cultural changes surrounding the meaning of the parenthood and in the dominant mental/cultural schema of having children.

Lesthaegue (1983) points toward an increase in individualism and self-fulfillment proportioned by increases in secularization that represents a rupture in the status quo, as well as the growth of individualization and more gender equality. This framework understand fertility decline as the increasing necessity for non-material goods, such as prestige and recognition; increase in tolerance, individual autonomy, gender equality, de-standardization of the life course, and diversification in household formation (Van de Kaa, 2004). In this case, late marriage, increase of cohabitation and divorce, less remarriages, and more extra-marital childbirth are associated with having fewer children and are also part of this new set of attitudes.

Compatible with the description of the deinstitutionalization of the life course (Giddens, 1991), a new schema in which children are not the main goal of a person becomes more acceptable. Caring for children is now optional and adults are looking for stimulant and meaningful lives without necessarily becoming parents. If they do so, the decision is to contribute for individual self-actualization with altruism toward the children as the core of schemas, with growing sentiment and investment in them (van de Kaa, 2003). More than a decade earlier, Van de Kaa (1987) had noticed that the ideal number of children will vary according to a woman’s or couple’s preferences, and will match their necessity for non-material goods.

Rackin (2002) believes in a theory of preference. For her, women are heterogeneous in their life styles. Some are family oriented (only work when it is a necessity and only study to have more bargain power in the household). Others are career oriented. These two profiles might be the extremes of intermediate types: the ones that try to combine work and family, enjoying the opportunities as they appear. According to her, preferences and life style are the main determinants of the women's fertility. However, these three models for women originated in five structural changes: the contraceptive pills, the sex revolution which increased equality and opportunities, the expansion of white collar jobs, the increase of the secondary sector in the economy, and the increase in the attention to personal values and preferences. Lesthaeghe & Surkyn (2004) elaborated a dual model of economy and culture called ideational change. Changes and preferences are transmitted by diffusion or education, not necessarily through material wellbeing, but rather culturally and ideationally. In the case of Brazil, there is indication that ideational changes might have happened. Miranda-Ribeiro and Potter show how ideational and institutional factors might be also contributing to the decline (2010). Potter et al. (2010) show spatial spread of the fertility transition in Brazil and how much faster the spread was among the poor educated when compared to the less educated. That means economic factors are not the main driver of fertility decline.

Finally, a new body of theory emerges: the theory of conjunctural action[6] provides a framework that allows the convergence among all theories explaining not only fertility intention and outcomes, but changes and variations within and across developed countries (Johnson-Hanks et al, 2011). They demonstrate that low fertility is a product of the interactions between materials and schemas of fertility that emphasizes "individuals' pursuit of a meaningful and satisfying life, and the rewards to "hard work" and persistence in planning and attaining one's goals". Because, as I mentioned before, in some context schemas can be competing, these factors get re-evaluated and they are continued transformed by globalization, economic

[6] For more information on TCA and fertility, see Johnson-Hanks et al (2011) and Morgan and Rackin (2010).

development, and social interaction, among others. "The diverging response of fertility is due to the interaction of these demographic changes with institutional contexts, norms and cultures, and historical and demographic trends" (Johnson-Hanks et al. 2011, 73).

Using this last framework, I will use the Bongaarts Proximate Determinants of low Fertility to investigate and compare each of the components, or parameters, that structure the fertility rate, expecting to pointing toward a multiple responsibility of economic explanations driven by either institutional changes or a lack of institutional change to accommodate new necessities of modern life and also driven by ideational changes surrounding the meaning of childbearing.

The proximate determinants of low fertility and their estimation

The proximate determinants of fertility are the biological and behavioral factors through which social, economic and environmental variables 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. 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.

Below, I will present this first equation and its four parameters that are used to explain variation in fertility rates up to replacement level. Later, I will present the Proximate Determinants of Low Fertility, an equation design for calculation of fertility rates below replacement – the one I will use in this paper.

Proximate Determinants of Fertility

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 universal, something everybody did. 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[7]. Thus, changes in the pattern of contraceptive behavior with age and with time and cohort will likely have an impact. Rate 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 the TFR is a function of the fourth elements multiplied by one another and by the maximum number of children a women can have. Note that it is possible that two populations with the same TFR will have different values for the determinants.

Proximate Determinants of Low Fertility

For contexts in which fertility is below replacement, a new equation had to be put together, which weakened the importance of certain variables in the model and strengthened those of the others. 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 determinants. So, if low fertility is a result of desire, it is an achievable goal, and marital fertility, natural fertility, length of breastfeeding or biological maximum become irrelevant.

[7] Condoms and spermicides, which requires action right before the penetration will have worse effectiveness when compared to sterilization, which is a once in a life time event, or the pill, who needs to be taken daily but it does necessarily linked to the sexual act. Intended fertility may also have an impact because the choice of contraceptive may depend on the desire to have future children and in the desired birth interval, if any.

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. 2012).

The seven parameters of the Proximate Determinants[8] that are responsible for fertility (TFR) and fertility variation (TFR over time) according to Bongaarts (2001) can be divided into three groups, the desired family size (DFS), the 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 unwanted fertility (F_U), replacements for child mortality (physiological replacement, volitional replacement, hoarding, the F_R), and sex preference (F_{SP}). The second group is composed of 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 F_T), involuntary 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,

$$TFR = DFS * (F_U * F_R * F_{SP}) * (F_T * F_I * F_C)$$

Thus, if woman realizes her fertility intention, TFR=DFS.

The article by Dharmalingam et al. (2012) 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

[8] For more information on what could affect each determinants and how they affect one another, see Bongaarts (2001).

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.

Below, I present the seven factors of the Bongaarts Proximate Determinants of Low Fertility, the methods I will use to calculate them and what might influence each of these factors in the case of Brazil - the covariates.

CONCEPTUALIZATION, DATA AND MEASUREMENTS[9]

Total Fertility Rate (TFR)

To measure Total Fertility Rate (TFR), I will calculate the fertility rates of the last 5 years preceding the Demographic and Health Surveys - DHS, (1986, 1996, 2006). I will divide the number of children born in the last 60 months 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 will be 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.

