Cohabitation, Marriage, and Fertility: Divergent Patterns for Different Education Groups *

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February 15, 2018

Abstract

The U.S. has been experiencing a long-term decline in the rates of marriage and fertility and a steady rise in cohabitation. We use data from the the Current Population Survey to show these patterns vary across education groups. We argue such divergence is related to the changes in sources of gains from marriage. The traditional gender specialization in market work versus home production has weakened as the gender wage gap narrows and both educational attainment and labor force participation for women rise. The primary source of the gains of marriage shifts to investment in children since marriage provides strong commitment mechanism that allows parents to adopt a high-investment strategy. These changes imply that cohabitation becomes a desirable living arrangement choice for some people, in which they gain utility from living with a partner enjoying public goods but face less commitment. On the other hand, a highly educated woman, who faces a higher opportunity cost of raising a child due to higher wage compensation, also experiences a higher return of investment in children. Thus it's crucial to examine the marital choice and fertility decision jointly. Using a two-period over-lapping-generation model, we theorize the influence of changes in labor market on females' martial choices and fertility decisions by examining the trade-off between working, producing household service, and investing in children for different skill groups. Calibrating the simplified benchmark model using targets from period 1995 to 2008, we are able to explain over 65% of the differential fertility choices for females with different education background and marital status.

Keywords: fertility, cohabitation, marital choice, quantity-quality trade-off, schooling, skill premium

JEL Codes: I20, J13, J24

*Preliminary and incomplete: please do not cite without permission.

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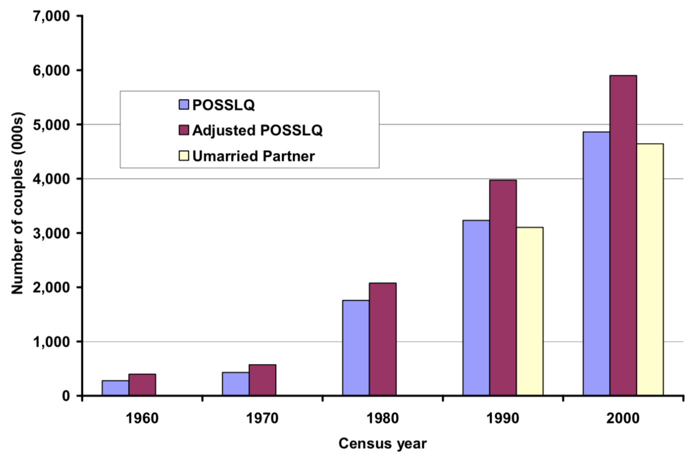
1 Introduction

The U.S. has been experiencing a long-term decline in the rates of marriage and fertility, which are among the most prominent behavioral changes to affect the family structures over the past few decades. A lot of early discussions have been focused on the increases in the age at first marriage, greater instability leading to "retreat from marriage", out-of-wedlock birth and non-marital childbearing, and delay in childrearing decisions. However, one striking fact that is often ignored is the rising trend of cohabitation. Figure 1 [1], borrowed from Fitch et al. (2005), shows the number of cohabiting households nearly doubled from 1960 to 1970 and now cohabitation becomes a common living arrangement.

Figure 1: Number of Cohabiting Households in the United States



Source: Fitch et al. (2005)

Subsequent works explaining the emergence of these behaviors tend to analyze marriage, cohabitation, and childrearing decisions separately. As far as to our knowledge, this paper is the first attempt to develop a theory to discuss marital choices, including both marriage and cohabitation choices together with fertility decisions of quantity and quality of children and to explain the divergent patterns for different education groups.

The traditional theory, stemmed from Becker's sequences of work[2], emphasizes the sources of gains of marriage from specialization and exchange that marriage is rationalized as a life-time contract between a man and a woman, in which the man performs market work while the woman performs home production. As the gender gap narrows because of the fact that changes in production technology help increase the productivity of female workers

[1]POSSLQ refers to Persons (or Partners) of Opposite Sex Sharing Living Quarters.
[2]Becker (1973), Becker (1974), Becker (1981).

more than male workers (Galor and Weil, 2000), and women have better and easier access to higher education and labor market, the marital surplus fell with reduced specialization. In response to these underlying changes in opportunity cost of females, the divorce rate has also been increasing, along with the declining marriage rate and fertility (Lundberg et al., 2016).

However, if we take a closer look at the data for different education groups, we find a divergent pattern of marital and fertility choices for high school graduates (low human capital group) and college graduates and above (high human capital group). In 1970s, the share of women aged between 40 and 45 currently married was about 83% for low education group and 88% for the high education group. Nevertheless, by 2015 only 55% of high school graduates and still around 70% of college graduates and above were currently married. Though both groups have experienced a drop in marriage rate, the decline is much more dramatic for the low human capital group. Similarly, the share of currently single/unpartnered [3] increases for both education groups, but the rise is more pronounced for the high school graduates. The share of women choosing cohabitation increases overtime, but unlike the marriage rate and single rate, this increase is more evident for the high education group. Moreover, at each time period, the fertility rate, measured by the average number of children ever born, is higher for the low education group. If the sources of gains of marriage mainly come from specialization between market production and household activities, we would have expected a more pronounced drop in marriage rate and fertility for high skill females, which is not consistent with the data. The divergent patterns imply that something else is driving up the willingness of women in high skill group to get married and raise children nowadays. We argue that the investment in children is a key in order to understand such divergent patterns between various skill groups. Data from the American Time Use Survey show that the higher-educated women not only spend more time working in the outside labor market but also that those high skill mothers are more willing to and do spend more time with their children. Given the higher opportunity cost of working and earning income, the stronger willingness to invest in children confirms our conjecture that high skilled women should have enjoyed an implicit higher return from investment in children.

The primary source of the gains of marriage shifts to the return of investment in children since marriage provides stronger commitment mechanism that allows parents to adopt a high-investment strategy. These changes imply that cohabitation becomes a desirable

[3] We use "single" and "unpartnered" interchangeably in this paper.

living arrangement choice for some people, in which agents gain utility from living with a partner enjoying public goods but face less commitment. Thus it is of great importance to understand the different marital choices together with childrearing decisions by examining the trade-off between working, producing household service, and investing in children for different education groups, since the skill level is a key determinant of labor market outcome and has an influential impact on return of investment in children.

In order to examine these different patterns of marital choices and childrearing decisions, we build an over-lapping-generation model, in which the economy is populated by a continuum of agents who are heterogenous in education types, H or L, representing whether finishing college or not, their human capital h, and the type of their potential partners θ. The agents live for two periods in the model. In the first period, the young agents are all employed as unskilled labor and decide whether to go to school or not, and this would affect the unit wage rate that they will receive in the second period. The probability of finishing college successfully or not would depend on the education types of her parent and her endowed human capital. Later in the second period, they make marital and childrearing decisions (both quantity and quality), and they work, consume, and produce public good for their families. For investment strategies in children, an agent with higher human capital would face a higher marginal cost as childrearing takes time, nevertheless she also enjoys a higher return from investing in her children's human capital. Since different living arrangements imply different implicit costs for childrearing and household service production, schooling decision, working decision, marital choice, and childrearing decision are jointly determined in the model.

The new mechanism through the human capital channel enriches the model in the way that higher wage rate from getting a bachelor's degree enhances the opportunity cost of raising a kid, but at the same time, this also increases the return of raising a child. The two opposing forces interact with each other, so it's not obvious how women, especially those with higher education degree, would react to the better labor market working conditions and rising skill premium. We simplify the full model and calibrate the simple benchmark model by using the average moments and data covering year 1995-2008 in the U.S. economy. Overall, the simplified benchmark model does a good job in terms of predicting differential fertility decisions for women in different marital status; overall the benchmark model is able to explain over 65% of the differential fertility choices.

1.1 Literature

Our paper is related to several themes of research. The first related field is the study on economics of marriage and evolving role of marriage. Back to 1970s, Gary Becker [4] developed the economic model of marriage. He rationalized the marriage between a man and a woman as a lifetime contract that the man provides income from market work and the women provides household work such as cooking, childcare, and house cleaning. The expected source of gains of marriage stemmed from specialization and exchange (Becker, 1981). Later work has recognized gains from joint consumption of public goods such as children and housing (Lam, 1988). Other than Becker's altruist model, another way to model marriage is bargaining model. For example, Manser and Brown (1980) and McElroy and Horney (1981) developed the divorce-threat bargaining model, in which distribution within the marriage is treated as the solution to a cooperative game that usually the threat point is divorce. Empirically, Lundberg and Pollak (2015) investigates the evolving role of marriage in the United States. Since the focus of this paper is not on the distribution within marriage or the matching process between two parties, similar to De La Croix and Doepke (2003) and Doepke (2004) we follow a more macro approach by modeling the choices of female agents, abstract from matching market. Among all the approaches, the most two popular ways are life-cycle model and over-lapping-generation model. We prefer the over-lapping-generation model over the life-cycle model because we focus on parents' choices (marital and fertility decisions) instead of children's own choices. The implicit assumption is that parents have a great influence on their children's life.

However in most of these works, cohabitation is not explicitly considered as a possible option to marriage or being single. Empirically, it's also hard to measure cohabitation due to data limitations. Researchers at the Census Bureau started developing national representative estimates of the number of cohabiting couples in the late 1970s (Glick and Norton (1977), Glick and Spanier (1980), Glick (1984), Bumpass and Sweet (1989b)). The measure known as POSSLQ (Partners of the Opposite Sex Sharing Living Quarters) was developed to infer cohabiting couples indirectly from the data. Later Casper and Cohen (2000) refined this measure into the adjusted POSSLQ to improve the estimates. Not until year 1995 did the CPS start to report cohabitation information by providing the relationship of an individual to the head within the same household [5]. Later in 1980s and 1990s, with

[4] Becker (1973), Becker (1974)

[5] This paper only considers opposite-sex cohabiting and married couples. We understand that same-sex cohabitation and marriage are becoming an important issue to investigate, but this is not our main interest in this paper

more data available, researchers started to investigate the emergence of cohabitation using either direct measure and indirect inference tools. Manning (2013) gives a good review of the related empirical literature. Another stream of literature studies cohabitation is by investigating the wealth accumulation (Vespa and Painter, 2011), the happiness, and the influence of different family structures on children (Thornton (1988), Bumpass and Sweet (1989a), Bumpass and Lu (2000)). Our paper uses the direct measure from CPS to study the characteristics of cohabiting females by emphasizing their fertility decisions.

Besides marital choices, another important aspect in our paper is fertility decision, including both the intensive and the extensive margins. We not only study whether a female decides to have kids or not, but also study the quantity and quality tradeoff. Advanced by Becker (1960), Becker (1973), and Willis (1973), economists who study modern economic demography concentrate on parental trade-offs between the number and quality of children. Hanushek (1992) provides empirical evidence showing that family size directly affects children's achievement. Our paper contributes to the theory by providing another new channel considering the return of investment in kids. To reinforce this idea, a female agent faces the time allocation problem between market work, household work, and childrearing activities. For a woman with higher human capital, she earns a higher wage, thus implying a higher opportunity cost of raising a kid. Nevertheless, because of her high human capital, she also enjoys a higher return in the investment into her children's skill if she decides to have a kid at the first place. The two conflicting forces react with each other, and this helps explain the divergent fertility and marital patters between the low educated and the high educated groups.

Our work is also related to studies on the linkage between gender gaps and female labor market performance, and economic growth. Barro and Becker (1989) applied the framework of altruistic parents making choices of family size together with consumption decisions and intergenerational transfers to a closed economy, extending the optimal economic growth literature by allowing optimal choices fertility and intergenerational transfers. Galor and Weil (1993) linked the gender gap with fertility and investigated the impact on aggregate growth in the economy. Although our paper is not directly discussing the economic growth, it's essential to study the fertility decisions, especially the intergenerational human capital transmission to understand how demographic changes shape the quality of labor market. Additionally, it's also of great importance to investigate how the current labor market affects women's choices on family formations.

