

# Do Highly Educated Women Choose Smaller Families?\*

Moshe Hazan

Hosny Zoabi

Hebrew University and CEPR

Tel Aviv University

August 2012

## Abstract

Conventional wisdom suggests that in developed countries education and fertility are negatively correlated. We present new evidence that between 2001 and 2009 the cross-sectional relationship between total fertility rate and women's education in the U.S. is U-shaped. Our analysis of earlier periods shows that this pattern is new, which uncovers an emerging new pattern of cohort fertility. At the same time, average hours worked increases monotonically with women's education violating the well-known negative correlation between fertility and women's labor supply. This pattern is true for all women and mothers to newborns regardless of marital status. To explain these new evidence, we advance the marketization hypothesis. In our model, raising children and home-making require parents' time, which could be substituted by services bought in the market such as baby-sitting and housekeeping. Highly educated women substitute a significant part of their own time for market services to raise children and run their households, which enables them to have more children and work longer hours.

---

\*We thank Ghazala Azmat, David de la Croix, Alon Eizenberg, Oded Galor, Cecilia Garcia Peñalosa, Jeremy Greenwood, Nezih Guner, Oksana Leukhina, Guy Michaels, Yishay Maoz, Stelios Michalopoulos, Omer Moav, Steve Pischke, Tali Regev, Yona Rubinstein, Analia Schlosser, Christian Siegel, David Weil, Marios Zachariadis, seminar participants at the University of Cyprus, London School of Economics, Tel Aviv University, and conference participants in the II Workshop on "Towards Sustained Economic Growth", Barcelona 2011, the Society for Economic Dynamics, Limassol 2012 and the Economic Workshop at IDC, Herzliya 2012. Hazan: Department of Economics, Hebrew University of Jerusalem, Mt. Scopus, Jerusalem 91905 e-mail: moshe.hazan@huji.ac.il. Zoabi: The Eitan Berglas School of Economics, Tel-Aviv University, P.O.B. 39040 Ramat Aviv, Tel Aviv, 69978. e-mail: hosnyz@post.tau.ac.il

# 1 Introduction

Ever since the demographic transition, conventional wisdom suggests that income and fertility are negatively correlated. This has been documented at the aggregate level in a cross-section of countries (Weil 2005); over time within countries and regions (Galor 2005, Galor 2011) and in cross-section of households in virtually all developing and developed countries (Kremer and Chen 2002). Jones and Tertilt (2008) use data from the U.S. census to document the history of the relationship between fertility choice and key economic indicators at the individual level for women born between 1826 and 1960. They found a strong negative cross-sectional relationship between fertility on the one hand, and income and education of both husbands and wives on the other hand, for all cohorts. Finally, Preston and Sten Hartnett (2008) and Isen and Stevenson (2010) find similar pattern for cohorts born through the late 1950s.<sup>1</sup>

Using data from the American Community Survey, we present below new evidence on the cross-sectional relationship between fertility and women's education in the U.S. We show that between 2001 and 2009, the relationship between total fertility rate (henceforth: TFR) and female education is U-shaped. Specifically, we classify women into five educational groups: no high school degree, high-school degree, some college, college degree and advanced degree. We show that TFR decreased from 2.24 for the first group to 2.11 and 1.79 for the second and third groups, respectively, but then rises to 1.93 and 1.98 for the fourth and fifth groups, respectively.<sup>2</sup>

We extend our examination of the association between fertility and women's education by estimating linear probability models. This approach enables us to

---

<sup>1</sup>This inability to find positive correlation between income or education and fertility has led some scholars to cast doubts on the assumption that children are a normal good (see Jones and Tertilt 2008, Guinnane 2011). Black, Kolesnikova, Sanders and Taylor (2012) show that children are indeed a normal good. Using the exogenous increase in the price of coal during the energy crisis in the mid 1970s, they document that males' income in the Appalachian coal-mining region increased and that led to an increase in fertility.

<sup>2</sup>Shang and Weinberg (2009) study in detail the fertility of college graduate women. They show that since the late 1990s, fertility of college graduates has increased over time. They do not, however, discuss the cross-sectional relationship between fertility and female education, which is the focus here.

control for various characteristics such as marital status, age, state of residence and family income, which may be responsible for the relationship between fertility rates and women's education. We find that the partial correlation between fertility and women's education is indeed U-shaped.

The importance of this pattern crucially depends on the likelihood that the observed U-shaped pattern in TFR today will be translated into completed fertility rates for cohorts that have not yet completed their fertility. To address this issue we begin by showing that the U-shaped pattern in TFR is a new phenomenon. If not, then there is no obvious reason to expect that the pattern in TFR will be translated into completed fertility. Indeed, we find that fertility monotonically decreases in education in 1980 and that this is also true in 1990, although the differential fertility among women with exactly college degree and women with advanced degree declines. In 2000, in contrast, we find that fertility among women with advanced degree is slightly higher than for women with exactly college degree.

Since the U-shaped pattern in TFR is indeed a new phenomenon, it is not surprising that it is not yet reflected in completed fertility even for the youngest cohort for which this measure is available. Nevertheless, it is instructive to look at the fertility of cohorts that have recently approached the end of their fertile period. We show that while completed fertility monotonically declines across the educational groups for all cohorts, the changes in the cross-sectional relationship across cohorts closely follows changes in TFR. In particular, completed fertility of women with advanced degree increases monotonically across recent cohorts, closing the gap between this group and any other group. This provide strong support to our conjecture that what we see in TFR today is likely to be translated into completed fertility in the future.

Turning to labor supply, standard models predict that to the extent that the substitution effect dominates the income effect, more educated women – who face higher wages – supply more hours to the labor market. Indeed, this prediction is well documented and is verified in our data as well. Meanwhile, standard models of household economics suggest that there is a negative relationship between female labor supply and fertility: women who work more have less time to raise

children (Gronau 1977, Galor and Weil 1996). Thus, our findings regarding the pattern of fertility, along with the pattern of labor supply, raise two questions: (i) what can account for the U-shaped fertility pattern and (ii) what can account for the positive correlation between fertility and labor supply for highly educated women.

We advance an explanation that relies on the *marketization hypothesis* (Freeman and Schettkat 2005, Freeman 2007). We argue that highly educated women find it optimal to purchase services such as nannies, baby-sitters and day-care, as well as to purchase housekeeping services to help them run their homes. This enables these highly educated women to have more children and work more hours in the labor market. Indeed, Cortes and Tessada (2011) found that (i) low-skilled immigration has increased hours worked by women with advanced degrees and that the labor supply effects are significantly larger for those with young children. (ii) Using time-use data for the period 2003 and 2005, Cortes and Tessada also found that hours spent on household chores declines quite dramatically along the educational gradient and (iii) using consumer expenditure data, they show that the fraction of women who uses housekeeping services increases sharply with education. Furtado and Hock (2010) found that college educated women living in metropolitan areas with larger inflows of low skilled immigrants experience much small tradeoff between work and fertility. Further support for the marketization hypothesis is provided in Mazzolari and Ragusa (2012) and Manning (2004). Manning (2004) showed that the employment opportunities of unskilled labor depend on physical proximity to skilled workers. Similarly, Mazzolari and Ragusa (2012) found that growth in a city top wage bill share is associated with significant low-skilled employment growth in the sector of services that substitute for home production activities.

To illustrate our argument, we use a standard model in which parents derive utility from consumption and the full income of children. On the children side, parents decide upon the quantity of children (fertility) and their quality (education). We follow the standard models along two assumptions. First, we assume that education is bought in the market, as in de la Croix and Doepke (2003) and Moav (2005) and show that for highly educated women education is relatively

cheaper, which allows them to purchase more education for their children, even if they allocate the same share of income for quality. Second, as in Hazan and Berdugo (2002) and de la Croix and Doepke (2003), we assume that nature equips children with a basic skill. This basic skill implies that as parents' human capital increases, the share of income that is allocated to the quality of each child increases at the expense of the share of income allocated to quantity. This happens because the value of the basic skill in terms of income is relatively high for low income parents. As a result, parents find it optimal to spend a relatively large share of income in quantity and a relatively low share in quality. In contrast, for high income parents, the value of the basic skill is relatively small, which induces parents to allocate a higher share of income for quality at the expense of quantity.

To emphasize the reliance on market substitutes for parental time, we deviate from the existing models (e.g. Galor and Weil 2000) by allowing parents to substitute other people's time for their own time by purchasing child-care or baby-sitting services in the market.<sup>3</sup> This marketization process is an essential element in our mechanism that yields U-shaped fertility pattern. To see this, ignore for the moment this marketization channel, and assume that quantity requires parents' time only. In this case, with an increase in parent's human capital, both parent's income and the price for quantity increase by the same proportion. However, since high income parents allocate a lower share of their income to quantity, the optimal number of children monotonically declines.

Marketization, however, affects the price for quantity that parents face. For parents with low levels of human capital, (i.e., low income), marketization is low and thus the parents themselves engage in most of the child raising. Thus, the intuition explained above holds. In contrast, parents with high levels of human capital optimally outsource a major part of their child-raising, which, in turn, reduces the price for children from parents' point of view. We show that this reduction can be sufficiently large to induce an increase in fertility above a certain level of human capital.

In terms of parents' time, our theory suggests that time spent on raising children

---

<sup>3</sup>Aiyagari, Greenwood and Seshadri (2002) allow parents to substitute child-care for their own time. However, in their model, fertility is exogenous and, therefore, they do not study the effect of such services on fertility choice.

may decrease or increase with parents' human capital. In our basic model, where education is only bought in the market, parents' time spent on raising children decreases with parents' human capital. This occurs for two reasons. First, as discussed above, the fraction of income allocated to raising children decreases with parents' human capital. Second, parents' reliance on market substitutes increases with human capital. However, Guryan, Hurst and Kearney (2008) found that mother's time allocated to childcare increases with mother's education.<sup>4</sup> In their empirical analysis, however, childcare is defined as the sum of four primary time use components: "basic", "educational", "recreational" and "travel". Clearly, the educational and recreational components and part of the travel component are investment in children's quality.

Ramey and Ramey (2010) reconcile the seemingly paradoxical allocation of time, according to which mothers with a higher opportunity cost of time spend more, rather than less time with their children despite the availability of market substitutes. They argue that as slots in elite postsecondary institutions have become scarcer, parents responded by investing more in their children's quality so that they appear more desirable to college admissions officers. Since more educated parents spend more of their own time and on market goods and services related to child's quality, it implies that parental time and market goods and services are strong complements in the production of children's quality. To capture this idea, we extend our model in Section 3.3 by assuming that children's quality requires not only education bought in schools but also parental time, and show that, consistent with the evidence, the model can predict that parents' time allocated to children increases with parents' human capital.

On the consumption side, we assume that individuals combine time and a market good to produce the consumption good that enters their utility function. Furthermore, we assume that parents can substitute a housekeeper's time for their own time by purchasing these services in the market. This substitutability implies that the share of income devoted to home production by parents decreases as parents' education increases.

---

<sup>4</sup>Table 2 in Guryan et al. (2008) reports that hours per week spent in total childcare are 12.1, 12.6, 13.3, 16.5 and 17 for mothers with <12, 12, 13-15, 16 and 16+ years of schooling, respectively.

One may suggest an alternative hypothesis to explain the positive association between fertility and female labor supply for highly educated women: spouses of highly educated women may work less to compensate for their wives' extra hours in the labor market. We show, however, that spouses of these highly educated women supply more hours compared to spouses of less educated women. As for the fertility pattern, a competing explanation can be related to marital status. If more educated women have higher marriage rates and if marital fertility is higher than non-marital fertility, this can give rise to the pattern we find. Looking at marriage rate by educational groups, we show that the fraction of currently married women is lower among those with advanced degrees compared to those with just a college degree.