[9] Formulas were copied from Dharmaling et al 2012

Desired Family Size (DFS)

Morgan and King (2001) discuss why having children in the 21st century. The first explanation is genetics, humans are wired to reproduce: we have predisposition to have sex, we have strong sex drive, we fall in love by babies, invest in intensive and long-term care for our offspring. Even if we don't know the wonders of having a child, we can anticipate the rewards. A second reason is the social coercion and social institutions that want to keep the status quo, the existing norms of number of children, rules for marriage, etc. Marriage, for example, used to be held as a lifetime marital union that provided a secure framework for within-household specialization. Changes in labor market and economy eroded this institution, and even made marital dissolution possible. A third reason to have children is that they generate social capital. Parents have more integration with community, form new relationships, have more marital solidarity, etc. The fourth reason is love. Such a long time obligation brings predictability and order to the life course as argued by Friedman (1994) and Giddens (1991) who writes about uncertainty reduction. It´s a solution for the meaning of life.

Desired family size (DFS) is conceptualized as "target fertility" and will be 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 pregnancy): "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 "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 ideal number of children reported by all women will be averaged and the result will stand as the Desired fertility (DFS).

Unwanted Fertility (FU)

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) evaluate 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). This is the pattern found in other low fertility countries, which are a sign of contraceptive failure and inconsistent contraceptive use, not to mention high proportion of induced abortion. Lacerda et al. 2005 found evidence of unmet need for contraceptive in Brazil in the year 2002. They used the methodology developed by Westoff Ochoa (1991) in which the group who has unmet need for contraception is compose by 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. Those, better off, that do not use contraceptive because sex is occasional and another one who does not use because is 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 (Dharmaling 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 she wishes she did not have had it. 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?" Critics of this retrospective question argue, again, that there might be ex post rationalizing of wantedness of births. This is a problem that only longitudinal surveys could solve.

The percentage of unwantedness will become an index. So, if 5% of the births were unwanted the index will be F_U=1.05.

Replacement Effect of Child Mortality (FR)

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).

The Total Replacement Effect (FR) of child mortality on fertility is estimated by a technique proposed by Olsen (1980) and Trussell and Olsen (1983). The technique consists in, for each woman, obtaining the number of children ever born (CEB), and the number of children who were born alive and then died (born alive, but died regardless of age), calculating a proportion of dead children. Then, regressing the number of children dead on the proportion dead. Then, using the predicted values as regressors in the regression of CEB. This is an estimation of the Total Replacement Rate. If the replacement of fertility takes on a number of 10%, for example, the Index of FR=1.10.

Sex Preference (FSP)

Gender preferences are a tricky phenomenon because they usually make fertility higher in order to go toward one´s compositional goals. However, that might include selective abortion, which could lead to longer spacing between children, and consequently, a lower fertility.

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. No information is given regarding sex selection or whether the sex of the two first siblings matter for a third.

In order to calculate the effect of sex preference on fertility, I will use 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, with different estimations by sex).

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, I believe the parity progression estimation will have better estimates of the impact of sex selection on fertility[10].

Tempo Effect (FT)

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 birth 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

[10] For the sake of this project, I will use the ideal sex composition as proxy of sex selection. Calculating by parity progression will be done over the summer.

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 negatively. 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.

$$TFR'_i = TFR_i / (1-r^i)$$

Where,

TFR_i is the observed total fertility rate in a given period for births of parity i,

TFR'_i is the adjusted parity-specific total fertility rate in the absence of postponement,

r_i is the change in mean age at childbearing at order i between the beginning and end of the period.

$$TFR' = \sum TFR'i$$

The effect of tempo on the TFR (FT) is the ratio of TFR' and the observed TFR[11].

Involuntary infertility (FI)

Sub-fecundity or infecundity stands for the effect of the inability to have a child and also the inability to find a suitable partner on fertility. Given that involuntary infertility has no selectivity factor, with the

[11]Due to time constrains to calculate fertility rates by parity, I will use Rios-Neto et al. (2005)'s estimation of tempo effect for Brazil.

exception of age (whose effect is already been considered at the postponement level), I will calculate the involuntary infertility based on the proportion of women who have never been 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 “Reasons for not ever being pregnant”. The answers to be considered are “is infertile” and “can´t get pregnant”. (M_224).

I need to take this measure with caution, however. Menken (1985) explain how the couples nowadays are not trying long before they think they can no longer conceive and in fact, if they had tried for at least two years, a large proportion of them would have got pregnant. So, perceived sterility might be higher than actual and the exaggeration of infertility might be a myth we have to break (Menken, 1985).

Competing Preferences (FC)

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.

Souza et al. (2011) also researched the effect of having children on the female labor participation by parity (1, 2, and 3). They find 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.

In order to measure competition, I will observe the proportion of women who did not have children before 30 years old due to reasons such as personal development and human capital attachment. 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?". The categories of answer followed by their English translation in parenthesis that I will pick as indication of competitions are: 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).[12]

Covariates

[12] Due to time constrains, this variable won't be explored in this paper.

The covariates will be factors that might shape fertility intentions and outcomes. They are: age, 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), 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). Future work will allow interactions between covariates.

I will calculate a Bongaarts Proximate Determinants of Low Fertility for each of the covariates (by applying filters to the database) and each of the DHS years. I will be able to see how the factors of the equation differ for each category within covariate and draw more precise conclusions.

DATA EXPLORATION AND PRELIMINARY DESCRIPTIVE RESULTS

The purpose of this section is to provide evidences that the proposal above specified is feasible and possible to be completed before the European Population Conference. Besides, I will point the caveats and frailties in the data that might require adjustments. I will interpret the descriptive results separated by parameter.

The first thing that needed to be done prior to the analysis was to check the availability of sufficient data in the three DHS years, besides the comparability of the questions and of the variables that I would be analyzing. A result of this comparison was summarized in Figure 1. The first thing one notice is the difference in sample size. The DHS 1986 contained only 5892 cases, which might make it impossible to

conduct stratified analyses or model micro-level data. One also notes that most of the covariates (age, race, marital status religion education geographic macro-region) are present in every DHS, with the exception of two: the DHS 1986 does not bring a variable for Race (or it might have been labeled differently in the database I gained access to), and the DHS 1986 does not contain 5 macro-regions, but 4 (considering Center-West and South-East as one) and only 4 educational levels.

Moving to the parameters of the Bongaarts equation, all the surveys have conditions to be used to calculate total fertility rates, desired family size, unwanted fertility (at least using "last pregnancy" as the index), replacement of fertility due to mortality of children ever born, sex preference (based on parity progression rates selective of sex of previous birth), infecundity based on reported infertility, tempo effect (by adjusting TFR based on parity specific rates), and lastly, competition based on women who are working. However, for this last question, the wording of the questions in the last survey changed a lot when compared to the 2006 DHS (older DHS ask about work, but women might understand as formal employment and do not report self-employment for example. DHS 2006 capture all sorts of paid work). Plus, the understanding of what work means might have changed throughout the years (since more women now work), weakening the reliability of my measurements.