The most related paper is by Lundberg et al. (2016). They used data from 1960-2000 US

Census and 2010 American Community Survey to document divergent patterns in marriage, cohabitation, and childbearing. They also discussed the changes in gender roles, marital surplus, and investments in children. There are two crucial aspects that our paper is different from theirs. First, in the empirical part, we restrict our sample to females age from 40 to 44 because our paper focuses on life-time choices instead of dynamic transitions and we believe this age range better captures the completed fertility. Second, unlike Lundberg et al. (2016)'s paper is an pure empirical work, we develop a theory to rationalize the importance of return of investments in children's quality and discuss the role of specialization.

An outline of the paper follows. Section 2 details the empirical evidence and some robustness check. Section 3 outlines the two-period OLG model. In section 4 we simplified the full model into our benchmark model, and section 4.2 and section 4.3 present the calibration strategy and results from the simple benchmark model. Section 5 concludes.

2 Data

We follow Lundberg et al. (2016) to consider only high school graduates and bachelors above. To be more specifically, the low skill group (low human capital group) is defined over the sample with high school degree, including individuals with some college experience but no diploma. The high education group is defined as individuals with at least a bachelor's degree. We further restrict the sample to females who age from 40 to 44 since this is the group we are interested in in order to measure fertility. For majority of the results, we take data from the Current Population Survey (IPUMS CPS) [6]. We focus on the time periods starting from 1976 to 2008. Year 1976 is the earliest year that we can get reliable data, and we choose year 2008 as the ending period because we do not want to emphasize the Great Recession. However, the cohabitation data become available only starting year 1995, and hence all data related to marital status will begin from year 1995 and end in year 2009.

2.1 Labor Market for Females

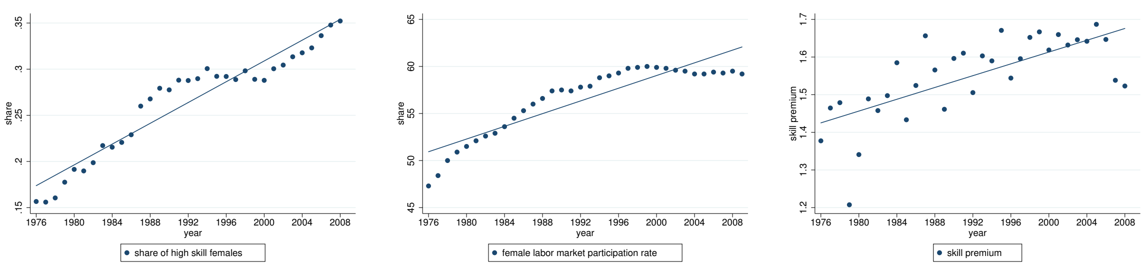
We follow Acemoglu (2002) in constructing the skill premium for females. The relevant measure of worker's income is constructed from the IPUMS variables INCWAGE and is the annual income reported in real 2010 USD. Those with no earnings and the remaining lowest 1 percent of earners are dropped from the sample. Top-coded incomes are assumed to be 1.5 times the top-code. The reported measure of skill premium is the coefficient on a dummy

[6] See appendix A for further discussion on June CPS and March CPS.

variable for those with at least a bachelor's degree (compared to those with only high school degree) in an OLS regression of log income with a variety of controls. The controls are; (1) a quartic in years of potential experience, (2) race (white/non-white) dummy, (3) state dummies (4) additional dummies for educational categories. Years of potential experience $E = \text{age} - S - 6$ is defined by assuming that an individual's schooling starts after age six and years of schooling, S, are assumed using the IPUMS variable EDUC. This variable reports the highest level of educational attainment of a respondent.

Figure 2 shows the changes in labor market for females. Panel a illustrates the rising share of females who have higher education experience. The share of the high skilled increases from 13.36% in 1972 to 35.33% in 2008. Panel b illustrates the striking increase in female labor market participation rate, and panel c shows the increasing trend of skill premium. All these statistics imply a better access to higher education and labor market, thus leading to a higher opportunity cost of getting married and having a child. Another implication that worths to be pointed out is that the rising skill premium shows the importance of getting at least a bachelor's degree. If a parent could foresee such trend, she would naturally invest more into her children if she is altruistic about her offspring.

Figure 2: Labor Market for Females



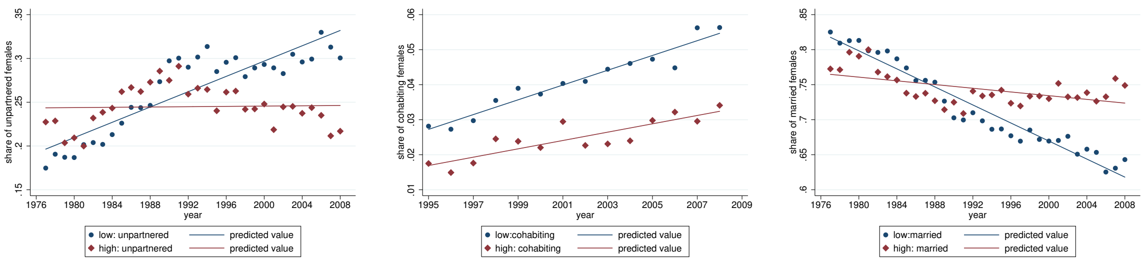
(a) college+ share (b) participation rate (c) skill premium

Source: CPS and FRED

2.2 Evolution of Marital Status

Figure 3 illustrates the evolution of marital choices by education groups. In 1970s, among the low skill group, about 17.25% percent of females remained unpartnered; about 3% were cohabiting with a partner, and the remaining were married; in 2008, these three numbers changed to 33.5%, 6%, and 62.5% respectively. For the high skilled, about 22.5% were unpartnered in 1972, slightly less than 2% were cohabiting, and 78.6% were in marriage. It is quite obvious to see from the figure that although the two education groups share the same trend: more likely to be unpartnered and cohabiting, and less likely to be married, the magnitude of changes are very different. The drop in marriage rate is much more pronounced for the low skilled females and the increase in the cohabiting rate is much less evident for the high skilled group.

Figure 3: Marriage Status for Females by Education Groups



(a) unpartnered (b) cohabiting (c) married

Source: June CPS Supplement

2.3 Evolution of Fertility

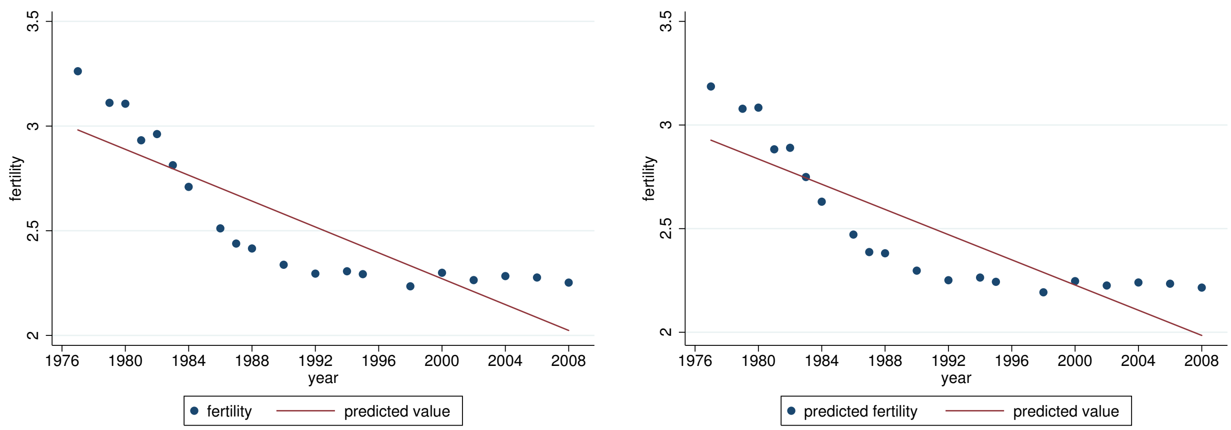
Next let's look at the changes of fertility rate [7]. Figure 4 shows the declining trend of fertility. The left panel is the naive measure, while the right panel shows the average predicted fertility from the OLS regression. In regression, we control for a quartic in age, education, experience, state dummies, and industry dummies. Figure 5 shows the trend of fertility by education groups. The drop of fertility rate is 64.6% for the low skill group, which is much more evident than the drop of the high skilled. Figure 6 shows the fertility rates by marital status. For cohabiting and married females, the completed fertility has dropped, however the fertility rate has increased for unpartnered females. Figure 7 shows the changes in fertility rate by education groups and marital status, and figure 8 gives us a better view to compare the starting point and the ending point. Over the period from year 1995 to year 2010, the completed fertility rates for all education groups all fall. The rate falls for the high school graduates by about 2.142% from 2.381 to 2.330, but the drop is much less pronounced for the females with a bachelor's degree that the fertility rate decreases by 1.561% from 2.242 to 2.207. For those with master or doctor degree, the drop, even slighter, is about 0.195% that the rate goes from 2.048 to 2.044. For more detailed data, see appendix B.2.

There are two take-aways from these figures: (1) on average, regardless of marital status,

[7]There are multiple ways to calculate fertility rates. Completed fertility is the number children ever born for women ages between 40 and 44. General Fertility is defined as birth per 1000 women ages 15-44. Total Fertility is the hypothetical lifetime births per woman. Due to the data limitations, we use completed fertility defined over the sample for those who have kids in order not to emphasize the zero-mass issue.

females with low human capital tend to have more kids than those with high human capital, and (2) contrary to common sense that highly educated are less willing to raise a kid, the fertility rate has dropped much less for them despite the fact that two groups both tend to be less likely to raise kids. The first point supports the quantity-quality-tradeoff theory, which has been discussed many times in the previous research. What is more interesting is the second fact, which tells us that there is something else driving up the likelihood of childbearing for highly educated women especially considering the higher opportunity cost that comes from the better occupations and higher wages.