As a last piece of evidence in favor of our theory, we study the association between fertility, women's education and wage inequality. The idea is that the higher the wage inequality, the lower is the relative price of unskilled labor intensive services, such as childcare and housekeeping. Since in theory the marketization mechanism is more effective when the relative price of these services is lower, inequality should positively affect the fertility of highly educated women. We add a measure of wage inequality to our linear probability models that study the association between fertility and women's education, and allow the partial association of fertility and inequality to vary with education. Taking women lacking a high-school diploma as the base group, we find that the difference in the conditional probability of giving a birth between women in any educational group and the base group increases with inequality and that this difference increases along the educational gradient.

The rest of the paper is organized as follows. Section 2 presents the evidence on the U-shaped fertility pattern. In Section 3, we lay out the model and present the main results of the theory. In Section 4, we provide evidence on labor supply and marriage rates, as well as on the association between women's education, fertility and wage inequality to support our theory. Finally, Section 5 provides concluding remarks.

## 2 Patterns of American Fertility by Education

We use the American Community Survey (henceforth: ACS) to document basic facts on the fertility behavior of American women and the correlation between fertility behavior and the education of these women (Ruggles, Alexander, Genadek, Goeken, Schroeder and Sobek 2010). The ACS is a suitable survey to study current trends in fertility of American women, as it explicitly asks each respondent whether she gave birth to any children in the past 12 months.

We pooled data from the ACS for the years 2001–2009 and restrict our sample to white, non-Hispanic women who live in households under the 1970 definition.<sup>5</sup> Using these data, we estimate age-specific-fertility-rates by five educational groups; no high school diploma, high school diploma, some college, college, and advanced degrees.<sup>6</sup> Figure 1 shows these estimates.

The pattern of these estimates is not surprising: while fertility rates of women who did not complete high school or have a high school diploma peak at ages 20–24, they peak at ages 25–29 for women with some college education and at ages 30–34 for women with college or advanced degrees.<sup>7</sup>

Next, we sum up these age-specific-fertility-rates, to obtain estimates of TFR. In principal, we could estimate age-specific-fertility-rates by educational groups year by year, and present TFR by educational group for each year between 2001 and 2009. Table 1 shows these estimates. As can be seen from the table, in each of these years, women with advanced degrees had a higher TFR than women with some college or college, and in most years, women with college degree had higher TFR than women with some college. However, since we are interested in period fertility as a predictor of completed fertility, we pooled all the observations over the period 2001–2009 and estimate TFR for this period as a whole, to smooth out temporary differences in the timing of births across educational groups.

---

<sup>5</sup>Our finding is unchanged if we include women of all races, but we want to avoid compositional effects coming from changes in the fraction of each race and ethnic group over the period.

<sup>6</sup>We assign women into educational groups according to their current highest year of school or degree completed. In Section 2.2 we discuss the potential bias this creates and correct for it.

<sup>7</sup>We do not report standard errors on these estimates. Given the sample size, the standard errors on these estimates are essentially zero.



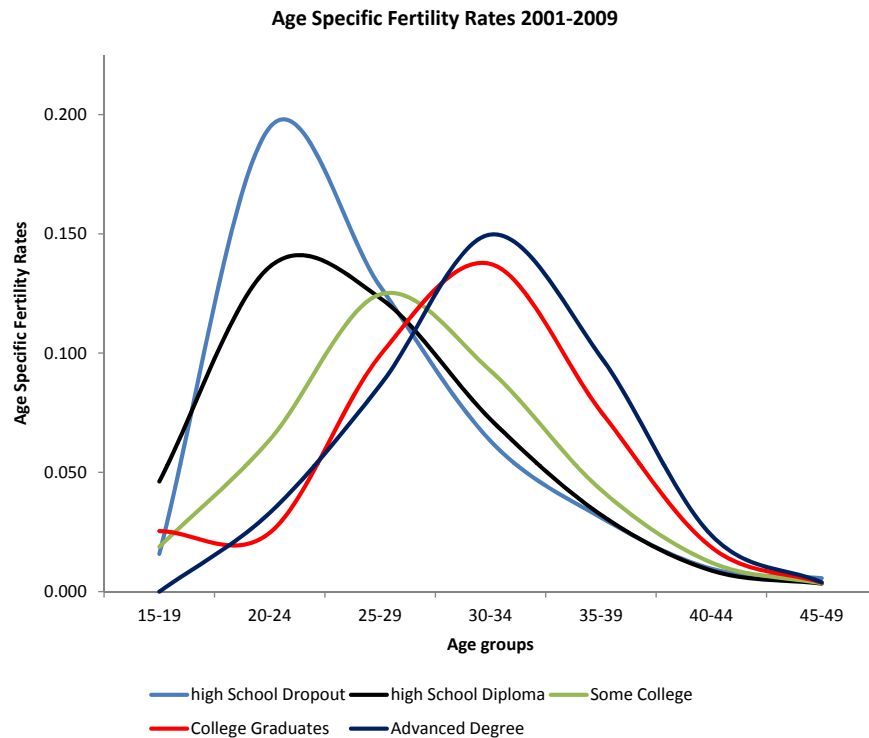


Figure 1: Age-Specific-Fertility-Rates by educational groups, 2001-2009. Authors' calculations using data from the American Community Survey.

Figure 2 shows our findings. As can be seen from the figure, TFR declines for women up to those with some college, but then increases for women with college and advanced degrees. Specifically, TFR among women with no high school diploma is 2.24, among women with high-school diploma it is 2.11 and among women with some college it is 1.79. However, the TFR among women with college degree is 1.93 and among women with advanced degrees it is 1.98.

This U-shaped fertility pattern raises few issues. First, is this pattern robust to differences in the age structure, marital status and family income across women in different educational group? Second, how one deals with the assignment of women to educational groups, which is based on current, rather than complete schooling? Third, is the U-shaped pattern really a new phenomenon? Finally, and most importantly, what can be learned from this new pattern of TFR, namely, will the period fertility rate be translated into completed fertility? In what follows

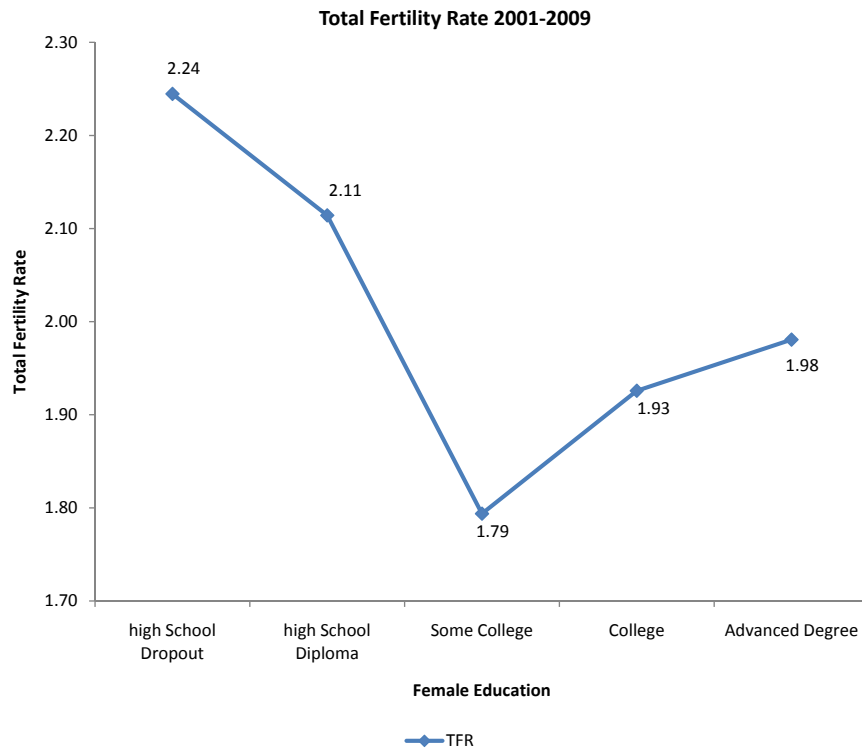


Figure 2: Total fertility rate, 2001-2009. Authors' calculations using data from the American Community Survey.

we address each of these questions. We show that our overall analysis paints a picture of an emerging new pattern of fertility by education.

## 2.1 The Partial Association between Fertility and Women's Education

Regression models provide a different means of presenting the association between fertility and women's education. The advantage of this approach is that we can control for various characteristics such as age, marital status, family income, year and state effects that may be responsible for the relationship between fertility and women's education. Table 2 shows the results from linear probability models that take the following structure:

$$b_{ist} = e'_{ist} \cdot \pi + X'_{ist} \beta + \epsilon_{ist}$$

where the dependant variable,  $b_{ist}$ , is a binary variable that takes the value 1 if woman  $i$  living in state  $s$  in year  $t$  gave birth to any children during the reference period and 0 otherwise,  $e'_{ist}$  is a set of five dummy variables that correspond to the five educational levels described above and the coefficients of interest are  $\pi$ .  $X_{ist}$  denotes other covariates including marital status dummies, age dummies, year and state dummies, as well as family income and family income squared. The educational group of high-school dropouts is the omitted category, so the coefficients on the other educational groups can be interpreted as the difference in the probability of giving birth relative to that group.

In column (1) we regress  $b_{ist}$  only on the educational dummies. Thus, the coefficients in this column are the unconditional differences in the probability of giving a birth, namely “fertility rates”, relative to fertility rates among women who do not have a high school diploma. As can be seen, fertility rates monotonically increase with education.<sup>8</sup> Column (2) adds dummies for marital status. Since the fraction of currently married women is the lowest for women lacking a high school diploma (see Figure 11 below) and one expects to find higher fertility rates among married women, controlling for marital status should lower the coefficients on education in column (2). Indeed, the coefficients are substantially lower in column (2) than in (1) and in particular, those on the groups high-school diploma and some college change sign and are now negative. The positive coefficients on college and advanced degrees imply a U-shaped pattern in fertility rates.

In column (3), we add age dummies. Since age is not monotonically related to fertility rates, a priori the effect on the educational dummies is not predictable. As can be seen in column (3), though, adding age dummies substantially reduces the coefficients on the educational dummies. Now the coefficients on high-school

---

<sup>8</sup>This may seem at odds with the reported TFR in Figure 2, where TFR is the *highest* for women without high-school diplomas. Notice, however, that TFR sums up age-specific-fertility-rates, which are mean births rates within educational-*age* groups; it could well be that the fertility rate is lower even if the sum of the age-specific-fertility-rates are larger.

diploma, some college and college graduates are negative and significant, while that on advanced degrees is essentially zero. Nevertheless, this still implies a U-shaped relationship between fertility rates and women's education. In Column (4) we add year dummies and in column (5) we also add state dummies. Neither the year dummies nor the state dummies change the results of column (3). Finally, in column (6) we add total family income and total family income squared. Interestingly, the partial correlation between family income and fertility rate is also U-shaped, even after controlling for women's education. More importantly, the inclusion of family income does not affect the coefficients on high-school graduates and some college, while it increases the coefficients on college graduates and advanced degrees, where the later becomes positive and significant. This strengthens the U-shaped relationship between fertility rate and women's education.<sup>9</sup>

## 2.2 The Assignment of Women into Educational Groups

One concern in our analysis so far is the assignment of women into educational groups. Given the structure of our data, we observe each woman only once and assign women into educational groups according to their educational attainment at the time of the survey, as measured by the highest year of school or degree completed. While this might not be an issue for relatively older women, it must create large biases among young women. For example, almost all women age 15 are currently in high-school. This implies that we assign all of these women into the group of high-school dropouts, even though some of them will end up with advanced degrees. If the true relationship between TFR and education is decreasing, then this assignment problem may bias the estimated TFR towards a U-shaped pattern.

