Why has the Health Inequality among Infants Declined?

Accounting for the Shrinking Gap*

[Job Market Paper]

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* I am deeply indebted to my advisor, Janet Currie, for her advice and support throughout this project. Special thanks to Sandra Black for her suggestions and continual encouragement. I also thank Moshe Buchinsky, Jinyong Hahn, Joseph Hotz, Kathleen McGarry, Erica Field, Jason Schnittker, Phillips Brown, Alan Barreca, Hal Snarr and seminar participants in the 2006 NBER Summer Institute, the 2006 Society of Labor Economics annual meeting, the 2006 Population Association of America annual meeting, the UCLA Albert Family Fund Proseminar in Applied Microeconomics and Econometrics, the 2006 WEAI annual meeting and the 2006 Econometric Society Summer Meeting.

ABSTRACT

Given that wealthier people are healthier, the increase in income inequality over the past two decades has led to fears that inequalities in health have also increased. Indeed, some papers have found that health disparities have become more salient among some adult populations. Using the U.S. Vital Statistics 1983-2000, this paper presents a new stylized fact: the infant health gap at age one, as measured by infant mortality has stayed constant over time; while the gap at birth, measured by Apgar scores, has indeed narrowed dramatically. In the face of rising inequality, this paper asks which factors account for the relative improvement in the health of babies of low socioeconomic status.

Using a decomposition method, I find that the most important factor in explaining the closing gap (accounting for 40%) is an increase in access to medical care. However, demographic shifts and maternal behavior changes are also critical. For example, research shows that foreign-born Hispanic women on average have better infant health outcomes than African-Americans. Given these racial differences in birth outcomes, the gap in Apgar scores decreased because an increasing number of infants whose mothers are less-educated are born to Hispanic immigrants rather than to African-Americans. There are also several behavioral factors which have had an important impact. Namely, the gap in Apgar scores has decreased because smoking among less-educated women has declined, though this improvement is partially offset by an increase in the number of less-educated women who gain excessive weight during pregnancy. Finally, the gap has decreased because an increasing number of college-educated women are delaying fertility and are seeking fertility treatment, which often leads to multiple births; such behaviors are usually associated with having infants with lower Apgar scores.

JEL: I10, I18, I12

1. INTRODUCTION

Wealthier people are healthier; differences in health are apparent in some key health indicators such as infant mortality and life expectancy. Increases in income inequality over the past two decades combined with rising labor returns to schooling (Autor, Katz and Kearney 2005) have led to fears that inequalities in health have also increased. Indeed, despite improvements in health for the population as a whole, some papers have found that health disparities have become more salient among certain adult populations.[2]

Economists have long recognized the phenomenon in which people with higher socioeconomic status have better health and longevity than people with low socioeconomic status; this phenomenon is known as the gradient in health status.[3] These health disparities have received attention from researchers and policy-makers alike; they are now systematically monitored in many countries throughout the world. One of the World Health Organization's stated targets in its *Health for All 2000* report is to eliminate social inequalities in health. Policy goals in the United States also reflect a strong desire to eliminate such disparities; in its *Healthy People 2010* report, the Public Health Service proclaims that one of its two primary goals is to eliminate health disparities among different segments of the population.[4]

This paper presents a new stylized fact regarding health inequalities: the infant health gap at age one, as measured by infant mortality has stayed constant over time; while the gap at birth, measured by Apgar scores, has indeed narrowed dramatically. I ask what factors account for the relative improvement in the health of low socioeconomic status (SES) babies.

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[2] see e.g., Crimmins and Saito 2001; Pappas et al. 1993.
[3] In the following, I use the terms gradient in health and health disparity interchangeably.
[4] Healthy People 2010 is designed to achieve two overarching goals: The first goal is to help individuals of all ages increase life expectancy and improve their quality of life. The second goal is to eliminate health disparities among different segments of the population (Healthy People 2010. Washington, DC: U.S. Dept. of Health and Human Services, Office of Public Health and Science.).

I use individual-level data from U.S. birth and death certificates from 1983 to 2000 to examine the evolution of inequality among infant health outcomes. Specifically, I explore the change in the infant health inequality using logistic regressions. My primary measures of infant health are infant death rates and low Apgar scores. The former refers to the death of an infant before his or her first birthday; the latter is a summary measure of an infant's condition at birth.

In sharp contrast to the increasing health inequality among adults, the main findings of this paper suggest that (1) the gap in infant death rates has remained constant over time and (2) the gap in low Apgar scores has indeed narrowed. Although the fact that improvements in Apgar scores do not decrease the infant mortality gap may be cause for concern, since these measures are good predictors of future child health, the relative improvement in Apgar scores for low SES infants is meaningful. For example, using the National Maternal and Infant Health Survey (NMIHS) data, Almond, Chay and Lee (2005) find that after controlling for family background variables and infant birth weight, the Apgar score is a significant predictor for measures of health, cognitive ability and behavioral problems of children at age three.

After observing such patterns over time, the natural question to ask is what accounts for the narrowing gap in Apgar scores. I utilize a decomposition technique to focus on three main factors: maternal behavioral changes, demographic changes and changes in access to medical care. Changes in maternal behavior include delays in pregnancy, fertility treatments (inferred from an increase in multiple births), unhealthy gestational weight gain, and reduction in smoking. Demographic changes include, for example, the fact that an increasing number of infants born to less-educated mothers are being born to Hispanics rather than African-Americans. Finally, access to medical care is linked to the rapid increase in public health insurance coverage that took place during the late 1980s and early 1990s.

I find that access to medical care and changes in maternal behavior are the two most important factors accounting for the reduction in the health gradient as measured by low Apgar scores, accounting for 40% and 30% of the decrease in the gradient, respectively. A remaining 12% of the gap is explained by demographic changes.

The rest of the paper proceeds as follows: Section 2 reviews the relevant literature. Section 3 discusses the underlying mechanisms of changes in infant health over time. Sections 4 and 5 provide an overview of the data and methods. Results appear in Section 6 and Section 7 presents some specification checks. Section 8 concludes.

2. PREVIOUS LITERATURE

2.1 LITERATURE ON MATERNAL EDUCATION AND INFANT HEALTH

Research on the effects of education on health has grown substantially. Extensive research concerning the social determinants of health has revealed that education is strongly associated with a broad range of health measures (see Marmot 2004 for a review). More importantly, some findings show that education has a causal impact on health (for example, Berger and Leigh 1989, Sander 1995ab, Leigh and Dhir 1997, Goldman and Lakdawalla 2001, Lleras-Muney 2005). Furthermore, education may not only have a causal effect on own health but also on children's health. For example, Currie and Moretti (2003) find that higher maternal education improves infant health as measured by birth weight and gestational age. They also suggest four pathways through which a mother can change her behavior to improve infant health: by increasing the probability of getting married; by reducing the number of children born; by increasing the use of prenatal care; and by smoking less.

In the standard infant health production model, first introduced by Rosenzweig and Schultz (1982, 1983), a mother derives utility from both a consumption good and infant health, subject to her budget constraint and an infant health production function. The infant health production function captures the technological and biological means by which maternal behavior and investments in infant health, such as prenatal care, translate into better infant health.

In the model, there are three ways maternal education can affect the health of children. First, higher education can increase the resources available for children through a direct increase in income. For example, Card (1999) concludes that in the 1990s, each extra year of schooling appears to be associated with an 8-12 % increase in earnings. Next, through assortative mating, maternal education may indirectly increase resources. Goldin (1992) finds, for example, that for women who graduated in the 1950s, 40% of the returns to college education come from an increase in the probability of marrying a more educated man and/or within an educational group, an increase in the probability of marrying the man with the highest earning potential. Third, even if the budget constraint remains constant, a mother's level of education may improve child health if it induces her to behave in healthier ways (for example, smoke less), to make better decisions (e.g., eat healthier, gain adequate gestational weight), or to alter her preferences (e.g., increase patience (Becker and Mulligan 1997) or risk aversion). Overall, theory and empirical work alike agree that maternal education is an important determinant for infant health.

2.2 LITERATURE ON HEALTH DISPARITY OVER TIME

All previous studies on health disparities over time are centered on *adults* with one exception.[5] Using data from 1964 -1966, Singh et al. (1995) find a negative relationship between maternal education and infant mortality among white mothers with less than 12 years of education. This relationship disappears for mothers with 12 or more years of education. However, using 1987 data, they find that for all levels of maternal education, infant mortality rates decrease consistently with increasing levels of maternal education. The authors view this as

[5] A few researchers have investigated trends in infant mortality by race (Collins and Thomasson 2002; Culter and Meara 2003), but not by income or education.

evidence of an increasing educational gradient in infant health in 1987 compared with the earlier period. In this paper I investigate the infant health gradient with respect to infant mortality and Apgar scores. I also update the gradient to a more recent period and investigate whether it has changed in a statistically meaningful way.

Although I focus on the evolution of infant health disparities, in what follows, I draw from the literature on the evolution of health inequalities among adults. The sharp contrast in trends among adults and among infants suggests that the driving factors for these two trends might be very different.

Research on adult health gradient generally finds that the gradient in health status has steepened over time among adults, in the sense that the same difference in years of education is now associated with a larger difference in the probability of death than twenty years ago. Increasing health disparities in mortality and life expectancy have been found both in Europe and in the United States.[6] For example, Pappas et al. (1993) suggest that in 1986, the differences in mortality across educational groups were larger than those in 1960 in the United States. Crimmins and Saito (2001) also find large and growing educational differences in healthy life expectancy in the United States from 1970 to 1990.