Figure 1: Correspondence between DHS in regards to variables used as covariates and as parameters of the Bongaarts Proximate Determinants of Low Fertility

	2006	1996	1986
Sample size before weight	15,575	12,612	5,892
Controls			
Age (5 year interval)	AGEGR	v013	v013
Race/Ethinicity (white, black, mixed, asian, native)	COR_PELE	v131	not registered
Marital Status (married or cohabiting, single, divorced/separated, widow)	MARITAL	v501	v501
Religion (No affiliation, Catholics, Mainline Protestants, Evangelical	M109_RELI	v130 (religion)	v130 (religion)
Education (less than middle school, middle school completed, High school completed, some graduate	anoest_gr	v133 (educ)	v133 (educ)
Macro-region (South, South-East, Center-West, North, Northeast)	regioes	v024 (region)	v024 (region). Only contains 4 regions.
Urban/rural	URB_RUR	v025	v102
Variables of interest			
Total Fertility Rate (TFT)	XD040_TOTA (children born last 5 years) Women's CMC	v208 (births last five years) Women's CMC	v208 (births last five year) Women's CMC
Desired Family Size (DFS)	M619 (n of children to have entire life)	v613 (ideal n of children)	v613 (ideal n of children)
Unwanted fertility (Fu)	M405 (last pregnancy wanted) M611_POR (reason not to use method) Difference between TFT and DFS	v367 (last pregnancy wanted) v602 (Unmet need) Difference between TFT and DFS	v364 (Unmet need) v367 (last pregnancy wanted) Difference between TFT and DFS
Fertility replacement (Fr)	M235A_FILH (dead boy) M235B_FILH (dead girl) M236 (CEB)	v206 (dead girl) v207 (dead boy) v201 (CEB)	v206 (dead girl) v207 (dead boy) v201 (CEB)
Fertility sex preference (Fsp)	M620A_FILH (ideal n of boys) M620B_FILH (ideal n of girls) Check if p of having one more child depends on sex of first	v627 (ideal n of boys) v628 (ideal n of girls) Check if p of having one more child depends on sex of first using birth history.	s619a (?) s619b (?) Check if p of having one more child depends on sex of first using birth history.
Fertility infecundity (Fi)	M224 (reasons never got pregnant)	v602 (infecundity)	v602 (infecundity)
Fertility Tempo (Ft)	Mean age at first birth Mean age at maternity Births by parity (check parity and CMC)	Mean age at first birth Mean age at maternity Births by parity (check parity and CMC)	Mean age at first birth Mean age at maternity Births by parity (check parity and CMC)
Fertility competition (Fc)	M706 (work besides domestic activities) M6370 (reasons 30 y without children): M3701b_NUNC	v714 Working v720 (cash for work)	v714 Working

For the purpose of this paper, I conducted descriptive analysis of variables that serve as proxies for each of the parameters of Bongaarts. I did it separately by macro-region and education level.

Figure 2: Total Fertility Rate (TFR) by macro-region and DHS year

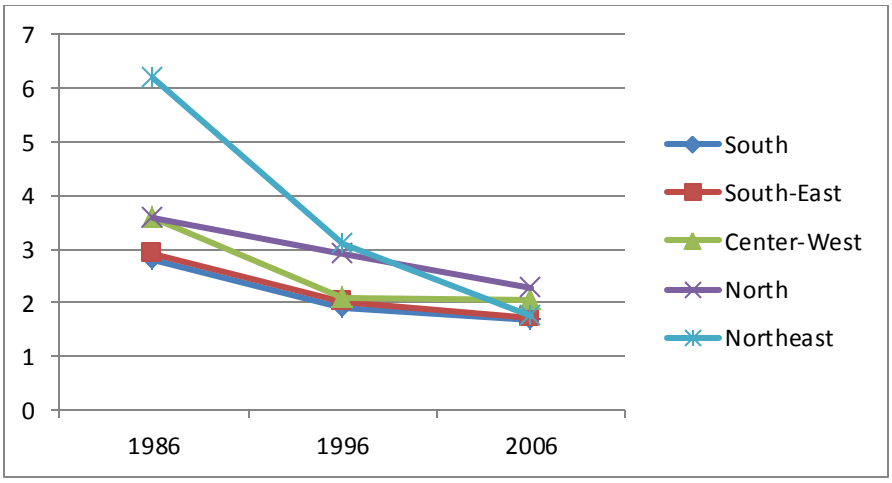
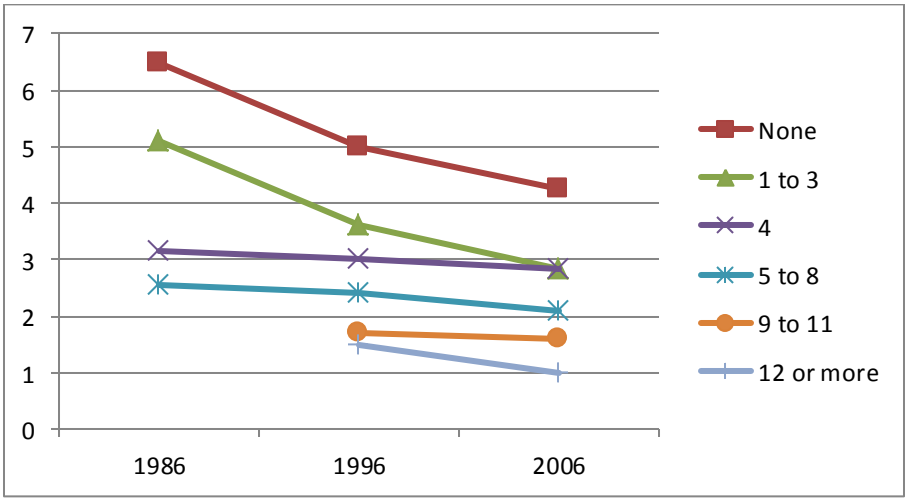


Figure 2 brings the Total Fertility Rates by macro region and year. One can see that the rate that fell more drastically over the years was the North-East region, also known for having the poorest index of quality of life. In 2006, however, macro-region differences are not very large. Throughout the 20 year time period, South and South-east take the lead on the lowest rates, reaching replacement level in 1996.