To address this concern, we propose a "hybrid" measure of fertility. As we pointed out, the bias may be severe for young women, but is less of a concern for older women. Our hybrid measure uses actual fertility experienced by young

---

<sup>9</sup>The results of these six models are essentially the same if we use a probit instead of a linear probability model. These results are shown in Table 3 but are not discussed in the text.

women, combined with period measure of fertility for older women. Specifically, we sum up the number of children ever born to women at age  $a$  and the age-specific-fertility rates from age  $a + 1$  to age 49. To the extent that women complete their education by age  $a$ , all women are assigned to their true educational group. This consideration suggests that we should choose a relatively large  $a$ . Such a choice, however, comes with a cost. The higher  $a$ , the larger is the weight we put on past fertility rates compared to current fertility rates. Thus, if fertility rates have changed differentially across the educational groups in the 2000s, choosing a relatively large  $a$  might prevent us from finding the new pattern, even if it exists.<sup>10</sup> As a compromise, we set  $a = 24$ .<sup>11</sup>

Figure 3 present this hybrid measure of fertility. As can be seen from the figure, the U-shaped pattern is still present, albeit the lowest fertility is now attained by women with exactly college degree. As a robustness check, we gradually increase  $a$  from 24 to 29. We find that the lowest fertility is attained by women with college degree up to  $a = 27$ , although the difference in fertility between this group and the group of women with advanced degree declines. At  $a = 28$  fertility of women with exactly college degree equals that of women with advanced degree and at  $a = 29$ , fertility of women with exactly college degree is larger than that of women with advanced degree.

One noticeable difference between our estimated TFR (Figure 2) and our estimated hybrid fertility (Figure 3) is that the minimum level is attained by the some college group and exactly college degree group, respectively. Given the limitation of the data, however, we do not take a stand as to whether the cross-sectional relationship between completed fertility and women's education will resemble Figure 2 or Figure 3.

---

<sup>10</sup>Clearly, choosing  $a$  in the 40s, coincides with completed fertility, a measure we discuss in detail in Section 2.4.

<sup>11</sup>The average number of own children in the household at age 24 equals 1.120, 0.786, 0.495, 0.092 and 0.084 for women with less than high-school degree, exactly high-school diploma, some college, exactly college degree and advanced degree, respectively.

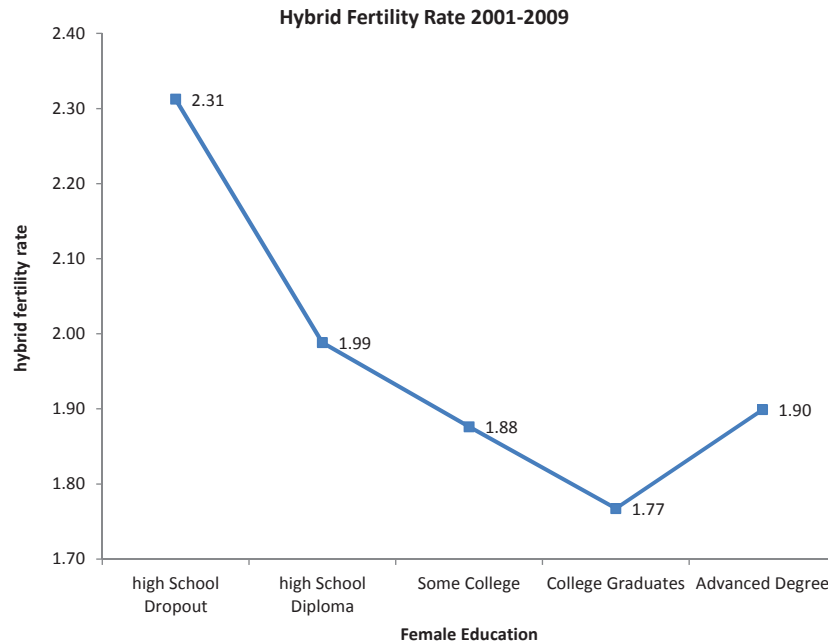


Figure 3: Hybrid Fertility Rate, 2001-2009. The hybrid fertility rate sums up the number of children ever born to women at age  $a$  and the age-specific-fertility rates from age  $a + 1$  to age 49. We assume  $a = 24$ . Authors' calculations using data from the American Community Survey.

### 2.3 Is the U-shaped Fertility Pattern New?

As mentioned in the Introduction, many studies have shown that in cross-sections of households, fertility decreases with education in virtually all developing and developed countries. However, the educational classification used in these studies are different from ours, which prevents a direct comparison between our work and the literature. For example, had we classified women into three groups of education; high-school dropouts, high-school graduates and more than high-school, we would have found a monotonically decreasing relationship between women's education and fertility as well. Hence, in this section we use earlier data to provide evidence that the U-shaped fertility pattern is indeed only a recent phenomenon.

For this purpose, we use data from the 1980, 1990 and 2000 U.S. censuses (Ruggles

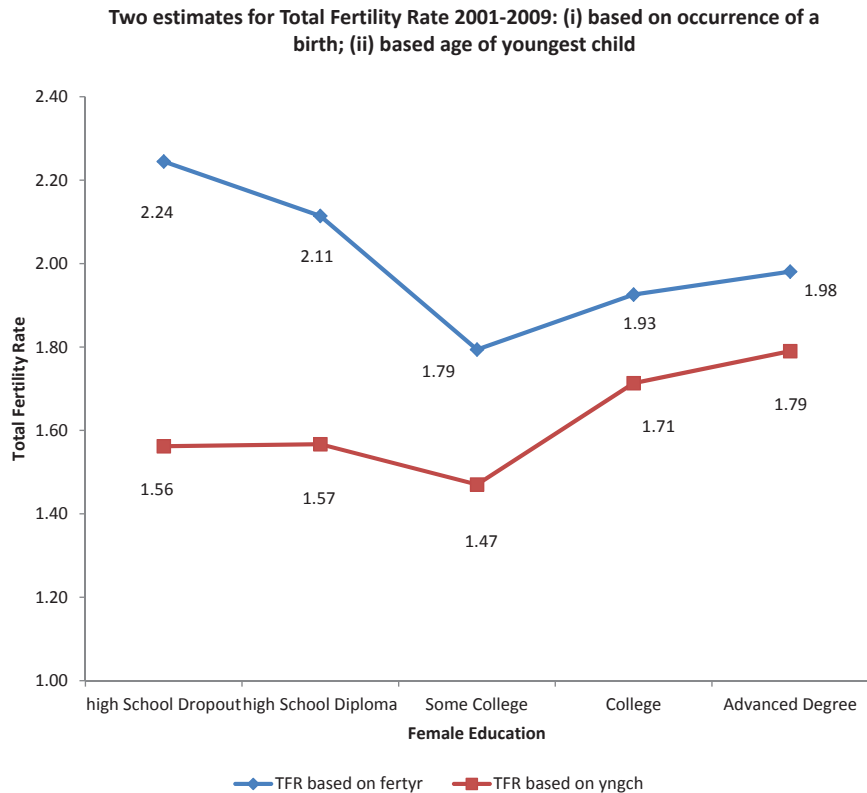


Figure 4: Two estimates for Total Fertility Rate, 2001-2009. Authors' calculations using data from the American Community Survey.

et al. 2010). Unlike the ACS, the census questionnaire does not contain a direct question about the occurrence of a birth during the past 12 months. The census as well as the ACS contains a related question about the age of the youngest own child in the household. One might expect, therefore, that any woman who reported giving a birth during the previous 12 months would answer that the age of youngest own child in her household is 0.<sup>12</sup> Given this, we construct a variable for the occurrence of a birth during the past 12 months if a woman reports having a child aged 0 years old.

<sup>12</sup>Clearly, multiple births, infant mortality and giving a child over to adoption or to relatives to raise the child could create some differences between these two measures, although we conjecture that in practice these are quantitatively unimportant. We therefore conjecture that discrepancies between the two measures are related to measurement errors.

Before using this indirect measure of births to estimate the cross-sectional relationship between fertility and education in the past, it is instructive to check the reliability of this measure in the ACS data, which contain the response to both questions. The correlation between the resulting two sets of estimates for the age-specific-fertility-rates is larger than 0.99 for all five educational groups. However, the age-specific-fertility-rates based on the age of the youngest own child in the household are systematically lower than those presented in Figure 1. More importantly, the gap between the two series monotonically declines with education. This can be clearly seen in Figure 5 that presents two estimates of TFR for the period 2001-2009. The estimate labeled “TFR based on fertyr” is the one reported in Figure 2, while the estimate labeled “TFR based on yngch” is the estimate based on the age of the youngest own child in the household. As can be clearly seen from the figure, the gap in TFR is smaller, the higher is women’s education.

A further examination of these two series of age-specific-fertility-rates reveals that within educational groups, the gap between the series is larger at younger ages. Although we do not have a good explanation for that, we overcome this problem by estimating the hybrid measure of fertility that we propose in Section 2.2. Figure 5 presents two estimates of hybrid fertility rates for the period 2001-2009. The estimate labeled “hybrid based on fertyr” is the one reported in Figure 3, while the estimate labeled “hybrid based on yngch” is the estimate based on the age of the youngest own child in the household. As can be seen from the figure, the gap between the two series is smaller for all groups, and more importantly, it is almost constant across the educational groups.

Given the clear superiority of the hybrid fertility rate estimate when using the indirect measure for an occurrence of a birth, we use the census data for 1980, 1990 and 2000 to estimate hybrid fertility rate for these three year.<sup>13</sup> Figure 6 presents the estimates for hybrid fertility rate for the years 1980, 1990 and 2000.<sup>14</sup>

---

<sup>13</sup>The educational attainment variable “EDUC” has been coded differently since 1990. Thus in 1980, we classified women with up to grade 11 as “less than high-school”, women with exactly grade 12 as “high-school diploma”, women with some college, but less than 1 year up to 3 years of college as “some college”, women with exactly 4 years of college as “college graduates” and women with more than 4 years of college as “advanced degree”.

<sup>14</sup>Like in Figure 3, we set  $a = 24$ .



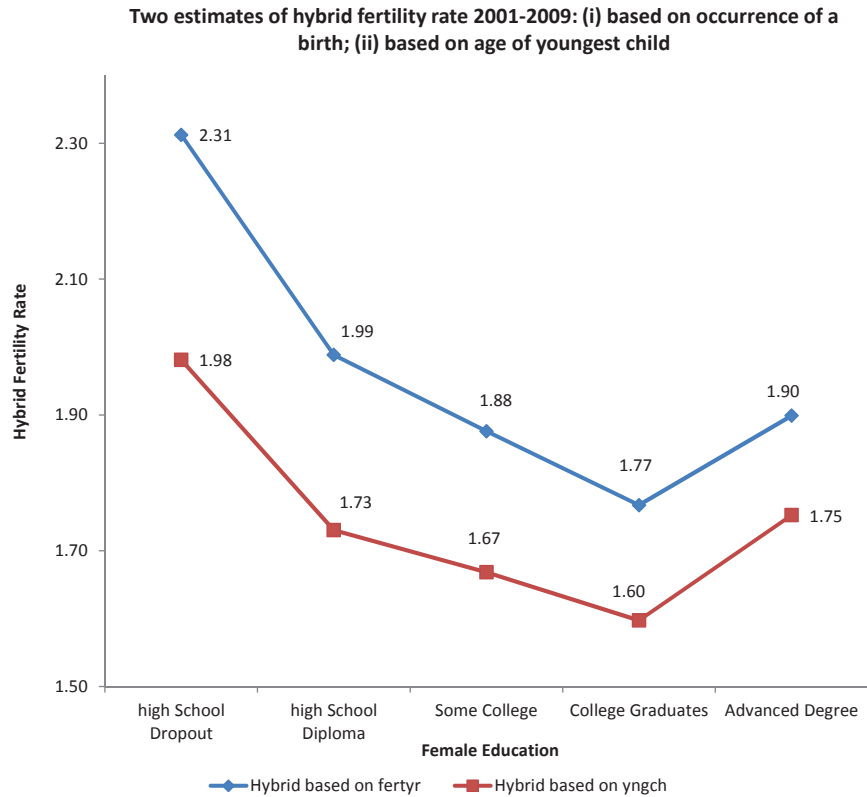


Figure 5: Two estimates for Hybrid Fertility Rate, 2001-2009. The hybrid fertility rate sums up the number of children ever born to women at age  $a$  and the age-specific-fertility rates from age  $a + 1$  to 49. We assume  $a = 24$ . Authors' calculations using the American Community Survey.