We also see increasing health disparities among adults when examining other measures of health such as self-reported health (Goesling 2005) and old-age disability rates (Schoeni et al. 2001, 2005). For example, Schoeni et al. (2001, 2005) find that educational differences in old-age disability rates have been declining since the early 1980s but that the gains have been concentrated among the most educated.

[6] For England and Walse, see Koskinen (1985) and Pamuk (1985). For Europe countries: Finland, Sweden, Norway, Denmark, England/Walse, and Italy see Mackenbach et al. (2003); For the US, see Feldman et al. (1989), Pappas et al. (1993), Crimmins and Saito (2001) and Preston and Elo (1995).

The gradient in certain health behaviors has also been increasing. For example, Pamuk et al. (1998) show that between 1974 and 1990, cigarette smoking declined for all levels of education among both men and women. The rate of decline, however, was greater among the most highly educated.

This paper extends the line of research that examines the evolution of the gradient in infant health to a more recent period (1983-2000). I first document the trend in the infant health gap – finding that the trend with respect to Apgar scores has narrowed over time. I then ask why, in the face of increasing income inequality, this gap decreases dramatically.

3. A FRAMEWORK FOR EXPLORING INFANT HEALTH OVER TIME

Three factors related to infant health have witnessed substantially different trends among the highly-educated and low-educated groups over the past two decades. They have the potential to account for most of the rapid narrowing that we observe in the infant health gap as measured by low Apgar scores. These three mechanisms are as follows: (1) maternal behavior changes, (2) demographic changes, and (3) access to medical care. In this section, I discuss in more detail how these three mechanisms affect infant health.

3.1 MATERNAL BEHAVIOR CHANGES

The measures of maternal behavior which I use are maternal age, marital status, whether the mother smokes, gestational weight gain, and whether the mother undergoes fertility treatments. This last element is unobserved, but I infer the use of such treatments through the prevalence of multiple births (see discussion below).

Advanced age, being unmarried and maternal smoking all adversely affect infant health outcomes. A number of studies have shown that advanced maternal age increases the probability of chromosomal abnormality, Down's syndrome, low birth weight, preterm delivery and small size for gestational age at delivery.[7] Similarly, out-of-wedlock birth has also long been recognized as one of the demographic risk factors associated with infant mortality and other adverse infant health outcomes (Bennett 1992). In this paper, I show that the infant death rate for unmarried mothers was 1.9 times higher than that of married mothers during the sample period.[8] Lastly, as is well-known and well-studied, maternal smoking adversely affects the health of both mother and child.[9]

Unlike maternal smoking, both inadequate and excessive weight gain have not yet been well-studied, though these are important risk factors. Some studies show that both of these factors are associated with maternal complications.[10] One limitation of previous studies on the effects of excessive weight gain is the use of small hospital data sets lacking information on Apgar scores. In contrast, I use the U.S. Vital Statistics data, which include information on Apgar scores and have a large sample size. Thus, I am able to present a new finding in this paper: a positive relationship between excessive weight gain and low Apgar scores.

The last factor related to maternal behavior that I investigate is the effect of fertility treatments. Although I do not have data on fertility treatments, the sharp increase in the number

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[7] Some studies suggest that the majority of a woman's eggs are chromosomally abnormal by age 40 (Velde and Pearson 2002, Gianaroli et al. 1999, Wells and Delhanty 2000). As a result, the infant may suffer from a chromosomal abnormality such as Down's syndrome. In addition, some studies have shown babies born to older mothers have increased risks of low birth weight (e.g., Cnattingius et al. 1993; Cnattingius et al. 1992), preterm delivery (e.g., Astolfi and Zonta 2002; Cnattingius et al. 1992) and small size for gestational age (SGA) (e.g., Dildy et al. 1996; Dollberg et al.1996).

[8] The infant death rate was 6.9 per 1000 births for married mothers, while it was 12.9 for unmarried mothers during the sample period (Author's calculation from U.S. Vital Statistics, 1983 to 2000). Note that these numbers refer to the unconditional mean.

[9] For example, Lien and Evans (2005) find that states that increased their cigarette taxes had a corresponding decrease in the percentage of pregnant women who smoke. Meara (2001) documents a strong correlation between smoking during pregnancy and the probability of having a low birth weight infant. Almond et al. (2005) find significant negative effects of smoking on birth weight and Apgar score. Chomitz et al. (1995) show that if all women stopped smoking when they became pregnant, at least 20 percent of all low birth weight infants could be avoided.

[10] For inadequate gestational weight gain, see for example, Abrams (1989). For excessive gestational weight gain, see for example, Jensen (2005); Thorsdottir et al. (2002); Wanjiku and Raynor (2004).

of multiple births in certain groups can be used to infer the prevalence of such procedures.[11] Compared with singleton births (i.e., only one child born to a mother), children from multiple births are usually smaller and have more complications.[12] As a result, children from multiple births are more likely to die.[13] If highly-educated mothers use fertility treatments more than less-educated mothers, then multiple births may reduce the health gap by worsening infant health among highly-educated women.

3.2 DEMOGRAPHIC CHANGES

Research on ethnic differences in the United States demonstrates that despite a socioeconomic profile comparable to African-Americans and a lower socioeconomic profile compared to the non-Hispanic white population, Hispanics are healthier than African-Americans and similar in health to non-Hispanic whites. This phenomenon is observed in several important health indicators such as mortality and birth weight, and has come to be termed an "epidemiologic paradox".[14] This pattern is partly explained by some health-related behaviors such as lower rates of smoking and drinking among Hispanics.[15]

However, when maternal nativity is examined, these positive effects are restricted to immigrant (foreign-born) Hispanics, and do not extend to American-born Hispanic women. For example, Collins and Shay (1994) show that in very low income (less than $10,000/year) census

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[11] Fauser (2005) shows that although an association between older females and multiple gestations is clear, the delay in childbearing accounts for no more than 30% of the recorded overall increase in multiple pregnancies. Furthermore, the rate of triplet and higher-order multiple pregnancies has increased four-fold over the same time period; a trend that can be attributed almost entirely to fertility treatments.

[12] For example, Schieve (2002) shows a positive relationship between (very) low birth weight and multiple births.

[13] Almond, Chay and Lee (2005) find that compared to singletons, twins are more likely to die within one day, one week, one month, and one year of birth. Twins have lower Apgar scores and they have higher incidences of breech birth, abnormal conditions and congenital anomalies.

[14] See for example Elo et al. (2004), Hummer at al. (2000), Morales at al. (2002), Palloni and Arias (2004) , Kington (2001), and Collins and Shay (1994).

[15] Lethbrideg-Cejku et al. (2004); Collins and Shay (1994); Winkleby et al. (2005).

tracts, the incidence of low birth weight infants among American-born Hispanics and African-Americans is equivalent. In contrast, foreign-born Hispanic infants have a low birth weight rate that is far less than that of African-Americans and is 40 % less than that of non-Hispanic whites. There are various hypotheses that have been proposed to explain Hispanics' favorable health outcomes. The most prevalent hypotheses include the healthy migrant effect, which argues that Hispanic immigrants are selected for their good health and robustness.

Historically infant mortality among blacks in the United States has been approximately twice that of whites.[16] Numerous studies have argued that the lower average relative birth weight of African-American babies to Caucasian babies is the primary reason for the persistence of black-white infant mortality differentials (for example, Lu and Halfon 2003).[17] Since an increasing number of infants in the less-educated population are now being born to foreign-born Hispanics rather than to African-Americans and foreign-born Hispanic women in general have favorable birth outcomes while African-Americans have worse outcomes, we can expect this change in demographic composition to improve infant health among the less-educated during the sample period.

3.3 ACCESS TO MEDICAL CARE

In an effort to increase the use of prenatal care, the late 1980s and early 1990s has witnessed a rapid expansion in the eligibility of pregnant women for Medicaid, a federal-state matching entitlement program that provides health insurance for the poor. Until the early 1980s, the eligibility for Medicaid was tied to the receipt of cash welfare payments under the Aid to

[16] National Vital Statistics Reports, Volume 50, Number 15, NCHS 2002.

[17] However, there is no consensus in the literature as to whether genetic factors are responsible for the lower average birth weight of African-American babies. Race may possibly reflect genetic differences but it may also be a proxy for health habits, familial support, exposure to stress or maternal health endowments – factors that are not easily observable by researchers. Therefore, when drawing causal inferences, it is necessary to be aware of key factors that may be correlated with race and which may significantly influence infant outcomes.

Families with Dependent Children (AFDC) program. This linkage had the effect of limiting eligibility to very low income women in single-parent households. However, since the inception of the Medicaid program, states have had the option of extending Medicaid benefits to some groups of pregnant women who were not on AFDC. Starting from the late 1980s, Medicaid eligibility for pregnant women has increased dramatically. As a result, by 2000, Medicaid covered medical expenses for nearly 40% of all US births.[18]

It is widely believed that expanding medical care can improve infant health. For example, Currie and Gruber (1996) show that broader eligibility for Medicaid increased the utilization of medical care and lowered the incidence of infant mortality.[19] By improving access to medical care, primarily among less-educated women, the rapid Medicaid expansion may have causes the gap in the infant health disparity to narrow significantly.

In this paper, adequate prenatal care is constructed using the Kessner Criteria, defined by the National Center for Health Statistics (NCHS), which uses the month in which prenatal care was initiated, the number of prenatal visits, and the gestation weeks to evaluate whether prenatal care is adequate. Specifically, NCHS defines adequate prenatal care as having one's first prenatal visit with a health professional within the first trimester of pregnancy and having an adequate number of follow-up visits based on gestational weeks.

