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ABSTRACT

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Conventional wisdom suggests that in developed countries income and fertility are negatively correlated. We present new evidence that between 2001 and 2009 the cross-sectional relationship between fertility and women's education in the U.S. is U-shaped. At the same time, average hours worked increase monotonically with women's education. This pattern is true for all women and mothers to newborns regardless of marital status. In this paper, we advance the marketization hypothesis for explaining the positive correlation between fertility and female labor supply along the educational gradient. 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. Finally, we use our model to shed light on differences between the U.S. and Western Europe in fertility and women's time allocated to labor supply and home production. We argue that higher inequality in the U.S. lowers the cost of baby-sitting and housekeeping services and enables U.S. women to have more children, spend less time on home production and work more than their European counterparts.

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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) 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.

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.[1]

We extend our examination of the association between fertility and women's education by estimating linear probability models. This approach enables us to control for various characteristics such as marital status, age, state of residence and family income, which may be responsible for the relationship between fertility and women's education. We find that the partial correlation between fertility and women's education is indeed U-shaped.

[1]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.

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, Angrist and Evans 1998). 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 more efficiently. 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 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. Moreover, 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. Finally, using consumer expenditure data, they show that the fraction of women who uses housekeeping services increases sharply with education.

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. 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 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.[2]

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.

Finally, given that time spent on raising children and home production decreases with parents' human capital, labor supply, which is merely the time residual, increases with parents' human capital.

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 add income 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. We find that the U-shape fertility pattern is robust to controlling for inequality. 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

[2]One may interpret this result as inconsistent with the evidence. However, one should notice that while the evidence on time spent on childcare does not distinguish between time allocated to quantity versus quality, in our model time with children is solely for quantity. We discuss this point in the Concluding Remarks and suggest a way to reconcile our model with the evidence.

with inequality. Moreover, we find that this increase increases along the educational gradient.

The paper ends with an application of our model to the differences between the U.S. and Western Europe regarding fertility and women's time allocated to labor supply versus to home production. The gap in hours worked between the U.S. and Europe that emerged since the early 1970s is well documented and caught the attention of macroeconomists in recent years (Prescott 2004, Alesina, Glaeser and Sacerdote 2005, Maoz 2010). As Freeman and Schettkat (2005) argue, the gap in hours for women is larger than it is for men. Using time use data, Freeman and Schettkat show that in the early 1990s, the average woman in the U.S. supplied almost 29 hours per week to the labor market, while her European counterpart supplied less than 21. At the same time, the average woman in the U.S. spent about 30 hours a week on home production, while her European counterpart spent more than 40.[3] Finally, Guryan, Hurst and Kearney (2008) show that the average American woman with children spends 11.64 hours per week on childcare while the average European woman with children spends about 10 hours.[4] Lastly, the gap in fertility between the U.S. and Europe is also well documented. In 1990, TFR in the U.S. was 2.08, while in European countries it was about 1.68.[5] This gap in TFR persisted in every single year since 1990. 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 0.29 for the eight European countries mentioned above and 0.31 for all European OECD members. Similarly, the 90-10 ratio during that

[3]In Freeman and Schettkat (2005) home production also includes mothers' time spent in childcare.

[4]We averaged the time spent on childcare for the UK, Germany, Norway, the Netherlands, Italy, Austria and France reported in Guryan et al. (2008).

[5]We averaged the TFR in the eight European countries for which Freeman and Schettkat (2005) work hours and time allocated to home production were reported. These are the UK, Germany, Norway, the Netherlands, Italy, Austria, Sweden and Finland. TFR for all EU member countries or countries belonging to the Euro area in 1990 are 1.64 and 1.5 respectively. Data on TFR for the U.S. as a whole and the European countries are from the World Development Indicators 2011.

period in the U.S. was 5.91 while for the eight European countries it was only 3.48 and for all European OECD members 3.84.

To understand the differences in fertility and women's time allocated to labor supply and home production, 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 childcare increase in inequality while the sum of time allocated to childcare and home production decrease in inequality.

Indeed, a recent article in the San Francisco Chronicle argues that the cost of raising children in Switzerland plays a major role in determining women's labor supply:

> Parents can end up spending almost a third of their wages on childcare, with Zurich nursery schools charging as much as 1,500 francs ($1,700) a month. Those costs, coupled with poor maternity benefits, banish many mothers to the home, said Clivia Koch, the former chief executive of an 8 billion-franc pension fund who now heads the nonprofit Swiss Business Women group.

Furthermore, the article quotes a recent poll for the L'Hebdo magazine according to which "Sixty-six percent see women's employment conditions as a brake on parenthood and 38 percent cite the lack of childcare as holding back the birth rate."[6]

Our explanation for the U.S. – Europe gap in fertility is related to Manuelli and Seshadri (2009). They argue that higher tax rates on labor income in Europe can

[6]"Why Swiss Women Can't Work After Winning Votes to Lead Nation", Business Report, *the Chronicle with Bloomberg*, May 20, 2011. See the *article*

explain the lower fertility there as compared to the U.S. Lower income inequality in Europe, which drives our result can also be attributed to higher tax rates. However, the mechanism in Manuelli and Seshadri (2009) is very different from ours. Specifically, using the Barro and Becker (1989) framework, they show that when the tax rate on labor income increases, individuals reduce their investments in human capital, which leads to a decrease in the present discounted value of net income associated with human capital investment relative to the decrease in consumption. This results in a decrease in the marginal benefit of having an additional child that exceeds the decrease in the marginal cost, and consequently, fertility declines.

Others have also addressed this issue. Preston and Sten Hartnett (2008) argue that one explanation of higher fertility in the U.S. than in other developed countries is that U.S. institutions have adapted better to the increase in women's labor force participation. An example of this adaptation is longer store hours, which provide both opportunities for shopping by people who work during the day and jobs at an hour when a spouse may be available for child care. We view our work as complementing these explanations.