As can be seen from the figure, fertility monotonically decreases in education in 1980. This is also true in 1990, although the slope of the curve decreases substantially (in absolute terms) when moving from women with exactly college degree to women with advanced degree. Finally, in 2000, this is no longer true. While fertility decreases up to women with exactly college degree, it slightly increases for women with advanced degree. In sum, the evolution of the cross-sectional relationship between fertility rates and women's education over time, shows a clear and monotonic increase in the fertility of women with advanced degree, relative to women with lower levels of education.

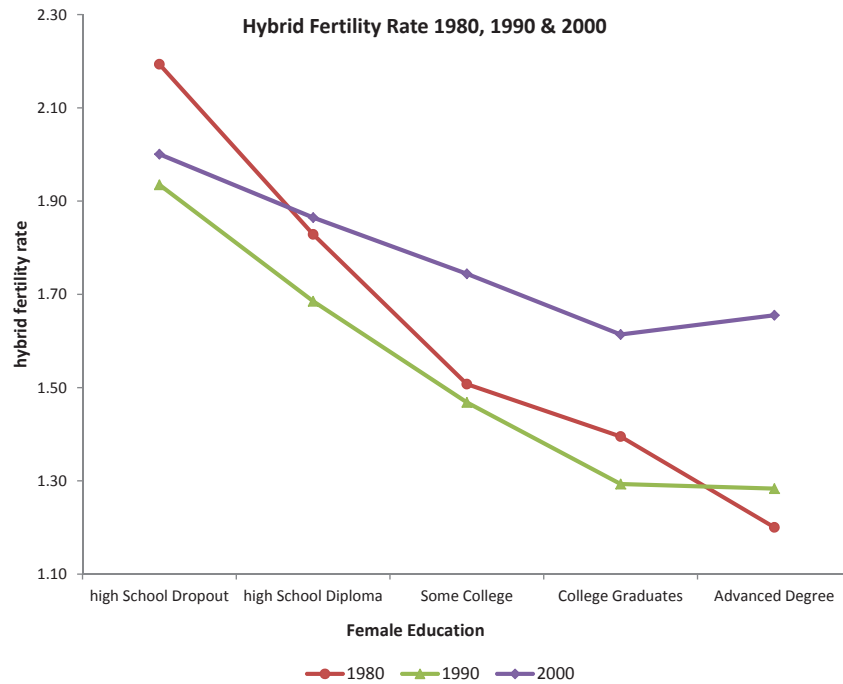


Figure 6: Hybrid Fertility Rate, 1980, 1990 & 2000. The hybrid fertility rate sums up the number of children ever born to women at age  $a$  and the age-specific-fertility rates from age  $a + 1$  to 49. We assume  $a = 24$ . Authors' calculations using Census data.

## 2.4 Total Fertility Rates and Completed Fertility Rates

Although our analysis is mostly concerned with TFR, our objective is to argue that what is observed in TFR today is likely to be translated into completed fertility rates for cohorts that have not yet completed their fertility.<sup>15</sup> Since completed fertility is estimated for women approaching the end of their fertile period, usually taken to be 40-44 years of age, the new patterns exhibited in Figures 2, 3 and 6 are still not reflected in the completed fertility even for the youngest cohort that have reached this age.

It is constructive, however, to look at the pattern of completed fertility rate by education for cohorts who have recently reached the end of their fertile period.

<sup>15</sup>Preston and Sten Hartnett (2008) showed that, with the exception of the baby-boom period, TFR and completed fertility rate in the U.S. almost coincide during the twentieth century.

Using data from the 1990 census as well as data from the Fertility Supplement of the June Current Population Survey for the years 1995, 2000, 2004 and 2008, we estimate completed fertility by education for women aged 40-44. This covers the cohorts born between 1946 and 1968. These estimates are shown in Figure 7.

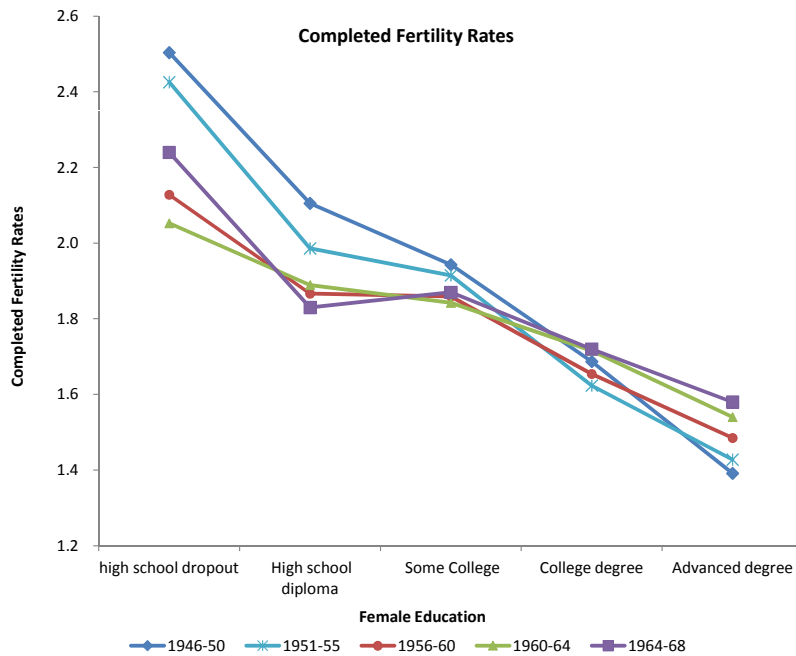


Figure 7: Completed Fertility Rates by Education for cohorts born between 1946 and 1968. Authors' calculations using data from the 1990 Census and the Fertility Supplement of the June Current Population Survey for the years 1995, 2000, 2004 and 2008.

Two features in Figure 7 are worth mentioning. First, completed fertility monotonically declines across the educational groups for all cohorts. Second, across cohorts the curves shift counter clockwise around the some college group. This later feature supports our conjecture as differential fertility between the least and the most educated groups of women contracts and the level of fertility for women with advanced degrees monotonically increases across cohorts.

## 3 The Model

### 3.1 Structure

There is a continuum of mass one of adult individuals that differ by their level of human capital. Each Individual forms a household, works, and chooses consumption and her number of children. Children are being raised and educated. Education is provided by the market through schools. To raise children, households combine parent's time and time purchased in the market. Likewise, households combine parent's time, time purchased in the market along with a market good to produce the consumption good. This market good serves as the numeraire. Finally, the remaining time is allocated to labor market participation.

Let  $h_i$  denote the human capital of individual  $i$ , which also equals her market productivity. The preferences of household  $i$  are defined over consumption,  $c_i$ , and total full income of the children,  $n_i h'_i$ . They are represented by the utility function:

$$u_i = \ln(c_i) + \ln(n_i h'_i). \quad (1)$$

The budget constraint is:

$$h_i = p_{ci} c_i + p_{ni} n_i + n_i p_{ei} e_i, \quad (2)$$

where  $p_{ci}$ ,  $p_{ni}$  and  $p_{ei}$  are the prices of consumption, quantity of children and children's education,  $e_i$ , faced by parent  $i$ , respectively.

Children's human capital,  $h'_i$ , is determined by their level of education,  $e_i$  and basic skills with which nature equips each child,  $\eta > 0$ , regardless of her parent's characteristics. The human capital production function is:

$$h'_i = (e_i + \eta)^\theta, \quad \theta \in (0, 1). \quad (3)$$

Education is provided in schools. We assume that the average level of human capital among teachers is  $\bar{h}$ . We follow de la Croix and Doepke (2003) by assuming that  $\bar{h}$  is the average human capital in the economy,  $\bar{h} = \int_0^\infty h_i dF(h_i)$ , where  $F(h_i)$  is the distribution of human capital, although nothing hangs on this choice. As all parents face the same market price for education,  $p_{ei} = p_e = \bar{h}$  the cost of educating  $n_i$  children at the level  $e_i$  is given by

$$TC_i^e = n_i p_e e_i = n_i \bar{h} e_i. \quad (4)$$

Raising children requires time independently of education. The time required to raise  $n$  children can be supplied by the parent or bought in the market, e.g., child-care or baby sitters. The production function of raising  $n$  children is:

$$n = (t_M^n)^\phi (t_B^n)^{1-\phi}, \quad \phi \in (0, 1)$$

where  $t_M^n$  is the time devoted by the mother and  $t_B^n$  is the time bought in the market, e.g., a babysitter.<sup>16</sup> We assume that the price of one unit of time bought in the market is some level of human capital denoted by  $\underline{h}$ . This implies that  $\underline{h}$  is the average human capital among babysitters.

The cost of raising  $n$  children is, therefore, given by the cost function,

$$TC^n(n, \underline{h}, h^i) = \min_{t_M^n, t_B^n} \{t_M^n h^i + t_B^n \underline{h} : n = (t_M^n)^\phi (t_B^n)^{1-\phi}\}.$$

The optimal  $t_M^n$  and  $t_B^n$  are:

$$t_M^n = \left( \frac{\phi}{1-\phi} \frac{\underline{h}}{h^i} \right)^{1-\phi} n \quad (5)$$

and

$$t_B^n = \left( \frac{1-\phi}{\phi} \frac{h^i}{\underline{h}} \right)^\phi n. \quad (6)$$

---

<sup>16</sup>This modeling approach is similar to Greenwood, Seshadri and Vandenbroucke (2005).

Using these optimal levels we obtain the cost function:

$$TC^n(n, \underline{h}, h^i) = p_{ni}n = \varphi \underline{h}^{1-\phi} h_i^\phi n, \quad (7)$$

where  $\varphi \equiv (\phi^\phi(1-\phi)^{1-\phi})^{-1}$ .

Notice from (7) that the marginal cost of raising children is constant. Moreover, this marginal cost increases with mother's human capital, although its elasticity with respect to the mother's human capital is  $\phi < 1$ .

Following Becker (1965), the consumption good that enters directly into the utility function is produced by combining time and a market good. However, our extension here is that the time allocated to this production can be either supplied by the mother or purchased in the market. The production function is:

$$c = m^{1-\alpha} [(t_M^c)^\sigma + (t_H^c)^\sigma]^{\alpha/\sigma}, \quad \sigma \in (0, 1)$$

where  $m$  is the market good and  $\frac{1}{1-\sigma} > 1$  is the elasticity of substitution. That is,  $t_M^c$  and  $t_H^c$  are assumed to be gross substitutes. This assumption captures the idea that mother's time and the time of a housekeeper is highly substitutable.<sup>17</sup> We assume that the price of one unit of time bought in the market is  $\hat{h}$ . This implies that  $\hat{h}$  is the average human capital among housekeepers.