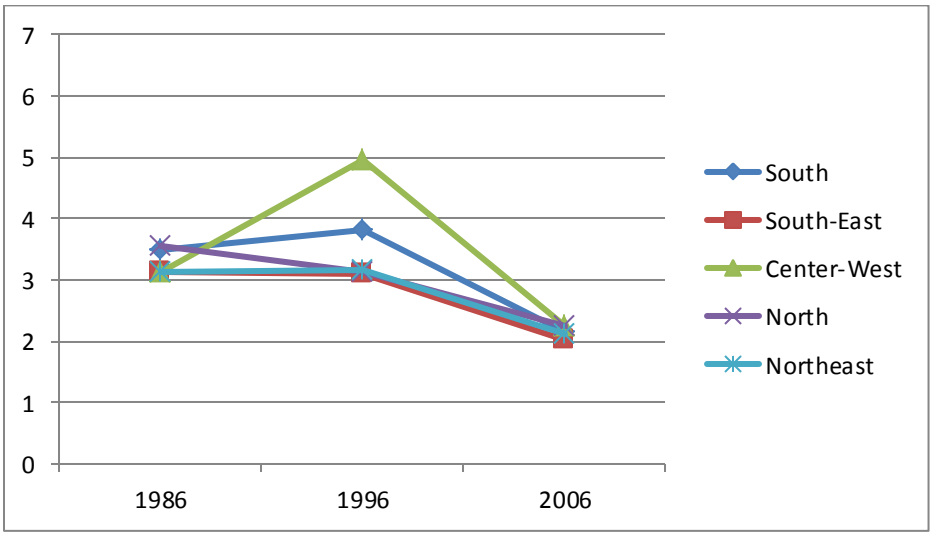
Figure 3: Total Fertility Rate (TFR) by education level and DHS year



The Total Fertility Rate (TFR) by education level and DHS year can be seen in Figure 3. Note how rates are apart according to educational level, regardless of the survey year. It is clear that TFR has been

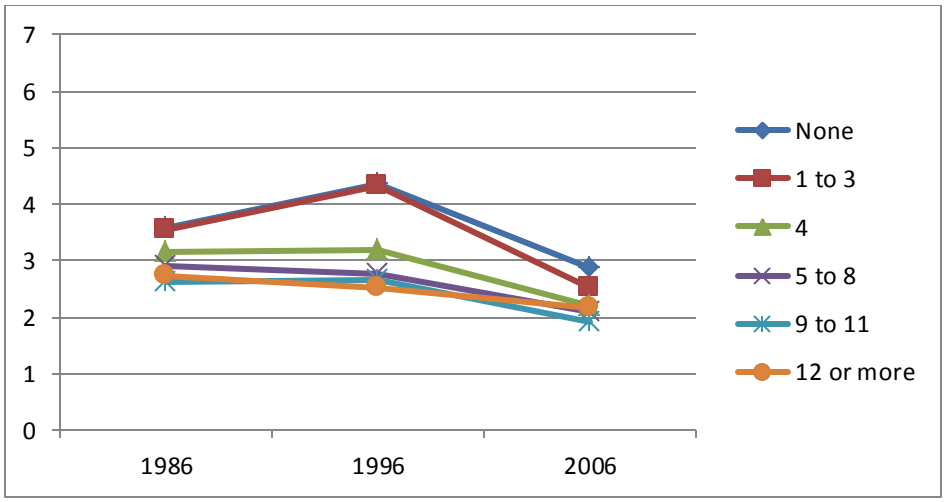
going down for all educational levels, but wide differences persist between those with higher education and those who are illiterate or have only done 4 years of basic education.

Figure 4: Desired Family Size (DFS) by macro-region and DHS year



Different from TFRs, the desired family size does not seem to have varied too much from region to region between the years 1986 and 2006 as can be seen in Figure 4. Note, however, how the year of 1996 represents an increase in desired family size for people living in the South and in the Center-West region. Those regions concentrate large agriculture and rural areas, but it is also possible that it is a problem with data. Generally speaking, desired family size decreased in one child and a half over 20 years.

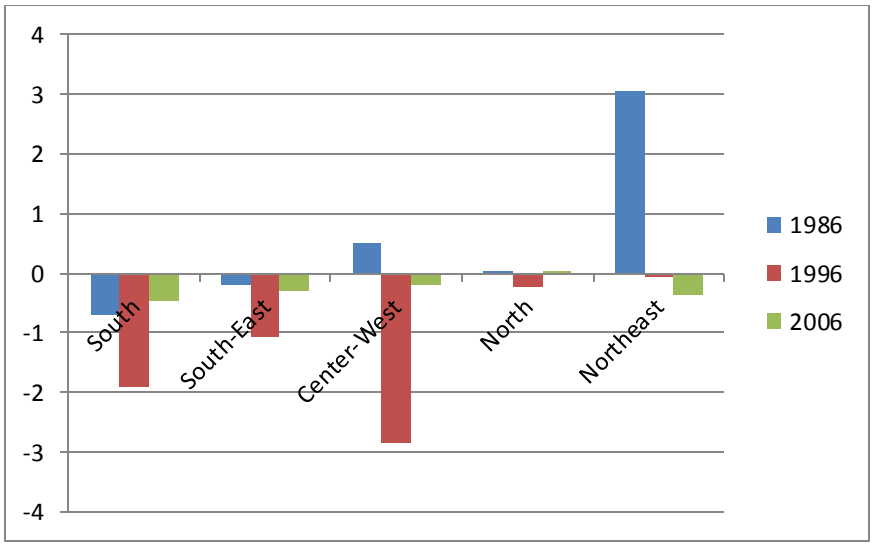
Figure 5: Desired Family Size (DFS) by education level and DHS year



When looking at educational level, one can see how higher levels of education are translated into smaller ideal family sizes. Not much change can be seen for the desires of the more educated (who tend to be between 2 and 3 children), decreasing half a child every 10 years. Overall, desired family size gets smaller over time, with the exception of the unexplained increase in 1996 for people who have less than 3 years of education.

The difference between the ideal fertility (desired family size) and the fertility rate at the macro level can be seen in figure 6. Note how in 1996 and 2006 women from all regions were already having fewer children than they desired. The only exception is the North-East region in 1986, which is also known for having the largest rate of unmet contraceptive needs in that decade. It is worth noticing that the sudden increase in intention for the Center-West in 1996 causes the large mismatch between desired fertility and fertility rates, making it appear as if they were having 3 children less than they desired.

Figure 6: Difference between Total Fertility Rate and Desired Family Size in number of children by macro-region and DHS year



Women with less education continue to be disadvantaged in the 21st century, as Figure 7 shows. Although fertility has been decreasing, for this group of women there might be high unmet need for contraception because they are having an average of one birth more than they wish (more than one birth for illiterate and half a birth for women with 4 years of education). High educated women, on the other hand, miss their target (at the macro level) by one birth. In 2006, the women close to their target fertility was the ones with 5-8 years of education.