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 fertility and income inequality to support our theory. In Section 5, we study an application of the model to the differences between the U.S. and Western Europe in fertility and women's labor supply. Finally, Section 6 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

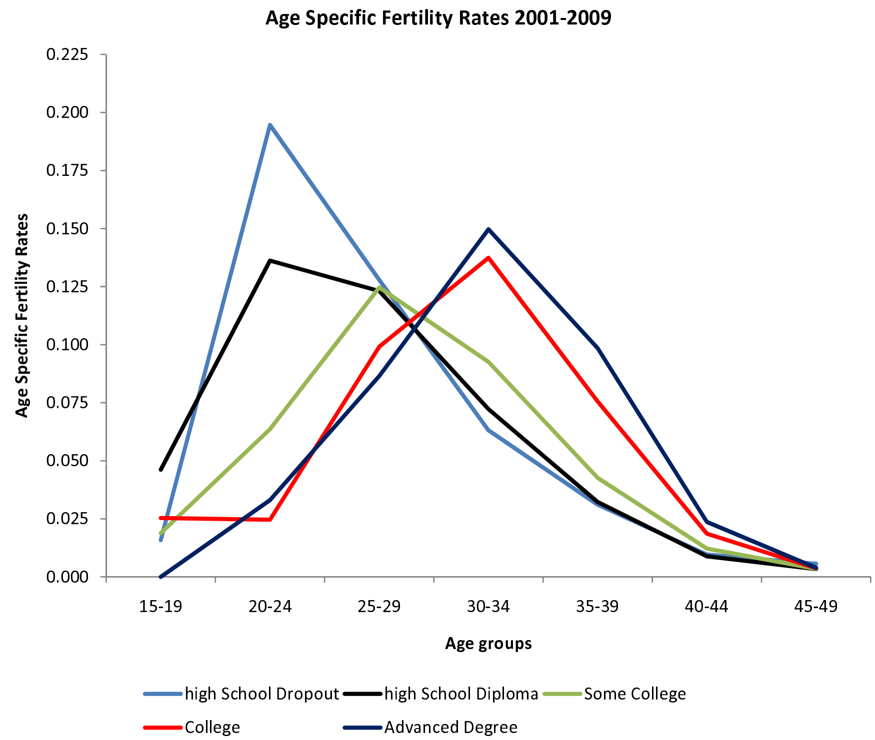

Figure 1: Age-Specific-Fertility-Rates by educational groups, 2001-2009. Authors' calculations using data from the American Community Survey.

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.[7] 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. 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

[7]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.

ages 30–34 for women with college or advanced degrees.[8]

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, given the nature of TFR, one may be worried that we may pick temporary differential trends in the timing of births. To address this concern, we pooled all the observations over the period 2001-2009 and estimate TFR for this period as a whole.

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.

2.1 Robustness of the U-shape fertility

Is the U-shaped relationship between women's education and TFR robust? We consider two types of robustness checks. In the first of these tests, we estimate TFR using a different survey's data: data from the March Current Population Survey (King, Ruggles, Alexander, Flood, Genadek, Schroeder, Trampe and Vick 2010) for the years 2001-2009. We compare the estimates to those shown in Figure 2. Our second exercise utilizes the micro structure of the ACS and investigates the partial association between fertility and women's education by using regression models.

[8] We do not report standard errors on these estimates. Given the sample size, the standard errors on these estimates are essentially zero.

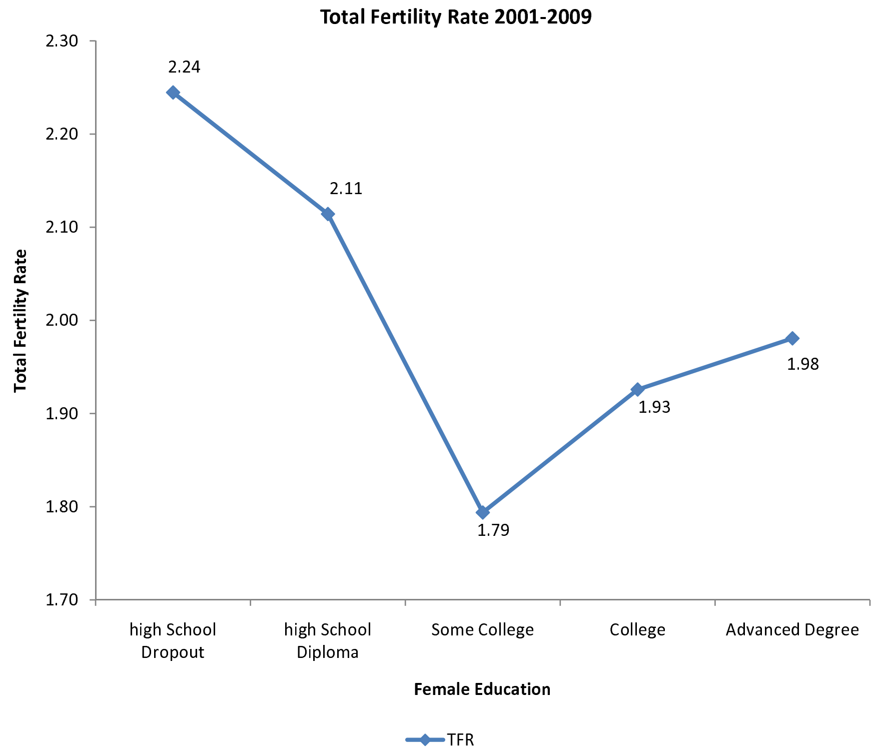

Figure 2: Total fertility rate, 2001-2009. Authors' calculations using data from the American Community Survey.

