AGE-SPECIFIC BIRTH RATES IN BRAZIL

ECONOMIC AND SOCIAL PREDICTORS OF REPRODUCTION BY ADOLESCENT AND ADULT WOMEN

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ECONOMIC AND SOCIAL PREDICTORS OF REPRODUCTION BY ADOLESCENT AND ADULT WOMEN

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Abstract

For those who have reason to doubt the certainty or quality of their futures, it may be adaptive to engage in an accelerated life course and reproduce earlier than the public health policy officials consider ideal. This hypothesis was examined using life expectancy, school registration, income, income inequality, and the degree of urbanization to predict the birth rates of 15-19 year olds across municipalities in Brazil. To evaluate whether adolescents respond differently to these indicators than older women, the results for 15-19 year olds were compared to those obtained for women 20-29, 30-39, and 40-49 years old. Negative binomial regression results indicate that although teenage women seem to be the most sensitive to these socioeconomic indicators, older women adjust their reproductive efforts in a similar manner. More specifically, higher birth rates in all age groups are found in municipalities with short life expectancies, lower rates of school registration, lower average incomes, and higher income inequality. The degree of urbanization predicts differential effects according to age; for the 15-29 age group it is positively associated with birth rates and for the 30-49 year old women it is a negative predictor. Repeating the analyses within the five Major Regions of Brazil yields directionally consistent relationships for all predictors compared to those for the country as a whole.

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CHAPTER 1

Age-Specific Birth Rates Across the Country
A challenge to traditional ideas about adolescent pregnancy

1.1 Introduction

This study will explore socioeconomic predictors of birth rates in women 15-19, 20-29, 30-39, and 40-49 years old, across municipalities in Brazil. With an emphasis on birth rates in the youngest age group, the first chapter will examine predictors across the whole country, while the second chapter will investigate the same relationships within each of the five Major Regions in Brazil. Based on these analyses, the popular notion that teenage pregnancy is undesirable will be challenged and, further, it will be argued that adjusting fertility-timing in accordance to cues of an uncertain future, deprivation, and inequality may be a desirable choice for young mothers.

1.1.1 Cultural Fertility-Timing Norms and the Stigma Attached to Teenage Childbearing

The ideal that teenage pregnancy is undesirable and irresponsible is both pervasive and ill founded. Although the misguided public judgment that early reproduction is an antisocial act has been highly contested by the scientific community, it is still propagated as 'commonsense' and applied indiscriminately in many countries. Of course, the idea that adolescent pregnancy may, in some circumstances, present less than optimal outcomes for the mother and or the child is not baseless. Rather it is the broad attribution of this standard to people from a spectrum of cultural, socioeconomic, and religious backgrounds that is without support. In the Northern province of South Africa, for example, Wood, Maepa, & Jewkes (1997) found that teenage pregnancy is largely considered to be socially acceptable and "infinitely preferable to the threat of contraceptive-induced infertility" (p. 3). Furthermore, many nurses who were interviewed during the study reported that it was often the mothers and grandmothers that encouraged young women within their families to have children (Wood *et al,* 1997). Therefore, it is evident that teenage childbearing can have drastically different connotations in different cultures, ranging from elevating a woman's status in her family or community to being the reason for social ostracism.

In the West, and in many developing countries, the prevailing view is the latter. Levine (1988) posits that parents impose and hence, propagate, such cultural ideals in an attempt to maximize the economic and reproductive success of their children in conditions that are specific to their particular cultural experiences. These practices then become entrenched in a culture as folk wisdom and are advertised by the dominant social groups in a given area (Levine, 1988; Geronimus, 2004). Therefore, a pregnancy "can generate stigma for the woman and/or her family if it happens out of the traditional norms of accepted behaviour" (Villarreal, 1998, p. 4). This becomes problematic in areas with extensive socioeconomic heterogeneity where the accepted social strategies may not be desirable for minority or disadvantaged groups. In the case of adolescent pregnancy, there is a clear divide in the United States, for example, between the cultural traditions of European Americans and African Americans that differentially inform the fertility-timing norms for each group. Geronimus (2004) has studied this phenomenon extensively within the American population and argues that "inasmuch as [these two groups] draw on different cultural traditions and historical experiences, and face different environments, resources, and constraints, cultural variation in family ideals and the ensuing pattern of family-related behaviour is expected-even inevitable" (p. 158). Further, she specifically suggests that in highly unstable and impoverished areas, African American parents may have legitimate reasons to factor in the uncertainty of their health and longevity when making life course timing decisions that bias them towards early reproduction. Uncertain health and longevity also interact with the normative family structure in a community in determining fertility-timing norms and impacting the outcomes of such decisions.

In general, much of the public concern generated over adolescent pregnancy stems from the belief that young girls drop out of school because they are pregnant, become single mothers, rely heavily on government support, become a major strain on a country's economy and perpetrate a cycle of poverty (Villarreal, 1998). However, despite early studies that supported this view, more recent investigation into this claim has failed to corroborate it and, in fact, has revealed that adolescent mothers may experience some better socioeconomic outcomes than their matched peers.

1.1.2 Socioeconomic and Health Outcomes of Teenage Mothers

The popular view that adolescent pregnancy produces bad outcomes is largely propelled by studies that have reported compromised health and economic measures for teen mothers. In Chile, Buvinic *et al.* (1992) showed that adolescent mothers had undernourished children, earned minimal wages if they joined the labour force, and were more likely to remain unwed the poorer and less educated they were. However, neither this nor other such studies have been able to demonstrate a causal relationship between teenage pregnancy and negative outcomes because they did not validly separate the influences of pre-pregnancy risk factors on the response measures from the effect of pregnancy alone. For instance, it is quite likely that differences between the socioeconomic outcomes of teen mothers and mothers who give birth at a later age merely reveal substantive differences between women who avoid teenage pregnancy and those who do not (Hotz, McElroy, & Sanders, 2004). Specifically, because teen mothers in developed countries largely come from relatively disadvantaged backgrounds, and this is negatively correlated with future socioeconomic success regardless of pregnancy, it is difficult to tease apart causal effects (Hoffman, Foster, & Furstenberg, 1993; Hotz, McElroy, & Sanders, 2004). Indeed, Hotz, McElroy, & Sanders (2004) showed that the background characteristics of teen mothers, including family income, social assistance, and parents' education, were markedly different from those of women who did not become teenage mothers. To begin addressing these potential confounds, Hoffman, Foster, & Furstenberg (1993) compared American teen mothers with their sisters who did not give birth as teenagers. They found that while controlling for family background decreased the magnitude of the differences between the two groups compared to previously reported findings, the sisters of teen mothers were still more likely to finish high school, go to college, get married, and be middle-class. The sisters were also less likely to be on public assistance (Hoffman, Foster, & Furstenberg, 1993). The 'sister method' is a step towards controlling for confounding factors compared to traditional regression analyses that are based on the assumption that teen pregnancy is uncorrelated with any variables unaccounted for in the regression; however, they still make the assumption that the family's living conditions were uniform throughout the lives of the sisters and also that the parents treated both children equivalently (Hotz, McElroy, & Sanders, 2004). In fact, this is an assumption that might lead to misleading results (Hao, Hotz & Jin, 2004; Andersen, 2002). Taking a different approach, Hotz, McElroy, & Sanders (2004) exploited the event of a miscarriage as a way of randomly assigning women to a birth or no-birth condition. As expected, the background characteristics of women who became teenage mothers and those whose pregnancies ended in a miscarriage grouped together as being different from teenagers who did not become pregnant and those who had induced abortions. This finding reinforces the hypothesis that the popularly reported negative socioeconomic outcomes of early pregnancy may reflect pre-pregnancy risk factors that differentiate teenage mothers from other women who did not become young mothers and further supports the use of the 'miscarriage' group as a control for the teen mothers. Although this approach still assumes that miscarriages are random, fertility events are correctly reported, and having a miscarriage has the same direct effect on adult outcomes as an abortion, it is arguably the closest reported method to elucidating the causal relationship between teen motherhood and its reported negative socioeconomic outcomes (Hotz, McElroy, & Sanders, 2004). In general, the authors found that other studies may have overstated the effects of adolescent childbearing on subsequent outcomes due to the methodologies used and a failure to account for other influential factors.

In a similar manner, the popular notion that teen mothers and their infants are more susceptible to negative health consequences such as reduced birth weight or maternal mortality has failed to account for pre-pregnancy risk factors. However, most studies investigating this topic that have controlled for confounding factors such as malnourishment, rural living conditions, and health repercussions from induced abortions have reported minimal or no effects of age on maternal and child health outcomes (Villarreal, 1998; Lawlor & Shaw, 2002; Gueorguieva, Carter, Ariet, Roth, Mahan, & Resnick, 2001; Geronimus & Korenman, 1993). For example, an American study, which compared pregnancy outcomes between middle school and high school age groups, found that prematurity was the only health hazard elevated in adolescence and, further, that it was only in the 11-15 year olds (Satin *et al.*, 1994). In fact, some studies have even found that children of teenage mothers may experience some better health outcomes than children born to older women (Gueorguieva *et al.*, 2001).

Taken together, the research suggests that negative socioeconomic and health outcomes are not strongly associated with teenage motherhood itself, but rather with the risk factors that differentiate women who avoid pregnancy during adolescence and those who do not. Teenage childbearing is apparently not intrinsically riskier for the mother or the child when compared to delaying birth until a later age.

1.1.3 Future Discounting and the Evolution of Fertility-Timing

Although adolescent pregnancy may not be considered risky, there is still the notion that young mothers engage in an accelerated life course compared to their peers. Such actions may be the result of devaluing the future and placing more weight on the present. In a broader context, this phenomenon has been extensively studied in economics and biology as well as in psychology; it is commonly referred to as having a high time preference or discounting the future. For example, Kagel, Green, & Caraco (1986) reported that foraging animals settle for smaller rewards in the present because the value of a delayed larger reward decreases as a function of the time delay and as its availability becomes more and more uncertain in the future. Since the acquisition of food resources has such a direct link to survival, a high time preference will be fixed by natural selection if it increases the fitness of those animals (Kagel *et al.*, 1986). The study of similar behaviour in humans began primarily with hypothetical money tasks. Green, Fry, and Myerson (1994) gave subjects the option to accept a lesser amount of money now or wait a period of time before receiving a much larger sum of money. Using this forced choice task, the experimenters were able to describe a discounting function for different age groups. They concluded that over the life span, the rate of discounting and the sensitivity to time delays decrease but that the process of choosing can be modelled by a single hyperbolic function with varying parameters and is, therefore, qualitatively the same (Green, Fry, & Myerson, 1994).

Research aimed at identifying other correlates of discounting rate have revealed that men more than women and substance abusers more than controls, have short time horizons (Wilson & Daly, 2004; Kirby, Petry, & Bickel, 1999). This framework has also been extended to include the study of more naturalistic choice tasks, such as decisions to engage in violence and illegal behaviour, also taking into account the effects of age, sex, and socioeconomic condition on discounting rates in these domains. For example, in polygynous species, including *Homo sapiens*, males compete intensely for reproductive opportunities, surpassing females and males from monogamous species (Daly & Wilson, 2005). As an assay for this male-male competition, Daly & Wilson (2001) showed that the majority of homicides were not only perpetrated by males but also involved male victims, and were often the result of a robbery or a public dispute over reputation and social status. Furthermore, such cases were most prevalent among unemployed and unmarried men, and those who had been divorced or widowed, compared to age-matched controls (Daly & Wilson, 2001). In general, homicide rates have been shown to be strongly associated with socioeconomic indicators and, in particular, the Gini index, a measure of income inequality within a population (Daly & Wilson, 2001; McAlister, 2006). However, in their study of 77 Chicago neighbourhoods, Wilson & Daly (1997) found that local life expectancy was a better predictor of homicide rates than even the Gini index. Furthermore, they reported that age-specific birth rates for women under 30 years old were greatest in the neighbourhoods with the shortest life expectancy and smallest in those neighbourhoods with the longest life expectancy (Wilson & Daly, 1997). This result accords with their hypothesis that one or more cues of reduced local life expectancy, such as disease prevalence and violence, may be salient psychological indications of an uncertain future and inspire a shortened time horizon.

In response to such a cue, an accelerated life course may be desirable, as evolutionary theory proposes that phenotypic traits that maximize an organism's fitness will be favoured. Such traits may include those that allocate limited resources such as time, energy, security, information, and nutrients in an optimal way, most directly, by allowing an organism to leave the greatest number of offspring (Chisholm, 1999). While such preferences may be transmitted through a mixture of culture and genetics, reproductive value is nonetheless directly dependent on an individual's probability of surviving to reproduce and the number and viability of their offspring (Rogers, 1994). In fact, "fertility is the most direct contributor to an organism's fitness" (Panel for the Workshop on the Biodemography of Fertility and Family Behavior, 2003, p. 171). Of course, this strategy will involve tradeoffs between survival, growth, and development, among other fitness components (Chisholm, 1999). Schaffer (1983) called the trade-off between current and future reproduction "the general life history problem" and defined it as the "schedule of age-specific reproduction and mortality which, given the environmental constraints and the biology of the species in question, is likely to be favoured by natural selection" (p. 418). Therefore, proximate factors that induce variation in the probability and success of reproductive efforts will also be expected to alter these timing decisions. Obvious determinants include rates of internal and external mortality, income, and health care. Accounting for several such factors when making reproductive timing decisions will yield a dynamic continuum of reproductive success probabilities according to the magnitude of these cues. To the degree that social, health, and economic variables signal an uncertain future in a given area, it may be desirable for women to reproduce earlier there than in an area where the future is more predictable. Therefore, when choosing whether to invest in reproductive efforts at a certain age, "the optimal allocation of limiting resources (time and energy) when the future is unpredictable would be based on scaling the investment to the probability of success" (Ellison, 2001, p. 212). For example, when local conditions indicate that future living conditions are likely to be stable and there is a high probability of surviving to reap delayed social and economic rewards, it may be rational to invest more time and energy into avenues such as schooling during adolescence than into reproductive efforts. However, when the future is less predictable, it may be advantageous to invest in reproductive efforts earlier in life, as the probability of surviving and being healthy enough to experience educational returns and retain the ability to reproduce, is decreased. Additionally, a large determinant of these 'perceptions' is the degree to which women regard their future living conditions to be a consequence of their own actions. Indeed, it has been predicted that those whose likely causes of mortality, for example, are independent of their actions, will display steeper discounting functions than those who perceive that they are more self-determining (Daly & Wilson, 2005). Therefore, even partial knowledge of what is to occur in the future would alter the optimal reproductive strategy. "To the extent that it is 'known' that future conditions will not improve, the value of waiting over trying to reproduce now, even if conditions are poor, is reduced" (Ellison, 2001, p. 214).

1.1.4 Birth Rates in Brazil

In humans, much research has been devoted to determining the socioeconomic correlates of age-specific birth rates in order to address how our species responds to such environmental constraints. As a country with so much variation in socioeconomic conditions, Brazil is an optimal candidate country within which to investigate these relationships further. With a population of approximately 170 million in 2000, it is the fifth largest country in the world by both population and land area (United Nations Statistics Division, 2008; National Geographic, 2008). Despite its strong economy as a Latin American country, Brazil is characterized by extreme income and health inequality. In 2001, it was reported that the richest 1% of the population earned more total income than the poorest 50% (Paes de Barros, Corseuil, Foguel, & Leite, 2001; as cited in Marió and Woolcock, 2008). Second only to South Africa in income inequality with a household-income based Gini coefficient in the range of 0.58-0.60, it has been estimated that approximately half the Brazilian population lives on less than the equivalent of two U.S. dollars a day (Paes de Barros, Corseuil, & Leite, 2000, as cited in Marió and Woolcock, 2008; International Fund for Agricultural Development [IFAD], 2007). Furthermore, many studies have reported that rural poverty is greater than urban poverty in Brazil (Mattos & Waquil, 2006) and, more specifically, that many of the nation's poor are concentrated in the rural Northeast, where around 80% of the population lives in poverty (IFAD, 2007). These people have limited access to water and sewage systems, as well as to technology and health and education facilities (IFAD, 2007). Taken together, these descriptions indicate that there are vast disparities in living conditions across Brazil;

in turn, this variability is expected to differentially dictate life strategies including investment in education, participation in the labour force, and family planning.

In the last fifteen years, much attention has been focused on the prevention of adolescent pregnancy in Brazil and, as the current head of the country, President Lula targets what he considers to be a huge public health issue (BBC International News, 2007). However, despite extensive health and educational incentives, the age-specific birth rates for women aged 15-19 in Brazil have been increasing, while birth rates for women twenty and over have been following the decreasing trend seen throughout the 1990s (Berquó & Cavenaghi, 2005; see Figure 1.1). Villarreal (1998) classified the fertility-timing of women 15-19 years old as unique, contrasting it with that of other age groups cross-culturally.

> The only common characteristic to most countries seems to be that the pattern and evolution of fertility among the 15-19 year olds is clearly different from that of other age groups. While fertility has decreased in a more or less smooth way, responding to social and economic development in groups over 20 [years old], the fertility behaviour of the 15-19 year olds is unique, seems to respond more to cultural, social and psychological factors, and has shown resilience to overall socio-economic development. Moreover, this indicates that reproductive health programmes have failed to effectively reach this age group (p. 10).

The unique trend in this age group is further supported by reports that in 2000, 15-19 year olds comprised 20% of all Brazilian women giving birth, a percentage that has been increasing since 1980 when this age group accounted for only 9% of all births (Berquó & Cavenaghi, 2005). It is worth noting, however, that there is extreme heterogeneity within the 15-19 age group. The 18 and 19 year olds, many of whom have formed families, represent the majority of mothers, but it is the birth rates for 15, 16, and 17 year olds, and not 18 or 19 year olds, that increased between 1991 and 2000 (Berquó & Cavenaghi, 2005).

Thus, fertility in the 15-19 age group seems to follow a different trend than fertility in the older age ranges. Given this, it is also probable that teenage women will respond differently to social, cultural, and economic cues in their environments when making decisions about the timing of major life events.

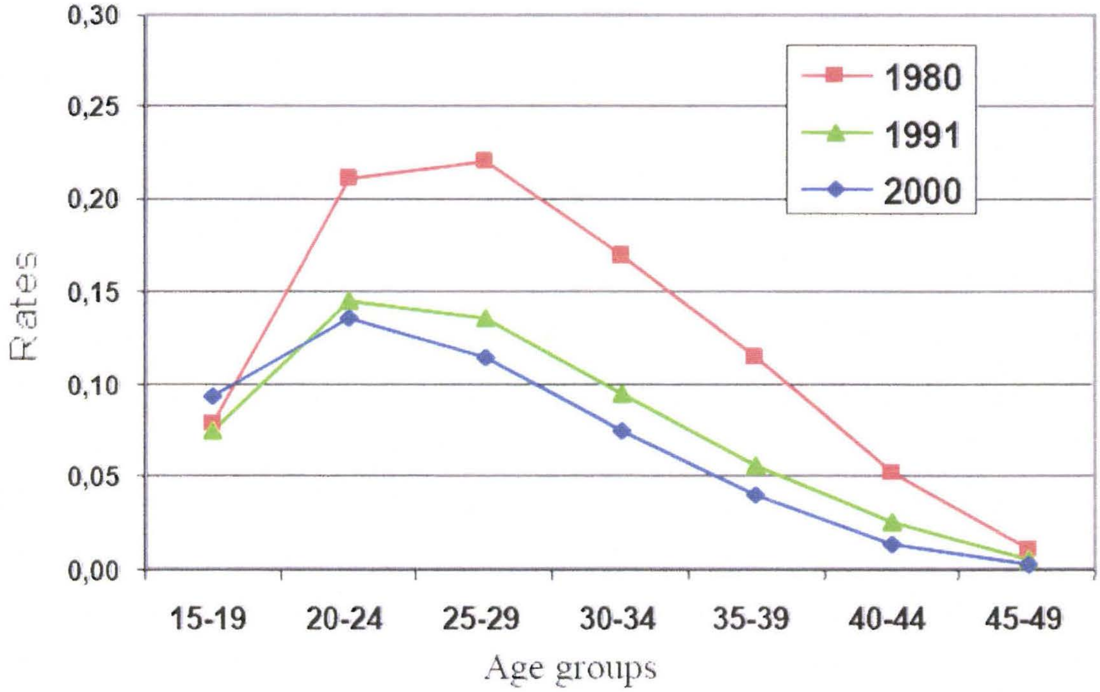


Figure 1.1. Age-specific fertility rates in Brazil, 1980, 1991, and 2000.

Note. From "Increasing Adolescent and Youth Fertility in Brazil: A New Trend of a One-Time Event?", by E. Berquó and S. Cavenaghi, 2005, *Annual Meeting of the Population Association of America*, p. 5.

1.1.5 Socioeconomic Indicators and Their Predicted Relationships with Age-Specific Birth Rates

In this thesis, local life expectancy, school registration of 15-19 year olds, income, the Gini coefficient, and the degree of urbanization are examined as semi-independent indices of living standards across municipalities in Brazil on the hypothesis that these variables are likely to influence birth rates. Following the proposition of Wilson & Daly (1997), it is suggested that local life expectancy serves as a more informative quality of life measure than economic variables alone, as it also reflects rates of internal and external mortality in a given area (Wilson & Daly, 1997). The percentage of 15-19 year olds registered in school is included as a proxy for female opportunity for education and career advancement in a given municipality. Income and the Gini coefficient are presented as the primary economic indicators, reflecting the level and dispersion of wealth, respectively. Lastly, the level of urbanization in a municipality is presented as a measure of accessibility of basic community services such as health clinics, of exposure to the mass media, and also of education and career opportunities.