Figure 4: Fertility over time

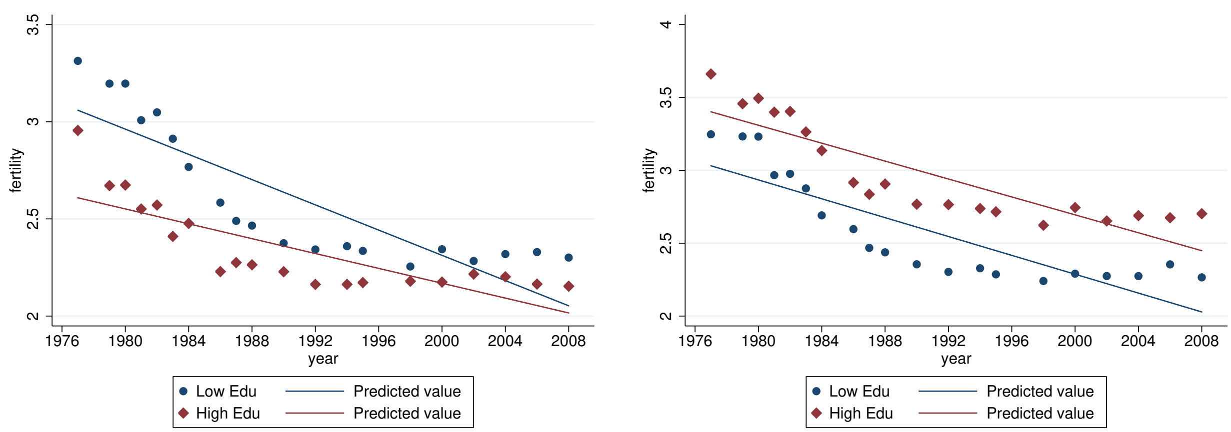


(a) naive measure

(b) regression measure

Source: June CPS Supplement

Figure 5: Fertility over time by Education Groups

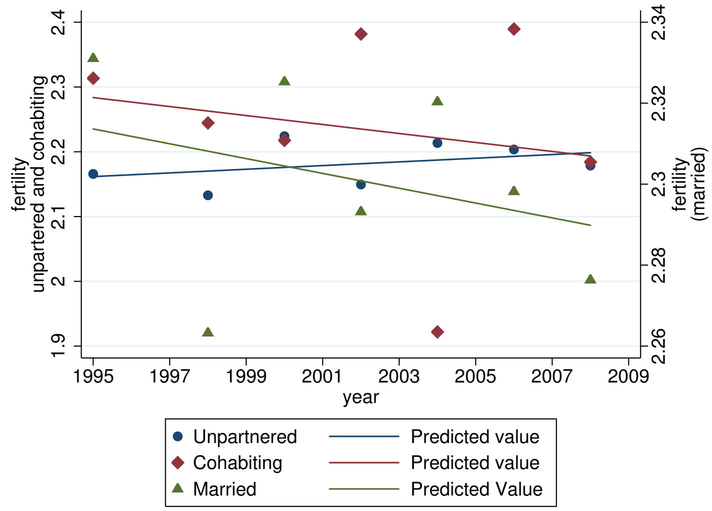


(a) Naive Measure

(b) Regression Measure

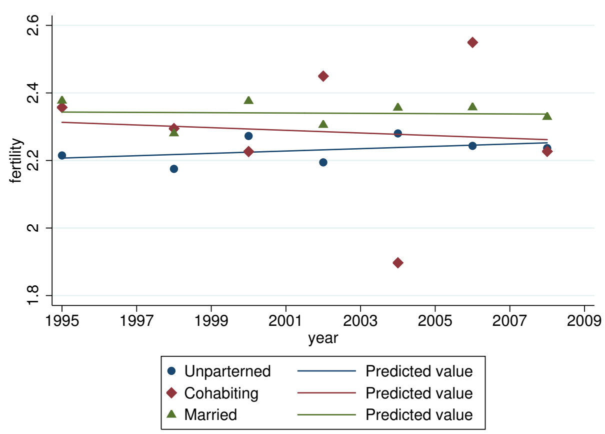
Source: June CPS Supplement

Figure 6: Fertility over time by Marital Status

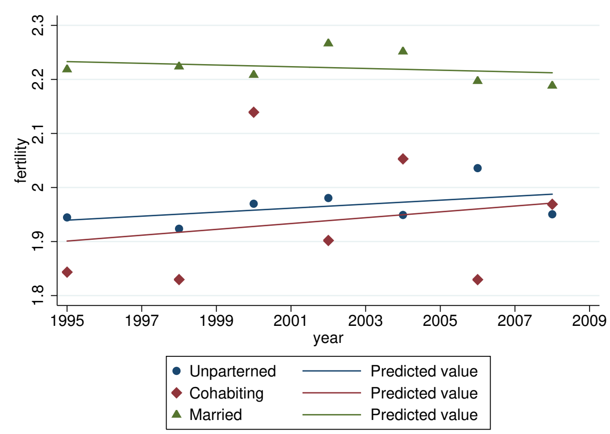


Source: June CPS Supplement

Figure 7: Fertility over time by Marital Status and Education



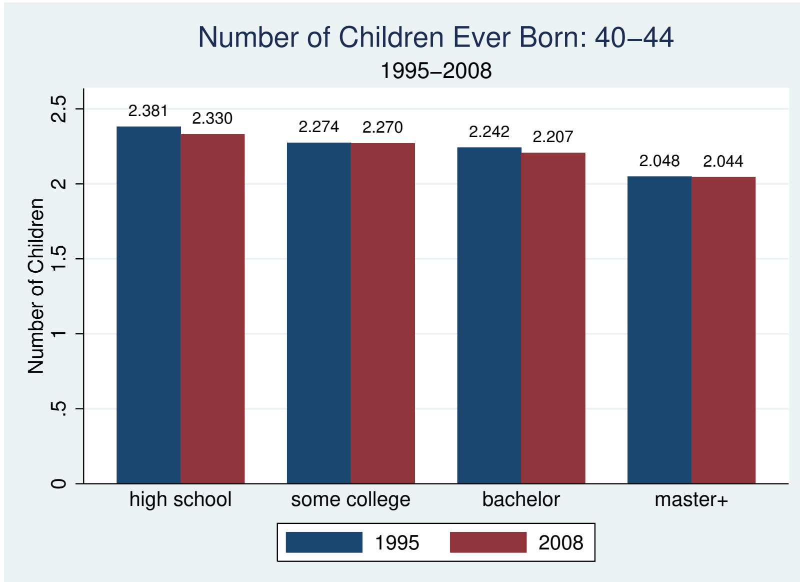
(a) Low Edu



(b) High Edu

Source: June CPS Supplement

Figure 8: Fertility by Education Groups 1995-2008



Source: June CPS Supplement

2.4 Time Spent on Kids

To confirm our conjecture, we need to provide evidence on the return of investment in children. However, the return is something intangible and hard to measure; instead, we provide supporting evidence on the time spent on children since it indirectly reflects how parents value investment in children.

Guryan et al. (2008) examines parental time allocated to childrearing using data from the American Time Use Surveys. They find that higher-educated parents are more likely to spend more time with their children. As shown in 9, mothers with at least a bachelor's degree spend approximately 4.5 hours more per week in child care than mothers with a high school degree or less. Given the fact that the higher-educated parents also spend more time working in the labor market, this striking relationship shows that these parents must have enjoyed an implicit higher return from such time investment into their children.

Figure 9: Hours per Week Spent in Total Child Care for Women in the United States by Educational Attainment

					Hours per week spent in total child care				
					All	*Nonworking*		*Working*	
Years of schooling	*Fraction married*	*Fraction working*	*Total market work*	*Number of children*			*Conditional (relative to education <12)*		*Conditional (relative to education <12)*
<12	0.63	0.42	14.6	2.2	12.1	14.9		8.3	
12	0.69	0.65	22.3	1.9	12.6	17.6	2.9	9.8	3.1
13–15	0.69	0.74	25.3	1.9	13.3	18.9	3.9	11.4	4.2
16	0.87	0.72	23.7	1.9	16.5	22.6	6.4	14.2	6.1
16+	0.89	0.79	27.4	1.8	17.0	25.9	9.7	14.4	6.4

Notes: This table presents means of demographic characteristics, total time in market work, and total time spent caring for children by educational attainment in the 2003–2006 waves of the American Time Use Survey. All time use measures are expressed in units of "hours per week." Samples include all women between the ages of 21 and 55 (inclusive) that have at least one child of their own under the age of 18. Samples are restricted to respondents who had time diaries summing to a complete day (i.e., 1440 minutes). Conditional differences report the coefficients from a regression of total time spent in child care on education dummies (with less than 12 years of schooling being omitted), a cubic in age, "number of children" dummies, a married dummy, and "age of youngest child" dummies. All means and regression coefficients are calculated using fixed demographic weights adjusted to equally represent each day of the week within subgroups. Total market work includes all time spent at work, in work-related activities, traveling to work, and looking for work.

Source: Guryan et al. (2008)

3 Model

Consider a model in which the economy is populated by a continuum of female agents who are heterogenous in their human capital h, their skill type H or L representing whether finishing college or not, and the exogenously-given type of their potential partners θ when they are born. The agents live for two periods in the model, and later they will also be different in their education types, H or L, representing whether they finish college or not. We assume if agents decide to have children, they are altruistic parents so that they not only care about their own consumption but also the human capital of their children (Becker and Barro, 1988). Since childbearing is costly, not only in terms of resource cost but also time demanding, such setup implies the tradeoff between quantity and quality of the kids, and this also implies that both income effect and substitution effect co-exist in agents' problem, thus leading to the natural prediction that agents with higher human capital tend to have less kids with higher quality comparing to the low-skill-group agents.

The timeline is as following. In the first period, the young agents are all employed as unskilled labor and decide whether to go to school or not, and this decision would affect the unit wage rate they receive in the second period. The probability of finishing college successfully would depend on the education types of her parent and her own human capital endowment. The major decisions are made in adulthood, in which they work, consume, and make marital and child-rearing decisions. To simplify notations, individual subscript i is omitted.

3.1 Agent's Problem in Adulthood

The agent's problem is adulthood is very much like our benchmark model illustrated above. Assume the t generation is born at time $t-1$. For the t^{th} generation who are in their adulthood (second period), the agents are identified into two education types type H or L and endowed with human capital h_t. Denote the distribution of human capital by $F^H(h_t)$ and $F^L(h_t)$ for these two groups respectively, and denote the share of agents who complete college by λ_t^H and the share of less educated agents by $\lambda_t^L = 1 - \lambda_t^H$. Assume the type of agents' potential partners is exogenously drawn from two distributions for the two education groups, denoted by $G^H(\theta)$, and $G^L(\theta)$ respectively.

Whether agents provide work in an skilled or unskilled job depends on being a college graduate (decision made in the first period) and is denoted by an indicator $\mathbb{1}_t^{col} = 1$ for a college graduate and $\mathbb{1}_t^{col} = 0$ for non-graduates. A skilled worker gets a unit wage of ω_t^H while an unskilled worker gets a wage of ω_t^L. At the same time, facing an exogenous θ that governs the income of their potential partners, these agents would also make marital choices denoted by $M = \{s, c, m\}$. To make notations simple, we also define three indicators that $\mathbb{1}_t^s = 1$ represents for being single, $\mathbb{1}_t^c = 1$ for cohabiting with a partner, and $\mathbb{1}_t^m = 1$ for being married. They also choose the quantity n_t of children and effort q_t in children's education. To summarize, the "type" of an agent in the adulthood period can be represented by the state variable $(h_t, \mathbb{1}_t^{col}, \theta)$.

Agent's Problem problem in Adulthood:

$$\begin{aligned}
U_t(h_t, \mathbb{1}_t^{col}, \theta) = & \max_{c_t \geq 0, 1 \geq s_t \geq 0, n_t \geq 0, q_t \geq 0, X_t \geq \underline{X}, M} \quad \frac{c_t^{1-\sigma} - 1}{1-\sigma} \\
& + \mathbb{1}_t^n \cdot \alpha_n n_t^\gamma \left[\frac{(n_t h_{t+1})^{1-\sigma} - 1}{1-\sigma} + \delta_n \right] \\
& + \mathbb{1}_t^s \cdot \alpha_{X_s} \frac{(X_t^s - \underline{X})^{1-\sigma} - 1}{1-\sigma} + \mathbb{1}_t^c \cdot \alpha_{X_c} \frac{(X_t^c - \underline{X})^{1-\sigma} - 1}{1-\sigma} + \mathbb{1}_t^m \cdot \alpha_{X_m} \frac{(X_t^c - \underline{X})^{1-\sigma} - 1}{1-\sigma} \\
& + \mathbb{1}_t^m \delta_m + \mathbb{1}_t^c \delta_c + \mathbb{1}_t^n \alpha_n \Delta_n
\end{aligned} \tag{3.1}$$

subject to

$$c_t = w_t(1 - s_t)(1 - \pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t \tag{3.2}$$

$$w_t = \omega_t h_t = \left[\mathbb{1}_t^{col}\omega_t^H + (1 - \mathbb{1}_t^{col})\omega_t^L\right] h_t \tag{3.3}$$

$$h_{t+1} = H(q_t, h_t) = B_t \cdot h_t^\tau \cdot (\kappa + \mu_m \mathbb{1}_t^m + q_t)^\eta \tag{3.4}$$

$$\begin{cases} X_t^s = w_t s_t \\ X_t^c = [(w_t s_t)^{\rho_c} + (w_{man,t} s_{man,t}^c)^{\rho_c}]^{\frac{1}{\rho_c}} / \xi \\ X_t^m = [(w_t s_t)^{\rho_m} + (w_{man,t} s_{man,t}^m)^{\rho_m}]^{\frac{1}{\rho_m}} / \xi \end{cases} \tag{3.5}$$

where

$$B_t = B(1 + b)^{(1-\tau-\eta)t}$$

$$\xi = \mathbb{1}_t^{col}\xi^H + (1 - \mathbb{1}_t^{col})\xi^L$$

$$1 > \tau, \quad \eta > 0, \quad \tau + \eta \leq 1, \quad \alpha_{X_s} \leq \alpha_{X_c} \leq \alpha_{X_m}$$