2.1.1 TFR using Alternative Data Sets

Recall that the main reason for using the ACS data is the specific question that asks each respondent whether she gave birth to any children in the past 12 months. The March Current Population Survey (henceforth March CPS) as well as the ACS asks 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. [9] Given this, we construct a variable for the occurrence of a birth if a woman reports having a child aged 0 years old.

[9]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.

We begin by comparing age-specific-fertility-rates as measured directly in the ACS using the question about giving birth during the past 12 months and those that correspond to the variable constructed from the age of the youngest own child. The correlation between the two sets of age-specific-fertility-rates is larger than 0.99 for all five educational groups. However, the age-specific-fertility-rates based on the latter variable are systematically lower than those presented in Figure 1. More importantly, once we compute TFR using these two sets of age-specific-fertility-rates, we notice that the gap between the two series, which are shown in Figure 3, monotonically decreases with women's education. Nevertheless, notice that the ratio between the two estimates for women with at least college degree is very similar. Specifically, for women with exactly college degree, the ratio is about 0.89 while for women with advanced degrees it is about 0.9. Thus, it is worthwhile to estimate TFR using this indirect inference on the occurrence of a birth from data of the March CPS for the period 2001-2009. Figure 3 presents the estimate for TFR using the CPS data. Notice that the estimates based on this indirect approach are very similar across the ACS and the March CPS data sets for women with up to college degree. For women with advanced degrees, however, the estimated TFR using the March CPS is much larger.

We conclude from this analysis that the total fertility rate is lowest among women with some college training, increases for women holding a college degree only and rising further for women with advanced degrees.

2.1.2 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:

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

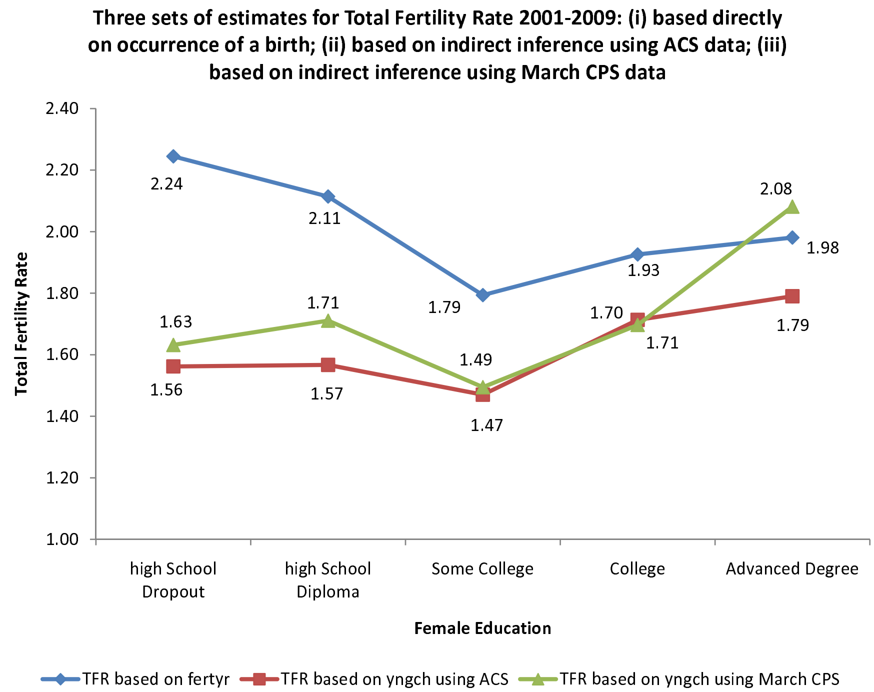

Figure 3: Three sets of estimates for Total Fertility Rate 2001-2009. Authors' calculations using data from the American Community Survey and the March CPS.

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 π. 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.[10] 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 6 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 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 strengthen the U-shaped relationship between fertility rate and women's education.[11]

[10]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 within educational-*age* groups; it could well be that the fertility rate be lower even if the sum of the age-specific-fertility-rates were larger.

[11]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.

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:

$$u_i = \ln(c_i) + \ln(n_i h_i'). \tag{1}$$

The budget constraint is:

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

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:

$$h_i' = (e_i + \eta)^\theta, \qquad \theta \in (0, 1). \tag{3}$$

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

$$TC_i^e = n_i p_e e_i = n_i \bar{h} e_i. \tag{4}$$

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:

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

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.[12] 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:

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

and

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

[12]This modeling approach is similar to Greenwood, Seshadri and Vandenbroucke (2005).

Using these optimal levels we obtain the cost function:

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

where $\varphi \equiv \left(\frac{\phi}{1-\phi}\right)^{1-\phi} + \left(\frac{1-\phi}{\phi}\right)^{\phi}$.

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:

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

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.[13] 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,

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

The optimal t_M^c and t_H^c are:

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

[13]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 breast-feeding are less substitutable than cleaning and cooking.

and

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

Substituting these optimal factors into the cost function yields:

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

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

3.2 Equilibrium

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

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

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

and

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

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, η, 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.[14] In contrast, for high income parents, the value of 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:

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

[14]Notice that for parents with low human capital, η 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 $\theta\varphi\underline{h}^{1-\phi}h_i^{\phi} - \eta\bar{h} > 0 \ \ \forall h_i$.

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.[15] Thus, for all $h_i > \tilde{h}$, marketization implies

[15]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.

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, t_M^n, is strictly decreasing with income, h_i.*

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

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

differentiating (14) with respect to h_i, yields:

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

□

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.