1.1.5(1) Life Expectancy

Following predictions from life history theory, a direct relationship between life expectancy and reproductive timing has been demonstrated in many species. Specifically, the theory predicts that in response to cues of mortality, organisms will increase their reproductive effort and decrease their selectivity in choosing mates and other aspects of breeding situations. When experimenters manipulated indicators of mortality risk by inflicting physical injury, the moth *Scotopteryx chenopodiata* L. showed decreased discrimination resulting in a shortened average latency period before oviposition (Javoi & Tammaru, 2004). In human populations, researchers cannot manipulate cues of longevity as easily and so, instead, they have relied on life-history reports and observational data collected for censuses and human development reports to study these effects. Theoretically, it has been suggested that the optimal strategy for humans in the environment of evolutionary adaptedness (EEA) when the future was threatening or uncertain was to discount the future at a steep rate (Chisholm, 1999; Hill, Ross, & Low, 1997, as cited in Chisholm, 1999). Migliano, Vinicius, & Lahr (2007) have advanced this theory by suggesting that the small body size observed in human pygmy populations is the by-product of an adaptation to a shortened life expectancy. In the groups studied by the researchers, life expectancy ranged from 15.6 years to 24.2 years and the chances of surviving to the age of 15 years ranged from 30-51% (Migliano, Vinicius, & Lahr, 2007). It was proposed that in the trade-off between growth and reproduction, natural selection had favoured early reproduction in these populations in order to lower the risk of death before first reproduction (Magliano, Vinicius, & Lahr, 2007). Wilson & Daly (1997) also examined this hypothesis in their study of 77 Chicago neighbourhoods. As expected, they found that age-specific birth rates for teenagers were highest in the neighbourhoods with the lowest life expectancies, but that by the age of 30, the differences in birth rates had disappeared. Similarly, Geronimus, Bound & Waidmann (1999) compared rates of disability and external mortality in four impoverished African American communities in the U.S. to those of Whites and Blacks across the whole country. They found that delaying reproduction from 15 years of age to 30 decreased a mother's probability of surviving able-bodied to her child's twentieth birthday by as much as 19% and proposed that such uncertainty may explain the bias towards early reproduction in these communities (Geronimus, Bound & Waidmann, 1999). Chisholm (1999) further tied together life history theory with the attachment theory put forth by Belsky, Steinberg, & Draper (1991), by hypothesizing that childhood attachment styles, which are sensitive to psychosocial stresses including social and economic uncertainty, will dictate time preference and, in turn, influence reproductive strategies. Using retrospective self-report data, he found that reported high levels of environmental stress during childhood were associated with heightened time preferences and these preferences were related to adult attachment styles and sexual behaviour. Of particular relevance is the finding that age at first intercourse (as an indicator of reproductive strategy) was positively associated with expected lifespan (Chisholm, 1999).

Given this evidence, it is expected that age-specific birth rates for Brazilian teenagers will show a strong negative association with life expectancy across municipalities. Based on previous research, primarily that of Wilson & Daly (1997), it is expected that the magnitude of this relationship will decrease as the age of the mother increases.

1.1.5(2) School Registration

It is also predicted that the opportunity for career advancement in a given area will have an effect on reproductive decisions. In Brazil, the education system is split into three categories: fundamental, intermediate, and higher education, both undergraduate and graduate (Mission of Brazil to the United Nations, 2008). In 2000, grades one through eight were mandatory, but intermediate education was not (Mission of Brazil to the United Nations, 2008). Given this, school registration for males and females in their late teens is considered optional and, therefore, likely reflects, in part, the perception of education as a valuable investment. If spending the extra time and money in school beyond what is required by law promises large financial and social rewards, then choosing that route over immediate entry into the work force or starting a family may be desirable. In parts of Brazil,

> . . . the poor quality of education associated with limited job opportunities might induce a great number of young women to start families as the most attractive choice for their lives. Hence, a large proportion of adolescent and young women see childbearing and the formation of a family as the only chance of having a different life (Heilborn, 1998, as cited in Berquó & Cavenaghi, 2005, p.13).

Therefore, instead of investigating the relationship between school and teenage pregnancy as a necessary trade-off, school registration is here regarded as an indicator of the local perception of professional opportunity in a given municipality. Therefore, it is expected that birth rates will show a negative association with school registration, and that this relationship will be strongest for teenage mothers.

1.1.5(3) Income

In addition to life expectancy and schooling, it has been well documented that women living in poverty show different patterns of fertility than those living in more affluent areas. For example, in a study of 25 Sub-Saharan countries, Schoumaker (2004) found that women living in the poorest areas had the greatest number of children, married younger, and used less contraception. For teen birth rates in the U.S. especially, many studies have reported a strong negative association with income (Gold *et al.,* 2002; Gold *et al.,* 2001; Coley & Chase-Lansdale, 1998). Similar results were obtained in a study of adolescent fertility in Brazil. Berquó & Cavenaghi (2005) compared the birth rates for 15-19 year olds in three groups of women with low, intermediate, and high levels of income and education in 1991 and 2000, and reported that the rates were highest in the most disadvantaged group in both years (Berquó & Cavenaghi, 2005). These studies suggest that women respond to cues of deprivation in their environments and adjust their patterns of fertility accordingly. Does income, as an indicator of current living conditions, act as a salient psychological cue? Most likely, it is income combined with a subjective perspective of economic mobility that will dictate women's responses. If a woman living in poverty perceives that there is little chance of ever escaping poverty, she has a greater reason to devalue her future and less reason to delay reproduction. If, on the other hand, she was born into poverty, for example, but believes that she has a chance to better her economic condition, perhaps through schooling and participation in the labour force, then it would be sensible for her to lower her time preference (by decreasing her rate of discounting) and invest in these other avenues. Importantly, Andersen (2002) reported that Brazil is one of the least socially mobile Latin American countries and that there is a positive correlation of 0.53 between national per capita income and a social mobility index across the countries included in the analysis. If this result generalizes to conditions within Brazil, it might be predicted that adolescent fertility rates will be higher in the municipalities with lower average income per capita. In fact, Marió & Woolcock (2008) reported that it is the poor, unemployed Brazilians with low education levels that become stuck in poverty and who have not benefited from the overall gain in mobility that came with industrialization.

> Social mobility between generations is greater in the more developed regions of the country, which adds to the regional differentiations and the lack of mobility of the poorest sectors. In short, Brazil is a society organized in well-demarcated classes, with a certain degree of fluidity within class divisions but with significant rigidity against crossing such boundaries (p. 15).

Therefore, the lack of social mobility is predicted to exacerbate the effect of income, increasing the perception that people's future economic positions are largely beyond their control. As with life expectancy, the lack of control may lead to steep future discounting and increased teenage birth rates. Bolland (2003) reported that in a sample of 2468 adolescents living in poverty, over one quarter of the females were categorized as having severe feelings of hopelessness. Furthermore, the degree of hopelessness was positively associated with sexual behaviour, including having had sexual intercourse in the last week and trying to get pregnant (Bolland, 2003). Poverty is also expected to inspire feelings of hopelessness in the older women, although the predicted effect on birth rates is less clear than for that of the teenagers.

1.1.5(4) Income Inequality

Over and above the effects of poverty, income inequality has been found to be a significant predictor of health outcomes, including birth rates. Gold, Kennedy, Connell, & Kawachi (2002) showed that age-specific birth rates for 15-17 year olds were higher in U.S. counties with greater poverty and greater income inequality. After controlling for the effect of income, inequality was still associated with birth rates in the 15-17 age group but not with those of women aged 18-19 (Gold, Kawachi, Kennedy, Lynch, & Connell, 2001). In an earlier study of 37 countries, Jones *et al.* (1985) found that countries with a more equitable distribution of income had lower birth rates among women less than 18 years of age.

Income inequality has more commonly been studied in relation to social cohesion and male violence, than to birth rates (Daly, Wilson, & Vasdev, 2001; Kawachi & Kennedy, 1997; Wilson & Daly, 1997). However, in this thesis, it is proposed that pervasive income inequality will exacerbate an individual's perceptions of his or her own social standing and inspire feelings of hopelessness, leading to higher teenage birth rates (see Bolland, 1993). For example, if a woman living in poverty lives only amongst families that also live in poverty, her relative socioeconomic status will likely seem average. If, however, she lives next door to an affluent community, she may perceive her living conditions as being worse than she would otherwise. Such social comparisons are expected to lead to feelings of hopelessness for those women who consider themselves to be in the lower portion on the income distribution. Using the Gini coefficient as a proxy for this compositional effect, it is predicted that teen birth rates will be higher in the municipalities with higher income inequality and that this relationship will be stronger than in the other age groups.

1.1.5(5) Urbanization

Lastly, the degree of urbanization in a given area has also been extensively researched as a predictor of teen birth rates. Consistently, lower teenage birth rates have been reported for women living in urban areas than for those living in rural settings (Zlidar, Gardner, Rutstein, Morris, Goldberg, & Johnson, 2003; Jones *et al.*, 1995; Findley, 1980). One reason for this may be that in rural areas, the preparation time for entry into adulthood is decreased compared to that required in urban areas because little or no education is required for performing adult social roles and early marriage is common (Villarreal, 1998). Such disparities alter the very definition of adolescence and attach different connotations to teenage pregnancy. Urban/rural differences can also account for varying amounts of exposure to the mass media and proximity to community and kin control over sexual choices (Singh and Samara, 1996). Apart from these distinctions, the dichotomy between urban and rural living also encompasses numerous differences including access to specialized community health, education, and career resources as well as economic conditions including average income and representation in the cash economy.

While birth rates for women 15-19 years old in urban Brazil increased more than those for rural areas between 1991 and 2000, rates were still approximately 40% higher in rural areas (Berquó & Cavenaghi, 2005). Given this, it is predicted that municipalities with a large rural population will have higher teen birth rates than municipalities that are predominantly urban.

1.1.5(6) Methodological Considerations

As well as selecting appropriate socioeconomic indicators, researchers conducting demographic analyses using variables such as life expectancy and income inequality must carefully consider whether to examine these relationships before or after controlling for other such indicators. For example, when investigating the association between income inequality and birth rates, should income and education be controlled for? Wilkinson and Pickett (2007) have suggested that inequality may be an integral part of the causal pathway that leads to social differentiation and, as such, it might be a mistake to control for factors that highlight differentiation. If, on the other hand, researchers are interested in examining the independent effects of socioeconomic variables, then it may be sensible to control for other related indicators. The same argument can easily be made for a variable such as life expectancy, which is undoubtedly a combined result of healthcare, income, violence, and disease. Although in the current context, both marginal and partial relationships were examined in this first chapter, the independent effects of life expectancy, income, and income inequality were of primary interest; the potentially confounding factors of schooling and urbanization were also controlled for and examined as independent effects.

These five socioeconomic variables – life expectancy, school registration, income, income inequality, and urbanization – are, therefore, expected to be associated with birth rates in all age groups. Based on Berquó & Cavenaghi's (2005) suggestion that young women may be more sensitive to psychosocial indicators than those in the older age groups, the effects are predicted to be strongest for teenage women. Further, any differences in the direction of these relationships among age groups may reinforce the authors' observations regarding the unique nature of fertility patterns for teenagers in Brazil.

1.2 Methods

1.2.1 Geographical Level of Analysis

A lot of literature has been focused on debating the appropriate geographical level at which to study the relationships between social and economic factors. If the municipal variables included in this analysis provide salient psychological cues, the challenge is to identify the scale of the area within which people include themselves and against which levels they make comparisons.

> Do people compare themselves to "peer groups" in their neighbourhood, city, region, country or possibly to diaspora groups in other countries or with people of whom they know very little? There are many kinds of non-geographical groups… to which we compare ourselves to be of similar social standing. It is far from clear how reference groups are constituted (Ballas, Dorling, & Shaw, 2007; as cited in Wilkinson & Pickett, 2007, p. 1967).

In a review of 155 studies that examined the association between income inequality and health, Wilkinson & Pickett (2006) reported that the relationship seems to be much weaker or nonexistent when examined using a small geographical scale such as across parishes or census tracts, as opposed to across nations, regions, states, or cities. However, in their study of 77 Chicago neighbourhoods, Wilson & Daly (1997) detected an association between local life expectancy and age-specific birth rates. In the current context, similar effects are examined at the municipal level. This level was chosen because the predictions in this study stemmed from Wilson & Daly's (1997) findings and because the municipality is the smallest geographical level for which age-specific birth rates are available on the DATASUS archive. As such, the level of analysis used here might fall somewhere between the two categories proposed by Wilkinson and Pickett (2006), but is clearly a larger geographical scale than that used by Wilson and Daly (1997). However, the appropriate level undoubtedly depends on the social process being examined and the context within in which it is being studied: "Whether or not the scalar structuration of a given social process generates sociologically or politically significant outcomes is an empirical question that can only be resolved through context-specific inquiries" (Brenner, 2001, p. 606). Given this assertion, it is recommended that the relationships analyzed in this thesis also be examined using smaller and larger geographical scales in order to further elucidate the level of any observed effects. Such endeavours may also result in important theoretical contributions regarding social inclusion and comparison, particularly for research relating to income inequality.

1.2.2 The Data

Data on live births were taken from the Brazilian System of Information on Live Births (SINASC) posted on the Ministry of Health website, DATASUS, from which they were extracted. The SINASC is managed by the Department of Health Situation Analysis of the Secretary of Health Monitoring, within the State and Municipal Secretariats of Health. The Secretary of Health collects birth certificates from hospitals and notary offices (for home births) and enters the information into the SINASC. Included with the raw counts of live births is information on the mothers' ages, education, and civil state, as well as details about each pregnancy such as birth weight, sex of the baby, and any congenital abnormalities. In 2000, data for live births were available for all 5507 Brazilian municipalities.

Information on municipal socioeconomic indicators was obtained from the Brazilian Atlas of Human Development, which is based on data from the Brazilian Foundation Institute of Geography and Statistics (IBGE) 2000 national census. Questionnaires were administered to a systematic sample of households within each tax bracket: 10% of households in municipalities over 15,000 and 20% of households in all other municipalities, totalling 5, 304, 711 families and an average representation of 11.4% of all families (Instituto Brasileiro de Geografia e Estatística, 2000, p. 6).

Table 1.1 lists and describes the variables from IBGE that are used in the regression analyses in this thesis.

1.2.3 Statistical Analyses

Using a linear regression model for count outcomes can lead to inconsistent, inefficient, and biased estimates (Long, 1997). This problem is especially relevant in samples in which the population is small compared to the event counts and the calculated rates are not fine-grained enough to be treated as continuous (Osgood, 2000). Osgood (2000) suggests a sample size of 200,000 as a rough cut-off above which ordinary least-squares (OLS) regression is appropriate. In the sample analysed here, only two

Table 1.1.

List and description of the variables used in regression analyses

Variable	Description
Life Expectancy	Length of the average statistically expected lifespan at birth in a given municipality in 2000 (in years).
School Registration (15-19 year olds)	Percentage of teenagers 15-19 years old that were registered in school in 2000, irrespective of level and subject area.
Income	Per capita income in Reais as of August 1st, 2000 (1 Canadian dollar=1.20 Brazilian Reais). Individual income is defined as the ratio of the total family income divided by the total number of people in the family.
Gini Coefficient	A measure of the degree of inequality in the distribution of household incomes within a given municipality in 2000. Ranges from 0, when all families have the same per capita income, to a maximum of 1, when one family in the municipality has all the income and the other families have no income.
Urbanization	Proportion of the municipal population that was residing in urban areas in 2000.

municipalities, São Paulo and Rio de Janeiro, meet that criterion for women in the four age groups of interest simultaneously.

The two main concerns with using an OLS regression are that the homogeneity of variance assumption cannot be met because the precision of the rate depends on the population size, and the distribution of errors will likely be non-normal or asymmetrical when event counts are low (Osgood, 2000). Performing a regression on a count variable requires that a Poisson distribution, or a variation thereof, be used to determine the probabilities of the counts. When the Poisson model is used, the variance of the conditional distribution, that is the distribution of the dependent variable given all of the explanatory variables, is constrained to be equal to the conditional mean (Long, 1997). If the mean depends on characteristics of the cases (in this case, municipalities) included in the analysis, the mean of the conditional distribution and the probability for a given count under the Poisson model is given as:

$$\mu_i = \exp(x_i B)$$

$$Pr(y_i|x_i) = \frac{\exp(-\mu_i)\mu_i^{y_i}}{y_i!} \quad \text{for } y = 0, 1, 2 \ldots$$

respectively, where y is the event count and μ can be thought of as the mean, expected count, or rate, defined as the expected number of times an event has occurred for a given amount of time (Long, 1997). The conditional mean of the errors, ε, in the nonlinear Poisson model is zero, but the errors are heteroscedastic, differentiating it from a simple linear regression model (Long, 1997). This model can be altered to incorporate an exposure variable that converts the regression from an analysis of counts to an analysis of rates. This is done by adding the natural log of the population size, for example, to the right-hand of the equation and constraining its coefficient to 1 (Osgood, 2000). The Poisson model is also able to account for the heterogeneity of error problem that is introduced by varying population sizes by defining the standard deviation of an event rate as inversely proportional to the square root of the population size (Osgood, 2000).

However, as mentioned, the Poisson model makes a strong assumption about the data. These assumptions are that the conditional variance is equal to the conditional mean and that there is no heterogeneity between cases included in the analysis that is not modelled by the predictor variables (Long, 1997). A negative binomial model is often used as an alternative to the Poisson model in order to fit data that do not conform to these assumptions. The negative binomial model is similar to the Poisson except that it incorporates a dispersion parameter, *k*, and allows for the expected count to be modelled by the predictor variables and a parameter, *e*, which can represent the effects of explanatory variables not included in the model or a degree of random error (Long, 1997). The parameter theta, θ, is equivalent to $1/k$ and is often used to describe the conditional distribution. The mean of the conditional distribution and the probability for a given count under the negative binomial model are given by:

$$\mu_i = \exp(x_i B + e_i)$$

$$Pr(y_i|x_i) = \frac{\Gamma(y_i + \theta)}{y_i!\Gamma(\theta)} \frac{(\mu_i)^{y_i}\theta^{\theta}}{(\mu_I + \theta)^{y_i+\theta}}$$

respectively, where e is assumed to have a gamma distribution, $\Gamma(1, 1/\theta)$. The variance of the negative binomial increases as a function of the expected count and the dispersion parameter according to:

$$Var(y_i|x_i) = \mu + \mu^2/\theta$$

where the smaller the θ, the greater the dispersion of the conditional negative binomial distribution. When the Poisson regression model fits the mean structure of the data but displays overdispersion, the "estimates are consistent, but inefficient" (Long 1997; Gourieroux, Monfort, & Trognon, 1984). This means that the values of the coefficients from the Poisson and negative binomial regressions will be similar but that the standard errors from an overdispersed Poisson model will be biased downwards, therefore overstating the precision of the estimates. However, as $\bar{k}$ approaches zero, the negative binomial model collapses into the Poisson. In this sense, using a negative binomial distribution is a conservative approach to modelling count data. The regression model for the negative binomial is defined as:

$$\hat{u}_i = \exp(x_i\beta + \varepsilon_i) = \exp(x_i\beta)\exp(\varepsilon_i)$$

This model assumes a Poisson distribution for the event counts and a gamma distribution for the unexplained variation in the true mean event counts (Osgood, 2000). Therefore, in the Poisson model, variation in the expected count is introduced through observed heterogeneity while in the negative binomial model, variation is introduced through observed and unobserved heterogeneity (Long, 1997).

A likelihood ratio (LR) test can be used to test the adequacy of the Poisson and negative binomial models by testing the null hypothesis that the dispersion parameter, *k*, is zero.

$$G^2 = -2\ln(L_{\text{Poisson}} / L_{\text{Negative Binomial}}) \quad \text{tests } H_0\text{: } 1/\theta = 0$$

where *L* is the likelihood of the model. This test statistic follows a chi-square distribution, with p-values less than the critical alpha favouring the negative binomial model over the Poisson.

The interpretation of the regression coefficients from Poisson and negative binomial regressions are the same and will be discussed in the Results sections.

