Social Norms and Fertility

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Abstract

We document three stylized facts about marriage and fertility in East Asian societies: They have the highest marriage rates in the world, but the lowest total fertility; they have the lowest total fertility, but almost all married women have at least one child. By contrast, almost no single women have any children. As these societies have been influenced by Confucianism, it is conventional wisdom that marriage and fertility decisions are related to two social norms: the unequal gender division of childcare and the stigma attached to out-of-wedlock births. To quantitatively investigate their roles in accounting for these facts, we incorporate the two social norms into Baudin et al. (2015)'s model and structurally estimate it using the data from South Korea censuses. We find that, on the one hand, the social norm of unequal gender division of childcare significantly contributes to the low fertility, especially for highly educated women; on the other hand, the social stigma has negligible effects on marriage and fertility. Pro-natal policies can increase average fertility, but they are not effective in mitigating the effect of the norm of unequal gender division of childcare, because they cannot sufficiently boost fertility for the highly educated. Our results show that the tension between the persistent gender ideology and rapid socioeconomic development is the main driving force behind the unique marriage and fertility patterns of East Asian societies.

Key Words: Confucianism; Social norms; Fertility; Demographic transition; East Asia societies

JEL Codes: J11; J12; J13

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1 Introduction

The demographic transition experienced by East Asian societies over the past few decades has been distinctive and drastic.[1] Figure 1 shows that compared with other societies, East Asia experienced much faster fertility declines, currently reaching the lowest fertility levels in the world. In 2016, total fertility rates (TFRs) in South Korea, Hong Kong, Taiwan, Macau, and Singapore are 1.26, 1.19, 1.13, 0.95, and 0.83, respectively; they rank 220th-224th in terms of TFR among 224 countries and territories in the world (Table 1).[2] Despite the lowest fertility levels, these societies have the highest marriage rates in the world (Fact 1). Whereas total fertility is among the lowest, almost all married women have at least one child (Fact 2). By contrast, almost no single women have any children (Fact 3). These three facts seem puzzling, because high marriage rates and low childlessness rates of married mothers usually imply high total fertility as opposed to low total fertility; moreover, married and single women's fertility decisions are usually consistent and not in sharp contrast to each other. These facts also imply that there is a divergence between the intensive and the extensive margin of fertility in East Asia along the demographic transition: The intensive margin of fertility has undergone a significant transformation, while the extensive margin has hardly adjusted. In contrast, both margins have fallen together in most other societies along demographic transition.

Although standard fertility theory may explain the lowest fertility levels in East Asian societies by rapid economic growth, the boom in women's education, and the decrease in the gender wage gap (Becker and Barro, 1988; Becker et al., 1990; Galor and Weil, 2000; Greenwood et al., 2017; Lee, 2003; Doepke, 2004), it may have difficulty jointly explaining all three stylized facts. To fully understand the unique marriage and fertility patterns in these societies, we have to consider marriage and fertility decisions simultaneously, and distinguishes between the extensive margin

[1] East Asian societies refer to China, Japan, South Korea, Hong Kong, Taiwan, Macau, and Singapore in our analyses. Even if China is markedly different from the other six in terms of both political structure and population-control policies, we include China because of her strong cultural connections with them. Moreover, China's marriage and fertility patterns are consistent with those in the other societies.

[2] The total fertility rate is measured by the average number of children that would be born per woman if all women were to live to the end of their childbearing period and give birth according to a given fertility rate at each age.

(1−childlessness rate) and the intensive margin (fertility of mothers) of fertility.