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

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

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 $\frac{\partial t_B^n}{\partial h_i} > 0$ for all h_i is $\theta < 1 - \phi$. □

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, θ, 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. □

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 slopping. Figure 4 shows that usual hours worked per week during the past 12 months by women aged 25-50 indeed monotonically increases with education.[16] 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 4 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.[17] As can be seen from the figure, highly educated mothers of newborns work more hours per week than less educated mothers with newborns.

[16]We restrict the minimum age to 25 because women with advanced degrees might still be out of the labor market at younger ages.

[17]The figure remains intact if we restrict ages to 25-50.

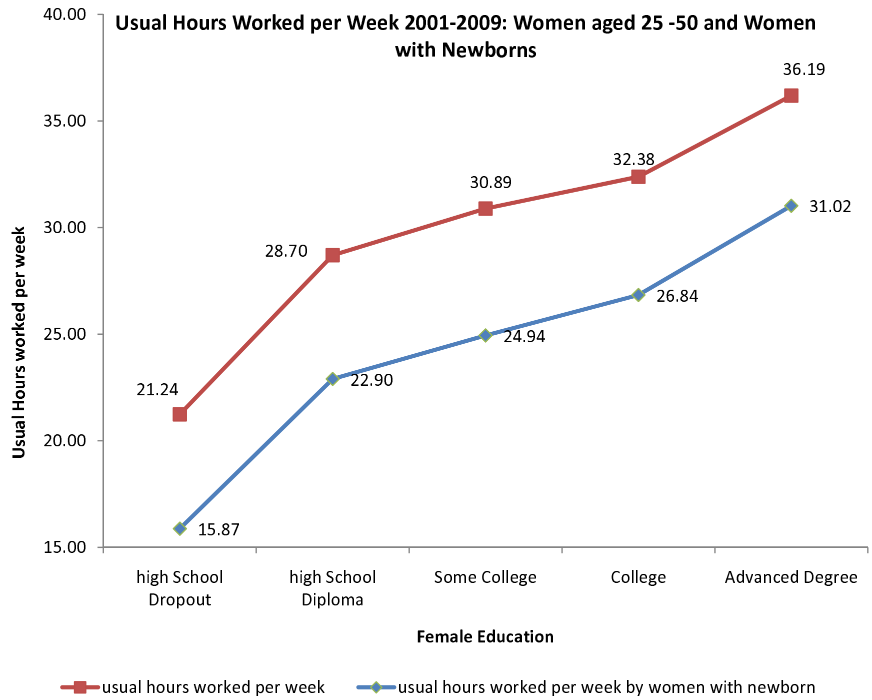

Figure 4: Usual hours worked by women aged 25-50 and women with newborns, 2001-2009. Authors' calculations using data from the American Community Survey.

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 5 shows that this is not the case.

Figure 5 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

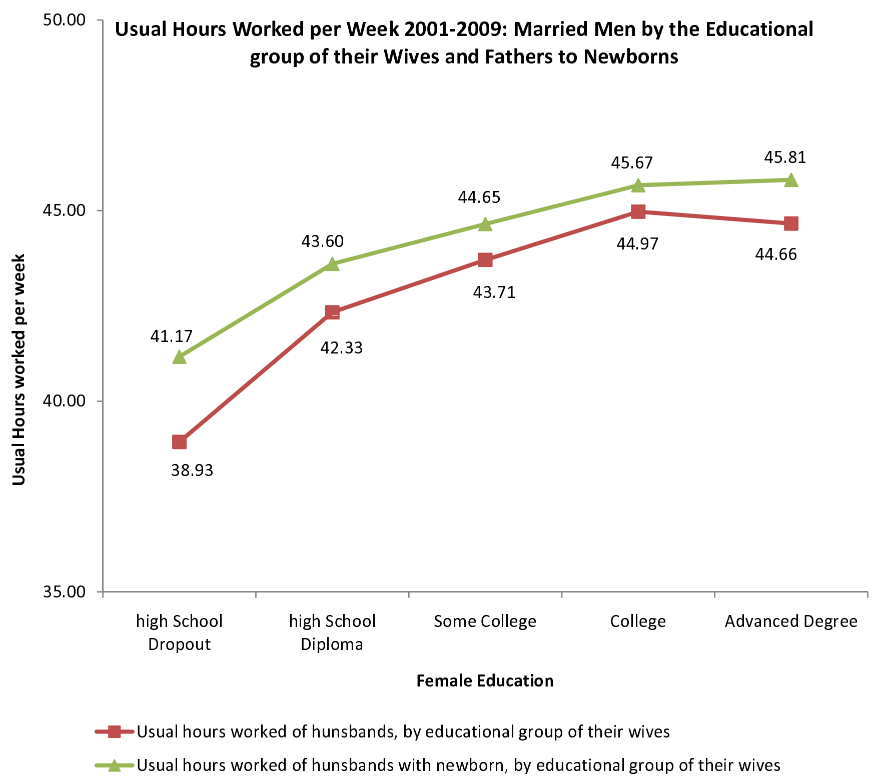

Figure 5: Usual Hours Worked per Week 2001-2009: Married Men by the Educational group of their Wives and Fathers to Newborns. Authors' calculations using data from the American Community Survey.

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.