1.2.4 Selection of Municipalities

In order to minimize the instability of the counts of live births, a subset of the total 5507 Brazilian municipalities was selected. Figure 1.2 shows the average difference between the birth rates of women in 1999 minus that in 2000, and in 2001 minus the 2000 birth rate plotted against the population of women in that age band for every municipality. Although some instability in the estimate from year to year is expected, the overall trend in Brazil for 20-29 year olds, as in most other developing countries, is towards decreased reproduction and family size (Berquó & Cavenaghi, 2005). Therefore, the probability of a woman of a given age giving birth in 2000 should also be less than in 1999, and less again in 2001. Therefore, subtracting the birth rates from 1999 and 2001 from those in 2000 should yield negative and positive values, respectively. Assuming a constant decline over those three years, taking the average of these two values should

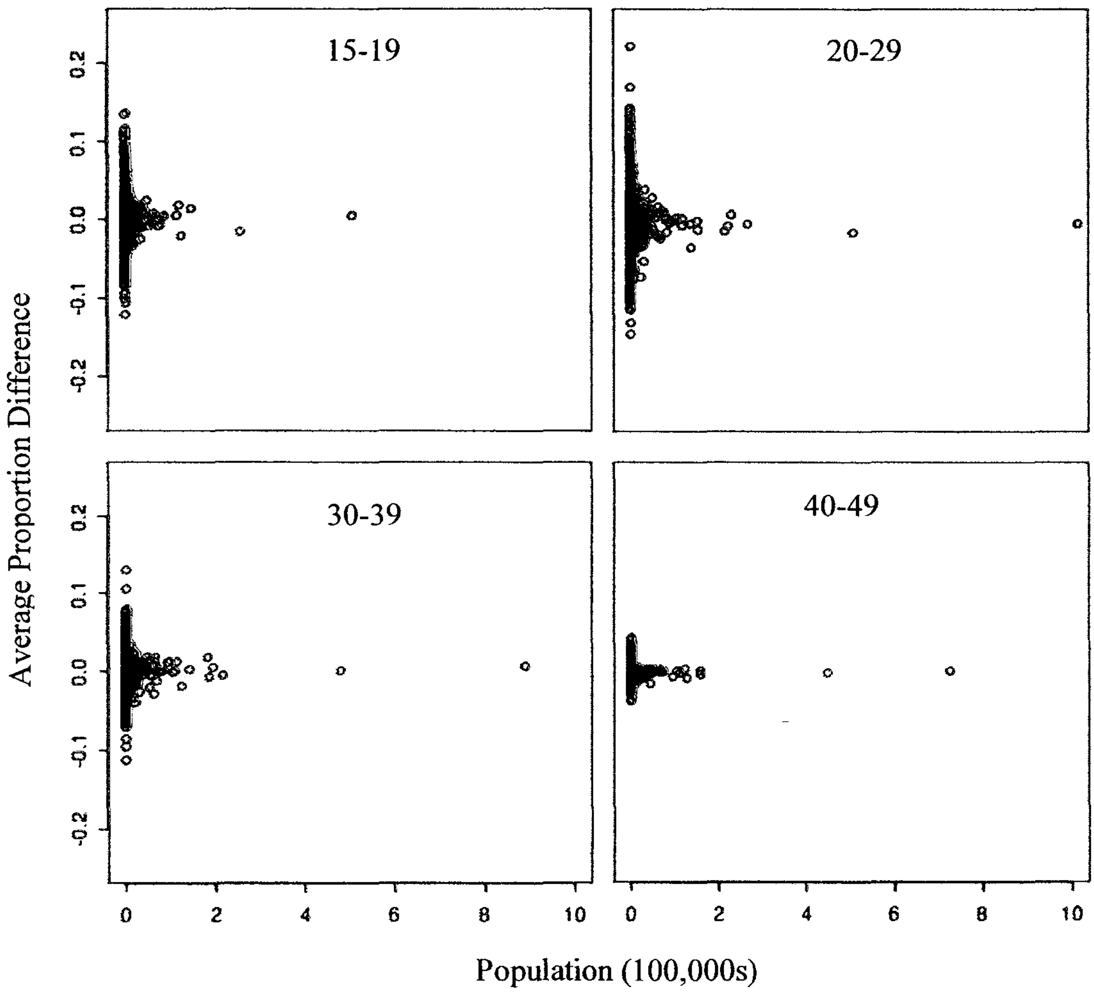


Figure 1.2. The average proportion difference between 1999 and 2000 and between 2001 and 2000 for live births in each age category for all 5507 municipalities.

Note. Age groups are indicated within each quadrant.

then result in a value close to zero. The municipalities with either relatively high or low values are then highlighted as being potentially unstable in their recorded estimates. As expected, it can be seen that the largest absolute difference values occur in municipalities with small populations. The most instability among the three years occurs for women aged 20-29, in one municipality exceeding an average proportion difference of 0.20. Berquó & Cavenaghi (2005) show that the decline in fertility for Brazilian women 20-34 years old from 1980-2000 was from approximately 0.70 to 0.68, an average decline of 0.001 a year. Therefore, this report suggests that the variation observed in Figure 1.2 is higher than would be expected. Based on this discrepancy, the 20-29 age group was chosen as the one to be used in selecting the subset of municipalities. In Figure 1.3, it is evident that the distribution of birth rates for women aged 20-29 has a slight positive skew and, therefore, the median of the distribution was chosen as the measure of centre around which to calculate a margin of error because it is less biased by extreme scores than is the mean (Howell, pg. 63). The median proportion of women 20-29 years old in the 5507 municipalities that had a live birth in 2000 was 0.1112. The sample size needed to maintain a given margin of error around a population proportion with 95% confidence is given by:

$$n = \frac{z^2 p\,(1-p)}{M^2}$$

$$n = \frac{(1.96)^2\,(0.1112)\,(1-0.1112)}{(0.01112)^2}$$

$$n = 3070.52$$

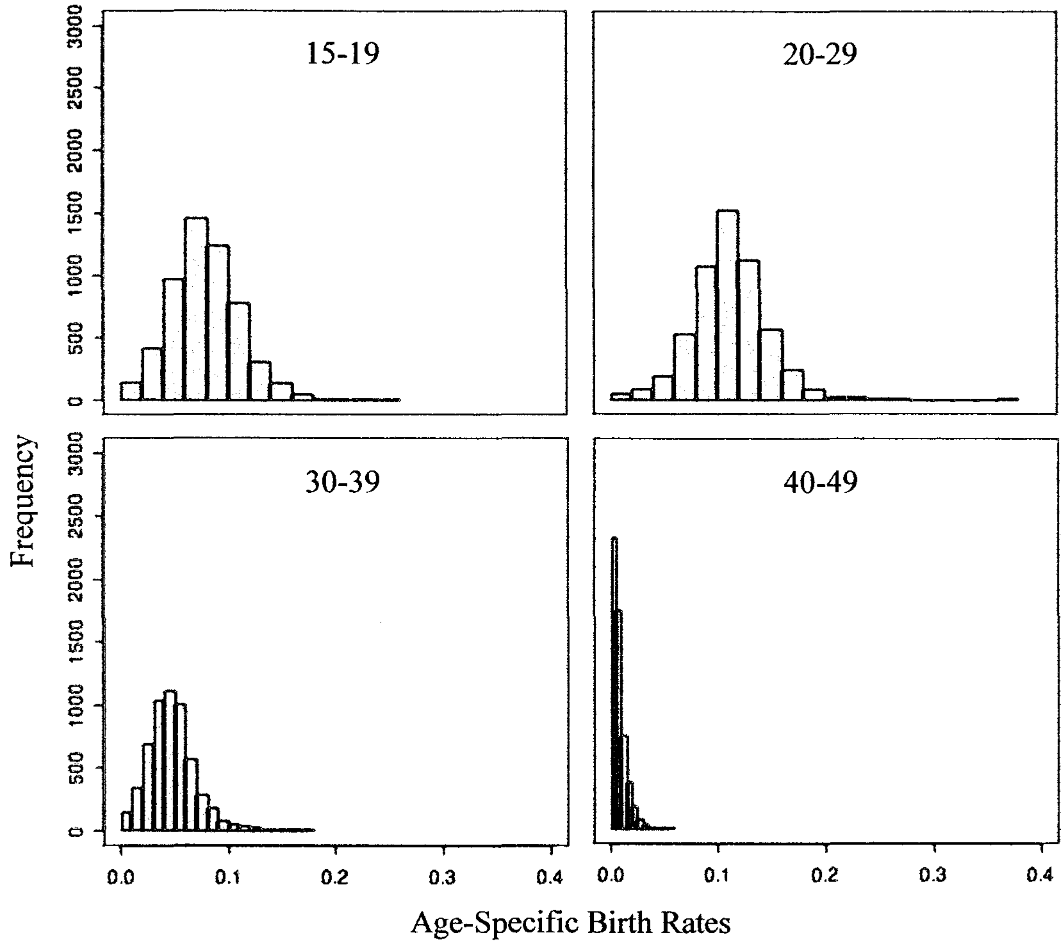


Figure 1.3. Distributions of birth rates in each age group are for all 5507 municipalities of Brazil.

Note. Age groups are indicated within each quadrant.

where *n* is the sample size, *z* is the multiplier for a 95% confidence interval, *p* is the population proportion (median proportion for women aged 20-29 used here), and *M* is the margin of error. Here, a margin of error that is 10% of the value of the median proportion, 0.1112, was used. Therefore, selecting only municipalities with more than 3070 women, yields median birth rates in those municipalities that, with 95% confidence, will be within 10% of the 'true' median. Selecting municipalities with at least 3071 women aged 20-29 yields a sample size of 725. The descriptive statistics for the original and new data sets are shown in Tables 1.2 and 1.3.

From the tables it can be seen that selecting a subset of municipalities does not alter the mean or median birth rates in each age group by a great deal, nor does it disturb the order of the groups relative to each other. After selecting the 725 municipalities with the largest populations of 20-29 year old women, the average differences in birth rates between 1999 and 2000 and between 2001 and 2000 are contained within the horizontal red lines of Figure 1.4 (p. 36).

Table 1.2.

Descriptive statistics for the per capita birth rates in each age group in 2000 for all 5507 municipalities of Brazil

	15-19	*20-29*	*30-39*	*40-49*
N	5507	5507	5507	5507
Mean	0.0788	0.1115	0.0466	0.0074
Median	0.0769	0.1112	0.0450	0.0059
SD	0.0315	0.0338	0.0214	0.0068

Table 1.3.

Descriptive statistics for birth rates in each age group in 2000 after selecting the subset of 725 municipalities

	15-19	*20-29*	*30-39*	*40-49*
N	725	725	725	725
Mean	0.0863	0.1191	0.0501	0.0064
Median	0.0836	0.1170	0.0505	0.0055
SD	0.0240	0.0239	0.0143	0.0040

Using the same margin of error calculation, the maximum margins of error for the median proportions in each age range given the populations in the subset of 725 municipalities were calculated (Table 1.4).

Table 1.4.

Maximum margins of error (M_{max}) for each age group, given the minimum number of women (n_{min}) in a municipality and the median proportion of women that gave birth in 2000

Age	n_{min}	*Median*	M_{max}
15-19	1665	0.0836	0.00017676
20-29	3069	0.1170	0.00012932
30-39	2129	0.0505	0.00018642
40-49	1227	0.0055	0.00015013

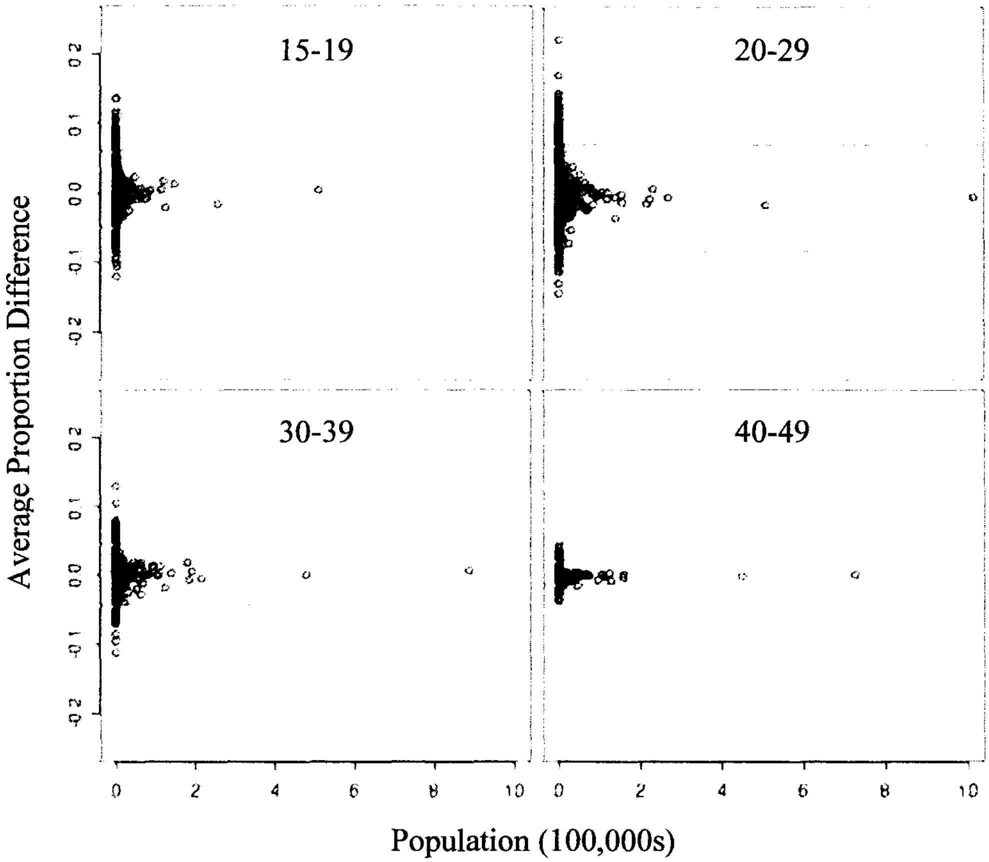


Figure 1.4. The average difference in birth rates between 1999 and 2000 and between 2001 and 2000 for live births in each age category for all 5507 municipalities of Brazil.

Note. Red horizontal lines indicate the maximum and minimum average proportion differences within the subset of 725 municipalities.

Using this criterion for selecting a subset of municipalities yields a data set in which each of the 27 Brazilian states is represented by at least one municipality (Table 1.5). The most represented state in the subset is São Paulo with 149 municipalities, and the least represented is Roraima with only 1 municipality. Furthermore, the geographic region that is most represented in the sample is the Southeast with 282 municipalities, and the least represented is the Central-West region with 50 (Figure 1.5, p. 39).

Regressions were run for women between the ages of 15 and 49, as this is the standard reproductive age range used by demographers (Khlat, 1994).

1.2.5 Regression Diagnostics

As discussed, one of the problems with using ordinary least-squares (OLS) regression for count data is that the homogeneity of variance assumption is often violated. Figure 1.6a shows that the dispersion of studentized residuals increases as the expected mean value increases for the linear regression model. Although the diagnostic graph is only shown for the regression on the age-specific birth rate for 20-29 year olds, the same pattern is seen for the other age groups as well (see Appendix A). Secondly, Figure 1.6b shows that the studentized residuals are highest in the municipalities with the lowest population of 20-29 year old women, confirming earlier speculations (p. 25-30) regarding the inadequacy of the OLS model.

Table 1.5.

Distribution of selected municipalities (N=725) within the 27 Brazilian states and the Distrito Federal

State	*Number of Municipalities in Subset (% of Full Sample)*	*Region*	*Total Number of Municipalities in Subset (% of Full Sample)*
	2 (9.09)		
Acre (AC)	2 (12.50)		
Amapa (AP)	7 (11.29)		
Amazonas (AM)	40 (27.97)	North	66 (14.70)
Pará (PA)	9 (17.31)		
Rondônia (RO)	1 (6.67)		
Roraima (RR)	5 (3.60)		
Tocantins (TO)			
Alagoas (AL)	14 (13.86)		
Bahia (BA)	55 (13.25)		
Ceara (CE)	39 (21.20)		
Maranhao (MA)	25 (11.52)		
Paraiba (PB)	11 (4.93)	Northeast	209 (11.70)
Pernambuco (PE)	41 (22.16)		
Piaui (PI)	8 (3.62)		
Rio Grande do Norte (RN)	9 (5.42)		
Sergipe (SE)	7 (9.33)		
Distrito Federal (DF)	1 (100.00)		
Goias (GO)	28 (11.57)		
Mato Grosso (MT)	12 (9.52)	Central-West	50 (11.21)
Mato Grosso do Sul (MS)	9 (11.69)		
Espirito Santo (ES)	13 (16.88)		
Minas Gerais (MG)	80 (9.38)	Southeast	282 (16.93)
Rio de Janeiro (RJ)	40 (4.40)		
São Paulo (SP)	149 (23.10)		
Paraná (PR)	43 (10.78)		
Rio Grande do Sul (RS)	44 (9.42)	South	118 (10.18)
Santa Catarina (SC)	31 (10.58)		

Figure 1.5. Map of Brazilian states and Major Regions.

Note. Major Regions, as proposed by the Brazilian Institute of Geography and Statistics, are colour-coded. From "Brazil to host the next world radiosport team championship", *The National Association for Amateur Radio,* 2003, http://www.arl.org/news/ stories/ 2003/10/16/4/?nc=1/.

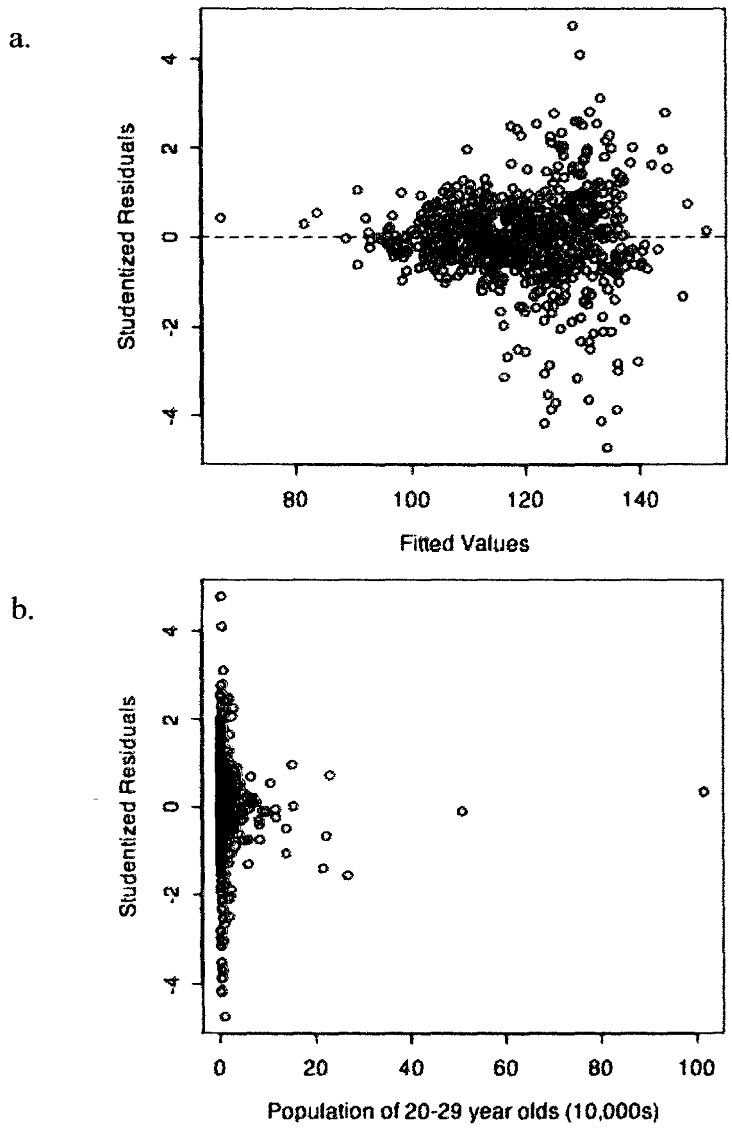


Figure 1.6. Diagnostic plots to justify the inappropriateness of the ordinary least-squares model.

Note. a) Predicted (fitted) values are for the regression of life expectancy, school registration, income, Gini coefficient, and urbanization on age-specific birth rates for 20-29 year olds. Diagnostic plots for the other age groups are shown in Appendix A.

Four separate regressions were run, one for the birth rate in 2000 in each of the age groups. The regression result table (Table 1.10, p. 49) gives estimates for the x-standardized coefficients, the corresponding percent change, the estimate and standard error of theta for each regression, and the chi-square (χ^2) test statistic for assessing the fit of the negative binomial model. The percent change represents the percent by which the response variable increases or decreases for every standard deviation increase in the explanatory variable. It is calculated by exponentiating the coefficient estimate, subtracting one from that value, and then multiplying by a hundred. The likelihood-ratio test used to determine whether a Poisson model provides an adequate fit to the data follows a chi-square distribution with 1 degree of freedom. At a significance level of α=0.05, any values surpassing $\chi^2_{critical}$= 3.84, provide evidence that the negative binomial model provides a significantly better fit to the data given the one additional parameter for the dispersion parameter. For all four regressions, the test statistic exceeds the critical value (where all χ^2 are $\geq$ 2486.82), therefore providing extremely strong evidence that the negative binomial model is favoured over the simpler Poisson model.

Within the sample of 725 municipalities used in the analyses, the five variables used as independent measures are somewhat correlated with each other as shown in Table 1.6. However, none of the correlations exceed r=0.650 and, therefore, the maximum variation in one measure that is explained by one of the other variables is approximately 42%. The variance-inflation factor (VIF) is a way of assessing how severely collinearity between predictors in a regression model influences the confidence interval around a given estimate. VIFs are given as:

$$VIF_j = 1/(1-R_j^2)$$

where R_j^2 is the value from the regression of X_j on the other independent measures in the model. Taking the square-root of the VIF yields the factor by which the confidence interval around a given coefficient is increased due to collinearity. It has been suggested that a VIF of 10 or greater, corresponding to a √VIF of about 3.15, poses some concern (Chatterjee & Price, 1991; as cited in Stine, 1995). For the models included in the present analysis, the VIFs do not exceed 2.5, therefore providing no evidence that collinearity constitutes a problem.

Table 1.6.