Equation 3.4 captures the intuition that the return of investment in children's human capital would depend on parents' human capital and different marital status, as discussed in the introduction. Notice that ξ captures the fact it's possible for a female to meet with a partner with negative asset (positive debt or liability) even the partner has a positive income. Assume $\xi^H = \xi^L = 2$ and $\delta_n < \dfrac{\alpha_n}{1-\sigma}$. For potential partner's income and contribution to the production of public goods, we assume the followings:

$$w_{man,t} = \omega_t h_t \cdot \theta = \omega_t h_t \cdot [\mathbb{1}_t^{col}\theta^H + (1 - \mathbb{1}_t^{col})\theta^L]$$

$$s_{man,t}^c = s_t \cdot s_{man}^c$$

$$s_{man,t}^m = s_t \cdot s_{man}^m$$

Hence the equation 4.5 can be rewritten into:

$$\begin{cases} X_t^s = w_t s_t \\ X_t^c = w_t s_t [1 + (\theta s_{man}^c)^{\rho_c}]^{\frac{1}{\rho_c}} / \xi \\ X_t^m = w_t s_t [1 + (\theta s_{man}^m)^{\rho_m}]^{\frac{1}{\rho_m}} / \xi \end{cases} \tag{3.6}$$

3.2 Young Agent's Problem

During the first period, the "type" of the young agents can be summarized by the state vector $(\mathbb{1}_{t-1}^{col}, h_t, \theta)$. The first indicator implies whether the parent of the young agent has attended the school or not. In this period, all young agents are employed as unskilled workers and the decision the agents make is whether to attend college as well as the how much effort to exploit for college, represented by the indicator $\mathbb{1}_t^{col}$ and e_t. If she goes to college, she needs to pay a part of income as tuition and exert effort; otherwise she consumes all her wage income; no saving or borrowing is considered in this model. The probability of college completion depends on the education type of agents' parents and her effort.

$$V_t(\mathbb{1}_{t-1}^{col}, h_t, \theta) = \max_{d_t \geq 0, \mathbb{1}_t^{\epsilon}, 1 \geq e_t \geq 0} \frac{d_t^{1-\sigma} - 1}{1-\sigma} + \beta E[U_t(h_t, \mathbb{1}_t^{col}, \theta)] \tag{3.7}$$

$$V_t(\mathbb{1}_{t-1}^{col}, h_t, \theta) = \begin{cases} \max\limits_{d_t \geq 0} \frac{d_t^{1-\sigma}-1}{1-\sigma} + \beta U_t(h_t, 0, \theta) & \text{if} \quad \mathbb{1}_t^{\epsilon} = 0 \\ \max\limits_{d_t \geq 0} \frac{d_t^{1-\sigma}-1}{1-\sigma} + \beta \big\{ \epsilon_t U_t(h_t, 1, \theta) + (1-\epsilon_t) U_t(h_t, 0, \theta) \big\} & \text{if} \quad \mathbb{1}_t^{\epsilon} = 1 \end{cases}$$

subject to

$$d_t = \omega_{t-1}^L h_t (1 - \mathbb{1}_t^{\epsilon} \cdot e_t) - \mathbb{1}_t^{\epsilon} \cdot \Pi \tag{3.8}$$

$$\epsilon_t = [\mathbb{1}_{t-1}^{col} \epsilon^H + (1 - \mathbb{1}_{t-1}^{col}) \epsilon^L](1 + e_t) \cdot \Phi(h_t) \tag{3.9}$$

where $\Phi(h_t)$ is the CDF of human capital distribution, and hence it is bounded between 0 and 1.

3.3 Equilibrium Characterization

Production of consumption good is carried out by a single representation firm which uses both skilled and unskilled labor:

$$\max_{L_t^H, L_t^L} A_t L_t^{H\nu} L_t^{L1-\nu} - w_t^H L_t^H - w_t^L L_t^L \tag{3.10}$$

Hence we have:

$$\frac{w_t^H}{w_t^L} = \frac{\nu}{1-\nu} \frac{L_t^H}{L_t^L} \tag{3.11}$$

Define population of (the t^{th} generation) adult agents at time period t by P_t, and hence we have $P_t^H = P_t \lambda_t^H$ and $P_t^L = P_t \lambda_t^L$. The market clearing conditions for labor market are:

$$\begin{aligned} L_t^H &= P_t^H \int_0^\infty \int_0^\infty h_t (1 - s_t)(1 - \pi_1 n_t)(1 - \pi_3 q_t n_t) \quad dF_t^H(h_t) dG^H(\theta) \\ L_t^L &= P_t^L \int_0^\infty \int_0^\infty h_t (1 - s_t)(1 - \pi_1 n_t)(1 - \pi_3 q_t n_t) \quad dF_t^L(h_t) dG^L(\theta) \\ &\quad + P_{t+1}^H \int_0^\infty \int_0^\infty h_{t+1} \quad dF_{t+1}^H(h_{+1}) dG^H(\theta) + P_{t+1}^L \int_0^\infty \int_0^\infty h_{t+1} \quad dF_{t+1}^L(h_{+1}) dG^L(\theta) \end{aligned} \tag{3.12}$$

Population evolves over time according to:

$$P_{t+1} = P_t^H \int_0^\infty \int_0^\infty n_t \quad dF_t^H(h_t) dG^H(\theta) + P_t^L \int_0^\infty \int_0^\infty n_t \quad dF_t^L(h_t) dG^L(\theta) \tag{3.13}$$

$$
\begin{aligned}
P_{t+1}^H &= P_t^H \int_0^\infty \int_0^\infty n_t \mathbb{1}_{t+1}^\epsilon \epsilon_t \quad dF_t^H(h_t) dG^H(\theta) + P_t^L \int_0^\infty \int_0^\infty n_t \mathbb{1}_{t+1}^\epsilon \epsilon_t \quad dF_t^L(h_t) dG^L(\theta) \\
P_{t+1}^L &= P_t^H \int_0^\infty \int_0^\infty n_t \mathbb{1}_{t+1}^\epsilon (1-\epsilon_t) \quad dF_t^H(h_t) dG^H(\theta) + P_t^L \int_0^\infty \int_0^\infty n_t \mathbb{1}_{t+1}^\epsilon (1-\epsilon_t) \quad dF_t^L(h_t) dG^L(\theta) \\
&+ P_t^H \int_0^\infty \int_0^\infty n_t (1-\mathbb{1}_{t+1}^\epsilon) \quad dF_t^H(h_t) dG^H(\theta) + P_t^L \int_0^\infty \int_0^\infty n_t (1-\mathbb{1}_{t+1}^\epsilon) \quad dF_t^L(h_t) dG^L(\theta)
\end{aligned}
\tag{3.14}
$$

The distribution function of human capital evolves according to:

$$
\begin{aligned}
P_{t+1}^H F_{t+1}^H(h) &= P_t^H \int_0^\infty \int_0^\infty n_t \mathbb{1}_{t+1}^\epsilon \epsilon_t \cdot \mathbb{1}(h_{t+1} \le h) \quad dF_t^H(h_t) dG^H(\theta) \\
&+ P_t^L \int_0^\infty \int_0^\infty n_t \mathbb{1}_{t+1}^\epsilon \epsilon_t \cdot \mathbb{1}(h_{t+1} \le h) \quad dF_t^L(h_t) dG^L(\theta) \\
P_{t+1}^L F_{t+1}^L(h) &= P_t^H \int_0^\infty \int_0^\infty n_t \mathbb{1}_{t+1}^\epsilon (1-\epsilon_t) \cdot \mathbb{1}(h_{t+1} \le h) \quad dF_t^H(h_t) dG^H(\theta) \\
&+ P_t^L \int_0^\infty \int_0^\infty n_t \mathbb{1}_{t+1}^\epsilon (1-\epsilon_t) \cdot \mathbb{1}(h_{t+1} \le h) \quad dF_t^L(h_t) dG^L(\theta) \\
&+ P_t^H \int_0^\infty \int_0^\infty n_t (1-\mathbb{1}_{t+1}^\epsilon) \cdot \mathbb{1}(h_{t+1} \le h) \quad dF_t^H(h_t) dG^H(\theta) \\
&+ P_t^L \int_0^\infty \int_0^\infty n_t (1-\mathbb{1}_{t+1}^\epsilon) \cdot \mathbb{1}(h_{t+1} \le h) \quad dF_t^L(h_t) dG^L(\theta)
\end{aligned}
\tag{3.15}
$$

Consider equilibrium [...].

4 Simplified Benchmark Model

To better understand the basic intuition on how different factors react with each other to influence people's marital decisions and fertility choice, we build a simplified benchmark model and calibrate the benchmark model by targeting the moments using data from year 1995 to year 2008 and show the prediction power.

The setup of the simple benchmark model is similar to the agent's problem in adulthood in our full model. There are two groups of agents in the economy, denoted by their skill type H or L. We use the function $\mathbb{1}^{col}$ to indicate their skill type. Within each skill groups, agents are endowed with their own human capital h, following the distribution of human capital by $F^H(h)$ and $F^L(h)$ respectively. Denote the share of agents who complete college by λ^H and the share of less educated agents by $\lambda^L = 1 - \lambda_t^H$. A skilled worker gets a unit wage of ω^H while an unskilled worker gets a unit wage of ω^L.

Facing an exogenous θ that governs the income of their potential partners, these agents would also make marital choices denoted by $M = \{s, c, m\}$. We assume the type of agents' potential partners is exogenously drawn randomly the two education groups, and denote the two distributions by $G^H(\theta)$, and $G^L(\theta)$. To make notations simple, we also define three indicators that $\mathbb{1}^s = 1$ represents for being single, $\mathbb{1}^c = 1$ for cohabiting with a partner, and $\mathbb{1}^m = 1$ for being married.

Together with marital choice, agents also face a time allocation problem s: how much time to devote to work versus home production of public good X. Even if a female agent chooses to be single, she needs to spend some time producing X due to subsistence level of $\underline{X}$.

The last decision agents make is on fertility; agents choose the quantity n of children and effort q in children's education; note that n could be zero in the mode. Though investments in children, both n and q, are costly, the parents are altruistic in the way that they value the human capital h' of the offspring.

4.1 Household Problem

Agents' Problem is defined as follows:

$$
\begin{aligned}
U(h, \mathbb{1}^{col}, \theta) = & \max_{c \geq 0, 1 \geq s \geq 0, n \geq 0, q \geq 0, X \geq \underline{X}, M} \quad \frac{c^{1-\sigma} - 1}{1-\sigma} \\
& + \mathbb{1}^n \cdot \alpha_n n^\gamma \big[\frac{(nh')^{1-\sigma} - 1}{1-\sigma} + \delta_n \big] \\
& + \mathbb{1}^s \cdot \alpha_{X_s} \frac{(X^s - \underline{X})^{1-\sigma} - 1}{1-\sigma} + \mathbb{1}^c \cdot \alpha_{X_c} \frac{(X^c - \underline{X})^{1-\sigma} - 1}{1-\sigma} + \mathbb{1}^m \cdot \alpha_{X_m} \frac{(X^c - \underline{X})^{1-\sigma} - 1}{1-\sigma} \\
& + \mathbb{1}^m \delta_m
\end{aligned}
\tag{4.1}
$$

subject to

$$c = w(1-s)(1 - \pi_3 qn) - \pi_0 n \tag{4.2}$$

$$w = \omega h = \big[\mathbb{1}^{col} \omega^H + (1 - \mathbb{1}^{col}) \omega^L \big] h \tag{4.3}$$

$$h' = H(q, h) = B \cdot h^\tau \cdot (\kappa + \mu_m \mathbb{1}^m + q)^\eta \tag{4.4}$$

$$
\begin{cases}
X^s = ws \\
X^c = [(ws)^{\rho_c} + (w_{man} s^c_{man})^{\rho_c}]^{\frac{1}{\rho_c}} / \xi \\
X^m = [(ws)^{\rho_m} + (w_{man} s^m_{man})^{\rho_m}]^{\frac{1}{\rho_m}} / \xi
\end{cases}
\tag{4.5}
$$

where

$$1 > \tau, \quad \eta > 0, \quad \tau + \eta \leq 1, \quad \alpha_{X_s} \leq \alpha_{X_c} \leq \alpha_{X_m}$$

The children's human capital evolution equation captures the idea that the return of investment in children's human capital would depend on parents' human capital and different marital status, as discussed in the introduction. δ_m needs to be calibrated from model and it can be either negative or positive. We do not want to put restriction on the sign of δ_m because on one hand, love and safety from marriage relationship would bring happiness to couples, however on the other hand, separation cost (divorce cost) is much higher for married couples than for cohabiting couples that include money, time, and even reputation. Notice that ξ captures the fact it's possible for a female to meet with a partner with negative asset (positive debt or liability) even the partner has a positive income. Assume $\xi^H = \xi^L = 2$ and $\delta_n < \dfrac{\alpha_n}{1-\sigma}$. For potential partner's income and contribution to the production of public goods, we assume the followings:

$$w_{man} = \omega h \cdot \theta = \omega h \cdot [\mathbb{1}^{col}\theta^H + (1-\mathbb{1}^{col})\theta^L]$$

$$s^c_{man} = s \cdot s^c_{man}$$

$$s^m_{man} = s \cdot s^m_{man}$$

To close the model, production of consumption good is carried out by a single representation firm which uses both skilled and unskilled labor:

$$\max_{L^H, L^L} A{L^H}^{\nu}{L^L}^{1-\nu} - w^H L^H - w^L L^L \tag{4.6}$$

Hence we have:

$$\frac{w^H}{w^L} = \frac{\nu}{1-\nu}\frac{L^H}{L^L} \tag{4.7}$$

4.2 Calibration strategies

For the calibration exercise, since the CPS cohabitation data started in 1995 and we do not focus on recessions, we only consider the time periods from 1995 to 2008. All the calibration results are summarized in table 1.