4. DATA AND VARIABLES

The main source of data used in this study comes from the Linked Birth and Infant Death files (LBID) released by the National Center for Health Statistics (NCHS). The data are publicly available for periods 1983-1991 and 1995-2000. These data contain linked information from birth and death certificates. Unfortunately, this linkage is not provided for 1992, 1993 or 1994,

[18] National Governor's Association, *MCH Update 2005: State Coverage of Pregnant Women and Children.*
[19] Currie and Gruber (1996) find that a 30-percent-point increase in eligibility would lead to a 8.5 percent reduction in infant mortality rate.

so for these years the Vital Statistics Detailed Natality data are used instead. Although infant morality information is not available in the Natality data, it contains several other infant health measures like Apgar scores which are of interest to this study.

The combined LBID and Natality data sets provide a census of virtually all of the approximately four million births that occur in the United States each year. Beginning in 1989, the Vital Statistic files include self-reported data on maternal smoking during pregnancy and gestational weight gain. My decomposition analyses, therefore, focus on the period between 1989 and 2000 when these two measures of maternal behavior are available. For consistency, I exclude states that do not report maternal education, Apgar scores, and relevant explanatory variables for all of the sample years.[20] To ease computation time, I then take a sample of 10%. After these exclusions I am left with a sample of 4,357,908 observations from 43 states. This large sample size allows the analysis of relatively rare outcomes, such as infant deaths, with high precision and enables me to conduct detailed analysis by maternal education groups.

My primary measures of health outcomes are low Apgar scores and infant death rates. Infant death is defined as an infant who dies before age one. I chose infant death because it is an objective and serious event that both policy-makers and researchers care about; however, it is also rare. Apgar scores measure a different aspect of infant health and provide details on infants that are not terminally ill. The Apgar score is an overall measure of infant health at birth. It was designed to quickly evaluate a newborn's physical condition after delivery and to determine any immediate need for extra medical or emergency care. APGAR is a system of assessing the health conditions of a newborn based on heart rate, respiration, muscle tone, skin color, and

[20] California, Texas, Washington and New York do not report mother’s education. California, Indiana and South Dakota do not report maternal smoking. California and Texas do not report Apgar scores. Louisiana, Nebraska and Oklahoma do not report gestational weight gain.

response to stimuli. The maximum score for each of the five health factors is 2; hence a perfect Apgar score is 10.

Besides these two measures, I also examine the changes in the gradient with respect to birth weight. I find that birth weight has not changed much over time either in terms of its distribution or in terms of the incidence of low birth weight (i.e. birth weight less than 2500 grams). Specifically, from 1983 to 2000, the overall mean of the birth weight distribution has decreased by 46 grams while the standard deviation has increased by 24 grams, which is a minute change given that the mean birth weight distribution is around 3,300 grams. Furthermore, the incidence of low birth weight has not changed much for singleton births. There has, however, been an increasing incidence of low birth weight, but only among the college graduate group. This observation is mainly due to the increasing incidence of multiple births, which is most likely a result of increasing fertility treatments.

Table 1 reports the distribution of Apgar scores as well as their relationship with infant mortality. Column 3 shows that for Apgar 1 to 10, every one point increase in the Apgar score leads to a decrease in the probability of infant death.[21] This shows that the Apgar scores do well in terms of assessing different infant health levels. Column 3 also shows that the relationship between Apgar score and infant death rate is not linear. For example, the effect of a one point increase in the Apgar score from 9 to 10 has a very small effect on infant death, but a one point increase, from 3 to 4 for example, has a very large effect on infant death.

In the analysis that follows, I define a low Apgar score as less or equal to 8. I use a dichotomous variable because the effect of Apgar score on infant health is not linear. By

[21] There might be some errors in recording an Apgar score of 0. It is odd that the death rate for Apgar score 0 babies is only 54%, whereas all of the other infant death rates decrease monotonically with the Apgar score. However, since I use Apgar score as a binary variable, with a "low" Apgar score being set at Apgar less than or equal to 8. This makes any potential problems with zero Apgar scores irrelevant.

choosing a cutoff point at 8, 10.84 percent of infants fall in low Apgar group. The result is robust with respect to different cutoff points.

It is important to bear in mind that education and income are often used as proxies for SES status; however neither of these are perfect measures of SES. It is also likely that these measures are related to health in different ways. Unfortunately, income and asset information is not contained in the U.S. Vital Statistics data and thus it is not possible to compare results based on these two measures. In this paper, I use educational attainment as an indicator of socioeconomic status. There are two main advantages of using education as an indicator of socioeconomic status. First, education is a more permanent and stable measure of socioeconomic status than income. Income measured at a specific point in time may be unusually high or low; for example, income may be affected by the health of the unborn child through reductions in maternal labor supply or high medical bills. Second, data on educational attainment is collected for all mothers, not only those who are employed.

This study distinguishes between three education groups: high school dropouts (less than 12 years of schooling completed, also referred to as the less-educated group), high school graduates (12 to 15 years of schooling completed, also referred to as the middle-educated group), and college graduates (16 or more years of schooling completed, also referred to as the highly-educated group). The striking differences across education groups can be seen in Table 2, which provides key summary statistics. High school dropout mothers are 1.27 times more likely to give birth to a low Apgar score baby. They are also 2.44 times more likely than college graduate mothers to have children who die before age one.

Besides differences in the two infant health measures above, there are also substantial differences in maternal characteristics by education group. As we see in Table 2, mothers who are college graduates are 3.48 times more likely to give birth after age 40 than high school dropout mothers. College graduate mothers are also more likely to have multiple births, more likely to be married, less likely to smoke during pregnancy, and less likely to have excessive gestational weight gain (over 60 pounds) or inadequate weight gain (less than 15 pounds). Demographically, college graduate mothers are more likely to be white and less likely to be Hispanic or African-American. Finally, college educated mothers are twice as likely to report having received adequate prenatal care.

Figures 1, 2 and 3 plot the trends in maternal behavior, demographic composition, and access to medical care by maternal education group – a first step to interpreting and understanding the decomposition results below. Figure 1 show that from 1983 to 2000, the percent of multiple births among college-graduated mothers doubled. At the same time, the percentage of mothers over 40 years old increased four fold. In addition, there is a more rapid decline in smoking among less-educated women than among highly-educated women (where the rates were already low). Figure 2 shows that the percentage of women who dropped out of high school who are Hispanic increased from 7% to 29%, while the percentage of those who dropped out of high school who are African-American decreased from 26% to 23%. We also see an increasing percentage of less-educated foreign-born women, of whom 80% are Hispanics. Finally, Figure 3 shows that the percentage of infants born with adequate prenatal care increased dramatically for the less-educated, going from 44% in 1983 to 55% in 2000, whereas it increased only 4% for the highly-educated group.

5. METHODS

5.1 REGRESSION ANALYSIS

In order to investigate the development of the gradient over time, I begin by graphing the relationship between infant health measures and maternal education over time. Figures 4a and

4b plot the conditional expectation, based on maternal education, of low Apgar scores and infant death rates as a function of time.

As shown in Figure 4a, the incidence of low Apgar scores is higher for infants born to less-educated mothers (line indexed by triangles) than for infants born to highly-educated mothers (line indexed by circles). While there is a good deal of variation in the incidence of low Apgar scores, it is obvious that the gap between the less-educated and highly-educated groups has narrowed over time. Figure 4b plots the number of deaths per 1,000 births based on maternal education groups. This figure shows that infants born to less-educated mothers always have higher death rates, and that the differences in death rates have stayed relatively constant over time.

In order to further investigate the gradient, I estimate a logistic regression model where the logarithm of odds is a linear combination of the independent variables.

$$\ln\left(\frac{\Pr(y_{it}=1)}{1-\Pr(y_{it}=1)}\right) = \beta_0 + \beta_1 L_{it} + \beta_2 M_{it} + \beta_3[L * yeartrend]_{it} + \beta_4[M * yeartrend]_{it} + \beta_5[year]_t + \beta_6 X_{it} + \varepsilon_{it} \qquad (1)$$

$\Pr(y_{it}=1)$ is the conditional probability of an infant with a low Apgar score or who dies before his or her first birthday. *L* and *M* are dummy variables for mothers who are in the less-educated group and in the middle-educated group, respectively. The *yeartrend* is a linear index of the sample year where 0 represents 1983 and 19 represents 2000[22]; *year* includes a full set of year dummies. The vector X_{it} represents measured at the individual level, which includes dummies for adequate prenatal care, inadequate prenatal care (the omitted group is intermediate prenatal care), mother's ethnic background (African-Americans, Whites, Hispanics, others), whether a mother is foreign-born, whether a mother is married, whether a child is part of a multiple birth, whether a mother is a teenager, whether a mother is over 40, whether a mother smoke during pregnancy and dummies for gestational weight gain.

[22] The results presented are robust to the specification of a full set of year dummies.

In this model, the main coefficients of interest are β_3 and β_4, which represent the changes in the gradient over time for the low and the middle education groups, respectively. For example, a positive β_3 indicates an increasing difference in infant health between the less- and highly-educated groups, while a negative coefficient indicates that this gap actually narrows.

5.2 DECOMPOSITION ANALYSIS

In order to examine the factors that account for the evolution of the gradient, I implement a decomposition method similar to that proposed by Smith and Welch (1989) and Heckman et al. (2000).