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 6 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

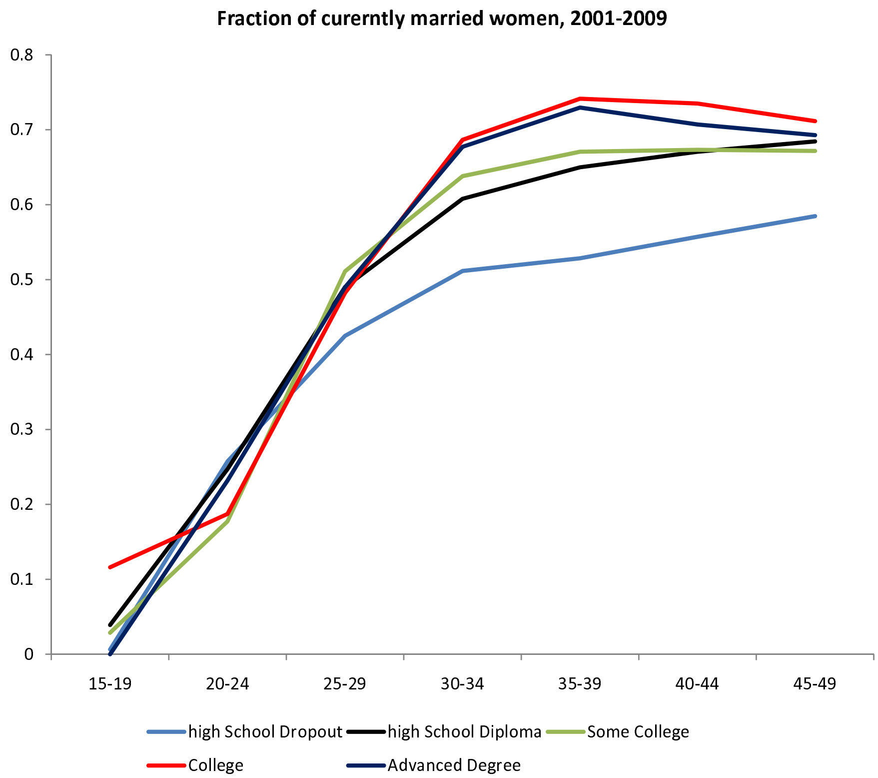

Figure 6: Fraction of currently married women by age and education. Authors' calculations using data from the American Community Survey.

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. For example, it might be that the increase in labor supply of mothers of newborns along the educational gradient, as shown in Figure 4, is driven by the pattern of unmarried mothers, while the reverse is true among married mothers. Figure 7 presents usual hours worked for women aged 15-50 with a newborn by marital status.[18]

[18]Both curves remain intact if we restrict age to 25-50.

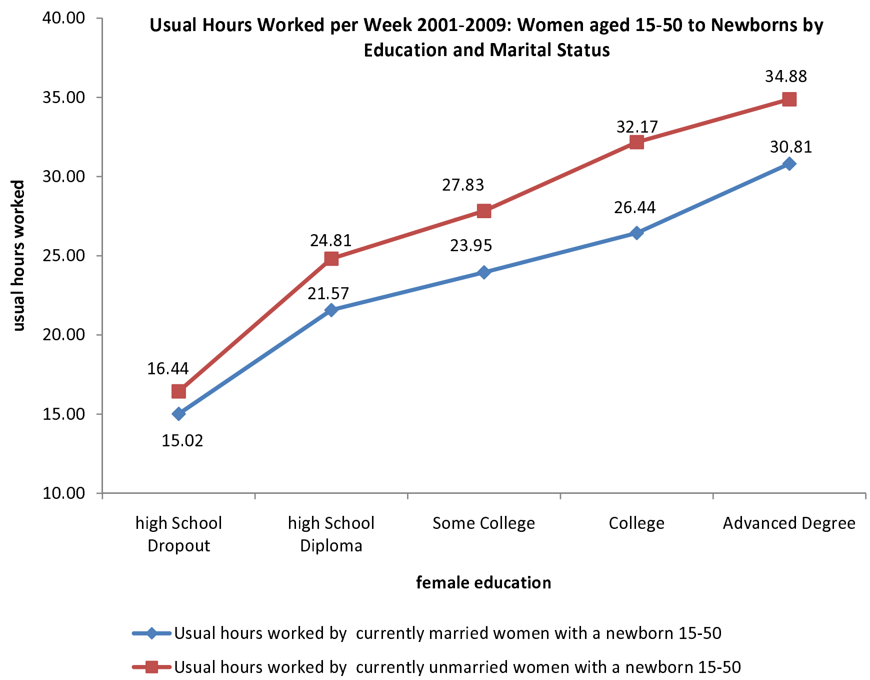

Figure 7: Usual hours worked of women with newborns by marital status, 2001-2009. Authors' calculations using data from the American Community Survey.

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 5 and 7 imply that household labor supply increases with mother's education regardless of marital status.

4.2 Fertility, Education, and Inequality

In this section we provide evidence on the correlation between fertility and 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).[19] We es-

[19]Our results are essentially the same if we use the 90-10 log wage differential for full-time full-year female workers.

timate this measure using data from the March CPS for the years 2001-2009 and allow it to vary by state and year.

The marketization hypothesis suggests that fertility will increase among women 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 interaction terms of inequality and 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. 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, $j = 1$. Formally, $\pi_j + \lambda_j I_{st} = Pr(b_{ist} = 1|e_{j,ist}, X) - Pr(b_{ist} = 1|e_{1,ist}, X)$. Figure 8 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.[20]

Three features emerge from this figure. First, the existence of an upward slopping relation between fertility and women's education, which we documented in Section 2, is robust to controlling for 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.

[20] Because our measure of inequality varies by state-year, we cluster the standard errors at the state level.