Matrix of bivariate Pearson correlations for the 5 predictor variables used in the regression analysis within the 725 municipality subset

	Life Expectancy	School Registration	Income	Gini	Urbanization
Life Expectancy	1	0.259*	0.642**	-0.396**	0.490**
School Registration		1	0.415**	-0.080**	0.435**
Income			1	-0.172**	0.614**
Gini				1	-0.307**
Urbanization					1

Note. ** $p < .01$ * $p < .05$

1.3 Results

1.3.1 Comparison of Age-Specific Birth Rates

The mean and variance for the birth rates in each age group are shown in Table 1.7. Across the subset of 725 municipalities, the birth rate for 15-19 year olds is 72.4% of the mean value for women in their twenties.

Table 1.7.

Means and standard deviations (SD) for age-specific birth rates (per 1000 women) in the subset of 725 municipalities

	Age Group (years)			
	15-19	*20-29*	*30-39*	*40-49*
Mean	86.26	119.14	50.09	6.40
SD	23.97	23.92	14.35	4.05

1.3.2 Predictor Variables in the Full Sample and Subset of Municipalities

Compared to the total sample of 5507 municipalities, restricting the analysis to what are, in effect, the 725 most populous municipalities results in substantial increases in urbanization (40.7%) and average income (47.6%) and lesser increases in life expectancy (2.3%), school registration (6.5%), and income inequality (1.8%) (see Table 1.8). Looking at the range of values, it can be seen that the sample of 725 municipalities excludes the richest and poorest places, but spans almost the entire range of urbanization values, from 0.02 to 1.00. With a moderate increase in the mean of school registration, the sample excludes municipalities with less than 50% school attendance. All differences between means in the full sample of 5507 municipalities and those in the subset of 725 municipalities are significant ($p < .01$, two-tailed).

Table 1.8.

Descriptive statistics for the explanatory variables across ***all municipalities (N=5507)*** *and in the restricted (N=725) sample*

Variable	*mean*	*standard deviation*	*min*	*max*
Life Expectancy (years)	**67.75***	**4.86**	**54.35**	**78.18**
	69.34	3.92	55.41	78.18
School Registration (% of 15-19 year olds)	**72.42***	**8.29**	**28.70**	**93.10**
	77.16	7.05	49.20	93.10
Income (Reais)	**170.80***	**96.43**	**28.38**	**954.60**
	252.10	125.48	47.34	834.00
Gini Coefficient	**0.56***	**0.06**	**0.36**	**0.82**
	0.57	0.05	0.36	0.78
% Urbanization	**0.59***	**0.23**	**0.00**	**1.00**
	0.83	0.18	0.02	1.00

Note. Values for the full sample are shown in **bold** font and values for the restricted sample are shown in regular font. The differences between the means in the two samples were tested with t-tests and corrected for multiple comparisons.

* $p < .01$, two-tailed

1.3.3 Bivariate Relationships Between Predictors and Age-Specific Birth Rates

In addition to the partial relationships between the independent measures and the age-specific birth rates, bivariate correlations were computed as shown below in Table 1.9. Furthermore, the relationships between each predictor and the birth rate in each age group are portrayed in Figure 1.7. These graphs were created by splitting municipalities into terciles of low, moderate, and high levels of each explanatory variable and then plotting the mean birth rate within each level against the four age groups.

Table 1.9.

Bivariate correlations between predictors and age-specific birth rates

	Age (years)			
	15-19	*20-29*	*30-39*	*40-49*
Life Expectancy	-0.36**	-0.34**	-0.02	-0.31**
School Registration	-0.38**	-0.26**	-0.05	-0.28**
Income	-0.40**	-0.37**	-0.04	-0.41**
Gini coefficient	0.26**	0.31**	0.09*	0.25**
% Urbanization	-0.16**	-0.21**	-0.14**	-0.52**

Note. ** $p < .01$ * $p < .05$

1.3.4 Appropriateness of Negative Binomial Regression Model

The summarized regression results for the four age groups are given in Table 1.10 (p. 49) and the full tables are shown in Appendix B. From the theta estimates, it is clear that the conditional distribution of birth rates for 20-29 year olds is the least dispersed, while the rates for 40-49 year olds are the most dispersed. As mentioned, the negative

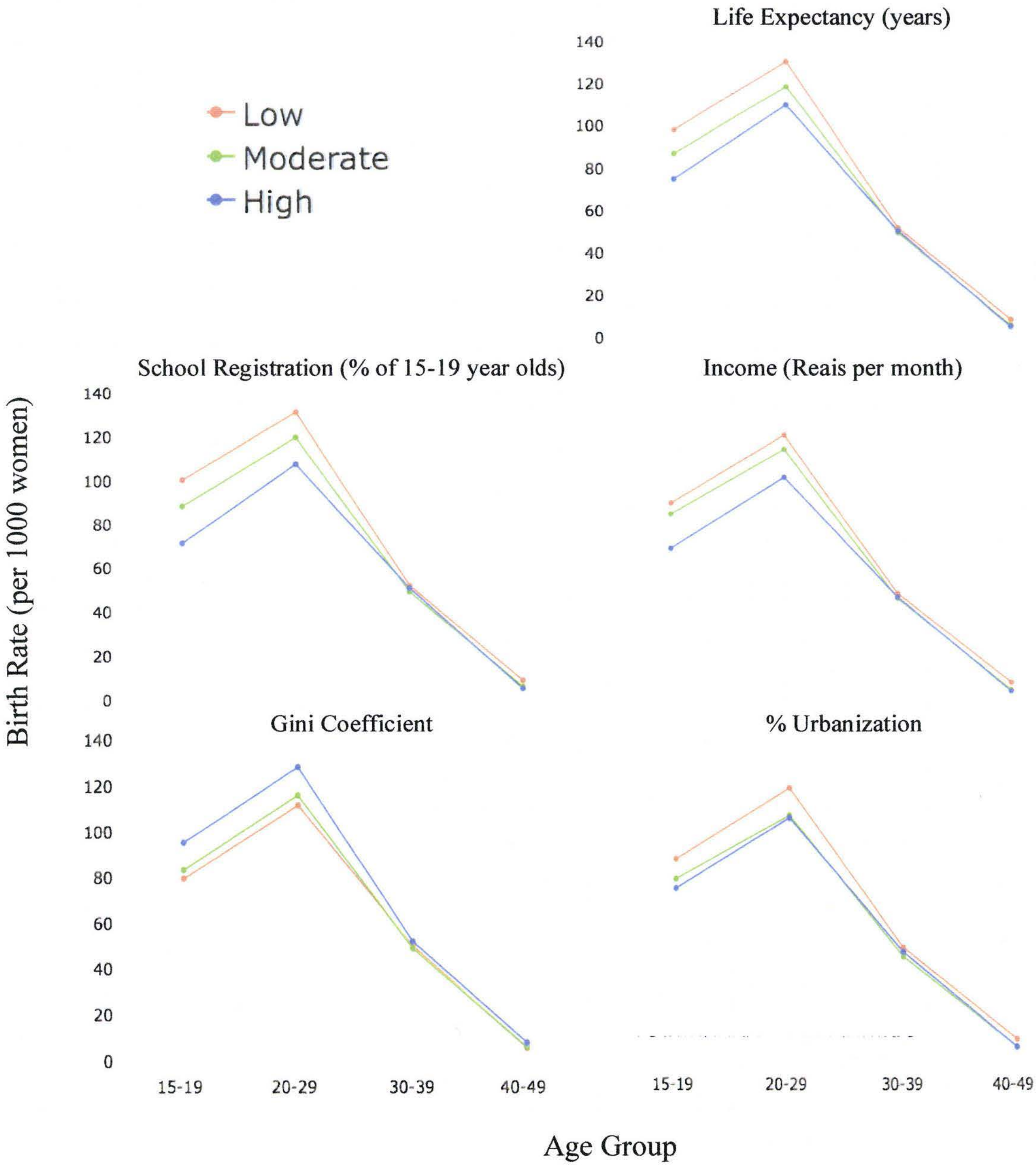


Figure 1.7. Mean municipality-specific birth rates by age group, in relation to 5 variables on which the municipalities were divided into terciles: life expectancy (years), school registration (% of 15-19 year olds), income (Reais per month), the Gini coefficient, and % urbanization.

binomial model provides a better fit than the Poisson model, even though dispersion of the conditional distribution is relatively small, with theta values ranging from 6.55-32.82.

1.3.5 Regression Results

As predicted, life expectancy is a significant negative predictor of teen birth rates but is non-significant for the older women; for the youngest women, the lower the municipal life expectancy, the higher the birth rate.

The percentage of 15-19 year olds registered in school is also a significant negative predictor of teen birth rates. Unlike life expectancy, however, it is also a significant predictor for 20-29 and 40-49 year olds, although the effect is of lesser magnitude. For the youngest women, every standard deviation increase in school registration predicts a 8.79% decrease in the birth rate. For 20-29 and 40-49 year olds, the predicted decreases are 3.38% and 4.34%, respectively.

The results for the income and Gini variables show the exact same pattern as for school registration. More specifically, income is a significant negative predictor for the 15-19, 20-29, and 40-49 year olds, having the largest effect on teen birth rates at a predicted percent change of -10.11. Gini shows the same pattern, but predicts an increase in birth rates for those same three age groups. The largest effect of Gini is, again, for women aged 15-19, predicting a 6.58% increase in the birth rate for every standard deviation, or 0.05, increase in the Gini coefficient.

The impact of urbanization, after controlling for the other independent measures in the model, follows a consistent pattern from a large positive effect for the 15-19 and

20-29 year olds to a large negative effect for 30-39 and 40-49 year olds. For teenagers and women in their twenties, an 18% increase in the degree of urbanization predicts a 9.70% and 3.93% increase in the birth rate, respectively. For the 30-39 year olds the predicted change switches to -4.76% and for the oldest women to -16.52%.

Comparing the graphs portraying bivariate relationships in Figure 1.9 (p. 45) to the partial relationships in the regression analyses (Table 1.10, p. 49), it is clear that most relationships are in the same direction. However, for others, like the degree of urbanization, controlling for other predictors in the model yields partial relationships that are quite different than what is shown above in Figure 1.7. More specifically, the simple bivariate relationship between urbanization and birth rates for 15-19 and 20-29 year olds is clearly negative with the highest rates in municipalities that are more rural. As shown in Table 1.10, however, this relationship becomes positive once life expectancy, school registration, income, and Gini are controlled for.

Figure 1.8 shows these relationships using effect plots. These graphs hold four of the explanatory variables at their average value and plot the partial relationship between the variable of interest and the dependent measure.

Table 1.10.

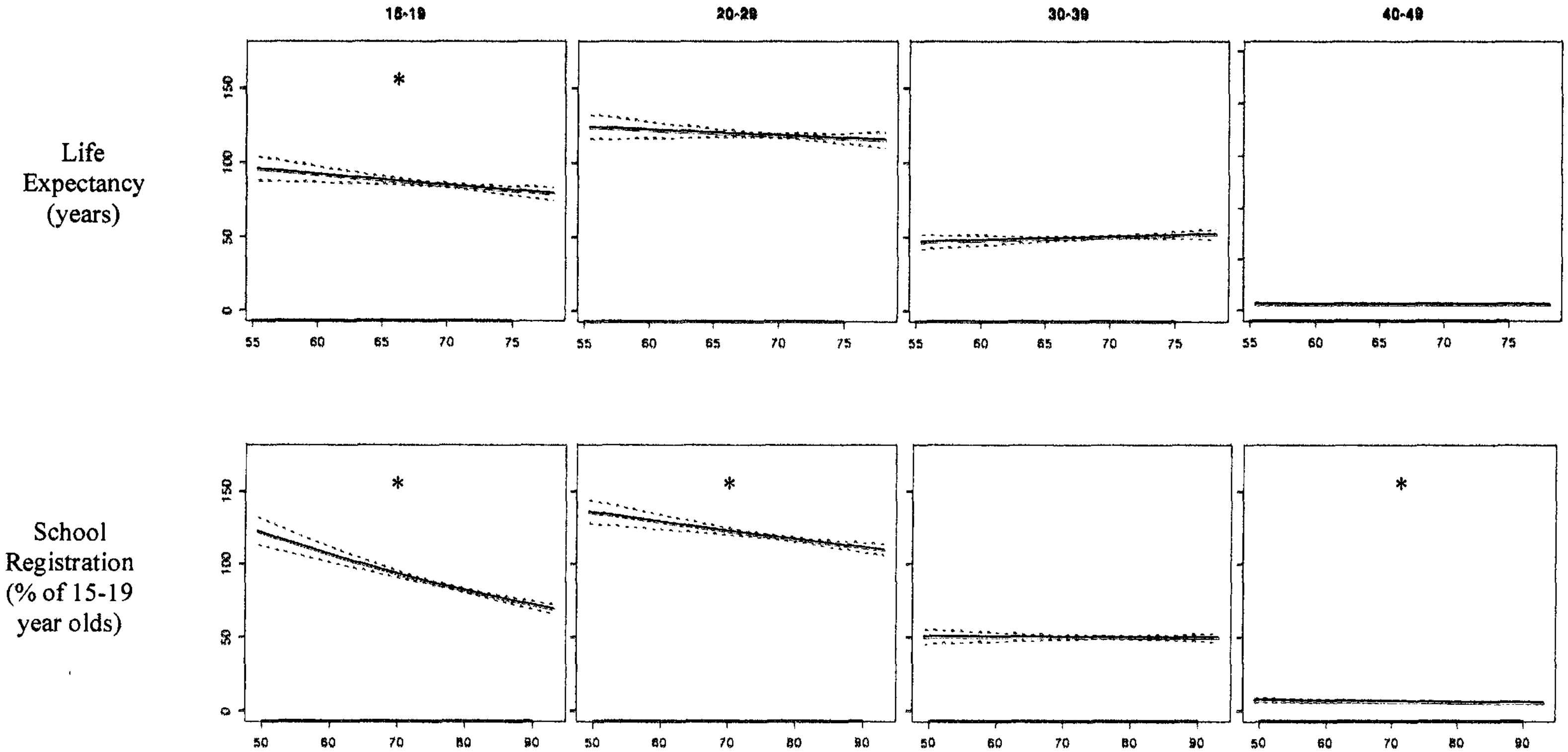
Regression of age-specific birth rates in the subset of 725 municipalities

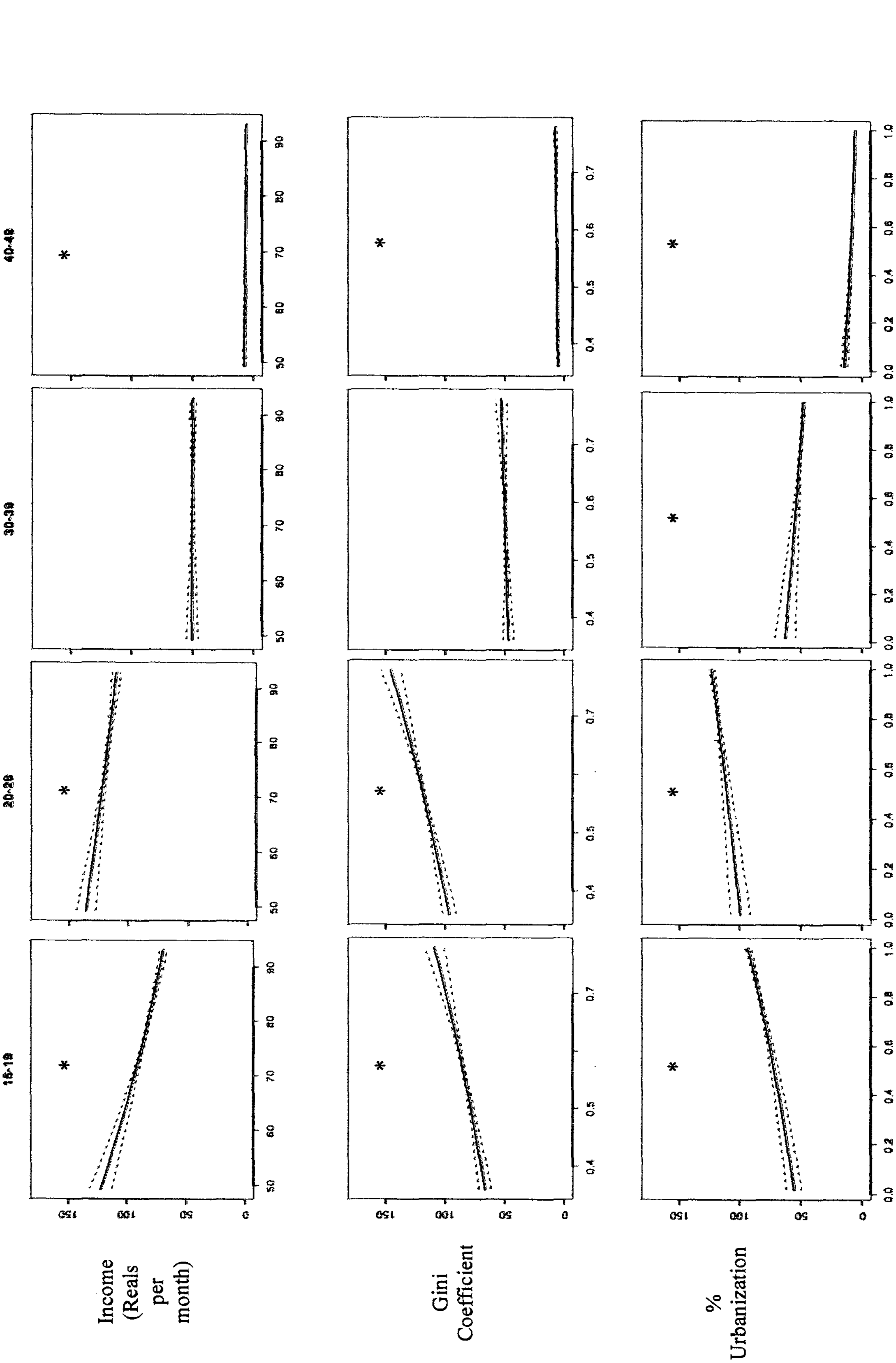
	Age Group (years)							
	15-19		20-29		30-39		40-49	
	B	% change	*B*	% change	*B*	% change	*B*	% change
Life Expectancy	-0.0332**	-3.27	-0.0122	-1.22	0.0189	1.91	-0.0034	-0.34
School Registration (15-19 year olds)	-0.0920***	-8.79	-0.0344***	-3.38	-0.0019	-0.19	-0.0444*	-4.34
Income	-0.1066***	-10.11	-0.0685***	-6.62	0.0125	1.26	-0.0847***	-8.12
Gini	0.0638***	6.58	0.0532***	5.46	0.0160	1.61	0.0459*	4.70
Urbanization	0.0926***	9.70	0.0385***	3.93	-0.0487***	-4.76	-0.1806***	-16.52
theta estimate, standard error	20.07, 1.12		32.82, 1.81		13.13, 0.73		6.55, 0.44	
X^2	14741.16		21548.22		15513.65		2486.82	

Note. Theta values (1 / dispersion parameter) are reported for each model as well as the results from a likelihood test evaluating the null hypothesis that the Poisson model is adequate ($X^2_{critical\ (0.05)}=3.841$).

*$p < .05$ ** $p < .01$ ***$p < .001$, one-tailed

Figure 1.8. Effect plots for life expectancy, school registration, income, the Gini coefficient, and % urbanization across the subset of 725 municipalities. The y-axis ranges from 0 to 175 births (per 1000 women in each age group) and the x-axis is as per the label to the left of each row. The solid line shows the predicted change in birth rates across the range of x-values, the dotted lines form the 95% confidence envelope, and significant effects are marked with an asterisk.




15-19
20-29
30-39
40-49
Income (Reals per month)
Gini Coefficient
% Urbanization
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1.4 Discussion

Examining the descriptive statistics for the birth rates and the five explanatory variables confirms that Brazil is a country with vast disparity in social, health, and economic conditions. Across the country, 8.3% of girls 15-19 years old have at least one child, and in the North region of the country, the average value is as high as 11.8%. Variability in municipality-specific life expectancy is also extremely great, ranging from 55.41 to 78.18 years, a difference of 22.77 years! Average household income and the Gini coefficient follow the same trend with ranges measuring 786.66 Reais/month, and a Gini of 0.36, respectively. The municipalities included in the analysis range from almost completely rural to completely urban, and the percent of older teens that decide to continue with schooling spans from 49.03% to 93.10%. Needless to say, Brazil is a country with extreme heterogeneity in these measures.

In these first chapter results, teen birth rates show the expected patterns with the predictor variables. That is, young women seem to alter their reproductive efforts in accordance with local life expectancy, level of school registration, income, Gini, and the degree of urbanization. Looking at the bivariate relationships between age-specific birth rates and life expectancy, the pattern observed is strikingly similar to Wilson & Daly's (1997) findings. In particular, birth rates for women under thirty vary in a predictable way with life expectancy, but the pattern disappears for women in their thirties. In this sample, the birth rates for women 40-49 years old were also examined, and the differences between municipalities with high, moderate, and low life expectancies were small for women in this age group as well. In accordance with Wilson & Daly's (1997) hypothesis, these results support the notion that women living in areas with short life expectancies have heightened time preferences and, therefore, favour early reproduction. Such an adjustment may be desirable in response to cues of an uncertain future, and because local life expectancy is a measure that accounts for multiple mortality threats including disease and violence, it seems to be a reliable index of an unpredictable future. Wilson & Daly (1997) extended this line of reasoning from their homicide studies, which showed that the prevalence of homicides, a predominantly male phenomenon, is greatest in the Chicago neighbourhoods with the shortest life expectancies.