To understand this decomposition, let x refer to the following three sets of variables: (1) maternal behavior: married, multiple births, smoking, unhealthy weight gain, advanced maternal age; (2) demographics: black, Hispanic, other races (other than white, black and Hispanic), foreign-born; and (3) access to medical care: adequate prenatal care and inadequate prenatal care. Let $\hat{\beta}$ be the associated vector of coefficients. Let t be the current year and τ be the base year, and let H denote the highly-educated group while L denotes the less-educated group. Let $\overline{x}_t^H, \overline{x}_t^L, \overline{x}_\tau^H, \overline{x}_\tau^L$ denote the mean vectors of high and low education group characteristics at different points in time. Then, the change in the low education group infant outcome minus the high education group infant outcome between time periods t and τ can be decomposed in the following way:

$$
\begin{aligned}
&\left[\left(\overline{x}_t^L \hat{\beta}_t^L - \overline{x}_t^H \hat{\beta}_t^H\right) - \left(\overline{x}_\tau^L \hat{\beta}_\tau^L - \overline{x}_\tau^H \hat{\beta}_\tau^H\right)\right] = \\
&\left[\left(\overline{x}_t^L - \overline{x}_t^H\right) - \left(\overline{x}_\tau^L - \overline{x}_\tau^H\right)\right]\hat{\beta}_\tau^H \text{.............}(a) \\
&+\left(\overline{x}_t^L - \overline{x}_\tau^L\right)\left(\hat{\beta}_\tau^L - \hat{\beta}_\tau^H\right) \text{.......................}(b) \\
&+\left(\overline{x}_t^L - \overline{x}_t^H\right)\left(\hat{\beta}_t^H - \hat{\beta}_\tau^H\right) \text{......................}(c) \\
&+\overline{x}_t^L\left[\left(\hat{\beta}_t^L - \hat{\beta}_t^H\right) - \left(\hat{\beta}_\tau^L - \hat{\beta}_\tau^H\right)\right] \text{...........}(d)
\end{aligned} \qquad (2)
$$

The first two terms ((*a*) and (*b*)) measure the contribution of changes in characteristics, valued at base-year coefficients. Term (*a*) measures the change in infant health inequality predicted by changes in the characteristics of the two groups over time. These changes are valued using base-year high education group parameters. For example, if differences between the characteristics of highly-educated and less-educated mothers had diminished over time, then this component of the infant health gradient would have decreased. Term (*b*) measures the additional change in the infant health gradient predicted by the change in characteristics among the low education group, taking into account the fact that the base-year coefficients of the high and low education groups differ. For example, if returns to medical care (in the base year) are higher among the highly-educated group, then an increase in the overall mean values of medical care leads to an increase in the infant health gradient because the highly-educated benefit disproportionately.

The last two terms measure the contribution of changes in coefficients. Term (*c*) measures the effect of a change in the infant health gradient due to a change in the returns to a specific characteristic, taking into account the fact that low and high education group mean characteristics differ in the current year. In other words, if the less-educated are less likely to have a characteristic for which the return decreases, then the gradient decreases. For example, if the return to medical care decreases over time, we can expect the infant health disparity to decrease because the highly-educated groups have more adequate medical care than the less-educated groups. Term (*d*) measures the predicted change in the infant health disparity that occurs because highly-educated women and less-educated women become more similar in terms of coefficients, valued at current-year low education group characteristics. This term implies that if the coefficients of the less-educated improve more than the coefficients of the highly-educated, the gap decreases due to a convergence in coefficients.

6. RESULTS

6.1 TRENDS IN INFANT HEALTH INEQUALITY

Table 3 displays the (unconditional) effects of maternal education on infant health outcomes as well as the evolution of the gradient over time. Since the coefficients of logistic regressions are not directly interpretable, the marginal effects of the regressions are reported.

The marginal effects in the regressions of low Apgar scores are shown in column 1. The probability of being a low Apgar score baby is 4.01 percentage points higher for a baby born to a less-educated versus a highly-educated mother. Likewise, the probability of being a low Apgar score baby is 2.01 percentage points higher for a baby born to a middle-educated versus a highly-educated mother.

The other key finding, also shown in column 1, is that the gap with respect to low Apgar scores has actually been *decreasing* over time. The interaction terms between the time trend and education levels are negative and significant, indicating that the differences in low Apgar scores between the highly and less-educated groups have decreased since the early 1980s. As a gauge of the size of the change in the gap, the education-based infant health gap between college-graduate and high school dropout mothers has decreased by 4 % per year.

Column 2 shows the results with respect to infant death. The estimated effects on the interaction terms of the time trend and low education dummy suggest that the gradient between the highly-educated and less-educated has stayed relatively constant over time. That is, the interaction terms between the time trend and education levels are small in magnitude and not precisely estimated. Therefore, I conclude that the gap with respect to infant death has stayed constant over time.

Table 4 shows the estimated effects of model (1) after adding various control variables. Columns 1 and 2 report the regression results for all years (1983-2000) while columns 3 and 4 report the regression results for 1989-2000, the period when information on gestational weight gain and smoking behavior is available.

As expected, Hispanics, foreign-born mothers, and married mothers are less likely to have babies born with low Apgar scores. Furthermore, children born in multiple births, born to high school dropouts, and born to a mother who smokes are more likely to have low Apgar scores. The effect of multiple births on low Apgar scores is particularly large -- a multiple birth baby is 11% more likely to have a low Apgar score than a singleton birth baby.

The marginal effects of the dummy variables for weight gain during pregnancy (column 2 in Table 4) are particularly interesting. I find a positive effect of inadequate weight gain on a low Apgar score, a finding that has not been previously documented in the literature. Mothers with weight gain of less than 15 pounds are 3.14 percentage points more likely to have low Apgar score babies. A new finding of this paper is that babies whose mothers gain over 60 pounds during gestation also have a higher probability of a low Apgar score; the effect is 0.43 percentage points.

6.2 DECOMPOSITION RESULTS

Table 5 shows the results of the decomposition.[23] Overall, access to medical care is the most important factor in explaining the narrowing infant health gap as measured by a low Apgar score. All else being equal, access to proper medical care accounts for 39.5% of the closing infant health gradient. While access to medical care is certainly a driving factor, it explains less than half of the narrowing in the gap over time. Maternal behavior changes and demographic changes also contribute significantly, explaining 29% and 12%, respectively. The remaining 18% is not explained by the variables that I include in my decomposition.

[23] In the decomposition, I use 1989 as the base year and 2000 as the current year. 1989 is the first year that data on weight gain and smoking behavior is available and 2000 is the latest year of this study. The decomposition results are robust to use 1983 and 2000 except when using 1983, the effects of maternal smoking and inadequate weight gains are not available which makes the model less interesting.

Within these categories, the four most important factors in explaining the reduction of the infant health gradient are adequate prenatal care, foreign-born mothers, married mothers and multiple births. In what follows, I briefly discuss each of these factors.

The single largest component is adequate prenatal care, reducing the gap by 37%. This finding suggests that the increases in access to medical care, perhaps caused by the rapid Medicaid expansion in the late 1980s and early 1990s, played a significant role in closing the infant health gap.

Being a foreign-born mother is the most important demographic variable, accounting for 12% of the closing gap. Coupled with the fact that 80% of foreign-born less-educated mothers are Hispanic, this result is consistent with the current literature that claims that foreign-born Hispanic immigrants have better infant health outcomes. When assessing the effects of the influx of Hispanics on the infant health gradient, it is important to look not only at the effects of being Hispanic but also at the effects of being foreign-born. Combining the positive effect of being foreign-born (12.1%) with the negative effect of being Hispanic (-5.9%), the net effect of the influx of Hispanic women over the past few decades accounts for approximately 6.2% [24] of the closing gap in infant health measured by low Apgar scores. This finding suggests that if the flow of Hispanic immigrants continues, we may see further decreases.

Of the maternal behavior variables, whether a mother is married explains 12% of the reduction of the infant health gradient. Whether a mother's marital status has a positive or negative effect on the infant health gap can be decomposed into changes in coefficients and changes in characteristics. On the one hand, changes in coefficients, i.e., the return to being married, have been decreasing over time. For example, data used in this study shows that being married was associated with 3% decrease in the probability of having a low Apgar score baby in

[24] 80% of the foreign born mothers are Hispanic.

1989 (base year) but it was associated with only a 1% decrease in the probability of having a low Apgar score baby in 2000 (current year). Since there is a higher percentage of unmarried mothers in the low education group versus the high education group, and since the negative effect of being an unmarried mother has been decreasing over time, less-educated mothers benefit disproportionately, thus narrowing the infant health gap. Table 4 shows that changes in coefficients close the gap by 13.7% (term (*c*) plus term *(d)).* On the other hand, changes in characteristics, i.e., the decreasing rate of being married among less-educated women, increase the gap by 1.6% (the sum of terms *(a)* and (*b*)). This is because being unmarried is associated with negative infant health outcomes, and over time we see a decreasing rate of being married among the less-educated, therefore, infant health among the less-educated has deteriorated – thus increasing the infant health gap.

The last important component is multiple births, which accounts for 11% of the narrowing infant health gradient. This should not be surprising because the percentage of multiple births increased from 2 % in 1989 to 4% in 2000 for highly-educated women while the percentage of multiple births remains at approximately 2% for less-educated women. Kogan et al. (2000) find that while constituting only 3% of all births in the United States in 1997, twins accounted for 21% of all low birth weight babies, 14% of preterm births, and 13% of all infant deaths. Although a decrease in the infant health gap is generally perceived as a good outcome, the increase in multiple births closes the gap in a less desirable way – instead of improving infant health at the low end of the distribution, it worsens infant health at the high end.