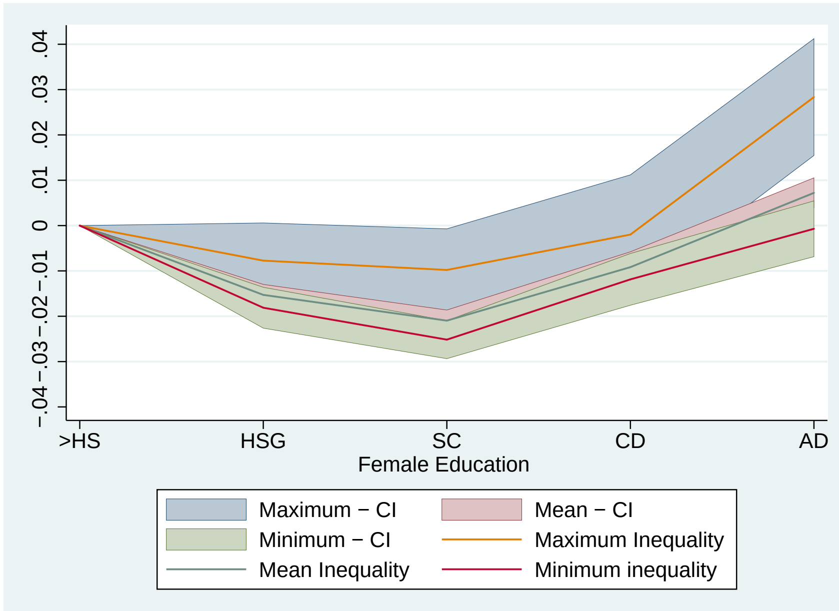

Figure 8: The Partial Association between inequality and the probability of giving birth.

5 The United States versus Europe

In this section we study an application of our model to the differences between the U.S. and Western Europe with respect to fertility, women's time allocated to labor supply and to home production. Our goal in this exercise is to show that our model has the necessary elements to generate these differences. To this end, we compute the average fertility, labor supply and time spent on home production in the 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.

We assume that human capital is uniformly distributed over the support $[\underline{H}, \overline{H}]$. Formally, let $h_i \sim U[\underline{H}, \overline{H}]$. In what follows we compute the aggregate levels of fertility, time spent on raising children and time spent on home production. The labor supply is directly derived from these measures.

Let N be the average fertility in the economy. Using (12), N is given by:

$$N = \int_{\underline{H}}^{\overline{H}} \frac{1-\theta}{2} \frac{h_i}{(\varphi \underline{h}^{1-\phi} h_i^{\phi} - \eta \bar{h})} f(h_i)\, dh_i$$
$$= \frac{1-\theta}{2(\overline{H} - \underline{H})} \int_{\underline{H}}^{\overline{H}} \frac{h_i}{(\varphi \underline{h}^{1-\phi} h_i^{\phi} - \eta \bar{h})}\, dh_i \tag{16}$$

The solution to this integral is a hypergeometric function for which the functional form depends on ϕ. Consequently, to elaborate the macroeconomic behavior, we assume that $\phi = 0.5$, for which a close form solution for (16) exists.

Substituting $\phi = 0.5$ into (16), integrating and substituting the boundaries yields:

$$N = (1-\theta) \tag{17}$$
$$\left[\frac{\overline{H}^{3/2} - \underline{H}^{3/2}}{6\underline{h}^{1/2}(\overline{H} - \underline{H})} + \frac{\eta \bar{h}}{8\underline{h}} + \frac{(\eta \bar{h})^2 (\overline{H}^{1/2} - \underline{H}^{1/2})}{8\underline{h}^{3/2}(\overline{H} - \underline{H})} + \frac{(\eta \bar{h})^3}{16\underline{h}^2(\overline{H} - \underline{H})} ln \left(\frac{2\underline{h}^{1/2}\overline{H}^{1/2} - \eta \bar{h}}{2\underline{h}^{1/2}\underline{H}^{1/2} - \eta \bar{h}} \right) \right].$$

Let T_M^n be the average time spent raising children in the economy. Using (14), T_M^n is given by:

$$T_M^n = \int_{\underline{H}}^{\overline{H}} \left(\frac{\phi}{1-\phi} \right)^{1-\phi} \frac{(1-\theta)\underline{h}^{1-\phi} h_i^{\phi}}{2(\varphi \underline{h}^{1-\phi} h_i^{\phi} - \eta \bar{h})} f(h_i)\, dh_i$$
$$= \left(\frac{\phi}{1-\phi} \right)^{1-\phi} \frac{(1-\theta)}{2\varphi(H - h_0)} \int_{h_0}^{H} \frac{\varphi \underline{h}^{1-\phi} h_i^{\phi}}{(\varphi \underline{h}^{1-\phi} h_i^{\phi} - \eta \bar{h})}\, dh_i \tag{18}$$

Once again, substituting $\phi = 0.5$, integrating and substituting the boundaries gives:

$$
\begin{aligned}
T_M^n &= \frac{1-\theta}{2(\overline{H}-\underline{H})} \\
&\left[\frac{(\eta\bar{h})^2}{4\underline{h}}\ln\left(\frac{2\underline{h}^{1/2}(\overline{H})^{1/2}-\eta\bar{h}}{2\underline{h}^{1/2}(\underline{H})^{1/2}-\eta\bar{h}}\right)+\frac{\eta\bar{h}}{2\underline{h}^{1/2}}\left((\overline{H})^{1/2}-(\underline{H})^{1/2}\right)+\left(\frac{\overline{H}-\underline{H}}{2}\right)\right] \\
&= \frac{1-\theta}{2} \\
&\left[\frac{(\eta\bar{h})^2}{4\underline{h}(\overline{H}-\underline{H})}\ln\left(\frac{2\underline{h}^{1/2}(\overline{H})^{1/2}-\eta\bar{h}}{2\underline{h}^{1/2}(\underline{H})^{1/2}-\eta\bar{h}}\right)+\frac{\eta\bar{h}}{2\underline{h}^{1/2}}\frac{(\overline{H})^{1/2}-(\underline{H})^{1/2}}{(\overline{H}-\underline{H})}+\frac{1}{2}\right]
\end{aligned} \tag{19}
$$