Figure 7: Difference between Total Fertility Rate and Desired Family Size in number of children by education level and DHS year

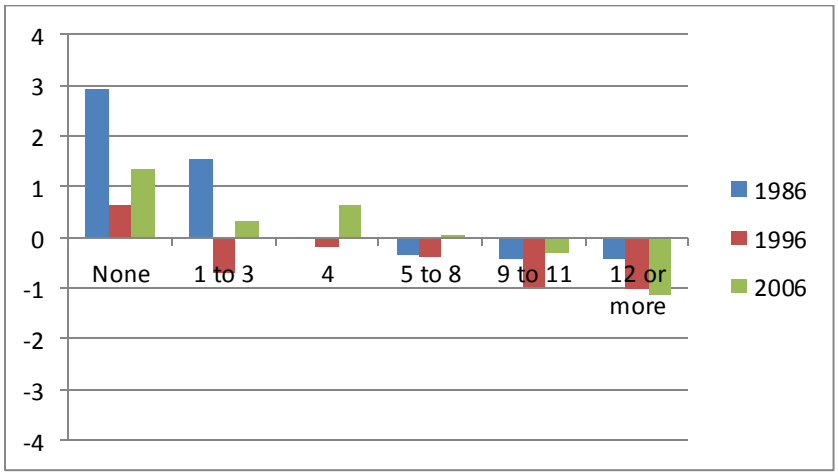
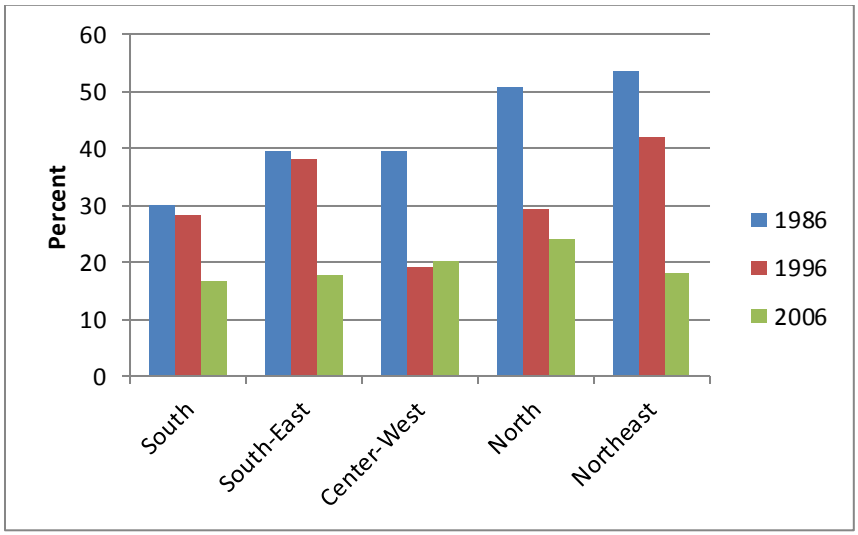


Figure 8: Percentage of women whose last pregnancy was unwanted by macro-region and DHS year



The percentage of women who reports the last pregnancy to be unwanted is striking, as can be seen in Figure 8. Although this number has been decreasing over the years (probably due to more access to more efficient forms of contraceptive), around 17% of pregnancies were still unwanted in 2006. In 1986 this number was above 50% for women living in the North-East and North and more geographic disparity could be observed than 2006, when rates are pretty similar across macro-region.

Figure 9: Percentage of women whose last pregnancy was unwanted by education level and DHS year

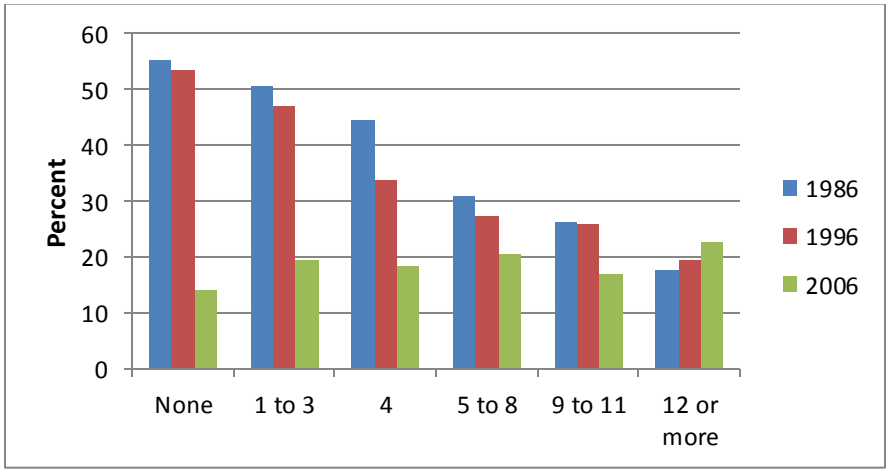
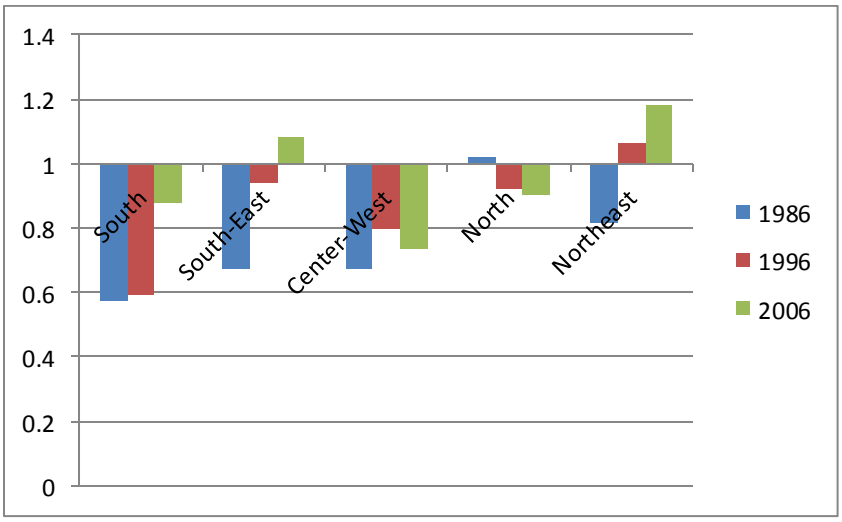