7. SPECIFICATION CHECKS

7.1 SELECTION ISSUES

When interpreting changes in the gradient using fixed education groups, it is important to address issues of selection because the observed differences may be driven by compositional changes. Over time, on average, an increasingly higher level of educational attainment has been achieved in the U.S. The crux of the selection problem is that people with the same characteristics were more likely to attain higher education levels in 2000 than in 1983. If we observe a narrowing of health gaps between college- and non-college-educated groups, this could be entirely due to changes in the way in which college and high school students are selected rather than due to policies, changes in behavior, or any of the other variables I have discussed above. Due to the general improvement in educational attainment, there are two selection issues: selection of college graduates and selection of high school dropouts.

In 1983, only 16% of mothers had graduated from college; this number increases steadily to 26% in 2000. If we assume that there is a monotonic relationship between the probability of going to college and of giving birth to healthy babies[25], then the individuals who fall between the top 16% and the top 26% can be expected to have worse health than the top 16% of the distribution. This is because these 10% who are college graduates in 2000 would not have finished college in 1983; college graduates are now less favorably selected. As a result, the average infant health of the group as a whole in 2000 is worse than if we included only the top 16% of the sample.

Similarly, there is a constant decline in the number of high school dropouts; in 1983, 21% of mothers fell into this category, as opposed to 18% in 2000. This means that high school dropouts are more negatively selected over time. Again, we need to assume that the probability of completing high school is monotonically correlated with the probability of giving birth to healthy babies. Since 3% of those who would have been high school dropouts are now high

[25] This assumption is supported by the data used in this study.

school graduates, the rest of the high school dropout group is more negatively selected. As a result, the average health of the group has worsened.

If we account for these selection problems, both the corrected college graduate and high school dropout groups would have better health than those observed in the data. This means that not correcting for selection into the college graduate group would overestimate convergence, while not correcting for selection into the high school dropouts group gives an underestimate of convergence. It is, therefore, an empirical question as to whether my evidence of a narrowing infant health gap provides a lower or upper bound on the convergence of health outcomes when using the relative education groups in the results section above.

To overcome these selection issues, I adopt a propensity score method. The objective is to hold constant the probability that a person attends college, given their characteristics. I first estimate a logistic equation predicting the probability of a person attending college in 1983. Next I take the 1983 coefficients and estimate the probability of attending college for the rest of the sample years. Finally, in each year, I take the top 20% of the people as the high education group and the bottom 20% of the people as the low education group. I then re-estimate model (1) using these new relative education groups.

Table 6 shows the changes in the infant health gradient using these relative education groups. The same patterns of convergence emerge as before; that is, we still see convergence in low Apgar scores but not in infant death rates. The interaction terms of the linear time trend and education levels are negative and significant, indicating that the differences in low Apgar scores have decreased since the early 1980s. In summary, the results in this section show that the convergence in low Apgar scores shown in Table 3 is robust to possible selection issues.

7.2 CONVERGENCE BY REGION

In order to further analyze the driving factor – access to medical care – in decreasing the gradient, I examine potential regional patterns given that over the past two decades access to medical care has increased more in southern states than in non-southern states. Thus, my third research question asks whether there is faster convergence in Southern or non-Southern states.[26]

The Medicaid expansion in the late 80s and early 90s might have been more important in the South than in the non-South because less-educated mothers in the South are, on average, poorer than their counterparts in the non-South. Therefore, a larger number of less-educated mothers are covered by Medicaid in the South than in the non-South. This statement is further confirmed by Figure 5 which uses adequate prenatal care as a proxy for access to Medicaid eligibility. The figure shows that the percentage of mothers who have adequate prenatal care over time varies by region and by maternal education. We see that although the percentage of women receiving adequate prenatal care has increased over time in both regions, the percentage increases more rapidly for less-educated women in the South. Before 1990, less-educated women in the South had, on average, less adequate prenatal care than their counterparts in other regions. However, after 1990, less-educated women in the South actually had a higher probability of receiving adequate prenatal care than their counterparts in the non-South. The timing of the rapid increase in adequate prenatal care among less-educated women in the South corresponds exactly to the rapid Medicaid expansion of the late 1980s and early 1990s.

These patterns are substantiated by regressions which divide the sample by region, showing faster convergence in the South relative to the Non-South. Table 7 shows the evolution of the gradient by region. Columns 2 and 3 show the convergence in the South and the non-South

[26] The South includes the following three census regions: West-South-Central, East-South-Central and South-Atlantic. West-South central include Texas, Oklahoma, Arkansas, Louisiana. East-South-Central includes Mississippi, Alabama, Tennessee and Kentucky. South-Atlantic includes Florida, Georgia, South Carolina, North Carolina, Virginia and West Virginia.

areas, respectively. The coefficient of the interaction term between low education and a linear time trend for the South is -0.20% while the coefficient for the non-South is -0.16%, indicating a faster convergence in the South. If we focus on columns 5 and 6, where I restrict the sample period from 1989 to 2000, the results are the same – the South converges faster than the non-South. The estimated effect of convergence is -0.23% for the South, while it is only -0.14% for the non-South. Overall, the coefficients reflect the slower convergence in non-South regions.

By applying the decomposition method described above by region, I show that the contribution of access to medical care to the closing gradient is greater in the South. This result is shown in Table 8. For comparison, Column 1 displays the results for the entire country as in Table 5. Columns 2 and 3 show the decomposition results for the South and for the non-South, respectively. From the table we see that access to medical care accounts for 40% of the reduction of the infant health gradient for the whole nation; however, the regional differences are quite stark. Access to medical care accounts for 65% of the reduction of the infant health gradient in the South, but only 25% of it in the non-South, further supporting the key finding of this section – that the infant health gap converges faster in the South is due to the relative importance of the Medicaid expansions.

8. DISCUSSION AND CONCLUSIONS

This paper provides two major findings regarding changes in infant health disparities over the past twenty years. The gradient, as measured by low Apgar scores, has decreased; however, when using infant death rates as a measure, the gradient has remained relatively constant.

A simple decomposition method reveals that increasing access to medical care is the most important factor in explaining the decrease in the infant health gradient, as measured by a low Apgar score, accounting for 40% of the gap. Changes in maternal behavior and demographic changes also contribute significantly, explaining a remaining 30% and 12%, respectively.

Research has shown that Apgar scores are good predictors of future child health. Therefore, the narrowing gap measured by these scores means that the infant health of the less-educated has improved relative to other groups in a meaningful way. However, these results are not entirely optimistic. First, we do not observe a similar decrease in the gradient when using infant mortality as a measure. Moreover, part of the closing gap is due to the deterioration of infant health among the highly-educated group.

Will the infant health gradient continue to decrease in the future? The results above highlight the fact that part of the convergence is due to the influx of Hispanic immigrants. Since the positive effect of infant health is restricted to immigrants but not to native-born Hispanics, this suggests that if in the future, the immigration influx stops, then health improvements in low SES babies might also slow or stop.

Predictions aside, this paper shows that Medicaid does have an effect on closing infant health inequality, lending some support to the fact that the large government expenditure on Medicaid has been effective.[27] However, there has been relatively little money spent on advocating healthier maternal behavior. An obvious policy implication from this paper is to devote more resources to educating women about prenatal care and fertility decisions, for example, gaining adequate gestational weight gain, and recognizing the negative effects of delayed fertility and treatments.

The framework presented in this paper, which combines demographics, maternal behavior and access to medical care, can provide a guide to addressing the complexities involved in infant

[27] The Medicaid payments made by State and Federal were 207.1 billion in fiscal year 2000, which represents 15 cents of every dollar spent on health care in the United States. Children comprise 51 percent of Medicaid enrollees but account for only 16 percent of Medicaid outlays. (U.S. House of Representatives. 2001.)

health outcomes – policies aimed to further close the health gap thus need to incorporate these three key factors.

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Table 1:

Distribution of Apgar Scores and its Relationship with Infant Death

Apgar Scores	***Percentage***	***Infant Death Rates***			
		ALL	***HS Dropouts***	***HS Graduates /Some College***	***College Graduates***
(1)	(2)	(3)	(4)	(5)	(6)
0	0.07	54.7%	49.4%	53.9%	59.0%
1	0.20	82.1%	80.7%	81.9%	82.3%
2	0.10	56.9%	55.3%	56.3%	56.3%
3	0.11	34.3%	34.8%	33.0%	32.7%
4	0.16	22.7%	23.3%	21.8%	20.6%
5	0.28	14.9%	15.4%	14.5%	13.9%
6	0.64	9.0%	9.8%	8.8%	8.0%
7	1.62	4.1%	4.9%	3.9%	3.3%
8	7.66	1.2%	1.6%	1.2%	0.9%
9	76.64	0.3%	0.6%	0.3%	0.2%
10	12.52	0.3%	0.5%	0.2%	0.1%

Notes: Data are from U.S. Vital Statistics, 1983 to 2000. A low Apgar score is defined as 8 or below—10.84% of infants have low Apgar scores.

Table 2: Summary Statistics by Maternal Education (Percentages Reported)

Variables	Low Education	Middle Education	High Education
Infant Outcomes			
Infant Death	1.32	0.85	0.54
Low Apgar Score	12.07	10.90	9.48
Maternal Behaviors			
Multiple Births	2.01	2.49	3.27
Mother Smokes during Pregnancy	28.33	16.46	3.05
Weight Gain less than 15 Pounds	10.02	8.04	4.30
Weight Gain greater than 60 Pounds	3.15	2.67	1.48
Teenage Mother	40.54	7.96	0.00
Maternal Age over 40	0.76	1.07	2.65
Married Mother	42.36	73.54	95.36
Demographic Variables			
Hispanic	15.79	5.35	2.79
African-American	26.84	17.99	7.08
White	53.84	73.78	85.52
Other Races	3.53	2.89	4.61
Foreign-Born Mother	15.44	7.75	10.69
Access to Medical Care			
Adequate Prenatal Care	49.47	72.22	85.42
Inadequate Prenatal Care	13.65	4.81	1.37
observations	874,774	2,632,968	904,444

Notes:

1. Low Education: less than 12 years of schooling completed; Middle Education: 12 to 15 years of schooling completed; High Education: 16 or more years of schooling completed.
2. Data are from U.S. Vital Statistics, 1983 to 2000.