Finally, let T_M^c be the average time spent in home production in an economy. Using (15), T_M^c is given by:

$$
\begin{aligned}
T_M^c &= \int_{\underline{H}}^{\overline{H}} \frac{\alpha}{2\left(1+\left(h_i/\hat{h}\right)^{\frac{\sigma}{1-\sigma}}\right)} f(h_i)\, dh_i \\
&= \frac{\alpha}{2(\overline{H}-\underline{H})}\int_{\underline{H}}^{\overline{H}} \frac{1}{1+\left(h_i/\hat{h}\right)^{\frac{\sigma}{1-\sigma}}}\, dh_i
\end{aligned} \tag{20}
$$

Similarly to the cases above, the solution to this integral is a hypergeometric function for which the functional form depends on σ. Consequently, to elaborate the macroeconomic behavior, we assume that $\sigma = 0.5$, for which a close form solution for (20) exists. Substituting $\sigma = 0.5$, integrating and substituting the boundaries gives:

$$
T_M^c = \frac{\alpha\hat{h}}{2(\overline{H}-\underline{H})}\ln\left(\frac{\overline{H}+\hat{h}}{\underline{H}+\hat{h}}\right). \tag{21}
$$

5.1 Mean Preserving Spread

Now we are ready to perform the mean preserving spread exercise and examine the impact of inequality on average fertility, labor supply, time spent on home production and child-raising. Given the uniform distribution of income assumed above, the average income is

$$\bar{h} = \frac{\underline{H} + \overline{H}}{2} \qquad \Rightarrow \qquad \underline{H} = 2\bar{h} - \overline{H} \tag{22}$$

We assumed that the average teacher possesses the average human capital in the economy. Given the assumed uniform distribution of human capital, the average human capital coincides with the median. Similarly, we assume that the average babysitter is located in the γ percentile and the average housekeeper is in the δ percentile. Alternatively, we could have assumed that the $\underline{h}$ and $\hat{h}$ take the same value across countries. This latter assumption would still reduce the relative price of these services, but it would do so, only for those who are in the upper tail of the distribution. In contrast, fixing the percentile of babysitters and housekeepers better captures the idea that greater inequality reduces the relative price of these services for the majority of the population. Our assumptions imply that:

$$\underline{h} = (1-\gamma)\underline{H} + \gamma\overline{H} \qquad \Rightarrow \qquad \underline{h} = 2(1-\gamma)\bar{h} - (1-2\gamma)\overline{H}, \tag{23}$$

and

$$\hat{h} = (1-\delta)\underline{H} + \delta\overline{H} \qquad \Rightarrow \qquad \hat{h} = 2(1-\delta)\bar{h} - (1-2\delta)\overline{H}. \tag{24}$$

Mean preserving spread is, thus, increasing $\overline{H}$ while (22), (23) and (24) hold. Put differently, by increasing $\overline{H}$, in order to preserve the mean, $\underline{H}$ should be determined by (22). As the babysitters and the housekeepers are assumed, on average, to be in the γ and δ percentiles, $\underline{h}$ and $\hat{h}$ are being determined by (23) and (24), respectively.

Figure 9 shows the results of a numerical example. As can be seen from the figure, an increase in inequality leads to an increase in average fertility, consistent with the evidence mentioned in the introduction. Similarly, time spent on child-care is also increases in inequality. While we do not have a direct evidence on

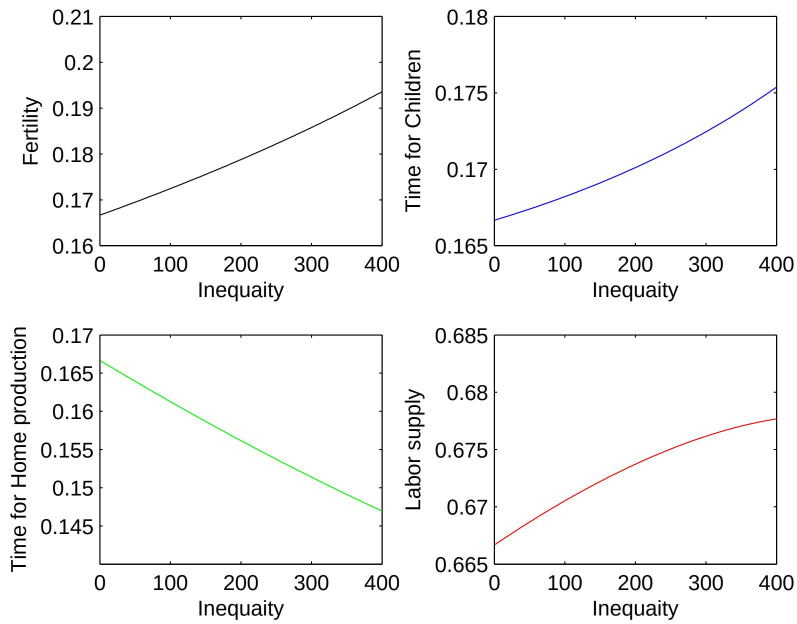

Figure 9: The effect of a mean preserving spread on economy's averages: Fertility (N), mother's time spent on child raising (T_M^n), mother's time spent on home production (T_M^c) and labor supply. The following values of the parameters are assumed: $\theta = 0.5$, $\eta = 0.1$, $\alpha = 0.5$, $\bar{h} = 1000$, $\overline{H} = \bar{h} + d$, $\underline{H} = \bar{h} - d$, $\gamma = 0.25$, $\delta = 0.125$, where d is the value at the horizontal axis, which is positively correlated with with human capital variation in the economy.

the relationship between inequality and time spent on child-care, women in the U.S. spend more time on child care than their European counterparts (Guryan et al. 2008). In contrast, time spent in home production is decreasing in inequality, consistent with the evidence that women in the U.S. spend much less time on this task compared to their European peers, while labor supply increases with inequality, again consistent with the evidence on women labor supply in the U.S. and Europe (Freeman and Schettkat 2005).