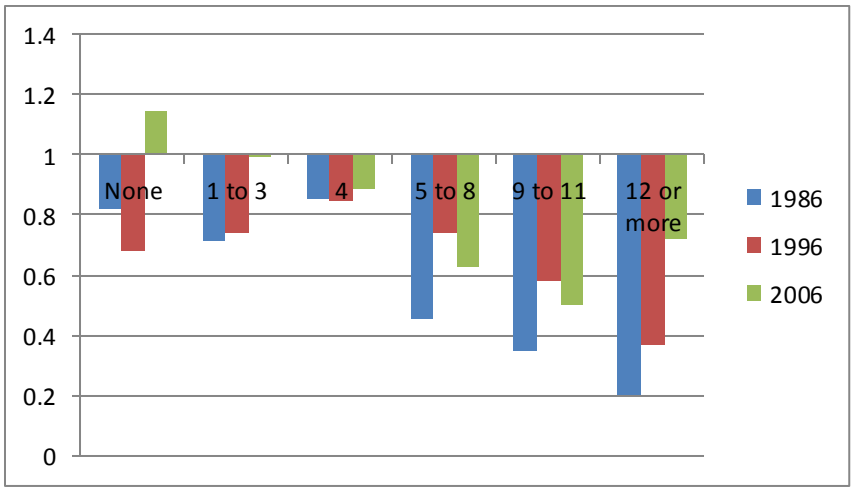
Figure 9 brings the percentage of women whose last pregnancy was unwanted by education level and DHS year. Although decreasing for all age groups with time, for women with very high education this number is increasing. Because we know this group is the one with fertility rates close to 1 child per women (and going down) this fact might be a sign that fertility of this group would be even lower if they were able to stick to their plans. That could also mean that having an extra child was less than a problem in the past than it is now.

Figure 10: Coefficient of the replacement effect of child mortality on the number of children ever born by macro-region and DHS year



The coefficient for mortality replacement gives an estimate of total replacement rate for the children who have died. In order to be adequately used, the coefficients above need to be multiplied by the Infant Mortality Rate. Given that most values are in between 0 and 1, I consider this value to be insignificant for South, South-East (except in 1006), Center West, North and Northeast in 1986. I do not feel very secure about this component, so the replacement effect needs to be further investigated using other techniques or other variables as proxies, for example, time between death of child and birth of next child, among others.

Figure 11: Coefficient of the replacement effect of child mortality on the number of children ever born by education level and DHS year



Regarding the ideal sex composition of the family, the preference in Brazil is given to having girls, with the exception, again, of the South and the Center-West, which are more agrarian and rural. The differences persist from 1996 to 2006 as can be seen in Figures 12.1 and 12.2. Unfortunately, I could not find this data for the year 1986 and this conclusion will have to wait for the results of the probability of birth given sex of previous children (parity progression by sex). Looking at these results, I do not believe there is a strong indication of sex selection that could positively affect fertility at the macro level or that family composition could be so important that women, in a context of very low fertility, would try another child. My hypothesis is that although they would like to have more girls, they are happy with what they have.

Figure 12.1: Percentage of women who prefer to have more children of a certain sex, by sex of children and macro region, 1996.

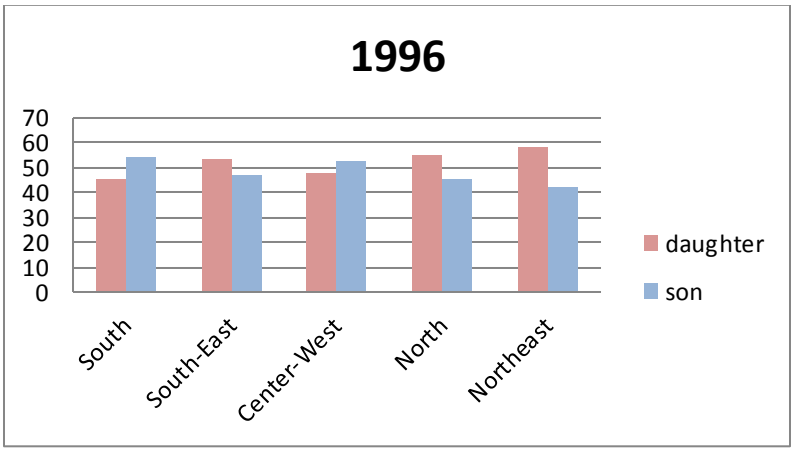
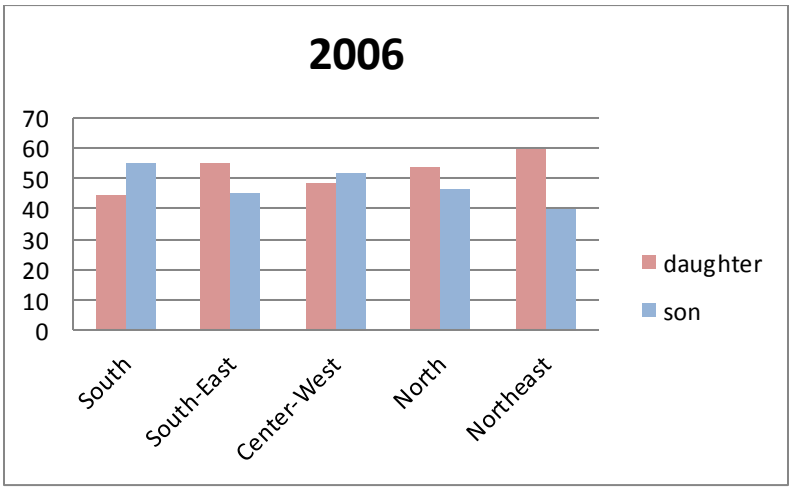


Figure 12.2: Percentage of women who prefer to have more children of a certain sex, by sex of children and macro region, 2006.



Education level does not seem to be associated with sex selection either because the preference for girls is higher in all education levels as can be seen in Figure 12.3 and 12.4.

Figure 12.3: Percentage of women who prefer to have more children of a certain sex, by sex of children and education level, 1996.