The proposition that women reproduce earlier in areas with short life expectancies must, of course, be studied further by investigating the relationships between age at first birth, number of children, and life expectancy using cross-sectional and longitudinal data. Nevertheless, these findings support an alternative view to the negative connotation of early motherhood that has long been entrenched in popular culture and in some scientific literature (for example, Trussell, 1988; Dickson, Fullerton, Eastwood, Sheldon, & Sharp, 1997; Felice, Feinstein, & Fisher *et al.*, 1999; Kirby, 2002).

When this same relationship was examined for Brazilian municipalities after accounting for other socioeconomic variables, life expectancy was a significant predictor of birth rates only in the 15-19 age group. This finding supports the argument that teenage girls are more likely to start having children when they have reason to doubt the certainty of their future, and suggests that reproductive decisions for women in their twenties may rely more on other socioeconomic cues; indeed, the regression results for women in this age group show that the birth rate for women 20-29 years old varies with income, income inequality, school registration, and the degree of urbanization but not life expectancy.

As predicted, the lower the percentage of 15-19 year olds who opted to stay in school longer than is mandatory, the higher the teenage birth rate in 2000. If this explanatory variable is in fact an indicator of career opportunities as here suggested, then it follows that women who perceive education as a fruitful investment may opt to allocate more time and energy into professional endeavours than into reproductive efforts.

In this study, the Gini coefficient was used as the indicator of income inequality. It is one of the most commonly used inequality measures, ranging from 0 to 1, with a value of one representing the most extreme inequality when one person or household has all the income in the area and the others have none. In response to concern over the seemingly arbitrary choices of income inequality measures in the literature, Kawachi & Kennedy (1997b) examined the relationships between numerous indicators of income equality and their abilities to predict mortality rates across the U.S. These researchers found that all measures were highly correlated with each other and were all significant predictors of local death rates. Kawachi & Kennedy (1997b) then concluded that the indicator used to calculate income inequality is largely inconsequential when used as a predictor of mortality rates. Similarly, in their review of income inequality and various health measures including teen birth rates, mental illness, obesity, racism, homicides, and social capital, Wilkinson & Pickett (2007) reported that the measure of income inequality used did not make any substantial difference to the results. If, on the other hand, the measure is being used to assess changes in income inequality due to a policy change, for example, then the results might be very sensitive to the choice of indicator (Kawachi & Kennedy, 1997b). Although further studies are needed to investigate this claim, in the current context, it is assumed that the choice of indicator is also inconsequential when predicting birth rates. Given this, it is possible to compare the current results with those from other studies that investigate the link between income inequality and various health measures.

For the teenage women, the municipal average household income was the strongest predictor of birth rates after controlling for the other four predictors. This finding agrees with previously cited studies in the U.S. and Brazil that report a negative bivariate relationship between fertility and income (Gold *et al.,* 2002; Gold *et al.,* 2001, Coley & Chase-Lansdale, 1998; Berquó & Cavenaghi, 2005), although none of these studies examined the relationship between income and age-specific birth rates. Here, household income was a significant predictor of birth rates in the expected direction, lending support to the hypothesis that teenagers invest in reproductive efforts when there is little chance of accruing financial or social gains in the future. After controlling for the effects of income, the amount of inequality in the distribution of incomes is still a significant predictor of teen birth rates. Although a similar finding has been reported elsewhere (Wilkinson & Pickett, 2007), no study to date has linked together such findings with the proposition that poverty and relative deprivation may inspire short-sightedness.

In their review of income inequality and health outcomes, Wilkinson & Pickett (2007) reported that "many of the social problems [that] seem to be related to income inequality are inherently behavioural and provide evidence that income inequality has psychosocial effects" (p. 1974). In line with this reasoning are numerous other studies that report a link between poverty, income inequality, and mental health (Belle & Doucet, 2003; Singh-Manoux, Adler, & Marmot, 2003; Kahn, Wise, Kennedy, & Kawachi, 2000). For example, Fiscella & Franks (2000) showed that regardless of age, income and income inequality had independent effects on the prevalence of depressive symptoms in the U.S. population. Similarly, Singh-Manoux, Adler, & Marmot (2003) analysed the effect of subjective social status on depressive symptoms for men and women separately, and found that the position in which subjects considered themselves to be in the 'social ladder' was negatively associated with depressive symptoms for both sexes. In such studies, depressive symptoms are often evaluated using hopelessness scales (for example, Beck's Hopelessness scale) or questionnaires that include items addressing hopelessness (from the GHQ 30, one question asks respondents to indicate the degree to which they have "felt that life is entirely hopeless"). Furthermore, it has been argued that depressive symptoms are best described as learned helplessness and hopelessness (Seligman, 1975; as cited in Kopp, Skrabski, & Szedmák, 2000) and in a quantitative analysis, Kopp, Skrabski, & Szedmák (2000) found that depressive symptoms were best predicted by lack of purpose in life and hopelessness. Together, the results of these studies suggest that absolute and relative deprivation may induce vulnerability to depressive symptoms and, in particular, to feelings of hopelessness. Pickett, Mookherjee, & Wilkinson (2005) cited

Luker (1996) as saying, "It is the discouraged among the disadvantaged that become adolescent mothers" (p. 1182). What needs to be empirically tested then, is whether feelings of hopelessness heighten time preferences, perhaps biasing women to begin reproducing earlier in their lives. If they do, and if poverty and income inequality inspire hopelessness, then this provides a likely pathway through which the relationship between these socioeconomic variables and fertility timing is mediated.

In fact, this hypothesis has been offered previously. In a review of the literature, Ladner (1987) reports, "Various explanations have been advanced as to the causes of teen pregnancy. These include [. . .] a feeling of hopelessness and despair toward the future which stems from economic deprivation" (p. 54). Indeed, the link between hopelessness and early sexual activity in females has been demonstrated empirically (Whitbeck, Yoder, Hoyt, & Conger, 1999; Smith, 1997), as has the link between depression in midadolescence and greater risk of pregnancy in 15-19 year olds (Miller-Johnson *et al.*, 1999). Additionally, Whitbeck *et al.* (1999) showed that "higher levels of self-esteem and self confidence [are] negatively related to early intercourse (p. 940).

As previously mentioned, Ellison (2002) suggested that the value of waiting to reproduce over trying now is reduced when it is expected that future conditions will not improve, even if current conditions are unfavourable. Therefore, if hopelessness is characteristic of such a mindset and also an outcome of deprivation and income disparity, then it may be desirable for women to reproduce earlier when confronted with poverty and inequality. Pickett, Mookherjee, & Wilkinson, (2005) showed that adolescent birth rates and homicides were closely related across the U.S. and internationally across 25 developed countries. The authors found that the Pearson correlation between the two measures was r=0.95 across the 25 countries and r=0.74 within the U.S, and that both outcomes were significantly related to income inequality. Based on these results, they suggest that adolescent births and homicides may represent gender-differentiated responses to inequality. Therefore, just as accepting more risk and engaging in dangerous social competition may elevate a man's social standing and, therefore, mate value, a psychological algorithm that incorporates such cues when making decisions regarding major life transitions may also be adaptive if it alters time preferences in a way that maximize the chances of reproducing and/or increases a woman's number of offspring.

Interestingly, all these effects except life expectancy are also significant for the 20-29 and 40-49 year olds in the same direction as for teenage mothers, but appear to be lesser in magnitude. Although for the women in their twenties, these relationships may also support the hypothesis that they reproduce earlier in deprived conditions, the results are less interpretable for the women in their thirties and forties. If high income inequality and low average income do cause women to heighten their time preferences and decrease the value of waiting to reproduce, why do more women in the 30-39 and 40-49 age groups have children under those conditions? Without knowing whether the births recorded by DATASUS are first births or not, it is impossible to elucidate the meaning of these findings. If the births to these women were in fact their firsts, it may cast doubt on the proposition that these women favour early reproduction. However, if relative deprivation, minimal income, and a lack of social mobility inspire hopelessness in the same way for these older women as for women in Bolland's (2003) study, the higher birth rates may reflect increased levels of sexual activity, which may then be what is driving the effect.

Both behavioural and neurobiological studies have provided evidence that the brain development and psychology of teenagers is different than that of adults (Dahl, 2004; Giedd *et al.*, 1999) and that experiences perceived as important during adolescence may affect social cognition (Blakemore & Choudhury, 2006; Aneshensal & Sucoff, 1996). In this context, it is possible that the differences between predictors of teen birth rates and those of older women reflect an age-specific psychology, which is more sensitive in youth to cues of deprivation and an uncertain future. In turn, these sensitivities may heighten the pre-existing tendency for teenagers to be more short-sighted than adults, resulting in reproductive strategies that are closely linked to one's environmental conditions. Due to the cross-sectional nature of the data used, however, it is dangerous to make such an assumption without considering other alternatives. It is possible, for example, that women giving birth in their twenties and thirties are just as sensitive to cues of shortened life expectancy, for example, and did, in fact, start their families early and are now giving birth to their second or third children. It is also possible that predictors of birth rates in the four age categories differ because of additional differences in physical constraints, proportion of women who are married (which may alter reproductive decisions by involving the partner), or levels of promiscuity. Further cross-sectional studies and those using longitudinal data must be devoted to clarifying the relationship between age at first birth and cues of an uncertain future across age groups in order to tease apart these effects. Therefore, whether the effects of the studied socioeconomic variables influence reproductive decisions in the same way across ages and/or for first births versus subsequent births remains to be elucidated. What can be concluded, however, is that women knowingly or unknowingly tailor their reproductive efforts in accordance with these indicators and these effects seem to be strongest for the teenage mothers.

The effect of urbanization is the only explanatory variable that had effects in the opposite direction to those which were predicted. For the two older age groups, a higher proportion of women gave birth in municipalities that were more rural in accordance with previous studies. For the 15-19 and 20-29 year olds, however, the higher the degree of urbanization, the higher proportion of women that gave birth. From Figure 1.7 (p. 46), it is evident that the relationship is in the predicted direction for these women before controlling for the other predictor variables but that after controlling for the effects of life expectancy, income, Gini, and school registration inverts the relationship for the younger women (Table 1.10, p. 49). These results suggest that there may be something over and above these effects of living in an urban setting that encourages young women to have children and at the same time, discourages women thirty and over. Possible explanations for the younger women include exposure to advertising that promotes sexual freedom, increased nightlife in the city, and perhaps the effect of higher population density. However, it is unclear why these characteristics of urban living would result in the opposite effect for the older women, except that these women may not be taking as much advantage of the city nightlife or that women living in rural settings need more children to help with household duties, including farming. As well, if the older women are more likely to be having their second or third child, the cost of city living and the population density may act to discourage large families. Again, without knowing what proportion of the birth rate in each age group is comprised of first births versus subsequent births, it is difficult to further elucidate these associations.

CHAPTER 2

Age-Specific Birth Rates Within the Five Major Regions of Brazil
An analysis of geographical scale

2.1 Introduction

2.1.1 Geographical Scale

Previous research has suggested that the relationships among socioeconomic indicators may depend on the geographical level of analysis used (Wilkinson & Pickett, 2007; Brenner, 2001; Szwarcwald, Bastos, Viacava, & de Andrade, 1999; Wilkinson, 1997). In the context of studying income inequality and social cohesion, Wilkinson (1997) pointed out that average income is only weakly associated with mortality across U.S. states, but that income inequality is a strong predictor. However, the author suggested that across smaller geographical areas such as neighbourhoods, the relationship is probably reversed. This particular inconsistency may arise because in a given neighbourhood that is impoverished, the income inequality is likely very low, as is the average income, and the deprivation relative to the larger society is lost at that level of analysis (Wilkinson, 1997). In that particular case, Wilkinson's (1997) prediction was not correct as Wilson & Daly (1997) reported that homicides across Chicago neighbourhoods are indeed related to income inequality. Taking into account Wilkinson's concern, however, Szwarcwald *et al.* (1999) investigated the relationship between income inequality and homicide rates in the state of Rio de Janeiro at the level of municipalities and at the level of administrative regions within the municipality of Rio de Janeiro. They found that homicide rates were significantly related to income inequality across administrative units but not across municipalities. The authors suggested that the negative relationship between the variables could be explained by the varying degrees of urbanization across municipalities. In general, however, this suggests that the way in which socioeconomic variables interact to influence social outcomes is sensitive to the geographical lens used to examine these phenomena.

In this chapter, the analyses from Chapter 1 will be repeated for each of the five so-called Major Regions in Brazil. Although the geographical unit of analysis (municipalities) is not being altered here, restricting the analyses in this way will remove any heterogeneity introduced into the municipal data by virtue of being in different geographical regions.

In the early 1940's, under the supervision of Professor Fábio Macedo Soares Guimarães, the Brazilian Institute of Geography and Statistics proposed the division of Brazil into five 'Major Regions' based on common history, culture, economics, and politics. These regions, the North, Northeast, Central-West, Southeast, and South, have since been used consistently as a framework for the reporting of Brazilian demographic statistics and for the subsidization of public planning (Brazilian Institute of Geography and Statistics, 2008). Refer to map on p. 39 for the geographical divisions.

2.1.2 North Region

The North region contains seven states - Acre, Amapá, Amazonas, Pará, Rondônia, Roraima and Tocantins – and covers approximately 45% of the land area in Brazil (Ministry of External Relations, 2008). Many settlers from the economically depressed Northeast region migrated to the North in the 1870's and 1880's in search of better farming lands. Ultimately, many of these migrants and those from the South region were able to find employment tapping the native rubber trees in the Amazonian region (Encyclopædia Britannica, 2008).

Although a large proportion of its 12.9 million residents live in urban areas and are concentrated around big cities such as Belém, this region has the lowest demographic density of the five regions at just over three inhabitants per square kilometer (The Centre for Latin American Studies, 2006). The land is almost completely situated within the Amazon River basin and the major exports of this region are latex, lumber, and minerals such as gold, diamond, cassiterite, and tin (Ministry of External Relations, 2008).

2.1.3 Northeast Region

Covering only approximately 18% of Brazil's land area, the Northeast region contains nine states - Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia (Ministry of External Relations, 2008). The first European settlers came to Brazil in the early 16th century and settled along the Northeast coast to trade with the Indians for brazilwood (Encyclopædia Britannica, 2008). By the end of the 16th and into the early 17th century, the economy had become dominated by sugarcane and African slaves were being imported to work on the plantations (Encyclopædia Britannica, 2008).

With nearly 48 million present day inhabitants, the population in this region comprises almost 30% of the national total and is densely populated with about 29 inhabitants per square kilometer (The Centre for Latin American Studies, 2006; Ministry of External Relations, 2008). The majority of the population is concentrated in urban areas, particularly in Salvador, Recife, and Fortaleza. Due to the heterogeneity of the geography in this region, it has been further split into the mid-north, forest area, backland, and wild land sub-regions. The mid-land has an Amazon landscape and climate that becomes increasingly humid towards the west. The forest area was a strip of coastal Atlantic Forest that has since been largely replaced with sugarcane farming. In the backland, agriculture is limited due to poor soil and is, instead, dominated by arid land and palm tree groves. Along with processing of the palm trees, the economy in this sub-region is powered by cattle-rearing and cotton plantations. Lastly, the wild land is a transitional area, bridging the forest area and the backland, with a predominance of dairy farms on suitable land (Ministry of External Relations, 2008).

2.1.4 Central-West Region

This region encompasses three states - Goiás, Mato Grosso do Sul, and Mato Grosso – and the Federal District, Brasília (Ministry of External Relations, 2008). Many Brazilians migrated to this region in the mid-1900's in order to construct Brasília and it now has a total population of 11 million and a demographic density of 6.5

inhabitants/km^2 (Encyclopædia Britannica, 2008; Ministry of External Relations, 2008). With a diverse geographical landscape, this region's economy used to be fueled mainly by gold and diamonds but has since shifted to cattle farming (Ministry of External Relations, 2008).

2.1.5 Southeast Region

The Southeast region is the most highly populated with over 70 million inhabitants distributed over its four states - Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo (Ministry of External Relations, 2008). However, for the first two centuries after Brazil was colonized, few people inhabited this land except for parties of explorers from the North who introduced cattle into the region. The economy in this region was dominated by cattle ranching until the discovery of gold and diamonds in the region in the 17th and 18th centuries, when the promise of wealth initiated the migration of plantations owners and slaves from the North. The area became further developed after the government was transferred to Rio de Janeiro from Salvador in 1763 and with the development of coffee plantations which attracted an influx of Italian immigrants into the region (Encyclopædia Britannica, 2008).

Covering 11% of the Brazilian landmass, this region presently has an urbanization index of 88% and is the most densely populated with 72 inhabitants/ km^2. The Southeast region contains tropical and arid landscapes, as well as a lot of scrubland, concentrated in Minas Gerais. The main exports for this region are cattle, sugarcane, oranges, coffee, iron, and manganese (Ministry of External Relations, 2008).

2.1.6 South Region

The smallest of the five geo-political regions, the South covers only 6.75% of the land in Brazil and is comprised of three states - Paraná, Santa Catarina and Rio Grande do Sul. From the northern part of the region to the southern portion, the climate changes from tropical to sub-tropical and, as such, the landscape is diverse with a predominance of pine forests and grassy fields. The 25 million inhabitants in this region have the longest life expectancy in the country and an urbanization index of 74%, and are distributed at a density of 41 inhabitants per square kilometer (The Centre for Latin American Studies, 2006; Ministry of External Relations, 2008). The economy of the region is widely varied, exporting timber, wheat, soya, rice, beans, and tobacco alongside a strong industrial base (Ministry of External Relations, 2008).

Given the diverse nature of these regions, it is expected that much of the variation in life expectancy, school registration, income, and income inequality across the country is derived from analyzing municipalities in different regions simultaneously. Therefore, restricting the analysis to only one region at a time is expected to decrease the variance of these predictor variables and alter the relationships among them and age-specific birth rates. Specifically, it is hypothesized that effects like those found in chapter 1 will be also be found within regions that display a large degree of variation in living conditions but in more homogenous regions, the effects will be less evident.

2.2 Methods

2.2.1 The Data

The same data that were used in the first chapter to analyze municipalities across the whole country were used to examine the relationships between the predictor variables and age-specific birth rates in each of the five Major Regions of Brazil.

2.2.2 Selection of Municipalities

The 725 municipalities that were selected for analysis in the first chapter were divided into five groups according to the Major Region within which they fall. These municipalities were selected so that, again, the margin of error around the median birth rate for 20-29 year olds due to sampling variability is restricted to a maximum of 10%.

2.2.3 Regression Analyses

Negative binomial regressions were run for each of the four age groups in each of the five Major Regions in Brazil. As in the first chapter, result tables (Tables 2.9, 2.10, 2.11, 2.12, 2.13) show estimates for the x-standardized coefficients, the corresponding percent change, the estimate and standard error of theta for each regression, and the chi-square (χ^2) test statistic for assessing the fit of the negative binomial model.

In addition to these regression analyses, dummy variable regressions were performed using a region variable to predict income and income inequality in order to demonstrate the inverse relationship between the two predictors across the whole country.

2.2.4 Regression Diagnostics

For all twenty regressions, the chi-square test statistic exceeds the critical value (where all χ^2 values are ≥ 169.42), therefore providing extremely strong evidence that the negative binomial model is favoured over the simpler Poisson model.

The same five explanatory variables - life expectancy, school registration of 15-19 year olds, income, the Gini coefficient, and degree of urbanization – were used to predict birth rates in the five regions.

In the North, the correlations between the explanatory variables are comparable in magnitude to those in the first chapter. However, the largest correlation is now r=0.715. Therefore, 51% of the variance in the values of income is explained by the degree of urbanization or vice versa. There is a striking difference between the North regional correlations shown above the diagonal in Table 2.1 and those in the nation as a whole, shown below the diagonal. In particular, the relationships between the Gini coefficient and all the other variables except life expectancy have been reversed in this sample, although the correlation between income and Gini is the only correlation that is significant.

Despite some moderately high correlations between predictors, there is no evidence of a collinearity problem for these five variables, as the largest VIF does not exceed 3.0.

Similarly, in the Northeast region, the correlations among explanatory variables are not large enough to pose a concern over collinearity. The largest correlation is r=0.650 between urbanization and income, and the largest variance-inflation factor for the model with all variables is less than 2.5. The relationships between the Gini coefficient and income as well as school registration are reversed from that found in the larger sample, while all other relationships are in the same direction. Specifically, the correlations between Gini and each of school registration and income are positive in this sample of municipalities in the Northeast, so that the more unequal the distribution of incomes, the higher the average monthly income and the more the percentage of 15-19 year olds who attend school.

Table 2.1.

Matrix of bivariate Pearson correlations for all variables used in the regression analysis within the North region (N=66)

	Life Expectancy	School Registration	Income	Gini	Urbanization
Life Expectancy	1	0.213	0.067	-0.239	0.140
School Registration	**0.259****	1	0.385**	0.124	0.612**
Income	**0.642****	**0.415****	1	0.318**	0.715**
Gini	**-0.396****	**-0.080***	**-0.172****	1	0.221
Urbanization	**0.490****	**0.435****	**0.614****	**-0.307****	1

Note. Correlations in bold font below the diagonal are those from the national sample of 725 municipalities, as shown in Table 1.6 (p. 42).