As these societies have been influenced by Confucianism, it is conventional wisdom in the sociology and demographic literature that marriage and fertility decisions are heavily influenced by the two social norms associated with Confucianism (Greenhalgh, 1985; Qian and Sayer, 2015; Fuwa, 2004; Raymo et al., 2015). One is the unequal gender division of childcare within a household, and the other is the stigma attached to out-of-wedlock births. In traditional Confucian culture, the wife's responsibility was to obey her husband, which is embodied in the "Three Obediences and Four Virtues," the basic moral principles for women in Confucianism. Still influenced by this gender ideology, women normally do most of the housework and childcare (Table 2). At the same time, out-of-wedlock births have been regarded as a social stigma for women in the Confucian culture. Although legal and political institutions in East Asia have evolved substantially along with fast economic growth, these two norms still remain significant (Raymo et al., 2015).

These two social norms may be key to explaining the three puzzling facts. In Confucian societies, it is a social responsibility to have offspring to pass on one's family name. Since out-of-wedlock births are a social stigma, single women would less likely give birth and rather get married to have children. So marriage rates, and childlessness rates for single women could be high, but childlessness rates for married couples could be low in these societies. On the other hand, the unequal gender division of childcare may significantly contribute to an increase in the opportunity cost of rearing children. Coupled with the boom in women's education in East Asia over the past decades, this social norm could significantly contribute to low fertility of married mothers.

Our first contribution to the literature is to document these stylized facts about East Asian societies, and extend the model in Baudin et al. (2015) to explain these facts and quantitatively evaluate the importance of the two social norms in marriage and fertility decisions. Baudin et al. (2015) provide a useful framework to discuss the divergence between the intensive and the extensive margin of fertility in East Asian societies, as they endogenize marriage and fertility decisions and distinguish between the extensive and intensive margins of fertility. To quantify the effects of the social norm of unequal gender division of childcare, we relax the standard assumption that wife's and husband's labor inputs are perfect substitutes (Becker, 2009; Baudin et al., 2015). Specifically, we introduce a home production function in the form of constant elasticity of substitution (CES) for childcare service. This general home production function allows us to distinguish the labor division governed by the social norm from the optimal labor division between a husband and wife. With this setup, the optimal fraction of wife's labor in the total amount of household labor depends on (1) the relative wage of a wife to her husband and (2) the degree of complementarity or substitutability between the two labor inputs in the production function. When wife's and husband's labor inputs are imperfect substitutes, the optimal fraction of wife's labor strictly decreases in her relative wage.[3] In reality, the social norm mainly governs spousal time allocation (Raymo et al., 2015): Women do most of the childcare in East Asian societies regardless of their relative wage, indicating that intrahousehold time allocation is not efficient. In traditional East Asian societies, where wife's wage had been much lower than that of her husband, the optimal labor division did not conflict with that governed by the social norm. The social norm would have had negligible effects on fertility. In modern societies, however, the labor division governed by the social norm deviates from the optimal labor division, because of the boom in women's education and the increase in their relative wage. The social norm of unequal gender division of childcare then leads to unnecessarily high cost of raising children. To quantify the effects of the social stigma associated with single mothers on marriage and fertility, we allow the marginal utility of having children to be different between single and married households in our structural model. We then introduce a new source of childlessness *exclusive* for single women—social-stigma-driven childlessness—besides natural sterility, poverty-driven, and high-opportunity-cost-driven childlessness in the literature.

We structurally estimate the model using data from South Korea censuses and household surveys, and find that the simulated moments fit the data well. We then conduct counterfactual analyses to investigate the roles of the two social norms in marriage and fertility in South Korea. Our

[3] Becker (1985, 2009) predicts that efficient time allocation between a wife and husband implies specialization: The wife does all housework if her wage is lower than that of her husband. As pointed out by Pollak (2011, 2013), this prediction relies on a critical assumption: Spousal time inputs are perfect substitutes in household production, which is empirically rejected by Knowles (2013) and our estimation results below.

results show that the removal of the social norm of unequal gender division of childcare would increase both marriage rates and fertility. Completed fertility of married mothers increases by 10 percent, but the fertility effect of the social norm varies across education. For married mothers with no schooling, fertility decreases by 7 percent. By contrast, fertility increases by 110 percent for those with a Ph.D. The marriage rate would also increase without the social norm. Effects vary by gender and across education. Without the social norm, the marriage rate increases more for higher-educated women. But for men, the marriage rate increases more for the less educated. Overall, total fertility in South Korea increases by 11.2 percent after the removal of the social norm, when we take into account all the endogenous changes in marriage rates, fertility for married and single mothers, and childlessness rates for married and single women.