The cost of  $c$  units of consumption is, thus, given by the cost function,

$$TC^c(c, \hat{h}, h^i) = \min_{m, t_M^c, t_H^c} \{m + t_M^c h_i + t_H^c \hat{h} : c = m^{1-\alpha} [(t_M^c)^\sigma + (t_H^c)^\sigma]^{\alpha/\sigma}\}.$$

---

<sup>17</sup>Notice that we assume that mother's time and housekeeper's time in producing the consumption good are more substitutable than mother's time and baby-sitter's time in raising children. This assumption can be justified by noting that pregnancy and breastfeeding are less substitutable than cleaning and cooking. For example, Sacks and Stevenson (2010) reporting that during the 2000s, mothers on average spend well over 2 hours a day breastfeeding their infants.

The optimal  $t_M^c$  and  $t_H^c$  are:

$$t_M^c = \frac{\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}}{h_i^{1-\alpha} \left(1 + \left(\frac{h_i}{\bar{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{1+\alpha\left(\frac{1}{\sigma}-1\right)}} c \quad (8)$$

and

$$t_H^c = \frac{\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha} h_i^{\alpha+\frac{\sigma}{1-\sigma}}}{\hat{h}^{\frac{1}{1-\sigma}} \left(1 + \left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{1+\alpha\left(\frac{1}{\sigma}-1\right)}} c \quad (9)$$

Substituting these optimal factors into the cost function yields:

$$TC^c(c, \hat{h}, h^i) = p_c c = \frac{h_i^\alpha}{\omega \left(1 + \left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{\alpha\left(\frac{1}{\sigma}-1\right)}} c, \quad (10)$$

where  $\omega = \alpha^\alpha(1-\alpha)^{1-\alpha}$ .

### 3.2 Equilibrium

Given the price of quality of children, quantity of children and consumption in equations (4), (7) and (10), respectively, the solution to maximizing (1) subject to the budget constraint, (2) yields:

$$e_i = \frac{\theta \varphi \underline{h}^{1-\phi} h_i^\phi - \eta \bar{h}}{\bar{h}(1-\theta)}, \quad (11)$$

$$n_i = \frac{h_i(1-\theta)}{2(\varphi \underline{h}^{1-\phi} h_i^\phi - \eta \bar{h})}, \quad (12)$$

and

$$c_i = \frac{\omega}{2} h_i^{1-\alpha} \left( 1 + \left( \frac{h_i}{\hat{h}} \right)^{\frac{\sigma}{1-\sigma}} \right)^{\alpha \left( \frac{1}{\sigma} - 1 \right)} \quad (13)$$

Equations (5), (6), (8), (9), (11), (12) and (13) yield the following seven propositions.

**Proposition 1** *The educational choice,  $e^*$ , is strictly increasing in  $h_i$*

**Proof:** Follows directly from differentiating equation (11) with respect to  $h_i$ .  $\square$

The intuition behind this result is straightforward. With a log linear utility function from consumption and full income of the children, the optimal level of education is independent of the parent's human capital, since any additional unit of education is given to all children equally. Moreover, since any additional child will be given the same education as her siblings, the optimal level of education depends negatively on the price of education (quality) relative to fertility (quantity).

The value of parental time is equal to her human capital. While quality is bought in the market at a given cost, independently of parents human capital, quantity requires some of parent's time and, thus, its price positively depends on parent's human capital. Consequently, the relative price of quality declines in the parent's human capital, yielding a higher investment in education.

Notice that as parent's human capital increases, the share of income that is allocated to the quality of each child increases on the expense of the share of income allocated to quantity. The intuition for this is simple. For low income parents, the basic skill,  $\eta$ , which is equivalent to  $\eta \bar{h}$  in terms of income, is relatively important. As a result, parents find it optimal to invest a large share of income in quantity and a low share in quality.<sup>18</sup> In contrast, for high income parents, the value of

---

<sup>18</sup>Notice that for parents with low human capital,  $\eta$  could be large enough such that the optimal level of education is 0. We ignore this corner solution and assume that even the parents with the lowest level of human capital,  $\underline{H}$ , still choose positive level of education. Formally, we assume that  $\theta \varphi \underline{h}^{1-\phi} h_i^\phi - \eta \bar{h} > 0 \quad \forall h_i$ .



the basic skill in term of income,  $\eta\bar{h}$ , is relatively small, which induces parents to allocate a higher share of income for quality on the expense of quantity.

**Proposition 2** *The fertility choice,  $n^*$  is U-shaped as a function of  $h_i$*

**Proof:** Differentiating (12) with respect to  $h_i$  yields:

$$\frac{\partial n^*}{\partial h_i} = \frac{(1 - \theta) \left( (1 - \phi) \varphi \underline{h}^{1-\phi} h_i^\phi - \eta\bar{h} \right)}{2 \left( \varphi \underline{h}^{1-\phi} h_i^\phi - \eta\bar{h} \right)^2}.$$

Thus,

$$\frac{\partial n^*}{\partial h_i} \begin{cases} < 0, & \text{for } h_i < \tilde{h} \\ = 0, & \text{for } h_i = \tilde{h} \\ > 0, & \text{for } h_i > \tilde{h} \end{cases}$$

Where  $\tilde{h} = \left( \frac{\eta\bar{h}}{(1-\phi)\varphi\underline{h}^{(1-\phi)}} \right)^{\frac{1}{\phi}}$  □

The intuition behind this result is as follows. As described above, the optimal level of education depends on the relative price of quality and the basic skill. Fertility, however, depends on the share of income allocated to quantity and the price of an additional child. Above, we already explained that the share of income allocated to quantity decreases with parent's human capital. We now turn to analyze how the price for quantity changes with parent's human capital to determine the optimal level of quantity.

Marketization is an essential element in our mechanism that yields U-shaped fertility pattern. Let us ignore for the moment this marketization channel, and assume that quantity requires parents' time only. In this case, with an increase in parent's human capital, both: parent's income and the price for quantity increase by the same proportion. Since parents allocate a lower share of their income to quantity, the optimal number of children monotonically declines.

Marketization, however, affects the price for quantity that parents face. For parents with low levels of human capital, (i.e., low income), marketization is low and most of child raising is done by parents. Thus, the intuition explained above

holds. Parents with high levels of human capital, in contrast, outsource a major part of child raising, which, in turn, reduce the price for children from parents' point of view. This reduction could be sufficiently large to induces an increase in fertility.

Notice from equation (7) that the price of quantity is  $\varphi \underline{h}^{1-\phi} h_i^\phi$ . Thus, although it increases with parents' human capital, marketization causes this price to increase at a lower pace than income does.<sup>19</sup> Thus, for all  $h_i > \tilde{h}$ , marketization implies that the share of income allocated to quantity decreases at a lower pace than price does, causing fertility to increase.

**Proposition 3** *Mother's time spent on raising children (quantity),  $t_M^n$ , is strictly decreasing with income,  $h_i$ .*

**Proof:** Substituting (12) into (5) gives:

$$t_M^n = \frac{(1-\theta)}{2} \left( \frac{\phi}{1-\phi} \right)^{1-\phi} \frac{\underline{h}^{1-\phi} h_i^\phi}{(\varphi \underline{h}^{1-\phi} h_i^\phi - \eta \bar{h})}, \quad (14)$$

differentiating (14) with respect to  $h_i$ , yields:

$$\frac{\partial t_M^n}{\partial h_i} = -\phi \left( \frac{\phi}{1-\phi} \right)^{1-\phi} \frac{(1-\theta)}{2} \frac{\eta \bar{h} (\underline{h}/h_i)^{1-\phi}}{\varphi \underline{h}^{1-\phi} h_i^\phi - \eta \bar{h}} < 0.$$

□

The intuition here is straightforward. First, with a log linear utility function as given in (1), the share of resources allocated to children is one-half. Secondly, as discussed above, the share of income allocated to quantity is declining in  $h_i$ . Finally, since child-care and mother's time are aggregated using a homothetic production function, the share of income allocated to each one of these two factors is independent of  $h_i$ . Thus, parents' time that is allocated to quantity declines with mother's education. In Section 3.3 below we extend the model such that mother's time is also used for producing child's quality and show that mother's

<sup>19</sup>Notice that the Cobb-Douglas production function for quantity is not crucial for this result. The Appendix provides a proof that this result holds for any CES production function.

total time spent on children can increase, consistent with the empirical findings from time use data (e.g. Guryan et al. 2008, Ramey and Ramey 2010).

**Proposition 4** *Mother's time spent on home production,  $t_M^c$ , is strictly decreasing with income,  $h_i$ .*

**Proof:** Substituting (13) into (8) yields

$$t_M^c = \frac{\alpha}{2 \left( 1 + \left( h_i / \hat{h} \right)^{\frac{\sigma}{1-\sigma}} \right)}, \quad (15)$$

which is, unambiguously, decreasing in  $h_i$  □

Since the consumption good is a Cobb-Douglas aggregate of the market good and time, the share of resources allocated to each one of these factors is independent of  $h_i$ . However, the assumed gross substitutability between mother's time and housekeeper's time yields a declining time spent by the mother as its price,  $h_i$ , increases.

**Proposition 5** *The labor supply,  $l^* \equiv 1 - t_M^n - t_M^c$ , is strictly increasing with mother's income,  $h_i$ .*

**Proof:** Follows directly from propositions 3 and 4 □

**Proposition 6** *The amount of baby-sitter services purchased in the market,  $t_B^{n^*}$ , is:*

- i* Strictly increasing with income,  $h_i$ , if  $\theta < 1 - \phi$ .
- ii* Strictly increasing with income for all  $h_i \geq \tilde{h}$ .

**Proof:** Notice from (6) that the amount of baby-sitter services purchased *per child* is strictly increasing in  $h_i$ . However,  $n^*$  is strictly decreasing in  $h_i$  for all  $h_i < \tilde{h}$  and strictly increasing in  $h_i$  for all  $h_i > \tilde{h}$ . Thus part ii of the proposition is trivial. Substituting (12) into (6) and differentiating with respect to  $h_i$ , implies that  $\frac{\partial t_B^{n^*}}{\partial h_i}$

is positive if  $\varphi \underline{h}^{1-\phi} h_i^\phi > (1 + \phi)\eta \bar{h}$ . Notice that for an internal solution for  $e^*$ , we assumed that  $\theta \varphi \underline{h}^{1-\phi} h_i^\phi > \eta \bar{h}$  for all  $h_i$ . Thus, a sufficient condition for  $\frac{\partial t_B^*}{\partial h_i} > 0$  for all  $h_i$  is  $\theta < 1 - \phi$ .  $\square$

The intuition behind part i is simple. For  $h_i < \tilde{h}$  there are two opposite effects. On the one hand baby-sitter services purchased *per child* are increasing in  $h_i$ , while the number of children is decreasing in  $h_i$ . Notice that the rate at which fertility declines with income depends on the returns to education,  $\theta$ , relative to the elasticity of baby-sitter services with respect to children. If the former is larger, the slope of the decline in fertility due to the quantity-quality trade-off is sufficiently large and, therefore, total baby-sitter services purchased is not increasing with income. Conversely, if the elasticity of baby-sitter services with respect to children is sufficiently large, total baby-sitter services purchased is increasing for all levels of income.