There are twenty-nine parameters in total, out of which four parameters will be taken from the existing literature, and five parameters are normalized or assumed to be one for simplicity , see table 1 for details. The normalization and simplification do not affect the predicting power of the model.

The parameter σ in the CRRA utility function that governs the intertemporal preference is set to be 0.68 as in Hanushek et al. (2014). Three parameters that shape the human capital accumulation process are taken from De La Croix and Doepke (2003). τ measures the intergeneration human capital transmission, while η governs the power of parents' investment in children's quality, and κ measures the return of investment in children's quality in the human capital accumulation function.

Twelve parameters are estimated from data. From Expenditures on Children by Families (CRC), we estimate the childrearing resource cost for the median income family, and subtract 25% to adjust for families with more than two children. Subsistence level of public goods, $\underline{X}$ is estimated using housing consumption out of total consumption, which ranges from 30% to 35%. The time contribution from partners is estimated from Time Use Survey for married and cohabited couples, which is a little bit surprising that husbands in cohabitation relationship on average contribute more to household work than those in marriage. Note that the household activities include 9 categories: (1) housework (interior cleaning, laundry, sewing, storing items, other housework), (2) food and Drink preparation, presentation, and clean-up, (3) interior maintenance, repair and decoration, (4) exterior maintenance, repair, and redecoration, (5) household activities related to lawn, garden, and houseplants, (6) household activities related to animal and pets, (7) household activities related to vehicles, (8) household activities related to appliances, tools, and toys, and (9) household management.

Both the skill premium and the share of different human capital groups are estimated from Current Population Survey (CPS). High skill group is defined as individuals with at least a bachelor's degree and low skill group is defined as those with high school degree. We do not include high school dropouts to be consistent with the fertility and marital shares data illustrated in the previous paragraphs. We follow Acemoglu (2002) in constructing the skill premium. The relevant measure of worker's income is constructed from the IPUMS variables INCWAGE and is the annual income reported in real 2010 USD. Those with no earnings and the remaining lowest 1 percent of earners are dropped from the sample. Top-coded incomes are assumed to be 1.5 times the top-code. The reported measure of skill premium is the coefficient on a dummy variable for those with at least a bachelor's degree (compared to those with only high school degree) in an OLS regression of log income with a variety of controls. The controls are; (1) a quartic in years of potential experience, (2) gender dummy , (3) race (white/non-white) dummy, (4) interactions between race and gender dummies (5) state dummies (6) additional dummies for educational categories. Years of potential experience $E = \text{age} - S - 6$ is defined by assuming that an individual's schooling starts after age six and years of schooling, S, are assumed using the IPUMS variable EDUC. This variable reports the highest level of educational attainment of a respondent.

For the distributions of human capital and types of potential partners, we use wage data from CPS to estimate distributions for low and high skill groups separately. Analogously, we restrict the sample of females aging from 40 to 44. we construct wage using the IPUMS variable INCWAGE and trim off the lowest 1 percent of earners. Top-coded incomes are assumed to be 1.5 times the top-code. Using the IPUMS variable SPLOC, we are able to link family members within a household, and that's how we estimate the husband-to-wife income ratio, which correspond to the parameter θ in the model. We assume log normal distributions for both human capital h and potential partners' types θ. For illustration purpose, panel a in figure 10 is restricted to those with income less than \$100,000 and panel b is restricted to the families, in which husband-to-wife income ratio is less than 10. But for estimation, we do use the whole sample.

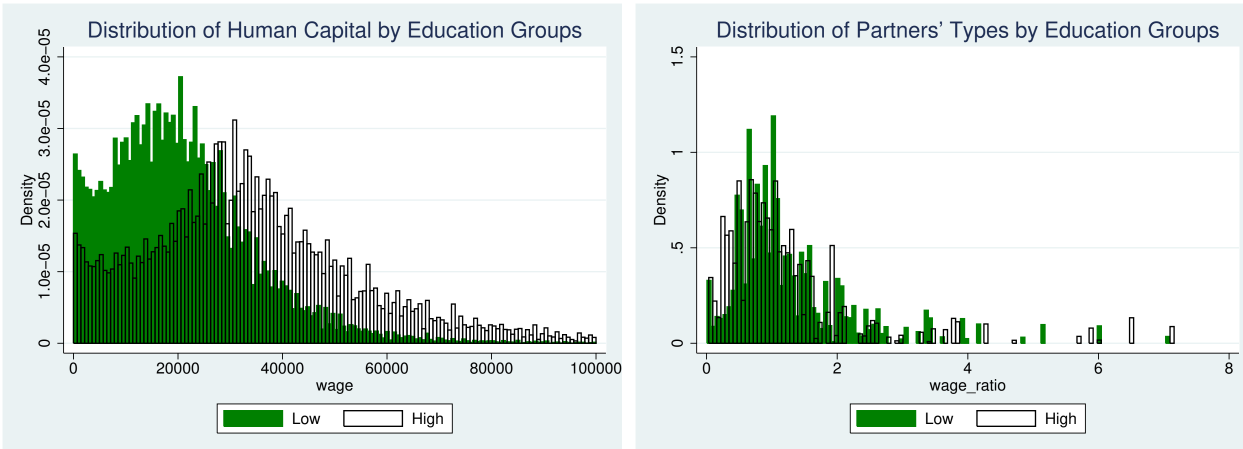
The remaining eight parameters are calibrated jointly using the benchmark model, targeting single share, cohabiting share, marriage share, and fertility[8] for two skill groups.

Table 1: Calibration parameters

Parameters	Values	Description	Source/Target
σ	0.680	Intertemporal preference	Hanushek et al (2014)
τ	0.200	Intergeneration human capital transmission	La Croix and Doepke (2003)
κ	0.012	Return in children's education	La Croix and Doepke (2003)
η	0.620	Parents' investment in human capital transmission	La Croix and Doepke (2003)
$\pi_{0,H}$	2019	Childrearing resource cost	CRC
$\pi_{1,L}$	1914	Childrearing resource cost	CRC
s'_c	0.5491	Husband income contribution (cohabited)	Time Use Survey
s'_m	0.4521	Husband income contribution (married)	Time Use Survey
W_H/W_L	1.626	Skill premium	CPS(Pooling)
λ_H	0.3104	Share of high skill population	CPS(Pooling)
λ_L	0.6896	Share of low skill population	CPS(Pooling)
$\underline{X}$	0.350	Subsistence level of public goods	CRC
h_H	(1.04, 9.78)	Human capital distribution: log normal(μ,σ)	CPS(Pooling)
h_L	(0.94, 9.64)	Human capital distribution: log normal(μ,σ)	CPS(Pooling)
θ_H	(0.81, 1.25)	Husband income distribution: log normal(μ,σ)	CPS(Pooling)
θ_L	(0.84, 1.15)	Husband income distribution: log normal(μ,σ)	CPS(Pooling)
γ	0.800	Fertility discounting factor	Assumption
B	1	Human Capital Accumulation	Assumption
ρ_c	0.500	Elasticity of substitution for public goods (cohabited)	Assumption
ρ_m	0.800	Elasticity of substitution for public goods (married)	Assumption
α_{X_s}	1.000	Utility parameter for public goods (single)	Normalization
μ_M	0.550	Marriage premium of return in education	Calibration
α_n	8.500	Utility parameter for kids	Calibration
α_{X_c}	0.150	Utility parameter for public goods (cohabited)	Calibration
α_{X_m}	1.950	Utility parameter for public goods (married)	Calibration
δ_n	11.200	Fertility premium	Calibration
δ_m	0.750	Marriage premium	Calibration
$\pi_{3,H}$	0.035	Resource cost investing in kids human capital	Calibration
$\pi_{3,L}$	0.015	Resource cost investing in kids human capital	Calibration

[8] In order not to overemphasize the zero-mass issue, the fertility target is defined over the sample who have kids.

Figure 10: Distributions of h and θ by Education Groups



(a) human capital h

(b) partners' types θ

4.3 Results & Discussions

As shown in table 2, the simplified model still does a fairly good job matching eight targets, especially for fertility. The calibrated cohabiting share is not matched with the targeted value perfectly, but considering the small magnitude of the number itself, we consider it a good match.

Table 2: Calibration Target: Marital Shares (Percent) and Fertility

	Single	Cohabiting	Married	Fertility
H-Model	24.000	5.000	71.000	2.188
H-Target	23.824	2.540	73.637	2.180
L-Model	25.000	6.000	69.000	2.304
L-Target	29.605	4.059	66.336	2.309

Our simple framework does not feature any dynamics, and hence we are not able to say anything about transitions between different marital status, such as divorce or breakup. Instead, we focus on the fertility choices for females with different skills in various marital status. Table 3 compares the model predicted fertility rate to the data for both the skilled and the unskilled females. Overall, the model predicts the differential fertility choices well. Compared with high skill group, the model does a better job for the low skill group. For unskilled females, model predicted fertility rate could account for 93.5%, 88.92%, and 100.67% for single, cohabiting, and married females respectively; and for the high skill group, the explaining power is 62.37%, 115.10%, and 102.04% respectively. Nevertheless, the model is able to explain 97.94% and 92.92% for the two skill groups.

There are two possible issue embedded in this framework that may have led to under- or over- prediction, which are dynamics transition and zero-mass issue. First of all, our simple model is a static setup, which does not allow females to transit from one state to another state, and we understand this is not consistent with the real-life observations. However, we are interested in how fertility choice is correlated with marital choices for different education groups, and hence the duration of one stage and dynamic transitions are not our main focus here. Second, in fertility literature, zero-mass is always a hard issue to solve. The fertility decision includes both intensive and extensive margins. The first natural question to ask is whether to have kids or not. If the answer to this question is "yes", then we could ask the second question on the quantity of children that a woman wants in her life-time.

Table 3: Predicted Marital-Group Fertility for Females With Kids

	Single	Cohabiting	Married
H-Model	1.227	2.320	2.267
H-Data	1.967	1.939	2.222
L-Model	2.077	2.023	2.355
L-Data	2.232	2.275	2.339

4.4 Counterfactual Exercise

[coming soon...]

5 Conclusion

Much research has been conducted in documenting the declining rates of marriage and fertility and increasing cohabitation behavior. White existing work has focused on the aggregate rates, this paper emphasizes divergent patterns for different skill groups, and develops a theory to explain the differential fertility decisions using a two-period OLG model. Building on the new channel emphasizing both the rising opportunity cost of childbearing and rising return of investment in children, we investigate the impact of better labor market conditions on female marital choices and fertility decision. Using the static and simplified setup, our benchmark model is able to explain over 65% of the differential fertility choices. Endogenizing skill premium, allowing for breakups/divorce, and investigating dynamic transitions are all areas that we intend on incorporating in future work.