Table 3: The Effects of Education on Infant Health (Logistic Marginal Effects)

	Low Apgar Score	*Infant Death*
	(1)	(2)
Low Education	4.012**	0.683**
	[0.256]	[0.043]
Middle Education	2.014**	0.252**
	[0.178]	[0.028]
Time Trend * Low Education	-0.166**	0.003
	[0.012]	[0.003]
Time Trend * Middle Education	-0.068**	0.011**
	[0.008]	[0.002]
Year Trend	-0.096**	-0.031**
	[0.018]	[0.002]
Constant	-20.71**	-4.009**
	[0.229]	[0.095]
Observations	4,357,908	3,667,295

Notes:

1. The coefficients are scaled up by 100.
2. Robust standard errors in brackets.
3. Regressions do not include any controls (unconditional regressions).
4. * Significant at 5%; ** Significant at 1%
5. Data are from U.S. Vital Statistics, 1983 to 2000.

Table 4: The Effects of Maternal Education on Infant Health (Logistic Marginal Effects) With Control Variables Reported

	1983~2000		1989~2000	
	Low Apgar Score	Infant Death	Low Apgar Score	Infant Death
Low Education	2.33**	0.26**	2.03**	0.03
	[0.22]	[0.04]	[0.29]	[0.05]
Middle Education	1.42**	0.08**	1.14**	-0.03
	[0.16]	[0.02]	[0.21]	[0.04]
Year Trend * Low Education	-0.13**	0.01**	-0.12**	0.01**
	[0.01]	[0.00]	[0.02]	[0.00]
Year Trend * Middle Education	-0.06**	0.01**	-0.05**	0.01**
	[0.01]	[0.00]	[0.01]	[0.00]
Year Trend	-0.12**	-0.03**	-0.01	-0.03**
	[0.02]	[0.00]	[0.02]	[0.00]
Adequate Prenatal Care	-1.21**	-0.28**	-0.92**	-0.19**
	[0.12]	[0.01]	[0.13]	[0.01]
Inadequate Prenatal Care	0.79**	0.15**	0.93**	0.11**
	[0.1]	[0.01]	[0.1]	[0.02]
Blacks	0.92**	0.38**	0.7*	0.31**
	[0.31]	[0.02]	[0.28]	[0.01]
Hispanics	-0.79	-0.05*	-0.85	-0.04
	[0.51]	[0.03]	[0.44]	[0.02]
Other Races	-0.44	0.09*	-0.53*	0.05
	[0.25]	[0.04]	[0.22]	[0.03]
Foreign-Born Mother	-1.4**	-0.17**	-1.19**	-0.11**
	[0.31]	[0.02]	[0.29]	[0.02]
Married Mother	-1.25**	-0.17**	-1.12**	-0.12**
	[0.07]	[0.02]	[0.08]	[0.01]
Multiple Births	11.42**	1.27**	10.96**	1.06**
	[0.28]	[0.03]	[0.27]	[0.03]
Teenage Mother	0.68**	0.03*	0.82**	0.09**
	[0.09]	[0.02]	[0.1]	[0.01]
Maternal Age over 40	1.87**	0.19**	1.61**	0.1**
	[0.16]	[0.03]	[0.17]	[0.03]

Table 4: (Continued)

Weight Gain <=15 Pounds			*3.14***	*0.74***
			[0.1]	[0.02]
Weight Gain >=60 Pounds			0.43**	-0.32**
			[0.13]	[0.05]
Smoking			0.01	0.15**
			[0.1]	[0.01]
Constant	-18.43**	-3.22**	-19.22**	-2.72**
	[0.24]	[0.06]	[0.34]	[0.06]
Observations	4,357,908	3,667,295	2,964,046	2,246,274

Notes:

1. The coefficients are scaled up by 100.
2. Robust standard errors in brackets.
3. * Significant at 5%; ** Significant at 1%
4. Data from U.S. Vital Statistics, 1983 to 2000.

Table 5: Decomposition Results

		Changes in Characteristics		Changes in Coefficients	
	Total	Term(a)	Term(b)	Term(c)	Term(d)
Adequate Prenatal Care	37.00%	9.40%	-4.90%	14.40%	18.10%
Inadequate Prenatal Care	2.50%	4.90%	-2.90%	3.00%	-2.60%
Total Effects of Access to Medical Care	*39.50%*				
Mom Black	4.80%	4.30%	-1.00%	3.30%	-1.80%
Mom Hispanic	-5.90%	1.90%	4.40%	9.10%	-21.50%
Mom Other Races	1.00%	-1.60%	-0.10%	1.70%	0.90%
Mom Foreign-Born	12.10%	3.40%	4.20%	2.60%	1.80%
Total Effects of Demographic Changes	*12.00%*				
Mom Married	12.10%	-5.70%	4.10%	7.70%	6.00%
Multiple Births	11.10%	11.30%	-0.40%	-1.50%	1.60%
Weight Gain <=15 Pounds	9.90%	0.70%	-0.30%	3.00%	6.50%
Weight Gain >=60 Pounds	-3.10%	-0.10%	0.20%	1.00%	-4.30%
Mother Smokes During Pregnancy	3.60%	1.60%	-1.20%	-2.60%	5.90%
Mom Age >= 40	-3.40%	0.90%	0.10%	-1.20%	-3.10%
Total Effects of Behavior Changes	*30.20%*				
Unexplained	18.40%	0.00%	0.00%	0.00%	18.40%
Total	100.00%	31.10%	2.40%	40.60%	25.90%

Note: The first column is the sum of Term(a) through Term(d).

Table 6: The Effects of Maternal Education on Infant Health Using Relative Education Measures
A Robustness Check- The Probability of Going to College is Held Constant in Order to Address the Selection Issue.

	Low Apgar Score	*Infant Death*
Low Education	6.133**	0.998**
	[0.377]	[0.045]
Middle Education	2.953**	0.424**
	[0.394]	[0.031]
Year Trend * Low Education	-0.166**	0.004
	[0.026]	[0.004]
Year Trend * Middle Education	-0.083**	0.009**
	[0.03]	[0.003]
Time Trend	-0.092**	-0.032**
	[0.027]	[0.003]
Constant	-21.598**	-4.025**
	[0.331]	[0.091]
Observations	4,357,908	3,667,295

Notes:

1. The coefficients are scaled up by 100.
2. I first estimate a logistic equation predicting the probability of people going to college for 1983. Second, I take the 1983 coefficients and estimate the probability of going to college for the rest of the sample years. Finally, in each year, I take the top 20% of the people as the high education group and bottom 20% of the people as the low education group. I then estimate model (1) using these new education group variables.
3. Data are from U.S. Vital Statistics, 1983 to 2000.

Table 7: The Effects of Maternal Education on Infant Health by Region (South, Non-South)

	1983~2000			1989~2000		
	All	South	Non-South	All	South	Non-South
Low Education	3.02**	3.54**	2.88**	3.06**	3.77**	2.71**
	[0.23]	[0.22]	[0.29]	[0.23]	[0.26]	[0.24]
Middle Education	1.61**	1.95**	1.49**	1.54**	1.87**	1.41**
	[0.16]	[0.17]	[0.2]	[0.16]	[0.19]	[0.19]
Year Trend * Low Education	-0.17**	-0.20**	-0.16**	-0.18**	-0.23**	-0.14**
	[0.01]	[0.02]	[0.02]	[0.02]	[0.04]	[0.02]
Year Trend * Middle Education	-0.07**	-0.08**	-0.06**	-0.06**	-0.07**	-0.05**
	[0.01]	[0.01]	[0.01]	[0.01]	[0.03]	[0.02]
Year Trend	-0.1**	-0.05*	-0.11**	0.02	0.04	0.02
	[0.02]	[0.02]	[0.02]	[0.02]	[0.04]	[0.02]
Constant	-20.71**	-21.13**	-20.62**	-21.24**	-21.41**	-21.26**
	[0.23]	[0.44]	[0.24]	[0.34]	[0.67]	[0.37]
Observations	4,357,908	1,627,326	2,730,582	2,964,046	1,125,508	1,838,538

Notes:

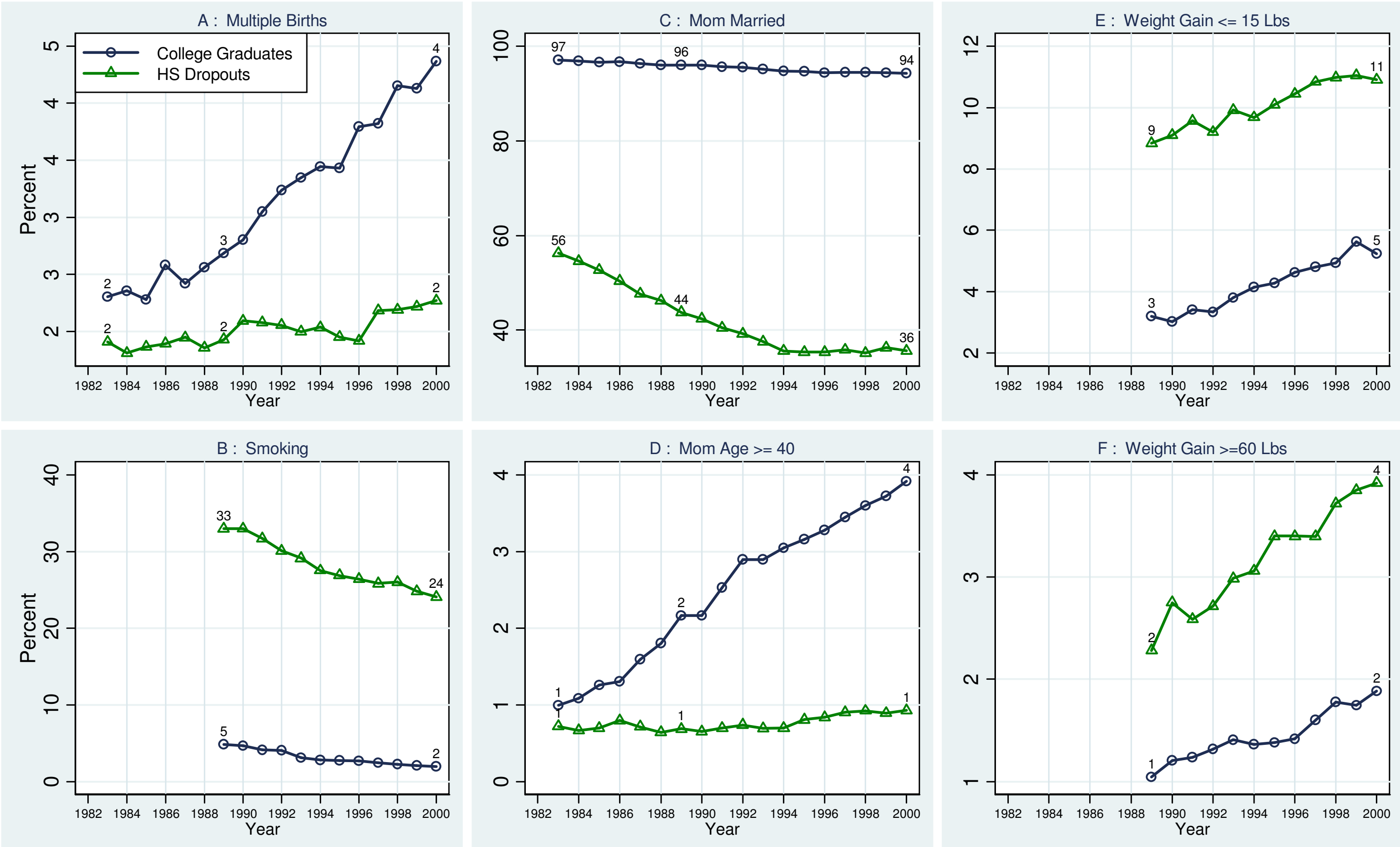
1. The dependent variable is a dummy variable for low Apgar score.
2. The coefficients are scaled up by 100.
3. Data from U.S. Vital Statistics, 1983 to 2000.
4. Robust standard errors in brackets.
5. * Significant at 5%; ** Significant at 1%.

Table 8: Decomposition Results by Region

Decomposition Results	All	South	Non-South
Adequate Prenatal Care	37.0%	64.3%	21.3%
Inadequate Prenatal Care	2.5%	2.2%	4.2%
Total Effect of Access to Medical Care	39.5%	66.5%	25.5%
Mother Black	4.8%	18.6%	-11.7%
Mother Hispanic	-5.9%	1.7%	-10.4%
Mother Other Races	1.0%	0.5%	0.2%
Mother Foreign-Born	12.1%	3.6%	14.8%
Mother Married	12.1%	43.0%	-22.5%
Multiple Births	11.1%	8.3%	14.5%
Weight Gain <=15 Pounds	9.9%	2.8%	17.5%
Weight Gain >=60 Pounds	-3.1%	-4.9%	-0.4%
Mother Smoke During Pregnancy	3.6%	6.7%	0.8%
Mother Age >= 40	-3.4%	-0.9%	-6.2%
Unexplained	18.4%	-46.0%	78.0%
Total	100.0%	100.0%	100.0%

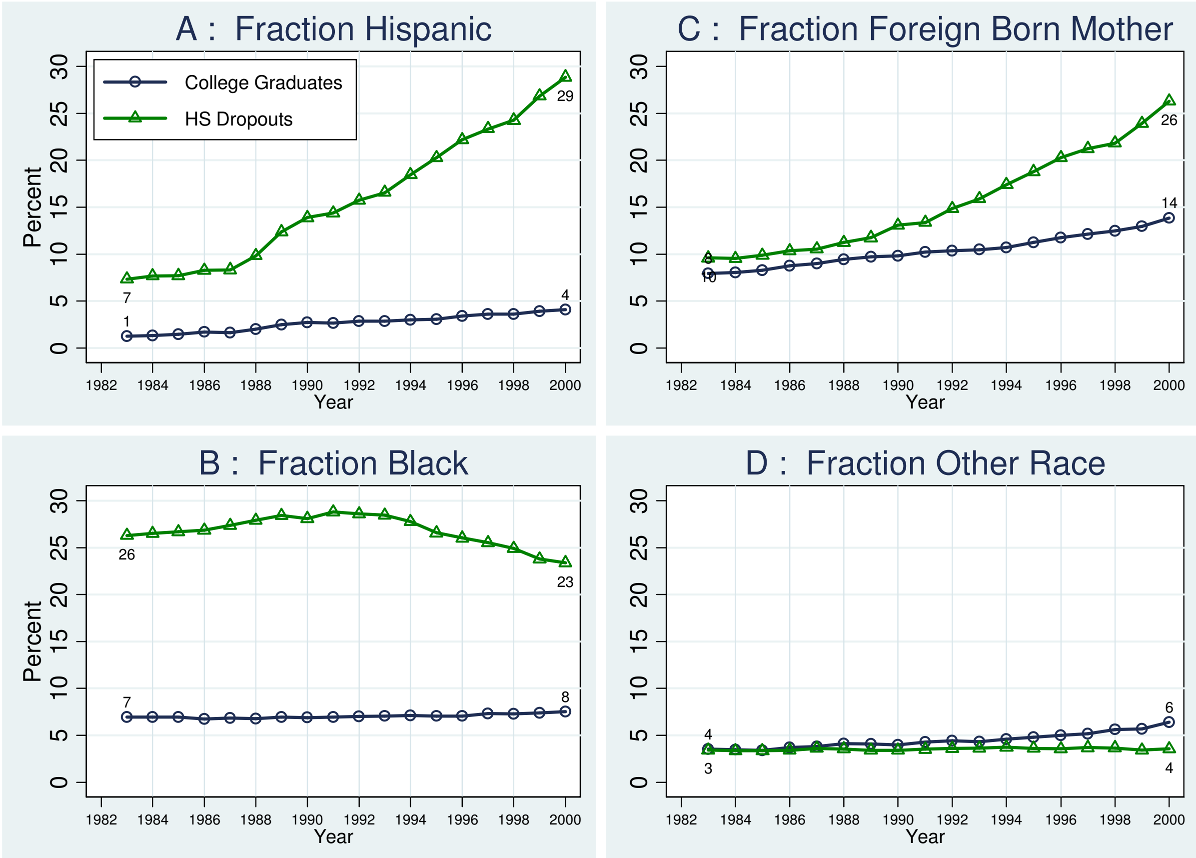
Notes: Data are from U.S. Vital Statistics, 1983 to 2000.

Figure 1: Changes in Characteristics - Maternal Behavior



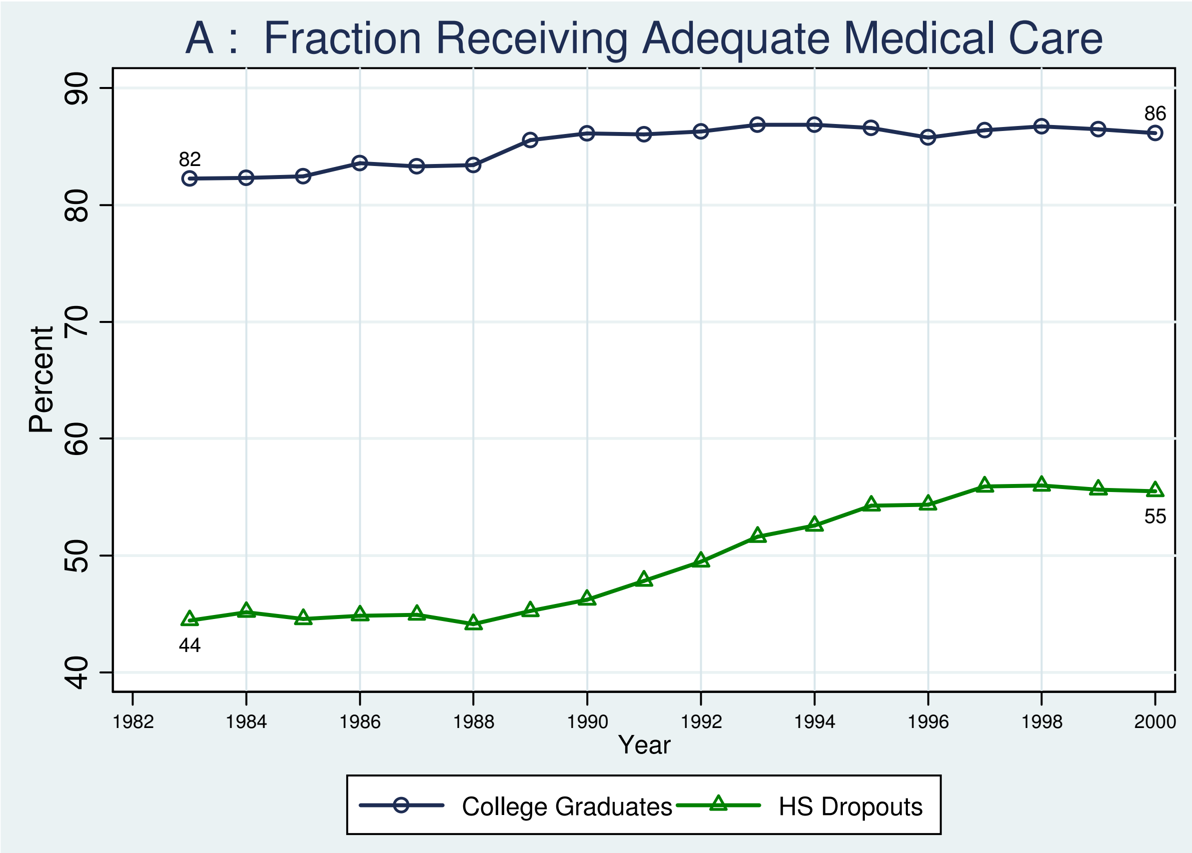
Notes: Data are from U.S. Vital Statistics, 1983 to 2000. This figure shows behavior change variables by maternal education over time.