In contrast to the social norm of unequal gender roles, we find that the social stigma has no effects on marriage rates, completed fertility for married mothers, or childlessness rates for married women. It also plays a negligible role in accounting for the high marriage rate and high childlessness rate for single women. We decompose childlessness for single women into four components, driven by natural sterility, poverty, social stigma, and high opportunity cost. We find that of the total childlessness rate for single women of 98.2 percent in South Korea, 91.70 percent is driven by high opportunity cost and only 2.25 percent by the social stigma. The insignificant role of the social stigma in accounting for the high childlessness rate for single women is related to the marriage pattern for women in South Korea: Marriage rates monotonically decrease with education, which is distinguished from the hump-shaped relationship between marriage rates and education in the US. Most single women in South Korea are well educated and thus have high wages. They choose not to have children due to high opportunity cost, not the social stigma.

We explain the three stylized facts based on our quantitative analyses. The high marriage rate in South Korea results from large marriage gains for men, which are mainly associated with the low intrahousehold bargaining power of women and the high marginal utility of having children. Total fertility for married women is low because of the high opportunity cost of childcare, which is significantly attributed to the social norm of unequal gender division of childcare. Childlessness rates for married couples are also low, because of the high marginal utility of having children; having offspring is a social responsibility in Confucian culture. Finally, most single women remain childless because they are highly educated so that their opportunity cost of childcare is high.

We conclude that the three stylized facts are consequences of the tension between persistent Confucian culture and rapid socioeconomic development in East Asian societies. Along this line, our paper is closely related to the literature on the consequences of culture and social norms on individual and household behaviors (Pollak and Watkins, 1993; Fernández and Fogli, 2006; Fernández and Sevilla Sanz, 2006; Fernández and Fogli, 2009; Bertrand et al., 2015, 2016; Hwang, 2016). We contribute to this literature by quantitatively evaluating the significant role of social norms in accounting for the unique marriage and fertility patterns in East Asian societies. Our study also methodologically contributes to the literature. Previous studies are theoretical, use calibration methods, or explore quasi-experimental variation in social norms. We incorporate social norms to an economic model, structurally estimate it, and quantitatively investigate the consequences of the norms in various counterfactual analyses. This method enables us to not only quantify the importance of various channels through which social norms affect marriage and fertility, but also conduct policy experiments.

Our second contribution is that our study is among the first to systematically investigate the rapid fertility decline in East Asian societies over the past decades. We use our model, albeit a simple and static one, to explain the change in fertility for the birth cohorts of 1920-1970. Our historical simulation results show that the three factors—the increase in education, growth in total factor productivity (TFP), and decrease in the gender wage gap—together account for 87.1 percent of the fertility decline in South Korea. Fertility would have decreased less dramatically in the absence of the social norm of unequal gender division of childcare, especially for younger cohorts.

Our results suggest that the tension between the persistent gender ideology and rapid socioeconomic development has been escalating over the past decades, which drives the rapid fertility decline in East Asian societies. Along this line, our study is closely related to the literature on demographic transition. Prior studies have attributed fertility decline to economic development

(Galor and Weil, 2000; Franck and Galor, 2015); women's labor force participation (Willis, 1973; Heckman and Walker, 1990); the gender wage gap (Galor and Weil, 1996); and investments in children's human capital (Becker et al., 1990; Becker and Barro, 1988; Barro and Becker, 1989). We find that although these factors are still important in determining the timing and speed of demographic transition, the persistent social norm of unequal gender roles is also important in East Asian societies, where Confucian culture still prevails. In this sense, our paper highlights the importance of unequal gender roles in marriage and fertility (Doepke and Tertilt, 2016, 2018).