**Proposition 7** *The amount of housekeeping services purchased in the market,  $t_H^{c*}$ , is strictly increasing with mother's income,  $h_i$ .*

**Proof:** Follows directly from substituting (13) into (9) and differentiating with respect to  $h_i$ .  $\square$

### 3.3 An Extension

The model analyzed above is consistent with data on time allocated to the labor market and to home production (excluding childcare). However, it also suggests that mother's time allocated to raising children decreases with mother's education. This is because the increasing part of the U-shaped fertility pattern in our model is obtained from the availability of market services, which are relatively cheap for highly educated mothers. As discussed in the Introduction Guryan et al. (2008) find that mother's time allocated to childcare increases with mother's education. As discussed in the Introduction, however, Guryan et al. defined childcare as the sum of four primary time use components: "basic", "educational", "recreational" and "travel". Clearly, the educational and recreational

components and part of the travel component are investment in children's quality, a component which, in our model, is bought in the market.

Ramey and Ramey (2010) reconcile the seemingly paradoxical allocation of time, according to which mothers with a higher opportunity cost of time spend more, rather than less time with their children despite the availability of market substitutes. They argue that as slots in elite postsecondary institutions have become scarcer, parents responded by investing more in their children's quality so that they appear more desirable to college admissions officers. Since more educated parents spend more of their own time and on market goods and services related to child's quality, it implies that parental time and market goods and services are strong complements in the production of children's quality.

To capture this idea, we extend our model by assuming that children's quality requires not only education bought in schools but also parental time. Thus, consistent with our notation, let child's education be

$$e_i = [(t_{SC}^e)^\zeta + (t_M^e)^\zeta]^{1/\zeta}, \quad (16)$$

where  $t_{SC}^e$  and  $t_M^e$  are the time invested in education provided by the school and parent, respectively; and  $\zeta \in (-\infty, 0)$ . To convey our idea in a simple example we assume that there is perfect complementarity between school time and parental time invested in children's education. Formally we assume that  $\zeta = -\infty$  and (17) becomes:  $e_i = \min \{(t_{SC}^e), (t_M^e)\}$ . This implies that at the optimum, for any unit of time provided by the school, a similar unit is provided by the parent in order to produce a unit of education:

$$e_i = t_{SC}^e = t_M^e, \quad (17)$$

and the cost of education, equation (4), becomes:

$$TC_i^e = n_i p_e e_i = n_i (\bar{h} + h_i) e_i. \quad (18)$$

Given this new price for quality of children in equation (18), the price of quantity of children and consumption in equations (7) and (10), respectively, the solution

to maximizing (1) subject to the budget constraint, (2) becomes:

$$e_i = \frac{\theta \varphi \underline{h}^{1-\phi} h_i^\phi - \eta(\bar{h} + h_i)}{(\bar{h} + h_i)(1 - \theta)}, \quad (19)$$

$$n_i = \frac{h_i(1 - \theta)}{2(\varphi \underline{h}^{1-\phi} h_i^\phi - \eta(\bar{h} + h_i))}. \quad (20)$$

Notice that as in the basic model, the economic forces that are behind the U-shaped fertility pattern and the increasing relationship between parental education and children's education are still at work: the decreasing part in fertility is due to a lower share of income that is allocated for quantity and the increasing part is due to the greater use of babysitter services as parental education increases. Likewise, children's education is positively affected by the price of quantity relative to the price of quality. However, the price of quality is now increasing with parent's education and, therefore, some additional conditions are necessary. Second, the positive relationship between parental education and children's education along with the complementarity between parental time and schooling time in producing children's education, implies that the time invested by parents also increases in parents' education. Finally, the steepness of the relationship between parental education and parental time spent on children's education can be sufficiently high such that it dominates the reduction in parental time allocated to raising children induced by the existence of market substitutes such as babysitters and child-care. In this event, the total time spent by parents on children increases with parental education. Deriving analytical conditions under which the total time spent on children is increasing with mother's education is complicated, however, and, consequently, we illustrate the ability of the model to account for this empirical fact, while maintaining all of the desired results of the model using a numerical example.

Specifically, Figure 8 shows that fertility is U-shaped as a function of mother's education and that children's education can increase with mother's education, even when the marginal cost of education is increasing with mother's education. The figure also shows that the sum of time devoted to both quantity and quality by the mother, that is the total time allocated to childcare is increasing with

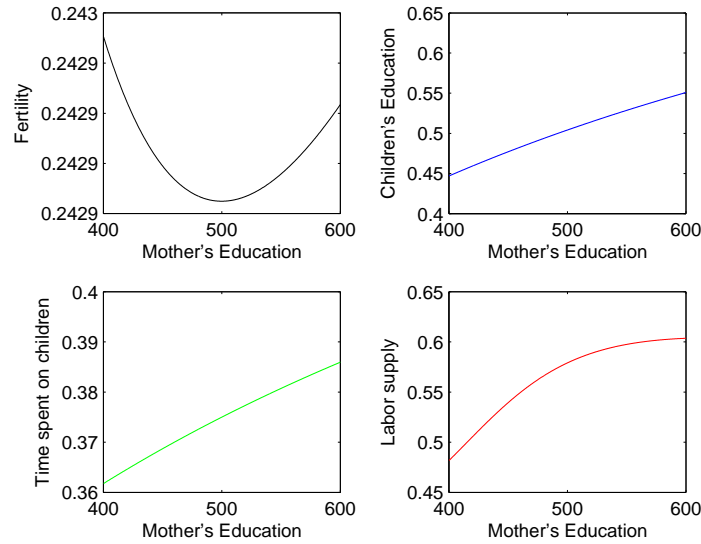


Figure 8: Numerical Example: Fertility, Children's Education, Mother's time Spent of Childcare and Labor Supply.

mother's education. Finally, labor supply is increasing with mother's education. Notice that the margin that allows parents to spend more time with their children and supply more hours to the labor market is the availability of housekeeping services, a service which highly educated mothers use more than mothers with lesser education.

## 4 Supportive Evidence

### 4.1 Labor Supply and Marriage Rates

In Section 2 we have established that the association between fertility and women's education is U-shaped. Using the ACS sample for the years 2001-2009, we present here evidence in support of our model. We begin with labor supply. It is well established that the cross-sectional relationship between female labor supply and education is upward sloping. Figure 9 shows that usual hours worked per week during the past 12 months by women aged 25-50 indeed monotonically increases

with education.<sup>20</sup> Notice that the difference across the educational groups is quantitatively large. Among all women aged 25-50, women lacking a high school diploma work somewhat more than 21 hours per week, while women with advanced degrees work more than 36 hours per week.

The positive correlation between fertility and labor supply for women with at least a college degree, however, does not necessarily imply that highly educated women work more and have more children. Since only a small fraction of women gives birth in each year, it could be, for example, that women who gave birth in a given year do not work at all during that same year. To address this, Figure 9 also shows the cross-sectional relationship between education and usual hours worked for the sub-sample of women age 15-50 who gave birth during the reference period.<sup>21</sup> As can be seen from the figure, highly educated mothers of newborns work more hours per week than less educated mothers with newborns.

We have thus far shown that highly educated women have higher fertility and work more hours, and that among mothers to newborns, usual hours worked increase with education. However, in relation to our model, one concern might be that it is in fact the spouses who respond to a birth by lowering their labor supply and in particular, that fathers to newborns, who are married to highly educated women reduce their labor supply by more than those who are married to women with lower levels of education. However, Figure 10 shows that this is not the case.

Figure 10 shows that men who are married to highly educated women work more than men who are married to women with lower levels of education, though men who are married to women with advanced degrees work slightly less than men who are married to women with a college degree. Interestingly, fathers to newborns work more than husbands who do not have a newborn at home, regardless of the education of their wives. More importantly, usual hours worked by fathers to newborns monotonically increased with their wives' education. Thus, the spouses of highly educated women are not the ones substituting in childcare for their working wives.

---

<sup>20</sup>We restrict the minimum age to 25 because women with advanced degrees might still be out of the labor market at younger ages.

<sup>21</sup>The figure remains intact if we restrict ages to 25-50.



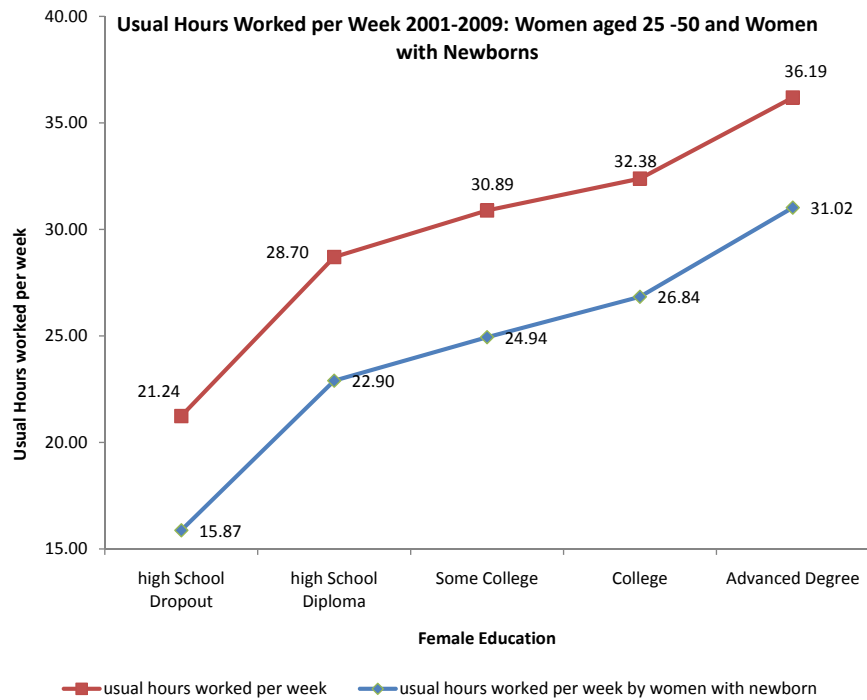


Figure 9: Usual hours worked by women aged 25-50 and women with newborns, 2001-2009. Authors' calculations using data from the American Community Survey.

Another concern our model may raise is that marriage rates differ across different educational groups. If married women have higher fertility rates and if more educated women have higher marriage rates, more educated women's higher fertility rates may not be caused by the availability of relatively cheaper childcare and housekeeping services, but rather simply by their higher marriage rates. Figure 11 shows the fraction of currently married women by age-group and education.

As can be seen, the fraction of currently married women increases with age at any level of education and for women above age 30, it increases with educational attainment only through college degrees. Notice that the fraction of women with advanced degrees who are currently married is somewhat lower than that of women with college degree. Thus, at least the increase in fertility between women with college degree and advanced degree cannot be attributed to marriage rates.

Another concern might be related to the mechanisms that govern these outcomes.