** $p < .01$ * $p < .05$

As for the other regions, the correlations among the predictors in the Central-West are not large enough to pose a concern over collinearity, as the highest variance-inflation factor for the regression model including all five variables is less than 2.5. As revealed in Table 2.3, the largest bivariate correlation in this region is between Gini and income at r=0.529. This relationship between income and Gini is positive and, therefore, reversed from the sample of 725 municipalities. This indicates that across municipalities in the

Table 2.2.

Matrix of bivariate Pearson correlations for all variables used in the regression analysis within the Northeast region (N=209)

	Life Expectancy	School Registration	Income	Gini	Urbanization
Life Expectancy	1	0.272**	0.373**	-0.086	0.296**
School Registration	**0.259****	1	0.389**	0.137*	0.257**
Income	**0.642****	**0.415****	1	0.309**	0.650**
Gini	**-0.396****	**-0.080***	**-0.172****	1	-0.012
Urbanization	**0.490****	**0.435****	**0.614****	**-0.307****	1

Note. Correlations in bold font below the diagonal are those from the national sample of 725 municipalities, as shown in Table 1.6 (p. 42).

** p < .01 * p < .05

Central-west, North, and Northeast regions, a higher average income is associated with higher income inequality.

The largest bivariate correlation between explanatory variables from municipalities in the Southeast region is r=0.552 between school registration and urbanization. There is not a large collinearity problem for the regression model in this region as the largest variance-inflation factor is less than 1.75. All correlations are in the same direction as those in the sample of 725 municipalities except for the relationship

Table 2.3.

Matrix of bivariate Pearson correlations for all variables used in the regression analysis within the Central-West region (N=50)

	Life Expectancy	School Registration	Income	Gini	Urbanization
Life Expectancy	1	-0.079	0.304**	-0.019	0.058
School Registration	**0.259****	1	0.319**	0.061	0.391*
Income	**0.642****	**0.415****	1	0.529*	0.179
Gini	**-0.396****	**-0.080***	**-0.172****	1	-0.405*
Urbanization	**0.490****	**0.435****	**0.614****	**-0.307****	1

Note. Correlations in bold font below the diagonal are those from the national sample of 725 municipalities, as shown in Table 1.6 (p. 42).

** p < .01 * p < .05

between Gini and income, which is positive within the Southeast region, as it was in the three previously discussed regions.

The correlation matrix for all explanatory variables in the South region is shown in Table 2.5. The highest bivariate correlation between variables is r=0.556, for school registration and income. However, all the other relationships have correlations under 0.400 and the highest variance-inflation factor for these models is 1.65, therefore suggesting that the degree of redundancy found between these variables is acceptable.

Table 2.4.

Matrix of bivariate Pearson correlations for all variables used in the regression analysis within the Southeast region (N=282)

	Life Expectancy	**School Registration**	**Income**	**Gini**	**Urbanization**
Life Expectancy	1	0.183**	0.424**	-0.134*	0.219**
School Registration	**0.259****	1	0.421**	-0.176**	0.552**
Income	**0.642****	**0.415****	1	0.177**	0.338**
Gini	**-0.396****	**-0.080***	**-0.172****	1	-0.314**
Urbanization	**0.490****	**0.435****	**0.614****	**-0.307****	1

Note. Correlations in bold font below the diagonal are those from the national sample of 725 municipalities, as shown in Table 1.6 (p. 42).

** p < .01 * p < .05

Table 2.5.

Matrix of bivariate Pearson correlations for all variables used in the regression analysis within the South region (N=118)

	Life Expectancy	School Registration	Income	Gini	Urbanization
Life Expectancy	1	0.366**	0.301**	-0.324**	0.131
School Registration	**0.259****	1	0.556**	0.070	0.386**
Income	**0.642****	**0.415****	1	0.144	0.386**
Gini	**-0.396****	**-0.080***	**-0.172****	1	-0.112
Urbanization	**0.490****	**0.435****	**0.614****	**-0.307****	1

Note. Correlations in bold font below the diagonal are those from the national sample of 725 municipalities, as shown in Table 1.6 (p. 42).

** p < .01 * p < .05

2.3 Results

Comparisons of birth rates and predictor variables across the five Major Regions in Brazil are presented below. Regression results for the five Major Regions are discussed and followed by a summary and comparison of the findings in each region for the 15-19 year olds. It will be shown that although some of the bivariate and partial relationships between the predictors and birth rates are unique to the particular region being examined, in magnitude or direction, many are consistent across regions. Of particular interest is the finding that, whether significant or not, the directions of the regression coefficients for all age groups are remarkably constant across the regional analyses and in comparison to the 725 municipalities analyzed in the first chapter.

2.3.1 Comparison of Birth Rates Across Regions

The mean and standard deviation for the birth rates in each age group for the full national sample and each of the five Major Regions are listed below in Table 2.6. As for the subset of 725 municipalities, the birth rates for the 20-29 year olds are the highest of the four age groups in all regions, followed by those for the 15-19, 30-39, and 40-49 year olds. Among the regional teenage birth rates, those for the North region are the largest, while those for the Southeast region are the smallest.

2.3.2 Comparison of Predictors Across Regions

A comparison of descriptive statistics for the independent measures across the municipalities used in Chapter 1 and those in each of the Major Regions is shown in Table 2.7. More detailed tables for each region that include minimum and maximum values and identify significant differences between means in the national sample and regional means are shown in Appendix C. In general, comparing the minimum and maximum values of each predictor between the national sample and each region indicate

Table 2.6.

Means ± standard deviations for age-specific birth rates (per 1000 women) in the national subset and in each of the five Major Regions

	15-19 yrs.	***20-29 yrs.***	***30-39 yrs.***	***40-49 yrs.***
	BRAZIL (N=725)			
Mean ± SD	86.26±23.97	119.14±23.92	50.09±14.35	6.40±4.05
	NORTH (N=66)			
Mean ± SD	118.80±24.27	141.61±84.42	47.12±17.52	8.04±5.31
	NORTHEAST (N=209)			
Mean ± SD	91.47±24.75	124.76±30.57	50.50±19.02	8.30±5.46
	CENTRAL-WEST (N=50)			
Mean ± SD	103.22±16.26	121.80±14.23	38.03±12.00	3.55±2.37
	SOUTHEAST (N=282)			
Mean ± SD	74.70±15.06	111.77±15.67	49.57±9.31	4.97±1.92
	SOUTH (N=118)			
Mean ± SD	79.30±18.52	113.10±15.58	57.40±8.34	6.75±2.32

that the ranges of values found within the regions are less than those for the larger sample of 725 municipalities.

Further comparison of the values in Table 2.7 indicates that municipalities in the North and Northeast have shorter life expectancies, are poorer, and more rural than the average municipality of the 725 selected in Chapter 1 and within the other three regions.

Again unlike the previous two regions, the means of the explanatory variables restricted to the Central-west region are all higher than the means from the original sample of 725 municipalities. From Table 2.7 it can be seen that although higher, the means match up fairly closely with those from the larger sample, with school registration showing the largest difference compared to the national sample (an increase of 10%) and being the highest in the Central-West of all the regions.

In the Southeast region, all of the means, except that of the Gini coefficient, are higher than in the national sample. Additionally, of the five regions, the Southeast has the average income and % urbanization.

Comparing the values of the independent measures in the South region to those in the larger sample, it is evident that the means of all variables are fairly consistent. However, as was found in some of the other regions, the means of the income and urbanization variables are slightly higher. Notably, life expectancy is longest and income inequality is the smallest in the South.

In order to evaluate the hypothesis that the regression effects will be most evident in regions with the greatest variation in predictor values, the coefficients of variation for

Table 2.7.

Means ± standard deviations for the explanatory variables in the national sample and in each of the Major Regions of Brazil

	Brazil (N=725)	*REGION* North (N=66)	Northeast (N=209)	Central-West (N=50)	Southeast (N=282)	South (N=118)
Life Expectancy (years)	69.34±3.92	67.93±2.12	65.45±3.72	70.30±1.81	71.29±2.49	71.95±2.65
School Registration (% of 15-19 year olds)	77.16±7.05	72.53±8.22	76.28±6.44	95.24±2.09	80.02±6.10	75.16±7.20
Income (Reais)	252.10±125.48	170.93±71.91	133.45±59.55	277.85±90.67	325.60±109.55	321.36±94.83
Gini Coefficient	0.57±0.05	0.60±0.03	0.60±0.05	0.58±0.05	0.55±0.05	0.54±0.05
% Urbanization	0.83±0.18	0.70±0.21	0.71±0.20	0.90±0.07	0.92±0.10	0.88±0.12

the five measures were computed for each region. Except for the Gini coefficient, the highest dispersion of each predictor is found in either the North or Northeast regions.

Table 2.8.

Coefficients of variation for the predictor variables

	REGION				
	North	*Northeast*	*Central-West*	*Southeast*	*South*
Life Expectancy	0.03	0.06	0.03	0.03	0.04
School Registration	0.11	0.08	0.02	0.08	0.10
Income	0.42	0.45	0.33	0.34	0.30
Gini Coefficient	0.05	0.08	0.09	0.09	0.09
% Urbanization	0.30	0.28	0.08	0.11	0.14

Note. The coefficient of variation is the ratio of the standard deviation to the mean of a probability distribution. It is used as a measure to compare the dispersions of distributions with different means.

2.3.3 Regression Results

The regression results for the North region, including coefficient estimates and percent changes, are shown below in Table 2.9. Full tables are given in Appendix D. Looking at the theta estimates, it is evident that the conditional distributions of birth rates for the 15-19 and 20-29 year old women are similarly dispersed and the distributions are more dispersed in the two older age groups. All four negative binomial regressions provide fits superior to the respective Poisson models.

For the 15-19 and 20-29 year olds, the directions of all five effects are the same as in Chapter 1. However, unlike in the larger sample of municipalities, only school registration and urbanization are significant predictors of teen birth rates. In the 20-29 age group, urbanization is still significant but predicts a lesser effect than for the teenage women. For the teens, every 21% increase in the degree of urbanization predicts a 14.18% increase in the birth rate, whereas for the older women, it predicts a 10.22% increase. Gini is also a positive predictor of birth rates for women in their twenties. For the 30-39 and 40-49 year old women, the only significant explanatory variable is income, predicting a 13.27% and 27.03% decrease in birth rates for the younger and older group, respectively.

Results from the four regressions in the Northeast region are summarized in Table 2.10 and the full tables are shown in Appendix E. The four estimates given for the theta value of each model show that the conditional distribution of birth rates for the 40-49 year olds is the most dispersed and that of the 20-29 year olds is the least dispersed.

Unlike in the North region, life expectancy is a predictor of birth rates, but it is a positive predictor and only significant for the 30-39 year olds. For the youngest women, income is a negative predictor and urbanization is a positive predictor. The same relationships are significant for the 20-29 year olds with the addition of the income inequality indicator, which predicts a 9.61% increase in the birth rate for every 0.05 increase in the Gini coefficient. As well as life expectancy, birth rates in the 30-39 year old group are predicted by income and income inequality in the same direction as for the 20-29 year olds. For the 40-49 year olds, school registration is a significant negative predictor along with all other variables except life expectancy. Interestingly, the effects of income, Gini, and urbanization are the largest for this oldest age group.

Table 2.9.

Regression of age-specific birth rates in the North region (N=66)

	Age Group (years)							
	15-19		20-29		30-39		40-49	
	B	% change	*B*	% change	*B*	% change	*B*	% change
Life Expectancy	-0.0227	-2.24	-0.0266	-2.62	-0.0565	-5.50	-0.0751	-7.23
School Registration (15-19 year olds)	-0.0720*	-6.95	-0.0096	-0.96	0.0954	10.01	0.1052	11.09
Income	-0.0299	-2.94	-0.0609	-5.91	-0.1424*	-13.27	-0.3151***	-27.03
Gini	0.0316	3.21	0.0545*	5.60	0.0777	8.08	0.1262	13.45
Urbanization	0.1326**	14.18	0.0973*	10.22	0.0008	0.08	-0.1673	-15.40
theta estimate, standard error	27.71, 5.13		27.33, 4.90		10.83, 1.97		6.53, 1.49	
X^2	1101.24		2334.06		1306.34		169.42	

Note. Theta values (1 / dispersion parameter) are reported for each model as well as the results from a likelihood test evaluating the null hypothesis that the Poisson model is adequate ($X^2_{critical\ (0.05)}=3.841$).

*$p < .05$ ** $p < .01$ ***$p < .001$, one-tailed

Table 2.10.

Regression of age-specific birth rates in the Northeast region (N=209)

	Age Group (years)							
	15-19		20-29		30-39		40-49	
	B	% change	*B*	% change	*B*	% change	*B*	% change
Life Expectancy	-0.0221	-2.19	0.0003	0.03	0.0597*	6.15	0.0598	6.16
School Registration (15-19 year olds)	-0.0506	-4.94	-0.0307	-3.03	-0.0338	-3.33	-0.0731*	-7.05
Income	-0.0865**	-8.28	-0.0994***	-9.47	-0.0919**	-8.78	-0.2092***	-18.88
Gini	0.0371	3.78	0.0917***	9.61	0.1447***	15.57	0.1945***	21.47
Urbanization	0.1093***	11.55	0.0543*	5.58	-0.0563	-5.48	-0.1575***	-14.57
theta estimate, standard error	13.21, 1.34		16.93, 1.69		9.62, 0.98		6.09, 0.74	
X^2	4897.88		8372.99		5113.88		697.14	

Note. Theta values (1/ dispersion parameter) are reported for each model as well as the results from a likelihood test evaluating the null hypothesis that the Poisson model is adequate ($X^2_{critical\ (0.05)}=3.841$).

*p <. 05 ** p < .01 ***p < .001, one-tailed

The coefficient estimates and corresponding percent changes for the regression effects in the Central-West region are listed in Table 2.11, while the full result tables can be found in Appendix F. The theta estimates show that, given the explanatory variables, birth rates in the 40-49 age group are the most dispersed and those for the 20-29 year olds are the least dispersed.

The effects of school registration and income are significant and in the expected direction for the teen mothers. Every 2.09 percent increase in the percent of 15-19 year olds who attend school predicts a 5.62% decrease in the birth rate and for every 90.67 Reais/month increase in the average municipal household income, the teen birth rate decreases by 6.19%. For the 20-29 age group, income is also a significant negative predictor, although lesser in magnitude, and a 0.05 point increase in the Gini coefficient predicts a 4.49% increase in the mean birth rate. Interestingly, none of the five explanatory variables were significant predictors of birth rates in the 30-39 age group but both school registration and urbanization were significant effects for the oldest women. In fact, the effect of school registration was strongest for the 40-49 year old mothers, predicting a 24.19% decrease in the birth rate for every 2.09% increase in school attendance. Lastly, the degree of urbanization predicted the largest change; for every 7% increase in the percentage of residents who live in an urban setting, the birth rate for 40-49 year olds is predicted to increase by 34.36%.

Table 2.11.

Regression of age-specific birth rates in the Central-West region (N=50)

	Age Group (years)							
	15-19		20-29		30-39		40-49	
	B	% change	*B*	% change	*B*	% change	*B*	% change
Life Expectancy	-0.0315	-3.10	-0.0264	-2.61	-0.0442	-4.33	-0.0567	-5.52
School Registration (15-19 year olds)	-0.0579**	-5.62	-0.0195	-1.93	-0.0717	-6.92	-0.2769**	-24.19
Income	-0.0639*	-6.19	-0.0420*	-4.11	-0.0021	-0.21	0.0327	3.33
Gini	0.0377	3.85	0.0439*	4.49	0.0614	6.33	0.0936	9.81
Urbanization	0.0034	0.34	0.0077	0.78	0.1067	11.26	0.2954*	34.36
theta estimate, standard error	78.00, 19.70		124.30, 29.7		13.46, 2.88		4.33, 1.20	
X^2	221.81		304.65		887.62		169.77	

Note. Theta values (1 / dispersion parameter) are reported for each model as well as the results from a likelihood test evaluating the null hypothesis that the Poisson model is adequate ($X^2_{critical\ (0.05)}$=3.841).

*p <. 05 ** p < .01 ***p < .001, one-tailed

Summarized results for the regressions within the Southeast region are displayed in Table 2.12 and the full tables are in Appendix G. Again, the conditional distribution of birth rates is the most dispersed in the oldest age group, and least dispersed for the 20-29 year olds. As in Chapter 1, life expectancy is a negative predictor of teen birth rates, predicting a rate decrease of 4.65% for every increase of life expectancy by 2.49 years. Interestingly, life expectancy is also a significant predictor for the 20-29 and 30-39 year olds, and as predicted, the magnitude of the effect is smaller. The percent of 15-19 year olds registered in school is only a significant predictor of births for the youngest women, predicting a decrease of 6.81% in the municipal birth rate for every 6.10% increase in school attendance. Income has a significant negative effect on the birth rate for the 15-19 and 20-29 year olds and urbanization and Gini have significant positive effects for the 15-19 and 20-29 year olds, respectively.

The summarized regression results for the four age groups in the South region are given in Table 2.13 and the full tables are shown in Appendix H. As in the other four regions, it is clear from the theta estimates that the conditional distribution of birth rates for the 40-49 year olds is the most dispersed and the distribution for the 20-29 year olds is the least dispersed.

Table 2.12.

Regression of age-specific birth rates in the Southeast region (N=282)

	Age Group (years)							
	15-19		20-29		30-39		40-49	
	B	% change	*B*	% change	*B*	% change	*B*	% change
Life Expectancy	-0.0477***	-4.65	-0.0257**	-2.53	-0.0351**	-3.45	-0.0765	-7.37
School Registration (15-19 year olds)	-0.0705***	-6.81	-0.0128	-1.27	0.0155	1.56	-0.0258	-2.55
Income	-0.0402**	-3.94	-0.0472***	-4.61	0.0060	0.60	-0.0669	-6.47
Gini	0.0124	1.25	0.0256**	2.59	0.0017	0.17	0.0331	3.37
Urbanization	0.0348**	3.54	0.0149	1.50	0.0017	0.63	-0.0158	-1.57
theta estimate, standard error	37.15, 3.59		70.48, 6.57		31.64, 2.98		14.83, 1.98	
X^2	2246.10		3934.50		3232.41		385.10	

Note. Theta values (1 / dispersion parameter) are reported for each model as well as the results from a likelihood test evaluating the null hypothesis that the Poisson model is adequate ($X^2_{critical\ (0.05)}=3.841$).

*$p <. 05$ ** $p < .01$ ***$p < .001$, one-tailed

The pattern of significant predictors of teen birth rates is the same for the 20-29 age group but lesser in magnitude and all variables provide significant prediction, except for life expectancy. Standard deviation increases in school registration and income predict decreases of between 5.64% and 9.95% in the mean birth rates. Conversely, Gini and urbanization have positive effects, predicting increases of between 4.61% and 12.27%. Interestingly, the pattern of predictors is also consistent across the 30-39 and 40-49 year olds, with the effects being greater for the older women. For both age groups, school registration and income are negative and positive predictors, respectively.

2.3.4 Synthesis of Regional Results for 15-19 year olds

A striking observation emerges when the relationships among the five predictor variables across Brazil (725 municipalities) are compared to those within each of the five Major Regions. While almost all of the bivariate correlations within each region are in the same direction as those in the larger sample, the association between the Gini coefficient and income is consistently reversed (although not significant in the South region). Across the country the relationship between the two variables is negative such that higher inequality is found in municipalities with a lower average monthly income, whereas within each region the relationship is positive (see Figure 2.1, p. 90). Conducting dummy variable regressions using the regions to predict income and income inequality confirms these findings (Appendices I and J). For income, the highest

Table 2.13.

Regression of age-specific birth rates in the South region (N=118)

	Age Group (years)							
	15-19		20-29		30-39		40-49	
	B	% change	*B*	% change	*B*	% change	*B*	% change
Life Expectancy	-0.0219	-2.16	-0.0051	-0.51	0.0155	1.57	0.0281	2.85
School Registration (15-19 year olds)	-0.0976***	-9.29	-0.0581***	-5.64	-0.0297	-2.93	-0.0703	-6.78
Income	-0.1049***	-9.95	-0.0682***	-6.59	-0.0309*	-3.04	-0.0651*	-6.31
Gini	0.0686***	7.10	0.0451***	4.61	0.0515***	5.29	0.0857**	8.95
Urbanization	0.1157***	12.27	0.0517***	5.31	0.0136	1.37	-0.0231	-2.28
theta estimate, standard error	63.30, 10.20		193.6, 31.80		66.60, 10.20		17.13, 3.27	
X^2	531.02		391.56		691.94		210.73	

Note. Theta values are reported for each model as well as the results from a likelihood test evaluating the null hypothesis that the Poisson model is adequate ($X^2_{critical\ (0.05)}=3.841$).

*$p <.05$ ** $p < .01$ ***$p < .001$, one-tailed

monthly averages are found in the South (S) and Southeast (SE) regions, followed by the Central-West (CW), North (N) and Northeast (NE) (S≅SE>CW>N>NE). Conversely, for income inequality, the highest mean values are in the North and Northeast, followed by the Central-West, Southeast, and South (NE≅N>CW>SE>S). Therefore, because the order of municipalities from the highest to lowest is reversed for income inequality compared to income, the regression results reinforce the negative relationship between the two variables across the country. In addition, the regression results indicate that the region variable single-handedly accounts for 48% and 22% of the variation in income and income inequality across Brazil, respectively.