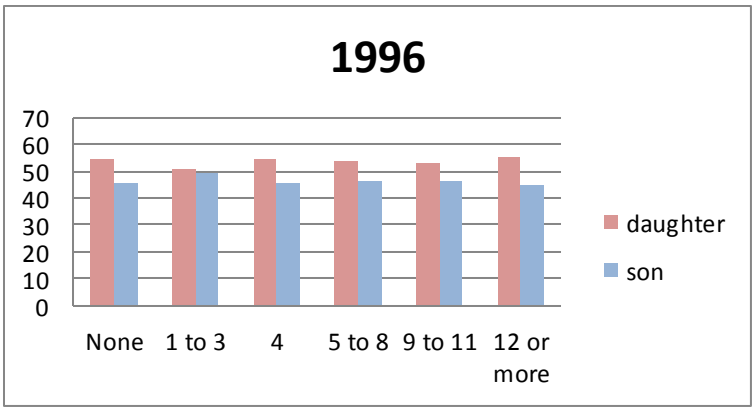
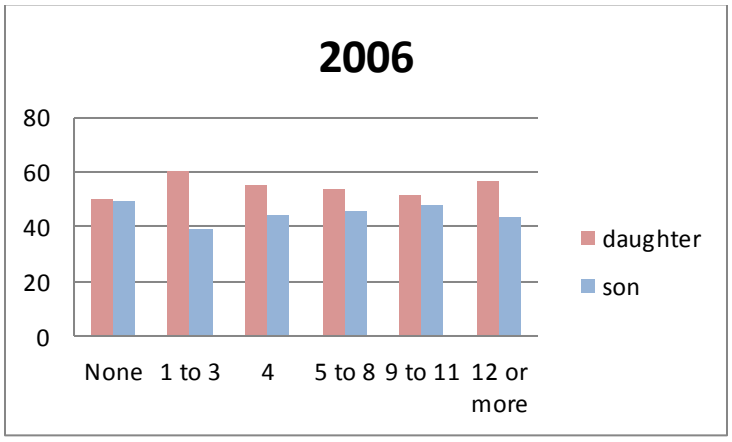


Figure 12.4: Percentage of women who prefer to have more children of a certain sex, by sex of children and education level, 2006.



In order to analyze postponement of fertility, I borrowed the table calculated by Rios-Neto et al. (2005), as can be seen in Figure 13. One can see that the adjusted fertility rates are even lower than the rates registered by the Census and DHS data. That means that in Brazil the tempo effect is negative because women tend to anticipate their births in spite of postpone. In the short run, it inflates the TFR and

makes it look higher than it really is. In the future, the stratification of the tempo effect by education level will shed light on the factors associated with postponement. As literature pointed out, low educated are having children at young ages while high educated are starting to postpone. Remains unanswered whether the increase in overall education level will lead to more postponement, or if the women who are selected for early births will continue to deliver early regardless of their improvements in education level. Literature has shown that the drop in education come before early pregnancy, which means that early pregnancy is not a cause of school dropout, but a consequence. Thus, increasing education track stability will prevent women from dropping school which ultimately could lead them to postpone their fertilities.

Figure 13: Adjusted Total Fertility Rate for Brazil, 1996-2000

	Parity						
	0	1	2	3	4	5+	Total
TFR	0.828	0.623	0.348	0.161	0.087	0.171	**2,217**
Adjusted TFR	0.705	0.233	0.108	0.073	0.053	0.121	**1,294**
Mean tempo effect	14.76	62.58	68.82	54.46	38.56	29.47	**41.63**

Note: Calculated using 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.
Source of data: BENFAM: Brazilian DHS, 1996, IBGE: Brazilian Demographic Census, 1991 and 2000
Table copied from Rios-Neto et al. 2005

The percentage of women who report being sterile (Figure 14) does not seem to present a clear pattern, but is higher for the year 1996, with exception of the Center-West. This could be due to a data problem in that year. Given that this question asks about declared infecundity, it does not include women who report "not being able to get pregnant", thus, this number might be underestimate. Note, however, how the reports tend to be higher for women of low education level (Figure 15). There are two potential explanations for that. It could be that highly educated have better access to treatment to get pregnant, so their perception of what infertility means and what their options and conditions are could lead them to

declare less infecundity. Or, it could also be that more educated women take longer to start trying to get pregnant, so they could not know yet that they will eventually have problem getting pregnant.

Figure 14: Percentage of women who report being infertile by macro region and DHS year

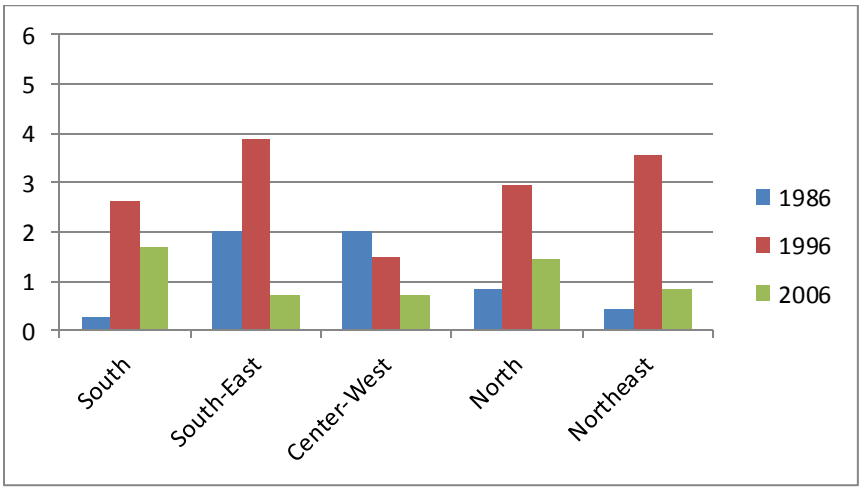
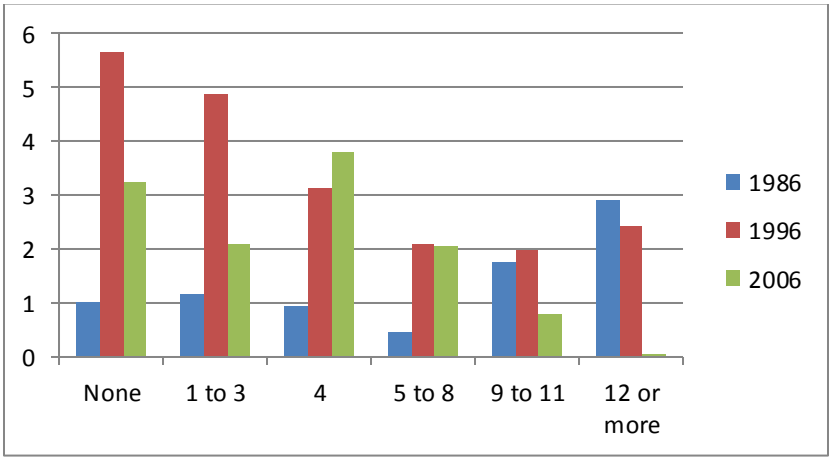


Figure 15: Percentage of women who report being infertile by education level and DHS year



In order to briefly analyze the last factor of Bongaarts Proximate Determinants of Fertility, competition, I will use the percentage of women who reports being at the workforce. This number seems to have been similar for women from different regions (Figure 16). It is possible to see increases from 1986 to 2006. However, counter intuitively, more women work in 1996 than in 2006. This might be a problem with data collection. I need to take a look more closely to the questionnaires and how the skips were done. It is interesting, however, to observe how women with different education level have different working profiles (Figure 17). In the past, highly educated women tended to work less often than their low educated counterparts, probably because their husbands and father´s working situation were able to afford them to stay at home. With time, highly educated women pass the less educated in regards to percentage working, which also makes sense in the literature.