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A MODEL APPENDIX

A.1 Random draws for potential partners

Recall that the equation 4.5 can be rewritten into:

$$\begin{cases} X_t^s = w_t s_t \\ X_t^c = w_t s_t[1 + (\theta s_{man}^c)^{\rho_c}]^{\frac{1}{\rho_c}}/\xi \\ X_t^m = w_t s_t[1 + (\theta s_{man}^m)^{\rho_m}]^{\frac{1}{\rho_m}}/\xi \end{cases} \tag{A.1}$$

Denote $M = [1 + (\theta s_{man})^{\rho}]^{\frac{1}{\rho}}$, and we have the followings:

$$\begin{aligned} \frac{\partial M}{\partial \theta} &= s[1 + (\theta s_{man}]^{\rho})^{\frac{1}{\rho}-1}(\theta s_{man})^{\rho-1} > 0 \\ \frac{\partial M}{\partial s} &= \theta[1 + (\theta s_{man}]^{\rho})^{\frac{1}{\rho}-1}(\theta s_{man})^{\rho-1} > 0 \\ \frac{\partial M}{\partial \rho} &= [1 + (\theta s_{man})^{\rho}]^{\frac{1}{\rho}}\Big[\frac{(\theta s_{man})^{\rho} ln(\theta s_{man})}{[1 + (\theta s_{man})^{\rho}]\rho} - \frac{ln(1 + (\theta s_{man})^{\rho})}{\rho^2}\Big] < 0 \end{aligned} \tag{A.2}$$

Since we know

$$\begin{aligned} &\frac{\partial M}{\partial \rho} < 0 \\ \Leftrightarrow &\frac{(\theta s_{man})^{\rho} ln(\theta s_{man})}{[1 + (\theta s_{man})^{\rho}]\rho} < \frac{ln(1 + (\theta s_{man})^{\rho})}{\rho^2} \\ \Leftrightarrow &\rho(\theta s_{man})^{\rho} ln(\theta s_{man}) < [1 + (\theta s_{man})^{\rho}] ln(1 + (\theta s_{man})^{\rho}) \end{aligned} \tag{A.3}$$

A.2 Marital Choices

A.2.1 Single without Kids: S0

$$U_t(h_t, \mathbb{1}_t^{col}, \theta; S0) = \max_{c_t \geq 0, 1 \geq s_t, X_t \geq \underline{X}} \frac{\left[w_t(1-s_t)\right]^{1-\sigma} - 1}{1-\sigma} + \alpha_{X_s} \frac{(w_t s_t - \underline{X})^{1-\sigma} - 1}{1-\sigma} \tag{A.4}$$

From the FOC wrt. s_t, we can get:

$$s_t = \frac{\underline{X} + w_t \alpha_{X_s}^{\frac{1}{\sigma}}}{w_t(1 + \alpha_{X_s}^{\frac{1}{\sigma}})}$$

This implies that as w increases, time devoted to public goods s will decrease. This gives the utility:

$$U_t(h_t, \mathbb{1}_t^{col}, \theta; S0) = \frac{\left[\frac{w_t - \underline{X}}{1 + \alpha_{X_s}{}^{\frac{1}{\sigma}}}\right]^{1-\sigma} (1 + \alpha_{X_s}{}^{\frac{1}{\sigma}})}{1-\sigma} - \frac{1 + \alpha_{X_s}}{1-\sigma}$$

A.2.2 Single with Kids: S1

$$\begin{aligned} U_t(h_t, \mathbb{1}_t^{col}, \theta; S1) = \max_{c_t \geq 0, 1 \geq s_t \geq 0, n_t \geq 0, q_t \geq 0, X_t \geq \underline{X}} & \frac{\left[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\right]^{1-\sigma} - 1}{1-\sigma} \\ & + \alpha_n n_t^{\gamma} \Big(\frac{\left[B_t n_t h_t{}^{\tau} (\kappa + q)^{\eta}\right]^{1-\sigma} - 1}{1-\sigma} + \delta_n \Big) \\ & + \alpha_{X_s} \frac{(w_t s_t - \underline{X})^{1-\sigma} - 1}{1-\sigma} \end{aligned} \tag{A.5}$$

First order conditions wrt. n, q, s are:

$$\begin{aligned} & \frac{w_t(1-s_t)(\pi_1 + \pi_3 q_t) + \pi_2 q_t + \pi_0}{\left[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\right]^{\sigma}} \\ & = \frac{\alpha_n(\gamma + 1 - \sigma)}{1-\sigma} \cdot [B_t h_t^{\tau} (\kappa + q_t)^{\eta}]^{(1-\sigma)} \cdot n_t^{\gamma - \sigma} - \alpha_n \big(\frac{1}{1-\sigma} - \delta_n\big) \gamma \cdot n_t^{\gamma - 1} \\ & \frac{w_t(1-s_t)\pi_3 n_t + \pi_2 n_t}{\left[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\right]^{\sigma}} = \alpha_n \eta \cdot (B_t h_t^{\tau})^{(1-\sigma)} \cdot (\kappa + q_t)^{\eta(1-\sigma) - 1} \cdot n_t^{\gamma + 1 - \sigma} \\ & \frac{1 - \pi_1 n_t - \pi_3 q_t n_t}{\left[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\right]^{\sigma}} = \alpha_{X_s} \cdot \frac{1}{(w_t s_t - \underline{X})^{\sigma}} \end{aligned} \tag{A.6}$$

We further simply the third FOC condition into the followings:

$$s_t = \frac{\underline{X} + \left[\frac{\alpha_{X_s}}{(1 - \pi_1 n_t - \pi_3 q_t n_t)}\right]^{\frac{1}{\sigma}} \cdot \left[w_t(1 - \pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\right]}{w_t + \left[\frac{\alpha_{X_s}}{(1 - \pi_1 n_t - \pi_3 q_t n_t)}\right]^{\frac{1}{\sigma}} \cdot w_t(1 - \pi_1 n_t - \pi_3 q_t n_t)} \tag{A.7}$$

In the special case $q_t = 0$, we have:

$$\frac{w_t(1-s_t)\pi_1+\pi_0}{\left[w_t(1-s_t)(1-\pi_1 n_t)-\pi_0 n_t\right]^{\sigma}} = \frac{\alpha_n(\gamma+1-\sigma)}{1-\sigma}\cdot[B_t h_t^{\tau}\kappa^{\eta}]^{(1-\sigma)}\cdot n_t^{\gamma-\sigma} - \alpha_n(\frac{1}{1-\sigma}-\delta_n)\gamma\cdot n_t^{\gamma-1}$$
$$\frac{(1-\pi_1 n_t)}{\left[w_t(1-s_t)(1-\pi_1 n_t)-\pi_0 n_t\right]^{\sigma}} = \alpha_{X_s}\cdot\frac{1}{(w_t s_t-\underline{X})^{\sigma}} \tag{A.8}$$

Hence we can solve the equations:

$$s_t = \frac{\underline{X}+(\frac{\alpha_{X_s}}{1-\pi_1 n_t})^{\frac{1}{\sigma}}\cdot[w_t(1-\pi_1 n_t)-\pi_0 n_t]}{w_t+(\frac{\alpha_{X_s}}{1-\pi_1 n_t})^{\frac{1}{\sigma}}\cdot w_t(1-\pi_1 n_t)} \tag{A.9}$$

From the FOC wrt n and q we can see **Quantity and Quality Tradeoff** (omitting subscript t for notation simplification) :

$$\begin{aligned}&\frac{w(1-s)(\pi_1+\pi_3 q)+\pi_2 q+\pi_0}{w(1-s)\pi_3 n+\pi_2 n}\\ &=\frac{\gamma+1-\sigma}{\eta(1-\sigma)}\frac{\kappa+q}{n}-\frac{\gamma}{\eta}(\frac{1}{1-\sigma}-\delta_n)\frac{n^{\sigma-2}}{(Bh^{\tau})^{(1-\sigma)}(\kappa+q)^{\eta(1-\sigma)-1}}\end{aligned} \tag{A.10}$$

Hence we have

$$\begin{aligned}&\frac{w(1-s)(\pi_1+\pi_3 q)+\pi_2 q+\pi_0}{w(1-s)\pi_3+\pi_2}\\ &=\frac{\gamma+1-\sigma}{\eta(1-\sigma)}(\kappa+q)-\frac{\gamma}{\eta}(\frac{1}{1-\sigma}-\delta_n)\frac{n^{\sigma-1}}{(Bh^{\tau})^{(1-\sigma)}(\kappa+q)^{\eta(1-\sigma)-1}}\end{aligned} \tag{A.11}$$

If we further simplify the algebra, we can get:

$$\begin{aligned}&\frac{[w(1-s)\pi_3+\pi_2]\cdot q+[w(1-s)\pi_1+\pi_0]}{w(1-s)\pi_3+\pi_2}\\ &=\frac{\gamma+1-\sigma}{\eta(1-\sigma)}(\kappa+q)-\frac{\gamma(\frac{1}{1-\sigma}-\delta_n)}{\eta(Bh^{\tau})^{(1-\sigma)}}\frac{(\kappa+q)^{1-\eta(1-\sigma)}}{n^{1-\sigma}}\end{aligned} \tag{A.12}$$

Denote:

$$\begin{aligned}\bar{A}&=[w(1-s)\pi_3+\pi_2]-[w(1-s)\pi_3+\pi_2]\cdot\frac{\gamma+1-\sigma}{\eta(1-\sigma)}=-[w(1-s)\pi_3+\pi_2]\frac{\gamma+(1-\sigma)(1-\eta)}{\eta(1-\sigma)}<0\\ \bar{B}&=[w(1-s)\pi_3+\pi_2]\cdot\frac{\gamma(\frac{1}{1-\sigma}-\delta_n)}{\eta(Bh^{\tau})^{(1-\sigma)}}>0\\ \bar{D}&=[w(1-s)\pi_1+\pi_0]-[w(1-s)\pi_3+\pi_2]\cdot\frac{\kappa(\gamma+1-\sigma)}{\eta(1-\sigma)}\end{aligned} \tag{A.13}$$

We have:

$$\bar{A} \cdot q + \bar{B} \cdot \frac{(\kappa + q)^{1-\eta(1-\sigma)}}{n^{1-\sigma}} + \bar{D} = 0 \tag{A.14}$$

In the case $s = 0$, we could see clearly that:

$$n^{1-\sigma} = \frac{\bar{B}(\kappa + q)^{1-\eta(1-\sigma)}}{\bar{D} - \bar{A}q} \tag{A.15}$$

$$\Rightarrow \frac{\partial n^{1-\sigma}}{\partial q} = \bar{B} \frac{[1-\eta(1-\sigma)](\kappa + q)^{-\eta(1-\sigma)}(\bar{D} - \bar{A}q) + \bar{A}(\kappa + q)^{1-\eta(1-\sigma)}}{(\bar{D} - \bar{A}q)^2} \tag{A.16}$$

Hence we know

$$\begin{aligned} \frac{\partial n^{1-\sigma}}{\partial q} &\leq 0 \\ \Leftrightarrow [1-\eta(1-\sigma)](\bar{D} - \bar{A}q) + \bar{A}(\kappa + q) &\leq 0 \\ \Leftrightarrow \frac{[1-\eta(1-\sigma)]\bar{D} + \bar{A}\kappa}{\eta(\sigma - 1)\bar{A}} &\leq q \end{aligned} \tag{A.17}$$