The mean birth rates of 15-19 year olds also vary significantly across regions (see Table 2.14). The highest rate is found in the North region and the lowest is in the Southeast region. Using Tukey's HSD, all pair-wise comparisons between regions and with the country as a whole were examined at a significance level of $\alpha=0.05$. All comparisons are significant except for that between the south and southeast regions.

Furthermore, a likelihood ratio test comparing the regressions of teenage births controlling for life expectancy, school registration, income, income inequality, and the degree of urbanization, with and without the region variable indicates that region provides significant additional prediction ($p_{\chi^2}<0.0001$).

Figure 2.1. Linear relationship between the Gini coefficient and monthly income across Brazil (725 municipalities) and within each Major Region.

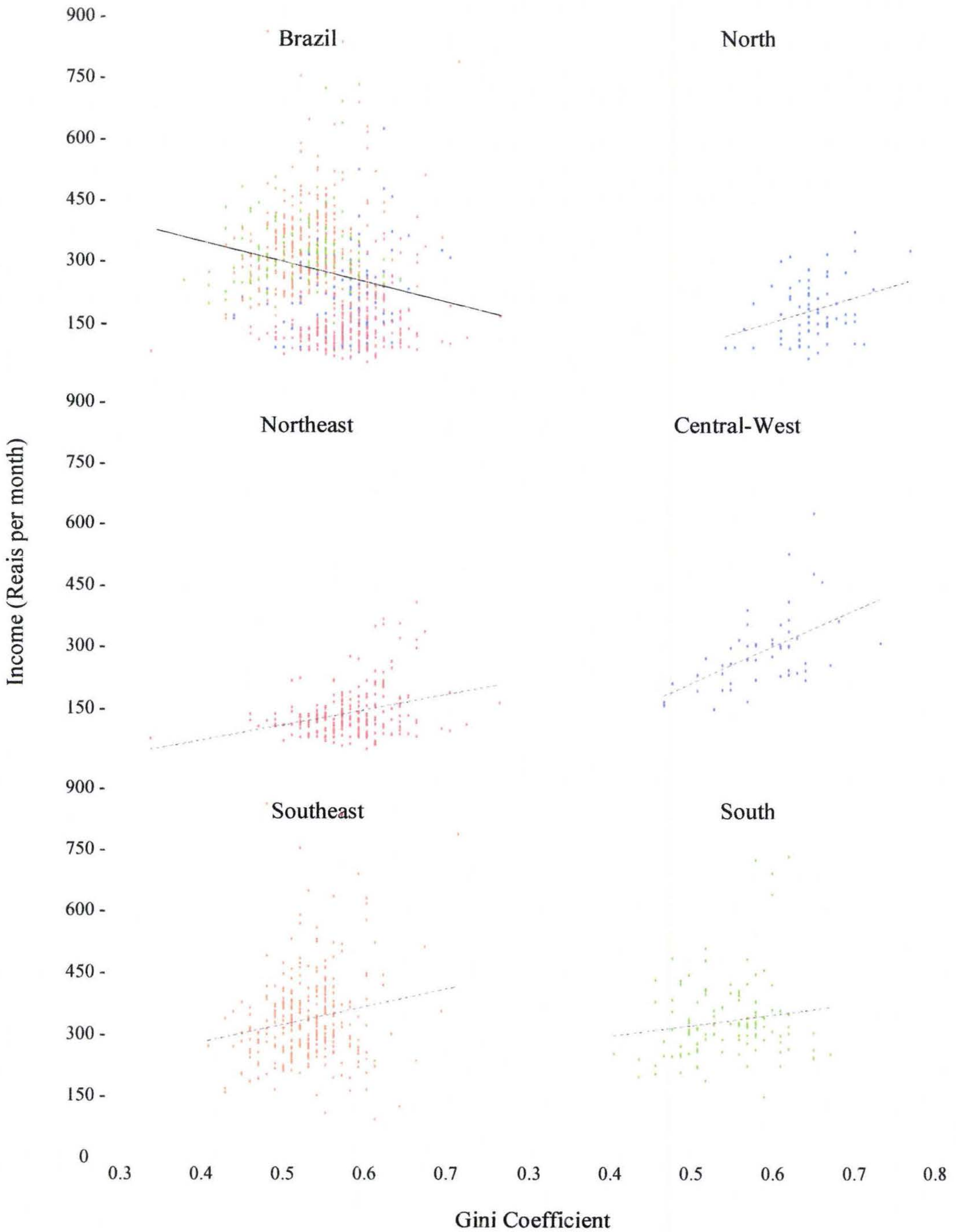

Table 2.14.

Means and standard deviations (SD) for the birth rates (per 1000 women) for 15-19 year olds across Brazil and in each Major Region

		Region				
	Brazil	*North*	*Northeast*	*Central-West*	*Southeast*	*South*
Mean	86.26	118.80	91.47	103.22	74.70	79.30
SD	23.97	24.27	24.75	16.26	15.06	18.52

Examining the bivariate correlations between each of the five socioeconomic predictors and birth rates for women 15-19 years old shows that the directions of these relationships are remarkably consistent for the country as a whole and each of the five regions (see Table 2.15). Among the significant correlations, the one exception to this pattern is the relationship between urbanization and teenage birth rates in the North region, which, unlike for the country as a whole and in the Central-West and Southeast regions, is positive.

Interestingly, as seen in Table 2.16, the relationships between the five predictors and teenage birth rates in the negative binomial regression models are exactly the same as in Table 2.15, except that the relationships between urbanization and birth rates are consistently positive for the country as a whole and across the five Major Regions.

Table 2.15.

Bivariate correlations between birth rates for 15-19 year olds (per 1000 women) and each predictor variable

	15-19 year olds					
	Brazil (N=725)	*North (N=66)*	*Northeast (N=209)*	*Central-West (N=50)*	*Southeast (N=282)*	*South (N=118)*
Life Expectancy	-0.36**	-0.14	-0.15*	-0.31*	-0.34**	-0.41**
School Registration	-0.38**	-0.04	-0.19**	-0.43**	-0.37**	-0.53**
Income	-0.40**	0.21	-0.12	-0.40**	-0.34**	-0.48**
Gini	0.26**	0.21	0.02	0.02	0.05	0.17
Urbanization	-0.16**	0.33**	0.11	-0.30*	-0.14*	0.12

Note. Bivariate correlation tables for the other age groups are shown in Appendices K, L, and M.

*$p < .05$ **$p < .01$ ***$p < .001$, two-tailed

Table 2.16.

Percent change in birth rates for 15-19 year olds (per 1000 women) predicted by each explanatory variable in the regression model

	15-19 year olds					
	Brazil (N=725)	*North (N=66)*	*Northeast (N=209)*	*Central-West (N=50)*	*Southeast (N=282)*	*South (N=118)*
	% change	% change	% change	% change	% change	% change
Life Expectancy	-3.27**	-2.24	-2.19	-3.10	-4.65***	-2.16
School Registration	-8.79***	-6.95*	-4.94	-5.62**	-6.81***	-9.29***
Income	-10.11***	-2.94	-8.28**	-6.19*	-3.94**	-9.95***
Gini	6.58***	3.21	3.78	3.85	1.25	7.10***
Urbanization	9.70***	14.18**	11.55***	0.34	3.54**	12.27***

*$p < .05$ ** $p < .01$ ***$p < .001$, two-tailed

2.4 Discussion

Comparing the regression results from the country as a whole to those in the five Major Regions of Brazil, the first generalization that can be made is that when an effect is significant in both the Brazilian regression and in one of the regional regressions, the relationships are in the same direction. The one exception is the effect of urbanization for 40-49 year olds, which has a significant positive effect in the Central-West region and a significant negative effect across the country. Together these observations suggest that the analysis of birth rates in Brazil is not highly sensitive to the scale of the geographical area being examined, such that the direction of the relationships between age-specific birth rates and the predictor variables are consistent when examined across the entire country and within each Major Region. More specifically, with each region, birth rates are highest in municipalities with a shortened life expectancy, decreased career opportunities, lower income, and higher income inequality; the effect of urbanization varies among age groups such that birth rates for 15-19 and 20-29 year olds increase with increasing urbanization and birth rates for 30-39 and 40-49 year olds generally decrease.

Despite the directional consistency of the results, the statistical significance of these relationships varies across regions and in comparison to the analyses presented in the first chapter. In order to evaluate the hypothesis that the significance of these relationships depends on the amount of variation in the explanatory variables, coefficients of variation for the five predictors within each region were calculated (Table 2.8, p. 79). As mentioned, the highest coefficients of variation for all predictors except the Gini coefficient are found in the North or Northeast regions. Comparing those values to the regression results in Tables 2.9 – 2.13 (p. 81-88), it is evident that the significance of the beta estimates does not heavily depend on the variation in the predictor variables as the Southeast, South, and Northeast regions have the most significant effects and the North and Central-West have the least. Given this, it seems that the number of municipalities examined within each region may have more influence on the significance, such that the Southeast (N=282), South (N=118), and Northeast (N=209) regions have the most municipalities represented, and the North (N=66) and Central-West regions (N=50) have the least. However, it is also possible that the significance of the effects is more highly sensitive to the scale of the area being examined than the directions of the effects are, and that these distinctions among regions and in comparison to the whole country portray important geographical differences. In order to tease apart these effects, future studies in Brazil must analyze the relationships between age-specific birth rates and the five predictor variables across regions using the same number of municipalities within each region.

The consistency between Major Regions is particularly noteworthy given the vast social and geographical differences between the five areas. For example, using only the Major Regions to predict differences in income and income inequality accounts for a large proportion of the variance in these two indicators (0.48 and 0.22, respectively). Furthermore, all the pair-wise differences among mean regional birth rates are significant, except for that between the south and southeast regions. Therefore, these regional distinctions reinforce the legitimacy of the geographical divisions used and popularized by The Brazilian Institute for Geography and Statistics (IBGE) and indicate that the relationships between the predictors and birth rates are reliable across diverse socioeconomic areas in Brazil.

Similar analyses to those presented in this thesis using income and income inequality to predict homicide rates have come under some scrutiny due to the potential confounding effect of collinearity between measures of inequality and economic indicators such as income (Daly, Wilson, & Vasdev, 2001). Daly, Wilson, & Vasdev (2001) cited an early study that investigated the relationship between inequality and property crime in order to characterize this concern. "Regardless of whether one is analyzing across nations, states, or cities, the correlation between measures of inequality and measures of average prosperity is always negative, which implies that the poorer the area, the more one can expect unequal income distributions" (Jacobs, 1981, p. 14). In response to this concern, Daly, Wilson, & Vasdev (2001) examined the relationship between inequality and homicides across Canadian provinces, which display a positive association between the Gini coefficient and income. Just as for American states, across which income inequality and income are negatively associated, the Gini coefficient was a significant positive predictor of homicides across Canadian provinces. In the Brazilian analysis presented here, the association between Gini and income is negative across the country but positive within each region. Despite these opposite relationships, the Gini coefficient is always a positive predictor of birth rates in all ages and income is always a negative predictor from both the simple bivariate correlations and net of other variables in the regression analyses. Therefore, the results of this investigation lend further support to the notion that predictions of demographic variables are not confounded by the relationship between income and income inequality and that poverty and inequality are independent predictors.

Chapter 3: General Discussion

The findings of this thesis suggest that women adjust their reproductive efforts according to local life expectancies, levels of poverty and income inequality, career opportunities, and the degree of urbanization. Although the effects in each age group are directionally consistent (except for the degree of urbanization), teenage women do seem to be more sensitive to social and ecological conditions, therefore reinforcing Berquó & Cavenaghi's (2005) claim that adolescent fertility patterns are different from those of older women.

Like other studies that have examined the relationships among various socioeconomic and demographic variables, the current findings have the potential to inform public health policies. For example, the connections between income inequality and teen pregnancy, homicides, and other social and health concerns have been noted by many researchers in numerous parts of the world. Many of these authors share the opinion that public policies must address the underlying cause of relative deprivation in any hope to induce change. Until recently,

> . . . strings of policy initiatives [have been] designed to tackle each of these issues separately: policies to reduce overcrowded prisons, to reduce violence or teenage births [. . .] and so on as if there was no connection between them. [I]t may be cheaper and more rewarding to tackle the underlying inequalities themselves (Wilkinson & Pickett, 2007, p. 1976).

Taken together, the evidence cited and presented here suggests that, if the Brazilian government regards increasing adolescent births as a serious public health problem, policies directed at reducing the extreme variance in living conditions across the country, decreasing poverty, and aiming to extend the local life expectancies across municipalities may be more effective than targeting adolescent birth rates in isolation.

In Brazil, efforts to reduce teen pregnancies and the spread of sexually transmitted infections (STIs) have been initiated by the Ministry of Health (Osava, 2004). Primarily, these programmes involve sex education and the distribution of condoms in high schools (Osava, 2004). However, although such initiatives may be suited to reducing the spread of STIs, policies that fail to recognize that many adolescent girls *want* to become pregnant will undoubtedly be unsuccessful in achieving their goals. Evidence of this comes from a study conducted in the Northern city of Fortaleza, Brazil, which compared 396 adolescent girls seeking prenatal care with 196 adolescent girls who sought treatment after an incomplete abortion. The researchers found that compared to the girls seeking treatment for an abortion, the young mothers had a greater improvement in self-esteem 45 days postpartum than before the pregnancy and better relationships with their mothers. The authors further reported that, "Adolescent pregnancy cannot be equated with unwanted pregnancy -- 40 percent of the teen mothers in this study said that they wanted to have a baby when they became pregnant" (Family Health International, 2008). The attitudes as interpreted by the authors, therefore, closely parallel those described in Arline Geronimus's studies of African American teenage mothers in poverty stricken U.S. neighbourhoods (Geronimus 1999; Geronimus, 2004) and support the notion that young women may deliberately tailor reproductive efforts and fertility-timing in response to environmental conditions.

Although the analyses and interpretations presented in this thesis are revealing, the aggregate nature of the data used imposes some limitations that must be explored in future research. In particular, the study of women's fertility timing over the lifespan would be aided by the examination of age at first birth in addition to age-specific birth rates. Such an investigation would be able to demonstrate more concretely whether or not women start reproducing earlier when they have reason to doubt the certainty and quality of their futures. The second potential fallacy that should be further investigated is the claim that women in the lower portion of the income distribution drive the high birth rates in areas with increased income inequality. Although previous research supports this notion for 15-19 year olds, the evidence is less clear for women in the older age groups.

In addition to this thesis, a large amount of research has been aimed at investigating the conditions surrounding teenage pregnancy. Within that body of literature, there are many opposing opinions regarding the causes and implications of early reproduction. Hopefully future research will persist in challenging the erroneous notion that early reproduction is always undesirable in an effort to impact public health policies in a meaningful way.

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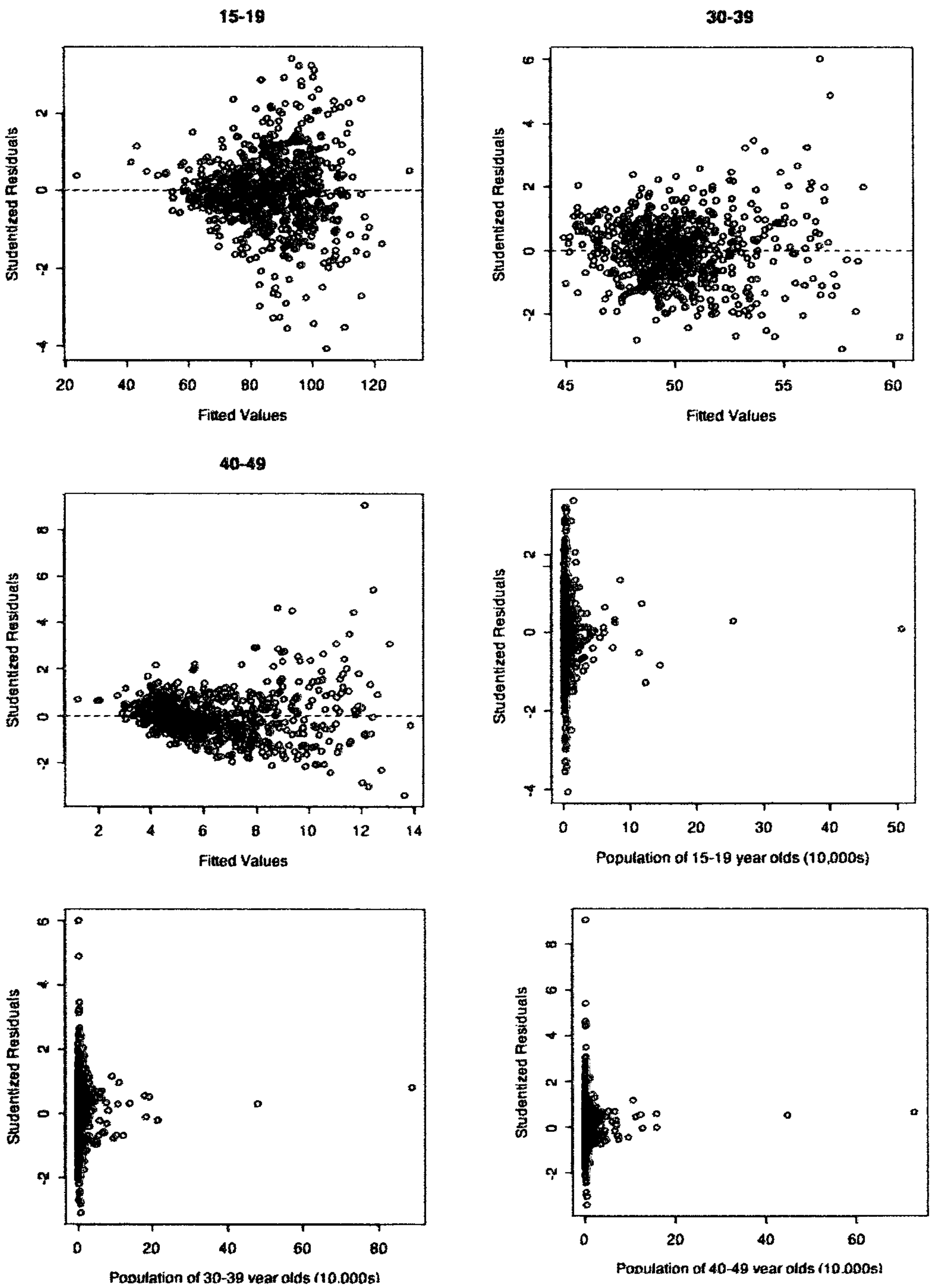
Appendix A.



Diagnostic plots for the linear regression model in the remaining age groups.

Appendix B.

Regression results for 15-19 year olds across the subset of 725 municipalities

	Estimate	*St. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-2.4632	0.0085	-288.1920	< 2e-16	***	
Life Expectancy	-0.0332	0.0121	-2.7470	0.0060	**	-3.27
Income	-0.1066	0.0129	-8.2580	< 2e-16	***	-10.11
Urbanization	0.0926	0.0117	7.9360	0.0000	***	9.70
School Registration	-0.0920	0.0098	-9.4170	< 2e-16	***	-8.79
Gini	0.0638	0.0096	6.6230	0.0000	***	6.58

Regression results for 20-29 year olds across the subset of 725 municipalities

	Estimate	*St. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-2.1321	0.0066	-321.7410	< 2e-16	***	
Life Expectancy	-0.0122	0.0094	-1.3030	0.1930		-1.22
Income	-0.0685	0.0100	-6.8390	0.0000	***	-6.62
Urbanization	0.0385	0.0090	4.2610	0.0000	***	3.93
School Registration	-0.0344	0.0076	-4.5430	0.0000	***	-3.38
Gini	0.0532	0.0075	7.1220	0.0000	***	5.46

Regression results for 30-39 year olds across the subset of 725 municipalities

	Estimate	*St. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-2.9943	0.0105	-284.9300	< 2e-16	***	
Life Expectancy	0.0189	0.0149	1.2690	0.2046		1.91
Income	0.0125	0.0159	0.7910	0.4290		1.26
Urbanization	-0.0487	0.0144	-3.3950	0.0007	***	-4.76
School Registration	-0.0019	0.0120	-0.1540	0.8778		-0.19
Gini	0.0160	0.0118	1.3480	0.1777		1.61

Regression results for 40-49 year olds across the subset of 725 municipalities

	Estimate	*St. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-5.0940	0.0163	-313.0190	< 2e-16	***	
Life Expectancy	-0.0034	0.0231	-0.1480	0.8820		-0.34
Income	-0.0847	0.0241	-3.5190	0.0004	***	-8.12
Urbanization	-0.1806	0.0220	-8.1980	0.0000	***	-16.52
School Registration	-0.0444	0.0189	-2.3430	0.0191	*	-4.34
Gini	0.0459	0.0184	2.4990	0.0125	*	4.70

Note. *** p < .001 ** p < .01 * p < .05

Appendix C.