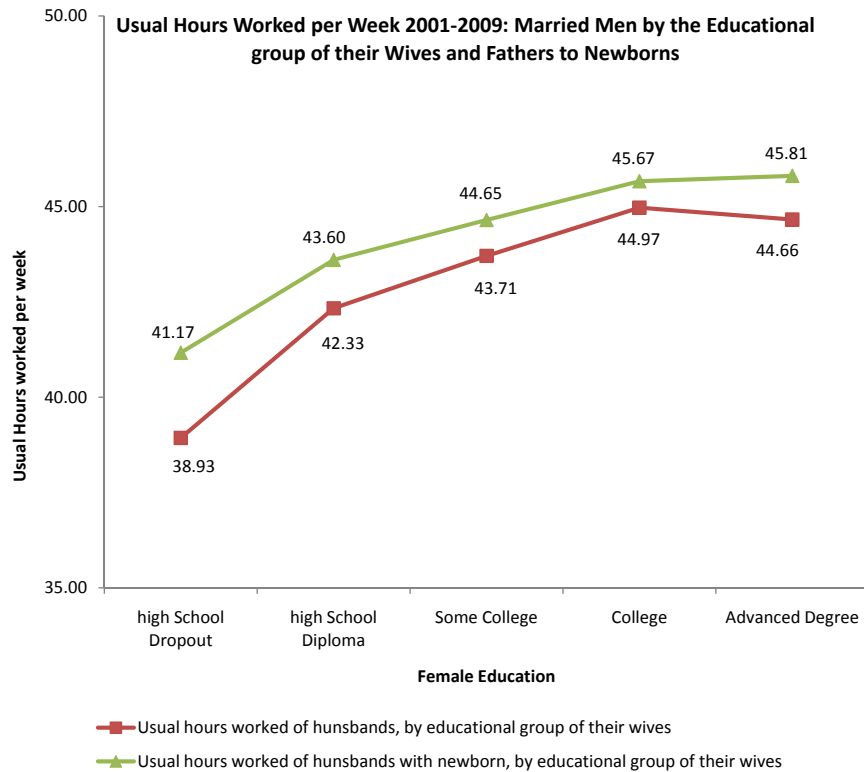


Figure 10: Usual Hours Worked per Week 2001-2009: Married Men by the Educational group of their Wives and Fathers to Newborns. Authors’ calculations using data from the American Community Survey.

For example, it might be that the increase in labor supply of mothers of newborns along the educational gradient, as shown in Figure 9, is driven by the pattern of unmarried mothers, while the reverse is true among married mothers. Figure 12 presents usual hours worked for women aged 15-50 with a newborn by marital status.<sup>22</sup>

Two features stand out from the figure. First, at any level of education, unmarried mothers work more than married mothers. Second, and more important for our theory, is fact that regardless of marital status, usual hours worked increase with women’s education. In sum, Figures 10 and 12 imply that household labor supply increases with mother’s education regardless of marital status.

<sup>22</sup>Both curves remain intact if we restrict age to 25-50.

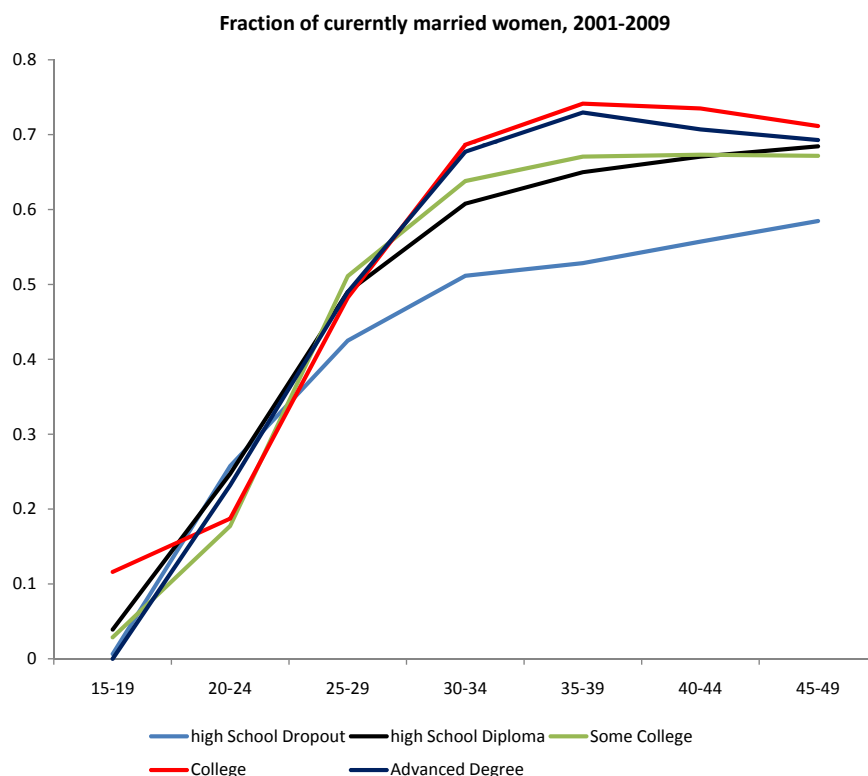


Figure 11: Fraction of currently married women by age and education. Authors' calculations using data from the American Community Survey.

## 4.2 Fertility, Education, and Inequality

In this section we provide evidence on the correlation between fertility of women at different level of education and wage inequality. We do so by augmenting the regression models described in Section 2 with a measure of inequality. Our measure of inequality is the 90-10 log wage differential for full-time full-year male workers, defined as working 35-plus hours per week and 40-plus weeks per year (Autor, Katz and Kearney 2008).<sup>23</sup> We estimate this measure using data from the March CPS on all 50 U.S. states and the district of Columbia for the years 2001-2009 and allow it to vary by state and year, a total of 459 cells.

The marketization hypothesis suggests that fertility will increase among women

<sup>23</sup>Our results are essentially the same if we use the 90-10 log wage differential for full-time full-year female workers.

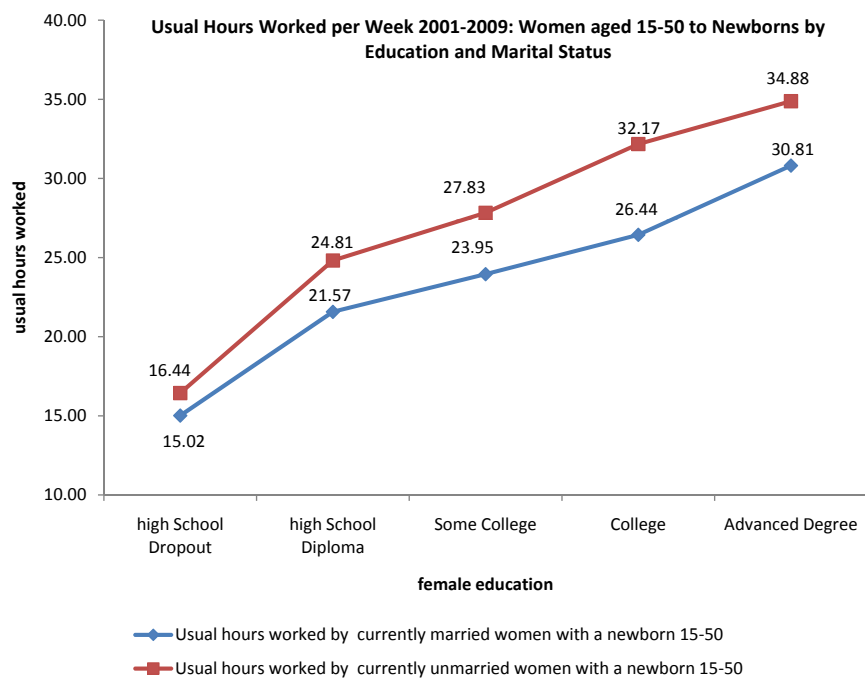


Figure 12: Usual hours worked of women with newborns by marital status, 2001-2009. Authors' calculations using data from the American Community Survey.

whose income increases relative to that of childcare and housekeeping providers. Furthermore, it suggests that the larger the increase in this relative income, the stronger this effect will be. To test if this prediction is consistent with the data, we add inequality and interact inequality with the educational dummies to the specification in column (6) of Table 2. That is, we estimate the model:

$$b_{ist} = e'_{ist} \cdot \pi + X'_{ist} \beta + \gamma I_{st} + e'_{ist} \cdot I_{st} \cdot \lambda + \epsilon_{ist}$$

where  $I_{st}$  is our measure of inequality and  $X_{ist}$  includes family income and family income squared, marital status dummies, age dummies, year and state dummies. Because our measure of inequality varies by state-year, we cluster the standard errors at the state level. Notice that in this specification,  $\pi_j + \lambda_j I_{st}$  is the conditional probability of giving a birth in the  $j$  educational category,  $j \in \{1, 2, 3, 4, 5\}$ , minus this probability in the omitted category, high-school dropouts,  $j = 1$ . For-

mally:

$$\pi_j + \lambda_j I_{st} = Pr(b_{ist} = 1 | e_{j,ist}, X) - Pr(b_{ist} = 1 | e_{1,ist}, X).$$

Figure 13 demonstrates our estimates for  $\pi_j + \lambda_j I_{st}$ . Since this difference in probabilities depends on the level of inequality, we present these differences evaluated at the minimum, mean and maximum levels of inequality in our sample.<sup>24</sup>

Three features emerge from this figure. First, the existence of an upward sloping relation between fertility and women’s education, which we documented in Section 2, is unaffected by the inclusion of inequality. Second, the upward shift of the curve when inequality increases suggests that the differences in the conditional probability of giving a birth increase with inequality. Finally, the shift in the curve is the largest for women with advanced degrees, suggesting that an increase in inequality increases the difference in conditional probabilities by a larger magnitude for highly educated women, compared to women with intermediate levels of education. Overall, these findings are supportive of the marketization hypothesis.

## 5 Concluding Remarks

We present new evidence that between 2001 and 2009 the cross-sectional relationship between total fertility rate and women’s education in the U.S. is U-shaped. This pattern is robust to controlling for a host of covariates such as family income, marital and age dummies, year and state of residence dummies. Our analysis of earlier periods shows that this pattern is new, which uncovers an emerging new pattern of cohort fertility. We also find that between 2001 and 2009, differences in the probability of giving a birth between highly educated women and less educated women are positively associated with income inequality and that these differences increase along the educational gradient.

Our model demonstrates how parents can substitute their own parenting time for market-purchased childcare. We show that highly educated women substitute a

---

<sup>24</sup>The minimum, mean and maximum levels of our measure of inequality are 1.25, 1.57 and 2.53, respectively.



Figure 13: The Partial Association between inequality and the probability of giving birth.

significant part of their own parenting with childcare. This enables them to have more children and work longer hours, consistent with the evidence. Furthermore, we show that these highly educated women not only work more and have more children, they invest more in the education of each of their children. This result may have important implications for the relationship between inequality and economic growth. In particular, de la Croix and Doepke (2003) argue that because poorer individuals have more children and invest less in the education of each child, higher inequality leads to lower growth. The evidence presented here that highly educated women choose larger families than women with intermediate levels of education may weaken or even undo this result. Nevertheless, this inquiry is beyond the scope of the current paper and is left for future research.

Our model can also explain the differences in fertility and time allocation of women between the U.S. and Europe. European women spend more time in home production and less time in labor market activities than American women (Freeman and Schettkat 2005). They also give birth to less children. For example, in 2009, the gap in TFR between the U.S. and EU members amounts to nearly

one-half of a child per woman. Another noticeable difference between the U.S. and Europe is in the degree of income inequality. For example, according to OECD stat, the Gini coefficient after tax and transfers in the mid 2000s for the working age population was 0.37 in the U.S. while it was 0.31 for all European OECD members. Similarly, the 90-10 ratio during that period in the U.S. was 5.91 while for for all European OECD members it was 3.84. In Hazan and Zoabi (2011) we study the aggregate behavior of the current model. Specifically, we compute the average fertility and time allocated to labor market and home production in our model economy. We then analyze the effect of a mean preserving spread of the distribution of women's human capital. This is the model's analogy to the higher income inequality in the U.S. compared to Europe. Consistent with the data, we find that an increase in inequality leads unambiguously to an increase in average fertility. The predictions of the model with respect to the average time allocated to home production and children depend on model's parameters. We demonstrate, however, that the time allocated to the labor market and to child-care increase in inequality while the sum of time allocated to childcare and home production decrease in inequality. We believe that research investigating differences between the U.S. and Europe along these lines in greater depth will likely be rewarding.