6 Concluding Remarks

We present new evidence about the cross-sectional relationship between fertility and women's education in the U.S. . between 2001 and 2009, showing that fertility rate, as a function of education, 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, as well as state-level income inequality.

One may be skeptical, however, as to whether this pattern in fertility rates will be translated into completed fertility. The evidence on completed fertility, thus far, points to a decreasing relationship between fertility and education. However, given the nature of this measure, it is currently impossible to estimate completed fertility for generations born after the 1960s. However, for two reasons, we assume that a good chance exists to observe the same U-shaped pattern in completed fertility in the future. First, this pattern covers nine years of fertility, almost one-third of the period during which a woman can give birth. Second, with the exception of the post-World War II baby-boom, total fertility rate and completed fertility rate in the U.S. have always tracked one another quite tightly (Preston and Sten Hartnett 2008).

Our model demonstrates how parents can substitute their own parenting time for market-purchased childcare. We show that highly educated women substitute a 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 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. Guryan et al. (2008) find that mother's time allocated to childcare increases with mother's education, when child care is the primary use of time. Guryan et al. (2008) also look at a broader definition of childcare called "with whom". This includes parental time around their children even if the parents are not engaging in tasks where "child care" is the primary activity. They found that "[i]n terms of the education gradient, high-educated parents and low-educated parents spend nearly identical amounts of total time around their children. In other words, no education gradient exists with respect to spending time around ones children." (p. 30) Ramey and Ramey (2010) argue that as slots in elite postsecondary institutions have become scarcer, parents responded by investing more in their children so that they appear more desirable to college admissions officers. Notice that in our model, time spent on childcare does not include any investment in the child's human capital, which takes place in schools. Perhaps one way to reconcile our model with the evidence regarding mother's time spent on childcare and the argument made in Ramey and Ramey is to extend our model by allowing strong complementarity between schooling time and parental time in the production of the child's human capital.

We conclude with an application of our model to the differences in fertility and time allocation of women between the U.S. and Europe. To this end, we compute average fertility and time spent on childcare, on home production and on labor supply. We then analyze the effect of a mean preserving spread of the income (human capital) distribution. Consistent with the evidence, we find that as a result of an increase in income inequality, average fertility, time spent on childcare and labor supply increase while time spent on home production declines. Further research investigating differences between the U.S. and Europe in this direction will likely be rewarding.

References

Alesina, Alberto, Edward Glaeser, and Bruce Sacerdote, "Work and leisure in the U.S. and Europe: Why so different?," *NBER Macroeconomics Annual*, 2005, *20*, 1–64.

Angrist, Joshua D. and William N. Evans, "Children and Their Parents Labor Supply: Evidence from Exogenous Variation in Family Size," *American Economic Review*, 1998, *88*, 450–477.

Autor, David H., Lawrence F. Katz, and Melissa S. Kearney, "Trends in U.S. Wage Inequality: Revising the Revisionists," 2008, *90*, 300–323.

Barro, Robert J. and Gary S. Becker, "Fertility Choice in a Model of Economic Growth," *Econometrica*, March 1989, *57*, 481–501.

Becker, Gary S., "A Theory of the Allocation of Time," *Economic Journal*, 1965, *75*, 493–517.

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 Gorwth: Why Differential Fertility Matters," *American Economic Review*, September 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.

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.

——— 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 Vandenbroucke, "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.

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.

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.

King, Miriam, Steven J. Ruggles, Trent Alexander, Sarah Flood, Katie Genadek, Matthew B. Schroeder, Brandon Trampe, and Rebecca Vick, *Integrated Public Use Microdata Series, Current Population Survey: Version 3.0. [Machine-readable database]* 2010.

Kremer, Michael and Daniel L. Chen, "Income Distribution Dynamics with Endogenous Fertility," *Journal of Economic Grwoth*, 2002, *7*, 227–258.

Manuelli, Rodolfo E. and Ananth Seshadri, "Explaining International Fertility Differences," *Quarterly Journal Economics*, 2009, *124*, 771–807.

Maoz, Yishay D., "Labor Hours in the United States and Europe: the Role of different Leisure Preferences," *Macroeconomic Dynamics*, 2010, *14*, 231–241.

Moav, Omer, "Cheap Children and the Persistence of Poverty," *Economic Journal*, 2005, *115* (500), 88–110.

Prescott, Edward C., "Why Do Americans Work So Much MoreThan Europeans?," *Federal Reserve Bank of Minneapolis Quarterly Review*, 2004, *28*, 2–13.

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.

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***	-0.002***	-0.016***	-0.016***	-0.017***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Some College	0.013***	-0.002***	-0.023***	-0.023***	-0.024***	-0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
College Graduates	0.024***	0.005***	-0.014***	-0.014***	-0.015***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Advanced Degrees	0.029***	0.008***	0.001	0.001	0.000	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Family Income						-2.20e-07***
						(0.000)
Family Income Squared						3.96e-13***
						(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
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***	-0.004	-0.155***	-0.155***	-0.161***	-0.149***
	(0.006)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Some College	0.141***	-0.015**	-0.228***	-0.231***	-0.238***	-0.217***
	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)
College Graduates	0.241***	0.039***	-0.142***	-0.145***	-0.153***	-0.113***
	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)
Advanced Degrees	0.282***	0.063***	-0.000	-0.004	-0.013	0.037***
	(0.007)	(0.007)	(0.009)	(0.009)	(0.009)	(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:

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

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.