*Descriptive statistics for the explanatory variables across the **sample of 725 municipalities** and municipalities in the North region (N=66)*

Variables	*mean*	*standard deviation*	*min*	*max*
Life Expectancy (years)	**69.34***	**3.92**	**55.41**	**78.18**
	67.93	2.12	64.28	73.02
School Registration (% of 15-19 year olds)	**77.16***	**7.05**	**49.20**	**93.10**
	72.53	8.22	56.70	86.90
Income (Reais)	**252.10***	**125.48**	**47.34**	**834.00**
	170.93	71.91	57.11	358.05
Gini Coefficient	**0.57***	**0.05**	**0.36**	**0.78**
	0.60	0.03	0.51	0.71
% Urbanization	**0.83***	**0.18**	**0.02**	**1.00**
	0.70	0.21	0.19	1.00

Descriptive statistics for the explanatory variables across the sample of 725 municipalities and municipalities in the Northeast region (N=209)

Variables	*mean*	*standard deviation*	*min*	*max*
Life Expectancy	**69.34***	**3.92**	**55.41**	**78.18**
	65.45	3.72	55.41	74.75
School Registration (15-19 years old)	**77.16**	**7.05**	**49.20**	**93.10**
	76.28	6.44	52.60	89.00
Income	**252.10***	**125.48**	**47.34**	**834.00**
	133.45	59.55	47.34	392.46
Gini	**0.57***	**0.05**	**0.36**	**0.78**
	0.60	0.05	0.36	0.78
Urbanization	**0.83***	**0.18**	**0.02**	**1.00**
	0.71	0.20	0.02	1.00

Note. Values for the larger sample are shown in bold font and values for the North region are shown in regular font. The differences between the means in the two samples were tested with t-tests and corrected for multiple comparisons.
* $p < .01$, two-tailed

Descriptive statistics for the explanatory variables across the sample of 725 municipalities and municipalities in the Central-west region (N=50)

Variables	*mean*	*standard deviation*	*min*	*max*
Life Expectancy (years)				
	69.34	**3.92**	**55.41**	**78.18**
	70.30	1.81	65.88	74.13
School Registration (% of 15-19 year olds)	**77.16***	**7.05**	**49.20**	**93.10**
	95.24	2.09	86.87	98.89
Income (Reais per month)	**252.10**	**125.48**	**47.34**	**834.00**
	277.85	90.67	141.71	605.41
Gini Coefficient	**0.57**	**0.05**	**0.36**	**0.78**
	0.58	0.05	0.46	0.72
% Urbanization	**0.83***	**0.18**	**0.02**	**1.00**
	0.90	0.07	0.68	1.00

Descriptive statistics for the explanatory variables across the sample of 725 municipalities and municipalities in the Southeast region (N=282)

Variables	*mean*	*standard deviation*	*min*	*max*
Life Expectancy (years)				
	69.34*	**3.92**	**55.41**	**78.18**
	71.29	2.49	61.84	78.18
School Registration (% of 15-19 year olds)	**77.16***	**7.05**	**49.20**	**93.10**
	80.02	6.10	54.10	93.10
Income (Reais per month)	**252.10***	**125.48**	**47.34**	**834.00**
	325.60	109.55	86.45	834.00
Gini Coefficient	**0.57***	**0.05**	**0.36**	**0.78**
	0.55	0.05	0.43	0.73
% Urbanization	**0.83***	**0.18**	**0.02**	**1.00**
	0.92	0.10	0.33	1.00

Note. Values for the larger sample are shown in bold font and values for the North region are shown in regular font. The differences between the means in the two samples were tested with t-tests and corrected for multiple comparisons.
* $p < .01$, two-tailed

Descriptive statistics for the explanatory variables across the sample of 725 municipalities and municipalities in the South region (N=118)

Variables	*mean*	*standard deviation*	*min*	*max*
Life Expectancy (years)				
	69.34*	**3.92**	**55.41**	**78.18**
	71.95	2.65	66.08	77.41
School Registration (% of 15-19 year olds)	**77.16**	**7.05**	**49.20**	**93.10**
	75.16	7.20	49.20	87.30
Income (Reais per month)	**252.10***	**125.48**	**47.34**	**834.00**
	321.36	94.83	139.94	709.88
Gini Coefficient	**0.57***	**0.05**	**0.36**	**0.78**
	0.54	0.05	0.40	0.66
% Urbanization	**0.83**	**0.18**	**0.02**	**1.00**
	0.88	0.12	0.34	1.00

Note. Values for the larger sample are shown in bold font and values for the North region are shown in regular font. The differences between the means in the two samples were tested with t-tests and corrected for multiple comparisons.
* $p < .01$, two-tailed

Appendix D.

Regression results for 15-19 year olds in the North region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-2.1358	0.0241	-88.5970	<2e-16	***	
Life Expectancy	-0.0227	0.0260	-0.8740	0.3819		-2.24
Income	-0.0299	0.0359	-0.8330	0.4046		-2.94
Urbanization	0.1326	0.0410	3.2370	0.0012	**	14.18
School Registration	-0.0720	0.0314	-2.2910	0.0220	*	-6.95
Gini	0.0316	0.0268	1.1790	0.2384		3.21

Regression results for 20-29 year olds in the North region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-1.9581	0.0240	-81.7410	<2e-16	***	
Life Expectancy	-0.0266	0.0258	-1.0310	0.3024		-2.62
Income	-0.0609	0.0357	-1.7090	0.0874		-5.91
Urbanization	0.0973	0.0406	2.3980	0.0165	*	10.22
School Registration	-0.0096	0.0312	-0.3090	0.7576		-0.96
Gini	0.0545	0.0266	2.0500	0.0404	*	5.60

Regression results for 30-39 year olds in the North region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-3.0653	0.0385	-79.5740	<2e-16	***	
Life Expectancy	-0.0565	0.0414	-1.3650	0.1723		-5.50
Income	-0.1424	0.0573	-2.4830	0.0130	*	-13.27
Urbanization	0.0008	0.0654	0.0120	0.9908		0.08
School Registration	0.0954	0.0503	1.8960	0.0579		10.01
Gini	0.0777	0.0427	1.8190	0.0688		8.08

Regression results for 40-49 year olds in the North region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-4.8972	0.0555	-88.2820	<2e-16	***	
Life Expectancy	-0.0751	0.0593	-1.2660	0.2056		-7.23
Income	-0.3151	0.0831	-3.7900	0.0002	***	-27.03
Urbanization	-0.1673	0.0950	-1.7610	0.0783		-15.40
School Registration	0.1052	0.0747	1.4080	0.1590		11.09
Gini	0.1262	0.0617	2.0460	0.0408	*	13.45

Appendix E.

Regression results for 15-19 year olds in the Northeast region

	Estimate	*Std. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-2.3970	0.0194	-123.5270	<2e-16	***	
Life Expectancy	-0.0221	0.0218	-1.0130	0.3111		-2.19
Income	-0.0865	0.0302	-2.8610	0.0042	**	-8.28
Urbanization	0.1093	0.0268	4.0740	0.0000	***	11.55
School Registration	-0.0506	0.0214	-2.3640	0.0181	*	-4.94
Gini	0.0371	0.0220	1.6840	0.0923		3.78

Regression results for 20-29 year olds in the Northeast region

	Estimate	*Std. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-2.0866	0.0170	-122.6210	<2e-16	***	
Life Expectancy	0.0003	0.0191	0.0170	0.9863		0.03
Income	-0.0994	0.0265	-3.7470	0.0002	***	-9.47
Urbanization	0.0543	0.0235	2.3110	0.0208	*	5.58
School Registration	-0.0307	0.0188	-1.6360	0.1019		-3.03
Gini	0.0917	0.0193	4.7530	0.0000	***	9.61

Regression results for 30-39 year olds in the Northeast region

	Estimate	*Std. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-3.0025	0.0228	-131.6800	<2e-16	***	
Life Expectancy	0.0597	0.0257	2.3230	0.0202	*	6.15
Income	-0.0919	0.0354	-2.5910	0.0096	**	-8.78
Urbanization	-0.0563	0.0315	-1.7910	0.0734		-5.48
School Registration	-0.0338	0.0252	-1.3420	0.1797		-3.33
Gini	0.1447	0.0259	5.5810	0.0000	***	15.57

Regression results for 40-49 year olds in the Northeast region.

	Estimate	*Std. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-4.8671	0.0313	-155.6380	<2e-16	***	
Life Expectancy	0.0598	0.0354	1.6890	0.0912		6.16
Income	-0.2092	0.0476	-4.3980	0.0000	***	-18.88
Urbanization	-0.1575	0.0429	-3.6750	0.0002	***	-14.57
School Registration	-0.0731	0.0350	-2.0860	0.0370	*	-7.05
Gini	0.1945	0.0359	5.4150	0.0000	***	21.47

Appendix F.

Regression results for 15-19 year olds in the Central-west region.

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-2.2755	0.0178	-128.1720	<2e-16	***	
Life Expectancy	-0.0315	0.0201	-1.5700	0.1164		-3.10
Income	-0.0639	0.0265	-2.4160	0.0157	*	-6.19
Urbanization	0.0034	0.0245	0.1390	0.8891		0.34
School Registration	-0.0579	0.0212	-2.7310	0.0063	**	-5.62
Gini	0.0377	0.0277	1.3650	0.1724		3.85

Regression results for 20-29 year olds in the Central-west region.

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-2.1044	0.0137	-153.0870	<2e-16	***	
Life Expectancy	-0.0264	0.0155	-1.7020	0.0887		-2.61
Income	-0.0420	0.0206	-2.0350	0.0418	*	-4.11
Urbanization	0.0077	0.0190	0.4070	0.6842		0.78
School Registration	-0.0195	0.0164	-1.1920	0.2332		-1.93
Gini	0.0439	0.0214	2.0550	0.0399	*	4.49

Regression results for 30-39 year olds in the Central-west region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-3.2718	0.0400	-81.8340	<2e-16	***	
Life Expectancy	-0.0442	0.0450	-0.9820	0.3260		-4.33
Income	-0.0021	0.0608	-0.0350	0.9719		-0.21
Urbanization	0.1067	0.0554	1.9250	0.0542		11.26
School Registration	-0.0717	0.0472	-1.5190	0.1287		-6.92
Gini	0.0614	0.0621	0.9880	0.3230		6.33

Regression results for 40-49 year olds in the Central-west region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-5.6805	0.0809	-70.2580	<2e-16	***	
Life Expectancy	-0.0567	0.0910	-0.6230	0.5331		-5.52
Income	0.0327	0.1168	0.2800	0.7795		3.33
Urbanization	0.2954	0.1191	2.4790	0.0132	*	34.36
School Registration	-0.2769	0.0966	-2.8680	0.0041	**	-24.19
Gini	0.0936	0.1274	0.7340	0.4627		9.81

Appendix G.

Regression results for 15-19 year olds in the Southeast region

	Estimate	*Std. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-2.5993	0.0104	-250.8130	<2e-16	***	
Life Expectancy	-0.0477	0.0118	-4.0300	0.0001	***	-4.65
Income	-0.0402	0.0134	-2.9950	0.0028	**	-3.94
Urbanization	0.0348	0.0134	2.5900	0.0096	**	3.54
School Registration	-0.0705	0.0134	-5.2820	0.0000	***	-6.81
Gini	0.0124	0.0120	1.0400	0.2986		1.25

Regression results for 20-29 year olds in the Southeast region

	Estimate	*Std. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-2.1926	0.0074	-295.8870	<2e-16	***	
Life Expectancy	-0.0257	0.0085	-3.0320	0.0024	**	-2.53
Income	-0.0472	0.0096	-4.9080	0.0000	***	-4.61
Urbanization	0.0149	0.0096	1.5510	0.1210		1.50
School Registration	-0.0128	0.0095	-1.3450	0.1786		-1.27
Gini	0.0256	0.0085	2.9950	0.0027	**	2.59

Regression results for 30-39 year olds in the Southeast region

	Estimate	*Std. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-3.0028	0.0111	-270.0680	<2e-16	***	
Life Expectancy	-0.0351	0.0127	-2.7660	0.0057	**	-3.45
Income	0.0060	0.0144	0.4130	0.6795		0.60
Urbanization	0.0063	0.0145	0.4310	0.6663		0.63
School Registration	0.0155	0.0144	1.0730	0.2832		1.56
Gini	0.0017	0.0128	0.1310	0.8958		0.17

Regression results for 40-49 year olds in the Southeast region

	Estimate	*Std. Error*	*z-value*	*Pr<|z|*		*% change*
(Intercept)	-5.3083	0.0193	-274.8960	<2e-16	***	
Life Expectancy	-0.0765	0.0220	-3.4780	0.0005	***	-7.37
Income	-0.0669	0.0244	-2.7430	0.0061	**	-6.47
Urbanization	-0.0158	0.0261	-0.6070	0.5436		-1.57
School Registration	-0.0258	0.0262	-0.9850	0.3248		-2.55
Gini	0.0331	0.0226	1.4650	0.1428		3.37

Appendix H.

Regression results for 15-19 year olds in the South region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-2.5503	0.0128	-199.4660	<2e-16	***	
Life Expectancy	-0.0219	0.0154	-1.4240	0.1550		-2.16
Income	-0.1049	0.0160	-6.5430	0.0000	***	-9.95
Urbanization	0.1157	0.0151	7.6420	0.0000	***	12.27
School Registration	-0.0976	0.0168	-5.8220	0.0000	***	-9.29
Gini	0.0686	0.0147	4.6690	0.0000	***	7.10

Regression results for 20-29 year olds in the South region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-2.1855	0.0074	-294.0020	<2e-16	***	
Life Expectancy	-0.0051	0.0089	-0.5740	0.5660		-0.51
Income	-0.0682	0.0092	-7.3800	0.0000	***	-6.59
Urbanization	0.0517	0.0088	5.8900	0.0000	***	5.31
School Registration	-0.0581	0.0098	-5.9240	0.0000	***	-5.64
Gini	0.0451	0.0086	5.2710	0.0000	***	4.61

Regression results for 30-39 year olds in the South region

	Estimate	Std. Error	z-value	Pr<|z|		% change
(Intercept)	-2.8578	0.0123	-232.4660	<2e-16	***	
Life Expectancy	0.0155	0.0148	1.0530	0.2925		1.57
Income	-0.0309	0.0154	-2.0070	0.0448	*	-3.04
Urbanization	0.0136	0.0144	0.9460	0.3443		1.37
School Registration	-0.0297	0.0163	-1.8270	0.0677		-2.93
Gini	0.0515	0.0142	3.6420	0.0003	***	5.29

Regression results for 40-49 year olds in the South region

	Estimate	St. Error	z-value	Pr<|z|		% change
(Intercept)	-4.9985	0.0273	-182.9640	<2e-16	***	
Life Expectancy	0.0281	0.0330	0.8510	0.3947		2.85
Income	-0.0651	0.0329	-1.9790	0.0478	*	-6.31
Urbanization	-0.0231	0.0322	-0.7160	0.4740		-2.28
School Registration	-0.0703	0.0368	-1.9100	0.0562		-6.78
Gini	0.0857	0.0319	2.6850	0.0073	**	8.95

Appendix I.

Regression results using the dummy variable 'region' to predict income

	Estimate	*Std. Error*	*t-value*	*Pr(>|t|)*	
	277.85	12.8	21.702	<2.00E-16	***
North	-106.92	16.97	-6.299	5.20E-10	***
Northeast	-144.4	14.25	-10.132	2.00E-16	***
South	43.51	15.28	2.848	0.004519	**
Southeast	47.75	13.89	3.437	0.000622	***

	Estimate	*Std. Error*	*t-value*	*Pr(>|t|)*	
	170.93	11.14	15.339	<2.00E-16	***
Central-West	106.92	16.97	6.299	5.20E-10	***
Northeast	-37.48	12.78	-2.932	0.00347	**
South	150.43	13.92	10.811	<2.00E-16	***
Southeast	154.66	12.38	12.494	<2.00E-16	***

	Estimate	*Std. Error*	*t-value*	*Pr(>|t|)*	
	133.455	6.262	21.312	<2.00E-16	***
Central-west	144.397	14.252	10.132	<2.00E-16	***
North	37.478	12.782	2.932	0.00347	**
South	187.91	10.424	18.026	<2.00E-16	***
Southeast	192.142	8.263	23.254	<2.00E-16	***

	Estimate	*Std. Error*	*t-value*	*Pr(>|t|)*	
	325.597	5.391	60.397	<2.00E-16	***
Central-West	-47.745	13.891	-3.437	0.000622	***
North	-154.664	12.379	-12.494	<2.00E-16	***
Northeast	-192.142	8.263	-23.254	<2.00E-16	***
South	-4.232	9.926	-0.426	0.669965	

	Estimate	*Std. Error*	*t-value*	*Pr(>|t|)*	
	321.365	8.334	38.561	<2.00E-16	***
Central-West	-43.513	15.276	-2.848	0.00452	**
North	-150.432	13.915	-10.811	<2.00E-16	***
Northeast	-187.91	10.424	-18.026	<2.00E-16	***
Southeast	4.232	9.926	0.426	0.66996	

Note. The missing region in each table is the baseline for that dummy regression.

Appendix J.

Regression results using the dummy variable 'region' to predict the Gini coefficient

	Estimate	*Std. Error*	*t-value*	*$Pr(>\lvert t \rvert)$*	
	0.5792	0.006794	85.257	<2.00E-16	***
North	0.023527	0.009007	2.612	0.009182	**
Northeast	0.020465	0.007563	2.706	0.00697	**
South	-0.040556	0.008106	-5.003	7.10E-07	***
Southeast	-0.028526	0.007371	-3.87	0.000119	***

	Estimate	*Std. Error*	*t-value*	*$Pr(>\lvert t \rvert)$*	
	0.602727	0.005913	101.931	<2.00E-16	***
Central-West	-0.023527	0.009007	-2.612	0.00918	**
Northeast	-0.003062	0.006783	-0.451	0.65179	
South	-0.064083	0.007384	-8.679	<2.00E-16	***
Southeast	-0.052054	0.006569	-7.925	8.71E-15	***

	Estimate	*Std. Error*	*t-value*	*$Pr(>\lvert t \rvert)$*	
	0.599665	0.003323	180.467	<2.00E-16	***
Central-west	-0.020465	0.007563	-2.706	0.00697	**
North	0.003062	0.006783	0.451	0.65179	
South	-0.061021	0.005532	-11.031	<2.00E-16	***
Southeast	-0.048991	0.004385	-11.174	<2.00E-16	***

	Estimate	*Std. Error*	*t-value*	*$Pr(>\lvert t \rvert)$*	
	0.550674	0.002861	192.501	<2.00E-16	***
Central-West	0.028526	0.007371	3.87	0.000119	***
North	0.052054	0.006569	7.925	8.71E-15	***
Northeast	0.048991	0.004385	11.174	<2.00E-16	***
South	-0.01203	0.005267	-2.284	0.022659	*

	Estimate	*Std. Error*	*t-value*	*$Pr(>\lvert t \rvert)$*	
	0.538644	0.004422	121.803	<2.00E-16	***
Central-West	0.040556	0.008106	5.003	7.10E-07	***
North	0.064083	0.007384	8.679	<2.00E-16	***
Northeast	0.061021	0.005532	11.031	<2.00E-16	***
Southeast	0.01203	0.005267	2.284	0.0227	*

Note. The missing region in each table is the baseline for that dummy regression.

Appendix K.

Bivariate correlations between birth rates for 20-29 year olds (per 1000 women) and each predictor variable

		20-29 year olds				
	Brazil (N=725)	*North (N=66)*	*Northeast (N=209)*	*Central-West (N=50)*	*Southeast (N=282)*	*South (N=118)*
Life Expectancy	-0.36**	-0.16	-0.15*	-0.34*	-0.33**	-0.41**
School Registration	-0.38**	0.13	-0.16*	-0.21	-0.23**	-0.57**
Income	-0.40**	0.09	-0.20**	-0.27	-0.36**	-0.54**
Gini	0.26**	0.28*	0.23**	0.16	0.13*	0.21*
Urbanization	-0.16**	0.26*	-0.09	-0.24	-0.15*	-0.02

*$p < .05$ ** $p < .01$ ***$p < .001$, two-tailed

Appendix L.

Bivariate correlations between birth rates for 30-39 year olds (per 1000 women) and each predictor variable

	30-39 year olds					
	Brazil (N=725)	*North (N=66)*	*Northeast (N=209)*	*Central-West (N=50)*	*Southeast (N=282)*	*South (N=118)*
Life Expectancy	-0.36**	-0.15	-0.03	-0.10	-0.14*	-0.13
School Registration	-0.38**	0.10	-0.14*	-0.09	0.08	-0.25**
Income	-0.40**	-0.25*	-0.23**	0.01	0.00	-0.22*
Gini	0.26**	0.15	0.31**	0.02	0.01	0.26**
Urbanization	-0.16**	-0.10	-0.32**	0.17	0.05	0.12

*$p < .05$ ** $p < .01$ ***$p < .001$, two-tailed

Appendix M.

Bivariate correlations between birth rates for 40-49 year olds (per 1000 women) and each predictor variable

	40-49 year olds					
	Brazil (N=725)	*North (N=66)*	*Northeast (N=209)*	*Central-West (N=50)*	*Southeast (N=282)*	*South (N=118)*
Life Expectancy	-0.36**	-0.16	-0.12	0.00	-0.29**	-0.11
School Registration	-0.38**	-0.20	-0.22**	-0.24	-0.25**	-0.33**
Income	-0.40**	-0.56**	-0.39**	0.01	-0.31**	-0.29**
Gini	0.26**	0.01	0.25**	-0.07	0.12*	0.21*
Urbanization	-0.16**	-0.49**	-0.48**	0.23	-0.27**	-0.31**

*$p < .05$ ** $p < .01$ *** $p < .001$, two-tailed