Figure 2: Changes in Characteristics - Demographic Composition



Notes: Data are from 1983 to 2000 U.S. Vital Statistic Data. This figure shows time trends for demographic composition variables by maternal education.

Figure 3: Changes in Characteristics - Access to Medical Care



Notes: Data are from U.S. Vital Statistics, 1983 to 2000. This figure shows time trends for access to medical care by maternal education.

Figure 4a: Low Apgar Score Fractions over Time

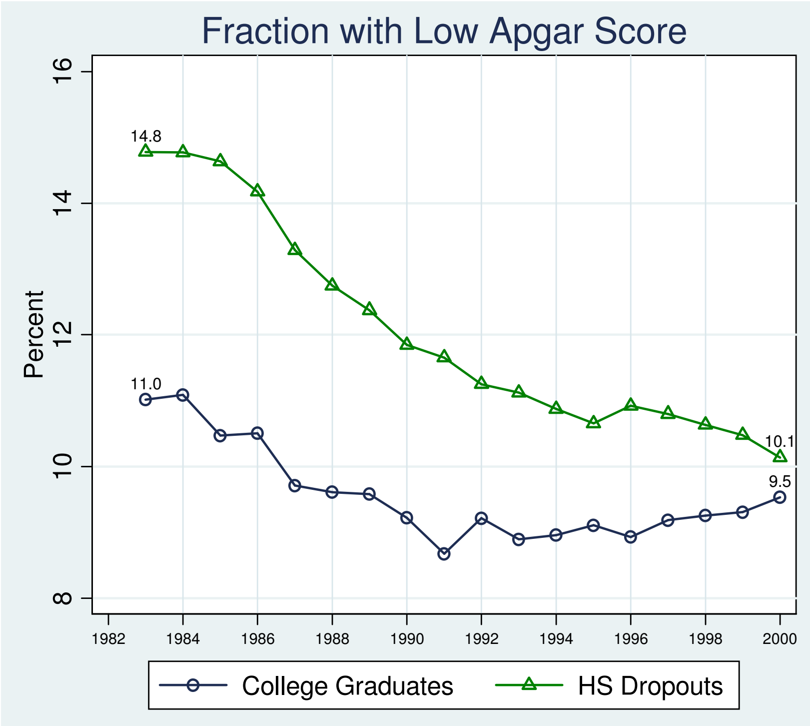
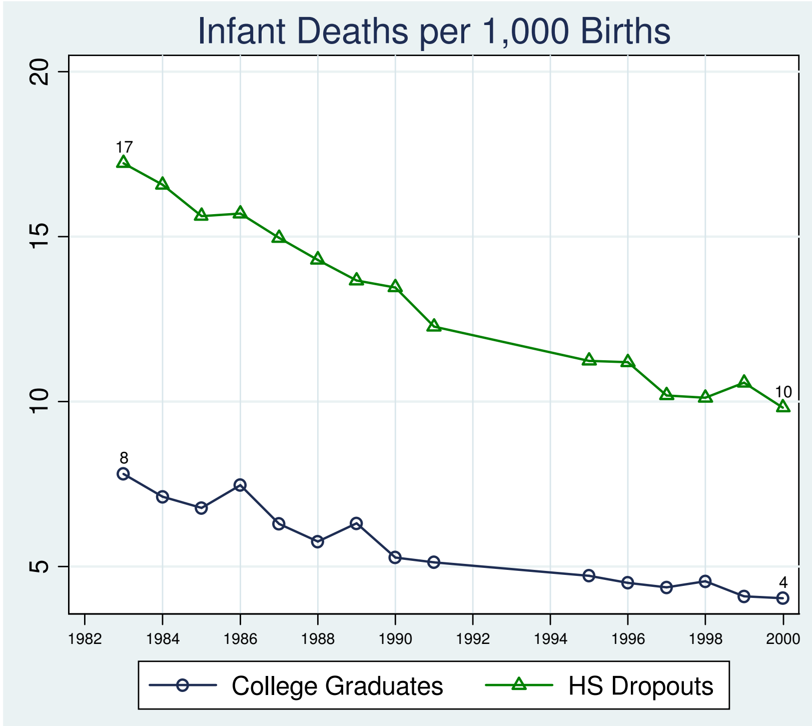
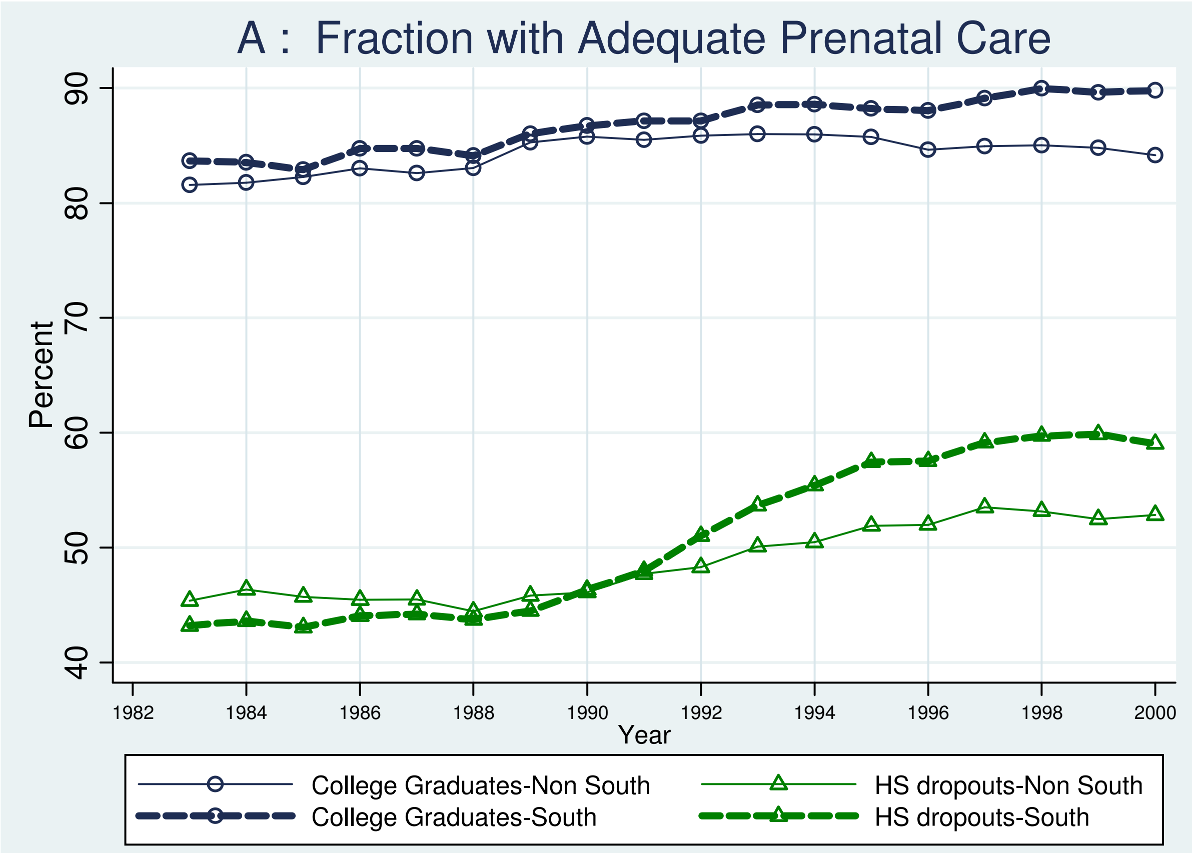


Figure 4b: Infant Death Fractions over Time



Notes: Data are from U.S. Vital Statistics, 1983 to 2000. Figures 4a and 4b plot the conditional expectation of low Apgar scores and infant death rates as a function of time by maternal education. The gradient has decreased in terms of low Apgar score and has stayed constant in terms of infant death rates.

Figure 5: Access to Medical Care by Maternal Education and by Region



Notes: Data are from U.S. Vital Statistics, 1983 to 2000. This graph shows that after 1990, the low education group in the South had more adequate prenatal care than their non-South counterpart. The timing of the increase of prenatal care coincides with the rapid Medicaid expansion in the late 80s and early 90s.