Figure 16: Percentage of women who report working by macro region and DHS year

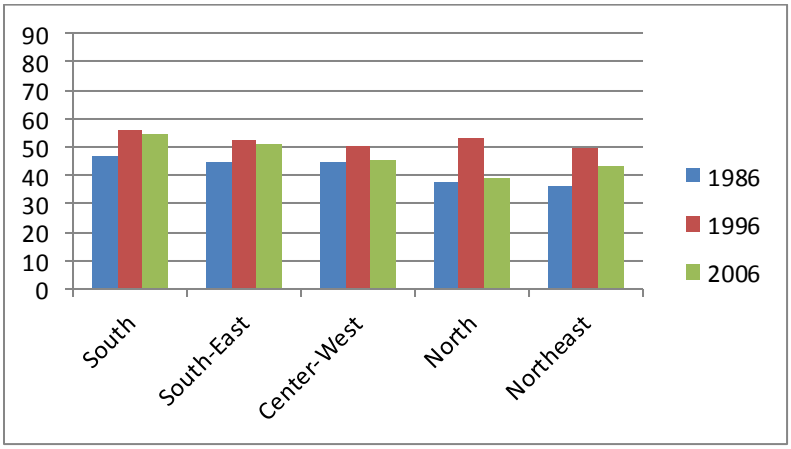
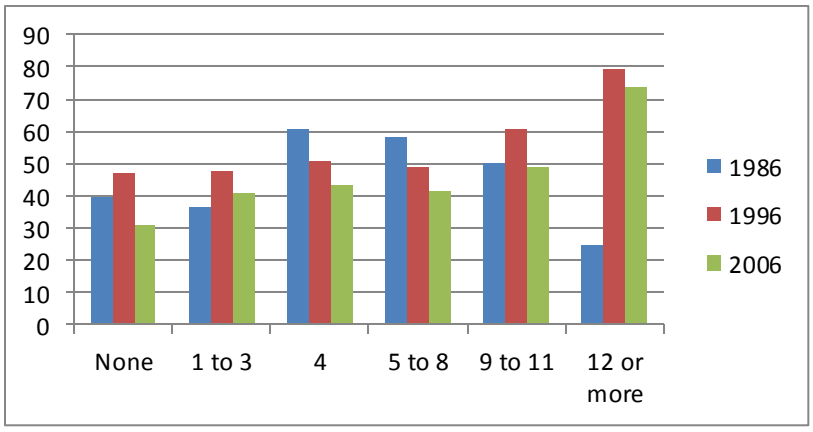


Figure 17: Percentage of women who report working by education level and DHS year



CONCLUSION

The descriptive analysis of selected variables that serve as proxies for the parameters of the Bongaarts Proximate Determinants of Low Fertility (Desired Family Size, Unwanted Fertility, Replacement Effect of Child Mortality, Sex Preference, Tempo Effect, Involuntary infertility, Competing Preferences) indicate that fertility has been falling throughout Brazil, but socio-demographic characteristics can affect the parameters of fertility differently, increasing or decreasing Total Fertility Rate (TFR).

In the case of this preliminary exercise, educational disparities seem to be stronger than macro-regions differences. For example, TFR has been going down for all educational levels, but wide differences persist between those with higher education and those who have less years of education. It is very clear that in the 21th century less educated women still seem to have unmet need for contraception given that they are having more children than they desire and their unwanted pregnancy might be source of increment to the TFR.

Three other findings are worth noticing. First, in general Brazilians have been having fewer children than they desire. Second, desired family size which seems to be roughly constant along the years suffered a decrease of one child in the last 20 years; Third, when looking at educational level, one can see how higher levels of education are translated into smaller ideal family sizes. Combined, these three facts suggest what might have been the main drivers of the fertility decline: women's participation in the labor force fostered by women's increasing educational attainment might be causing a decline in the desired family size but also more competition between motherhood and career. As a result, educated women present smaller desired family sizes and ended up achieving only a percentage of this number. In other words, women report fewer "desired" children, but the competition factor makes them have even fewer.

So far, negative tempo effect has been causing fertility in Brazil to be inflated, contrary to what Bongaarts predicted for more developed countries when he placed Fertility Postponement as a fact that decreases fertility. Unfortunately, I could not conduct the tempo effect analysis stratified by education level and macro-region, but it will be interesting to look more closely in my next analysis. My hypothesis is that highly educated women will postpone more often than low educated, who will remain with early fertility.

Regarding the ideal sex composition of the family, the preference in Brazil is given to having girls, but I do not think that this preference will impact the likelihood of having another birth, or even impact the fertility rates. More investigation needs to be done before considering this to be irrelevant in Brazil, especially because I am investigating time periods in which fertility was close to 3 children per woman and having grown up in the 80's, it used to be common to hear "we are going to try for a little girl".

Mortality replacement and involuntary infertility also appear to have only a marginal effect on fertility, if ever. Moreover, they might cancel one another at this stage of development where infant mortality

is not very high and when fertility is still early so involuntary infertility is not increased by late age at childbearing.

I believe fertility will decline further as more women get highly educated and more women are able to control their fertilities. However, it is too early to talk about convergence. Would low educated change their preferences once they acquire more education? Or would they end up with fewer children just because they are finally able to control more efficiently? Overall, I am looking forward to develop the Bongaarts models as they will allow me to look into the determinants more closely and make more informed suggestions. Moreover, the stratified analysis will allow me to understand how different socio-demographic characteristics are associated with reductions and/or increases in different parameters over time. Decomposing fertility is the first step to understand fertility change and variation.

As the goal for this preliminary exercise is concerned, I conclude that it is feasible to calculate the parameters and develop the models for the three periods above specified. Before starting, however, more data cleaning and exploring needs to be done to fix the problems with the Center-West region in the year 1996. I will also seek to improve the measurements of competition (causes women to miss their target by having less children) and unwanted fertility (makes women miss their target by having more children), as so far these two components seem to be the main causes of the mismatch between intended and realized fertility in Brazil. I believe these results will be ready by the time of the European Population Conference.

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