Our findings have general implications for demographic transitions in other developing or transitional economies. For example, gender ideology in Muslim countries may be similar to that in traditional East Asian societies. In Muslim countries, women also take care of most housework. In light of our model, the high fertility rate in these countries is due to the low education of women.[4] If Muslim women got more education, the tension between socioeconomic development and persistent gender ideology would likely result in marriage and fertility patterns similar to those of East Asian societies.

Our third contribution is to investigate pro-natal policies, which are aimed at mitigating the effects of the social norm of unequal gender division of childcare. We conduct two policy experiments. The first shows that the fertility effects of the social norm can be offset in terms of average fertility, if the government takes care of 4.6 percent of total childcare for each child—for example, by setting up childcare centers. The second experiment shows that the fertility effects can also be offset in terms of average fertility, if the government pays households a childcare subsidy equal to 4.7 percent of the average childcare cost for each child. However, both policy experiments show that pro-natal policies are insufficient in boosting fertility for highly educated women.

The paper proceeds as follows. The next section describes the three facts about marriage and fertility in East Asian societies. Section 3 sets up the model. Section 4 estimates model parameters.

[4] McClendon et al. (2018) document that average years of schooling for Muslim women have significantly increased recently, but they are still very low. For example, the average years of schooling for Muslim women in the world are 6.1 for those born in 1976-1985. According to the Global Gender Gap Report 2012 by the World Economic Forum, the average female labor force participation rate for the 11 majority Muslim countries was 27.6 percent in 2010.

Section 5 conducts counterfactual analyses. Section 6 explains the three facts. Section 7 conducts historical simulations. Section 8 conducts policy analyses and concludes.

2 Motivation

In this section, we first describe three facts about marriage and fertility in East Asian societies. We then introduce two social norms associated with Confucianism, which can be key to explaining these facts.

2.1 Three Stylized Facts about Marriage and Fertility in East Asian Societies

TFRs have decreased dramatically over the past five decades in East Asian societies (Figure 1), which now have the lowest fertility levels in the world (columns (1)-(2) in Table 1). The average TFR of seven East Asian Societies (China, Japan, Hong Kong, Macau, Singapore, South Korea, and Taiwan) has decreased by 75 percent, from 4.82 in 1960 to 1.19 in 2016. In particular, TFRs for South Korea, Hong Kong, Taiwan, Macau, and Singapore in 2016 are 1.26, 1.19, 1.13, 0.95, and 0.83, respectively, and they rank 220th-224th among 224 countries and territories in the world.

Along with this drastic demographic transition, these East Asian societies have experienced rapid industrialization and economic growth since the 1960s; the average growth rate of GDP per capita for the Four Asian Tigers (Hong Kong, Singapore, South Korea, and Taiwan) is 8.6 percent from 1960 to 2000. Meanwhile, educational attainment for these Four Asian Tigers has also increased substantially. Specifically, women's average schooling years increased from 2.77 to 10.87 from 1960 to 2000, whereas those for men increased from 5.48 to 11.83.[5] The neoclassical economic theory of fertility suggests that these socioeconomic changes in East Asian societies increase the opportunity cost of raising children and thus lead to a rapid decline in fertility (Becker

[5] The data source for GDP per capita is the World Bank, and the data source for educational attainment for the population aged 15 and older is from Barro & Lee's dataset.

and Barro, 1988; Becker et al., 1990; Doepke, 2004; Galor and Weil, 1996).[6] However, one may have difficulty jointly explaining the following three facts about marriage and fertility in East Asian societies.