A.2.3 Cohabited or Married without Kids: C0 & M0

$$\begin{aligned} U_t(h_t, \mathbb{1}_t^{col}, \theta; C0) = \max_{c_t \geq 0, 1 \geq s_t, X_t \geq \underline{X}} \quad & \frac{\big[w_t(1-s_t)\big]^{1-\sigma} - 1}{1-\sigma} \\ & + \alpha_X \frac{([(w_t s_t)^{\rho_c} + (w_{man,t} s^c_{man,t})^{\rho_c}]^{\frac{1}{\rho_c}}/\xi - \underline{X})^{1-\sigma} - 1}{1-\sigma} \end{aligned} \tag{A.18}$$

$$\begin{aligned} U_t(h_t, \mathbb{1}_t^{col}, \theta; M0) = \max_{c_t \geq 0, 1 \geq s_t, X_t \geq \underline{X}} \quad & \frac{\big[w_t(1-s_t)\big]^{1-\sigma} - 1}{1-\sigma} \\ & + \alpha_X \frac{([(w_t s_t)^{\rho_m} + (w_{man,t} s^m_{man,t})^{\rho_m}]^{\frac{1}{\rho_m}}/\xi - \underline{X})^{1-\sigma} - 1}{1-\sigma} \end{aligned} \tag{A.19}$$

First order condition wrt. s_t is:

$$\frac{1}{\big[w_t(1-s_t)\big]^{\sigma}} = \frac{\alpha_X}{\xi} \cdot \frac{\big[1 + (\theta s_{man})^{\rho}\big]^{\frac{1}{\rho}}}{\big(ws[1 + (\theta s_{man})^{\rho}]^{\frac{1}{\rho}}/\xi - \underline{X}\big)^{\sigma}} \tag{A.20}$$

And hence we have:

$$s_t = \frac{\underline{X} + w_t\big\{\frac{\alpha_X}{\xi} \cdot \big[1 + (\theta s_{man})^{\rho}\big]^{\frac{1}{\rho}}\big\}^{\frac{1}{\sigma}}}{w_t[1 + (\theta s_{man})^{\rho}]^{\frac{1}{\rho}}/\xi + w_t\big\{\frac{\alpha_X}{\xi} \cdot \big[1 + (\theta s_{man})^{\rho}\big]^{\frac{1}{\rho}}\big\}^{\frac{1}{\sigma}}} \tag{A.21}$$

A.2.4 Cohabiting or Married with Kids: C1 & M1

$$U_t(h_t, \mathbb{1}_t^{col}, \theta; C1) = \max_{c_t \geq 0, 1 \geq s_t \geq 0, n_t \geq 0, q_t \geq 0, X_t \geq \underline{X}} \frac{\big[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\big]^{1-\sigma} - 1}{1-\sigma}$$
$$+ \alpha_n n_t^{\gamma}\Big(\frac{\big[n_t {h_t}^{\tau}(\kappa + q_t)^{\eta}\big]^{1-\sigma} - 1}{1-\sigma} + \delta_n\Big)$$
$$+ \alpha_{X_c}\frac{([(w_t s_t)^{\rho_c} + (w_{man,t} s^c_{man,t})^{\rho_c}]^{\frac{1}{\rho_c}}/\xi - \underline{X})^{1-\sigma} - 1}{1-\sigma} \tag{A.22}$$

$$U_t(h_t, \mathbb{1}_t^{col}, \theta; M1) = \max_{c_t \geq 0, 1 \geq s_t \geq 0, n_t \geq 0, q_t \geq 0, X_t \geq \underline{X}} \frac{\big[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\big]^{1-\sigma} - 1}{1-\sigma}$$
$$+ \alpha_n n_t^{\gamma}\Big(\frac{\big[n_t {h_t}^{\tau}(\kappa + \mu_m + q_t)^{\eta}\big]^{1-\sigma} - 1}{1-\sigma} + \delta_n\Big)$$
$$+ \alpha_{X_m}\frac{([(w_t s_t)^{\rho_m} + (w_{man,t} s^m_{man,t})^{\rho_m}]^{\frac{1}{\rho_m}}/\xi - \underline{X})^{1-\sigma} - 1}{1-\sigma} \tag{A.23}$$

First order conditions wrt. n, q, s are:

$$\frac{w_t(1-s_t)(\pi_1 + \pi_3 q_t) + \pi_2 q_t + \pi_0}{\big[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\big]^{\sigma}}$$
$$= \frac{\alpha_n(\gamma + 1 - \sigma)}{1-\sigma} \cdot [B_t h_t^{\tau}(\kappa + q_t)^{\eta}]^{(1-\sigma)} \cdot n_t^{\gamma-\sigma} - \alpha_n(\frac{1}{1-\sigma} - \delta_n)\gamma \cdot n_t^{\gamma-1}$$
$$\frac{w_t(1-s_t)\pi_3 n_t + \pi_2 n_t}{\big[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\big]^{\sigma}} = \alpha_n \eta \cdot (B_t h_t^{\tau})^{(1-\sigma)} \cdot (\kappa + q_t)^{\eta(1-\sigma)-1} \cdot n_t^{\gamma+1-\sigma}$$
$$\frac{1 - \pi_1 n_t - \pi_3 q_t n_t}{\big[w_t(1-s_t)(1-\pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t\big]^{\sigma}} = \frac{\alpha_X}{\xi} \cdot \frac{\big[1 + (\theta s_{man})^{\rho}\big]^{\frac{1}{\rho}}}{\big(w_t s_t[1 + (\theta s_{man})^{\rho}]^{\frac{1}{\rho}}/\xi - \underline{X}\big)^{\sigma}} \tag{A.24}$$

And hence we have:

$$s_t = \frac{\underline{X} + [w_t(1 - \pi_1 n_t - \pi_3 q_t n_t) - \pi_2 q_t n_t - \pi_0 n_t]\Big\{\frac{\alpha_X[1+(\theta s_{man})^{\rho}]^{\frac{1}{\rho}}}{\xi(1-\pi_1 n_t - \pi_3 q_t n_t)}\Big\}^{\frac{1}{\sigma}}}{w_t[1 + (\theta s_{man})^{\rho}]^{\frac{1}{\rho}}/\xi + [w_t(1 - \pi_1 n_t - \pi_3 q_t n_t)]\Big\{\frac{\alpha_X[1+(\theta s_{man})^{\rho}]^{\frac{1}{\rho}}}{\xi(1-\pi_1 n_t - \pi_3 q_t n_t)}\Big\}^{\frac{1}{\sigma}}} \tag{A.25}$$

B DATA APPENDIX

B.1 Comparison using March data, June data, and Full sample

The Current Population Survey (CPS) is a monthly survey of about 60,000 U.S. households conducted by the United States Census Bureau for the Bureau of Labor Statistics (BLS). Since 1948, the CPS has included supplemental questions (at first, in April; later, in March) on income received in the previous calendar year, which are used to estimate the data on income and work experience. These data are the source of the annual Census Bureau report on income, poverty, and health insurance coverage - CPS Annual Social and Economic Supplement (ASEC). Similar to the March Supplement, the fertility supplement of the Current Population Survey asks women (either by self-response of proxy) questions about childbirth. Several fertility supplement samples also contain marital history information. This paper uses both the March Supplement and the June supplement. The following figures show that data from the two supplements are consistent with each other, and nothing essential would be missing if we use one of them.

Figure 11: Share of Females being Unparterned

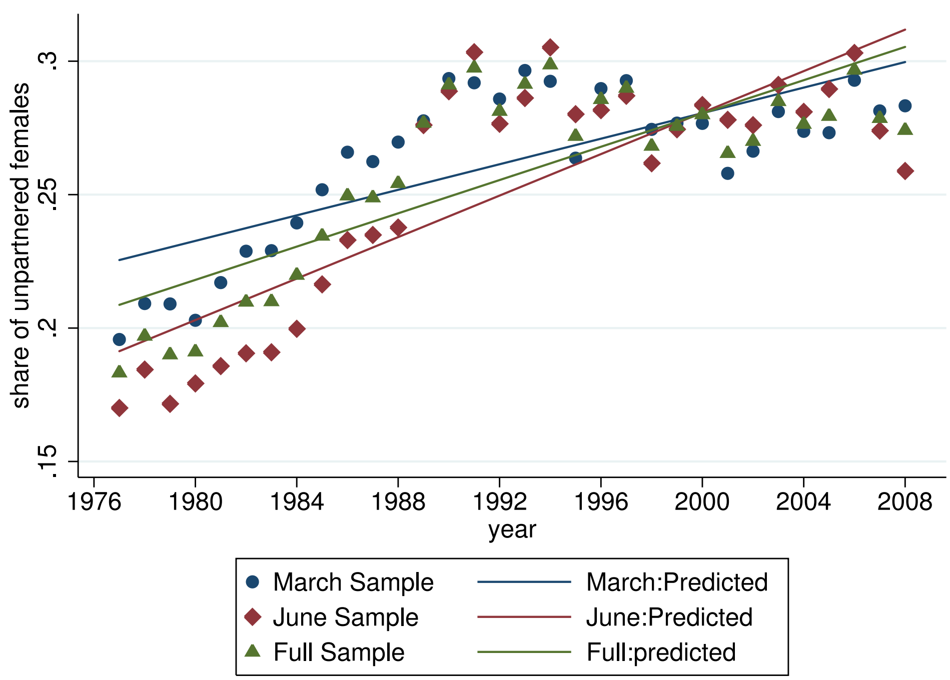


Figure 12: Share of Females being Cohabiting

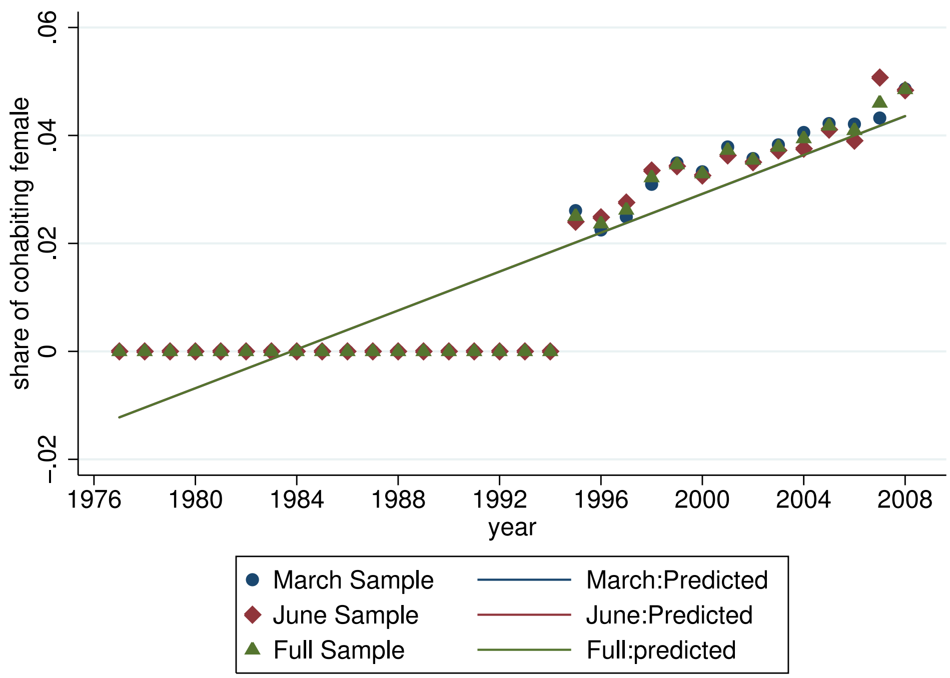
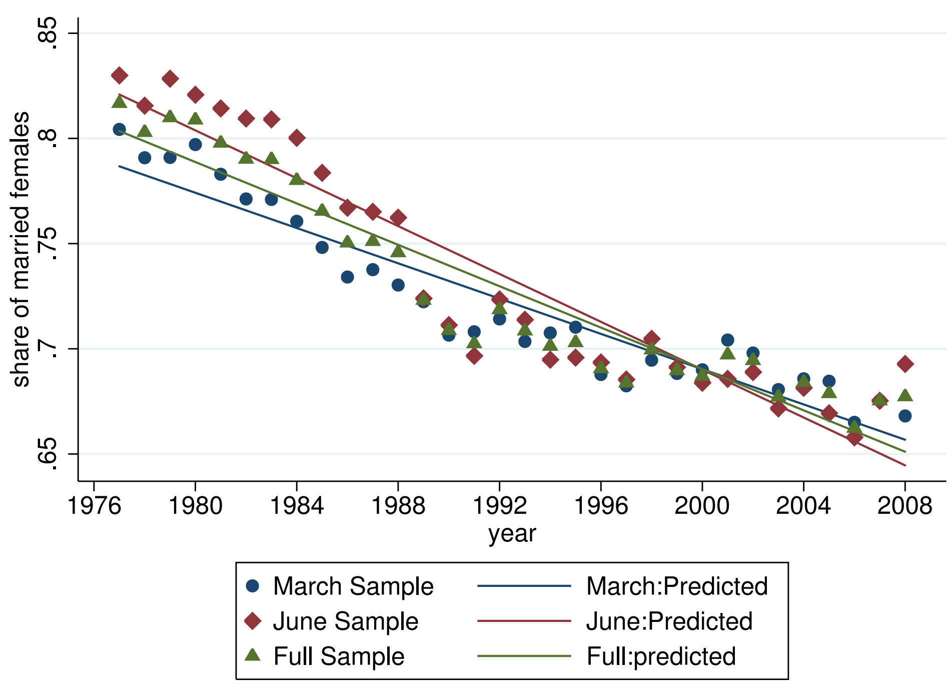
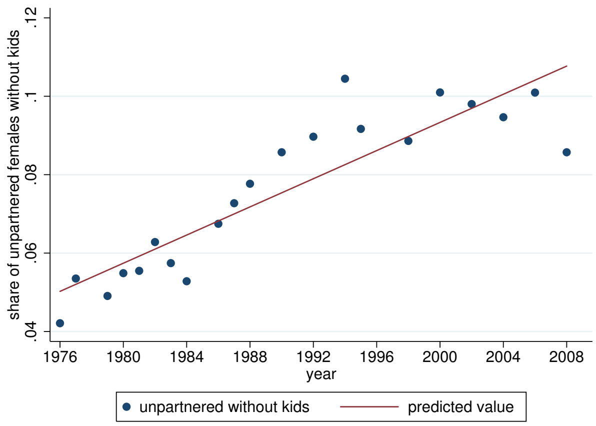