## References

- Aiyagari, S. Rao, Jeremy Greenwood, and Ananth Seshadri, "Efficient Investment in Children," *Journal of Economic Theory*, February 2002, 102 (2), 290–321.
- Autor, David H., Lawrence F. Katz, and Melissa S. Kearney, "Trends in U.S. Wage Inequality: Revising the Revisionists," *Review of Economics and Statistics*, 2008, 90, 300–323.
- Becker, Gary S., "A Theory of the Allocation of Time," *Economic Journal*, 1965, 75, 493–517.
- Black, Dan A., Natalia Kolesnikova, Seth G. Sanders, and Lowell J. Taylor, "Are Children "Normal"?", *Review of Economics and Statistics*, 2012. forthcoming.
- Cortes, Patricia and Jose Tessada, "Low-Skilled Immigration and the Labor Supply of Highly Skilled Women," *American Economic Journal: Applied Economics*, 2011, 3, 88–123.
- de la Croix, David and Matthias Doepke, "Inequality and Growth: Why Differential Fertility Matters," *American Economic Review*, 2003, 93 (4), 1091–1113.
- Freeman, Richard B., *America Works: the Exceptional U.S. Labor Market*, NY: Russell Sage Foundation, 2007.
- and Roland Schettkat, "Marketization of Household Production and the EU–US Gap in Work," *Economic Policy*, 2005, 20, 5–50.
- Furtado, Delia and Heinrich Hock, "Low Skilled Immigration and Work-Fertility Tradeoffs Among High Skilled U.S. Natives," *American Economic Review*, 2010, 2, 224–228.
- Galor, Oded, "From Stagnation to Growth: Unified Growth Theory," in Philippe Aghion and Steven N. Durlauf, eds., *Handbook of Economic Growth*, Vol. 1A, Elsevier, 2005, chapter 4, pp. 171–293.
- , *Unified Growth Theory*, Princeton University Press, 2011.



- and David N. Weil, “The Gender Gap, Fertility, and Growth,” *American Economic Review*, June 1996, 86 (3), 374–387.
- and —, “Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond,” *American Economic Review*, September 2000, 90 (4), 806–828.
- Greenwood, Jeremy, Ananth Seshadri, and Guillaume Vandembroucke, “The Baby Boom and Baby Bust,” *American Economic Review*, 2005, 95, 183–207.
- Gronau, Reuben, “Leisure, Home Production, and Work – the Theory of the Allocation of Time Revisited,” *Journal of Political Economy*, 1977, 85, 1099–1123.
- Guinnane, Timothy W., “The Historical Fertility Transition: A Guide for Economists,” *Journal of Economic Literature*, 2011, 49, 589–614.
- Guryan, Jonathan, Erik Hurst, and Melissa Kearney, “Parental Education and Parental Time with Children,” *Journal of Economic Perspectives*, 2008, 22, 23–46.
- Hazan, Moshe and Binyamin Berdugo, “Child Labor, Fertility, and Economic Growth,” *Economic Journal*, 2002, 112 (482), 810–828.
- and Hosny Zoabi, “Do Highly Educated Women Choose Smaller Families?,” 2011. CEPR Discussion Paper 8590.
- Isen, Adam and Betsey Stevenson, “Women’s Education and Family Behavior: Trends in Marriage, Divorce and Fertility,” in John Shoven, ed., *Demography and the Economy*, University of Chicago Press, 2010.
- Jones, Larry E. and Michèle Tertilt, “An Economic History of Fertility in the U.S.: 1826-1960,” in Peter Rupert, ed., *Frontiers of Family Economics*, Emerald, 2008, pp. 165 – 230.
- Kremer, Michael and Daniel L. Chen, “Income Distribution Dynamics with Endogenous Fertility,” *Journal of Economic Growth*, 2002, 7, 227–258.

- Manning, Alan, "We Can Work it Out: The Impact of Technological Change on the Demand for Low-Skill Workers," *Scottish Journal of Political Economy*, 2004, 51, 581–608.
- Mazzolari, Francesca and Giuseppe Ragusa, "Spillovers from High-Skill Consumption to Low-Skill Labor Markets," *Review of Economics and Statistics*, 2012. forthcoming.
- Moav, Omer, "Cheap Children and the Persistence of Poverty," *Economic Journal*, 2005, 115 (500), 88–110.
- Preston, Samuel H. and Caroline Sten Hartnett, "The Future of American Fertility," 2008. NBER Working Paper 14498.
- Ramey, Garey and Valerie A. Ramey, "The Rug Rat Race," *Brookings Papers on Economic Activity*, 2010, pp. 129–176.
- Ruggles, Steven J., Trent Alexander, Katie Genadek, Ronald Goeken, Matthew B. Schroeder, and Matthew Sobek, *Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database]*, Minneapolis, MN: Minnesota Population Center [producer and distributor], 2010.
- Sacks, Daniel W. and Betsey Stevenson, "What explains the rapid increase in childcare time: A discussion of Gary Ramey and Valerie A. Rameys "The Rug Rat Race"," *Brookings Papers on Economic Activity*, 2010, pp. 184–196.
- Shang, Qingyan and Bruce A. Weinberg, "Opting for Families: Recent Trends in the Fertility of Highly Educated Women," 2009. NBER Working Paper 15074.
- Weil, David N., *Economic Growth*, Pearson, 2005.

TOTAL FERTILITY RATE BY EDUCATIONAL GROUPS 2001–2009

Year	High-School Dropouts	High School Graduates	Some College	College Graduate	Advanced Degrees
2001	2.36	2.23	1.88	1.82	2.08
2002	2.13	2.29	1.78	1.81	1.99
2003	2.14	1.98	1.70	1.72	1.99
2004	1.99	2.04	1.78	1.85	1.95
2005	2.37	2.07	1.81	1.84	1.96
2006	2.19	2.13	1.75	1.79	2.00
2007	2.27	2.09	1.76	1.74	1.99
2008	2.47	2.11	1.86	1.87	1.97
2009	2.32	2.09	1.81	1.74	1.93

Table 1: Authors' calculations using data from the American Community Survey

THE CORRELATION BETWEEN GIVING A BIRTH IN THE PAST 12 MONTHS AND WOMEN'S EDUCATION

Dependant Variable: Birth in the past 12 months

	(1)	(2)	(3)	(4)	(5)	(6)
High School Graduates	0.013*** (0.001)	-0.002*** (0.001)	-0.016*** (0.001)	-0.016*** (0.001)	-0.017*** (0.001)	-0.015*** (0.001)
Some College	0.013*** (0.001)	-0.002*** (0.001)	-0.023*** (0.001)	-0.023*** (0.001)	-0.024*** (0.001)	-0.021*** (0.001)
College Graduates	0.024*** (0.001)	0.005*** (0.001)	-0.014*** (0.001)	-0.014*** (0.001)	-0.015*** (0.001)	-0.009*** (0.001)
Advanced Degrees	0.029*** (0.001)	0.008*** (0.001)	0.001 (0.001)	0.001 (0.001)	0.000 (0.001)	0.007*** (0.001)
Family Income						-2.20e-07*** (0.000)
Family Income Squared						3.96e-13*** (0.000)
Marital Status Dummies	No	Yes	Yes	Yes	Yes	Yes
Age Dummies	No	No	Yes	Yes	Yes	Yes
Year Dummies	No	No	No	Yes	Yes	Yes
State Dummies	No	No	No	No	Yes	Yes
Observations	3,198,937	3,198,937	3,198,937	3,198,937	3,198,937	3,198,937
R-squared	0.001	0.012	0.063	0.063	0.064	0.065

Table 2: Linear probability models. All models are weighted by ACS sampling weights. Robust standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

THE CORRELATION BETWEEN GIVING A BIRTH IN THE PAST 12 MONTHS AND WOMEN'S EDUCATION

Dependant Variable: Birth in the past 12 months

	(1)	(2)	(3)	(4)	(5)	(6)
High School Graduates	0.147*** (0.006)	-0.004 (0.007)	-0.155*** (0.008)	-0.155*** (0.008)	-0.161*** (0.008)	-0.149*** (0.008)
Some College	0.141*** (0.006)	-0.015** (0.006)	-0.228*** (0.008)	-0.231*** (0.008)	-0.238*** (0.008)	-0.217*** (0.008)
College Graduates	0.241*** (0.006)	0.039*** (0.006)	-0.142*** (0.008)	-0.145*** (0.008)	-0.153*** (0.008)	-0.113*** (0.008)
Advanced Degrees	0.282*** (0.007)	0.063*** (0.007)	-0.000 (0.009)	-0.004 (0.009)	-0.013 (0.009)	0.037*** (0.009)
Family Income						-0.000*** (0.000)
Family Income Squared						0.000*** (0.000)
Martial Status Dummies	No	Yes	Yes	Yes	Yes	Yes
Age Dummies	No	No	Yes	Yes	Yes	Yes
Year Dummies	No	No	No	Yes	Yes	Yes
State Dummies	No	No	No	No	Yes	Yes
Observations	3,198,937	3,198,937	3,198,937	3,198,937	3,198,937	3,198,937

Table 3: Probit models. All models are weighted by ACS sampling weights. Robust standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Appendix

We Generalize the production function of raising children to a CES aggregate of parent's time and child-care from the form:

$$n = [(t_M)^\rho + (t_B)^\rho]^{1/\rho}, \quad \rho \in (-\infty, 1]$$

Where the elasticity of substitution is  $\frac{1}{1-\rho}$ .  $t_M$  and  $t_B$  that minimize this cost function are:

$$t_M = \frac{\underline{h}^{\frac{1}{1-\rho}}}{\left(h_i^{\frac{\rho}{1-\rho}} + \underline{h}^{\frac{\rho}{1-\rho}}\right)^{\frac{1}{\rho}}} n$$

and

$$t_B = \frac{h_i^{\frac{1}{1-\rho}}}{\left(h_i^{\frac{\rho}{1-\rho}} + \underline{h}^{\frac{\rho}{1-\rho}}\right)^{\frac{1}{\rho}}} n$$

Substituting these optimal factors into the cost function yields:

$$C(n, \underline{h}, h^i) = \frac{\underline{h}h_i^{\frac{1}{1-\rho}} + h_i\underline{h}^{\frac{1}{1-\rho}}}{\left(h_i^{\frac{\rho}{1-\rho}} + \underline{h}^{\frac{\rho}{1-\rho}}\right)^{\frac{1}{\rho}}} n = p_n n$$

Where  $p_n$  is the price for quantity. Given the cost function, the solution to the optimization problem with regard to quantity is

$$n^* = \frac{h_i(1 - \theta)}{2(p_n - \eta \bar{h})}.$$

Recall from the intuition described in the paper that marketization decreases the price for quantity for rich parents. Specifically, the engine for this result to emerge is that the price for quantity,  $p_n$  should at most increase with parent's income but at a lower pace than parents income does. This implies that the ratio  $p_n/h_i$  should decline with  $h_i$ . Denote  $R_i = p_n/h_i$ . We get that

$$R_i = \frac{\underline{h}h_i^{\frac{\rho}{1-\rho}} + \underline{h}^{\frac{1}{1-\rho}}}{\left(h_i^{\frac{\rho}{1-\rho}} + \underline{h}^{\frac{\rho}{1-\rho}}\right)^{\frac{1}{\rho}}}$$

Differentiating this ratio with respect to  $h_i$  and rearranging yields:

$$\frac{\partial R_i}{\partial h_i} = -\underline{h}h_i^{\frac{2\rho-1}{1-\rho}} \left(h_i^{\frac{\rho}{1-\rho}} + \underline{h}^{\frac{\rho}{1-\rho}}\right)^{\frac{-1}{\rho}}$$

Which is always negative.