Figure 13: Share of Females being Married

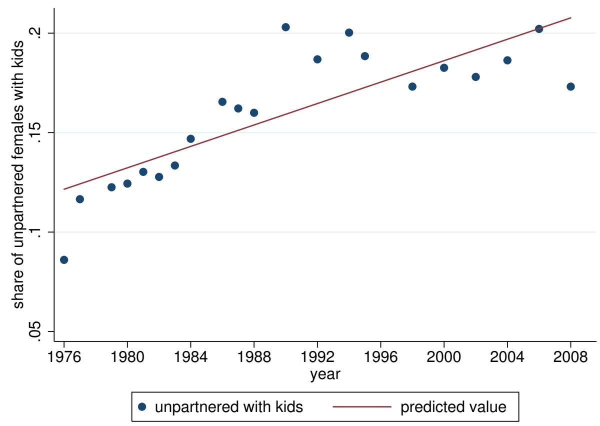


B.2 Detailed Marital Status and Fertility Evolution

Figure 14: Share of Unpartnered Females

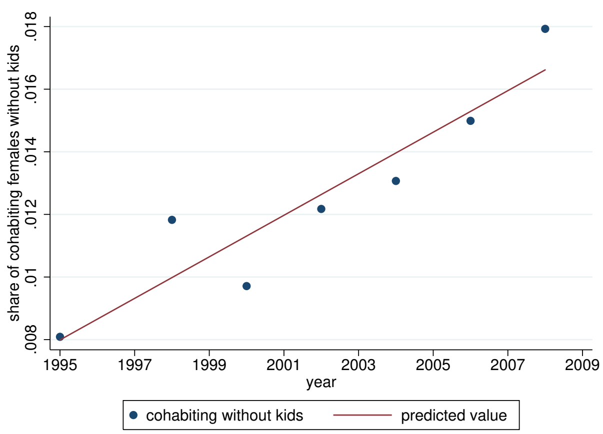


(a) without kids

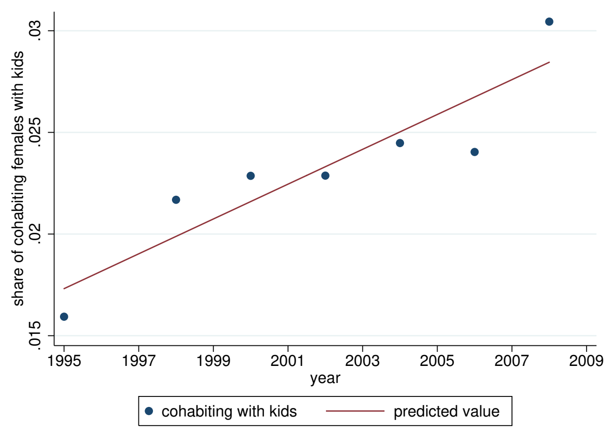


(b) with kids

Figure 15: Share of Cohabiting Females

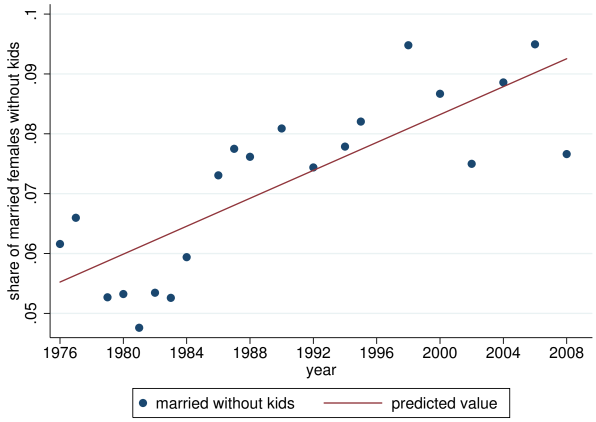


(a) without kids

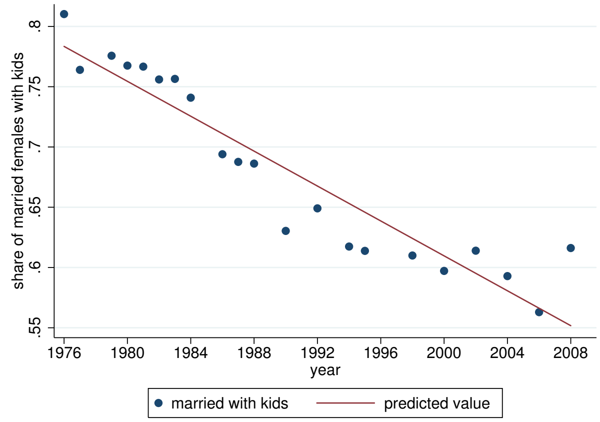


(b) with kids

Figure 16: Share of Married Females

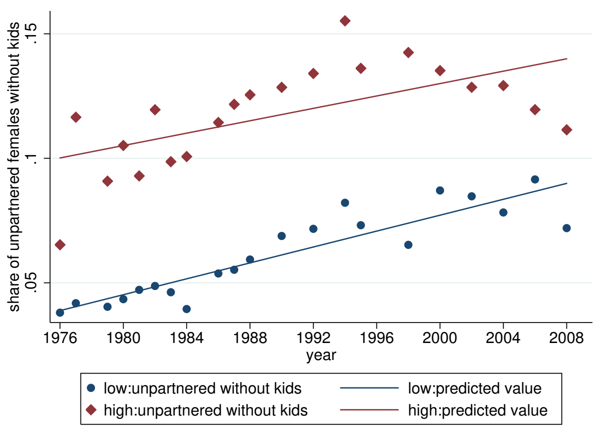


(a) without kids

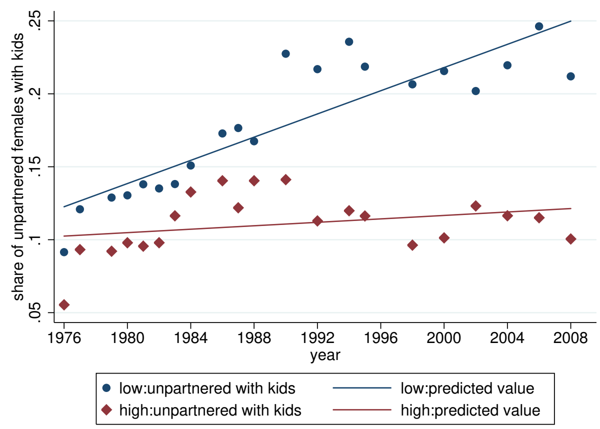


(b) with kids

Figure 17: Share of Single Females

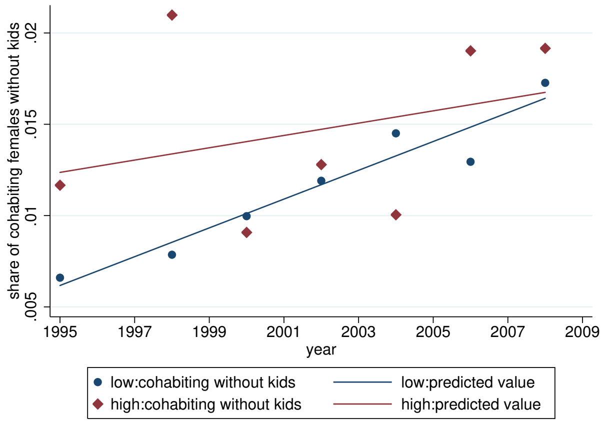


(a) without kids

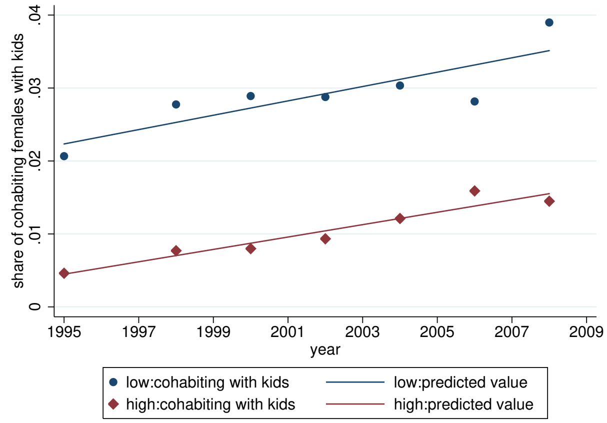


(b) with kids

Figure 18: Share of Cohabiting Females

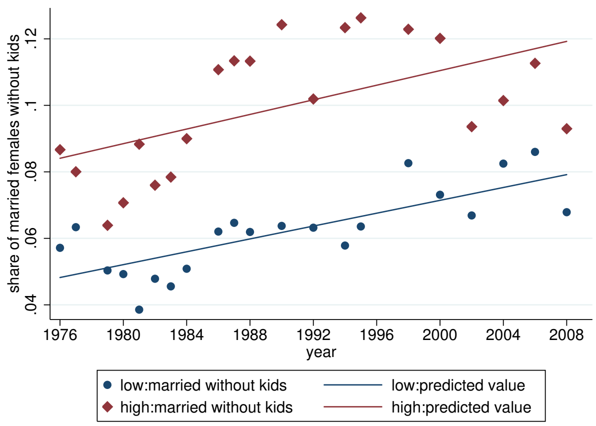


(a) without kids

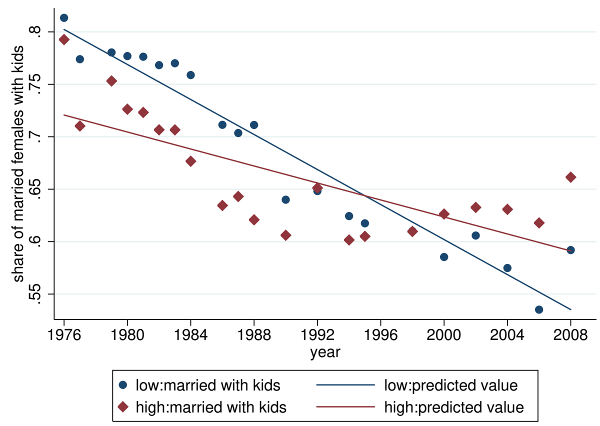


(b) with kids

Figure 19: Share of Married Females



(a) without kids



(b) with kids