Fact 1: ***Whereas the marriage rates of East Asian Societies are among the highest in the world, their total fertility rates are among the lowest.*** Columns (3)-(4) in Table 1 show that marriage rates in East Asian societies remain the highest in the world around 2000. The average proportion of married men (women) aged 45-49 is 89.0 (85.8) percent in these societies, compared to 68.0 (66.2) percent, the average proportion for the US, UK, and Canada. This proportion is also 11.7 (17.7) percentage points higher than that of developing countries for men (women).[7] On the other hand, the TFRs in East Asian societies are the lowest in the world (columns (1)-(2)).

Fact 2: ***Whereas their total fertility rates are among the lowest, almost all married women have at least one child.*** Column (5) shows that the childlessness rate of married women in East Asian societies on average was 2.4 percent around 2000, much lower than that for the US, UK, and Canada (10.5 percent) and for developing countries (8.5 percent).

Fact 3: ***By contrast, almost no single women have any children in East Asian societies.*** Column (6) shows that the childlessness rate for single women in East Asian societies on average was 97.9 percent around 2000, substantially higher than that for the US, UK, and Canada (36.1 percent) and for developing countries (45.8 percent).

These facts seem puzzling when considering the following decomposition of total fertility F in a population:

$$F = m(1-c^M)n^M + (1-m)(1-c^S)n^S, \tag{1}$$

where m is the marriage rate; c^M and c^S are the childlessness rates of married and single women,

[6] Jones et al. (2010) systematically examine the assumptions used in the neoclassic fertility theory, which attributes the fertility decline to high opportunity cost of childcare.

[7] Data from the World Bank show that the women's average age at the first marriage from 1990 onward is almost the same between East Asian (27.8) and western societies (28.0).

respectively; and n^M and n^S are the average fertility of married and single mothers, respectively. This decomposition indicates that high total fertility (F) is associated with the high marriage rate (m) and the low childlessness rate of married mothers (c^M), as $\partial F/\partial m > 0$ and $\partial F/\partial c^M < 0$. These relationships are, however, not in line with Facts 1 and 2.[8] Fact 3 also appears puzzling, as fertility decisions of married women contrast sharply with those of single women. Data for the US and 36 developing countries from Baudin et al. (2015, 2018) show a positive correlation between the childlessness rates of married and single women. Therefore, we should endogenize simultaneously the marriage decision (m) and fertility decisions at both the extensive margins (c^M and c^S) and intensive margins (n^M and n^S) to explain the three facts.

2.2 Two Social Norms Related to Confucianism

The sociology and demography literature suggest that Confucian culture has persisted in East Asian societies, despite the economic growth and progress in legal and political institutions (Greenhalgh, 1985; Qian and Sayer, 2015; Fuwa, 2004). Goldscheider et al. (2015) find that Western societies have experienced fundamental attitudinal shifts toward more equal gender roles in housework since the 1960s. In East Asian societies, by contrast, Raymo et al. (2015) find that family expectations and obligations regulated by Confucianism have changed very little during the same period.

The basic principles of Confucian ethics are the "Three Cardinal Guides": Ruler guides subject, father guides son, and husband guides wife. And the basic moral principles for women in Confucianism are the "Three Obediences and Four Virtues," which state that wife's responsibility is to obey her husband. Raymo et al. (2015) conclude that this gender ideology still prevails in East Asian societies. In addition, unmarried motherhood remains a taboo in these societies. Thus, we can conjecture that the tension between the persistent Confucian culture and the rapid economic development has led to the three marriage and fertility facts in East Asian societies. Specifically, our analyses focus on two social norms related to Confucianism: the unequal gender division of

[8] Baudin et al.'s (2015) theory suggests that Fact 2 holds for countries at an early stage of economic development, but not for East Asian societies, which have had high GDP per capita since the 1990s.

childcare and the stigma attached to out-of-wedlock births.

The norm of unequal gender division of childcare Women do most domestic housework and childcare in East Asian societies, which are well known to have a patrilineal and patriarchal family tradition (Greenhalgh, 1985; Tsuya et al., 2000; Qian and Sayer, 2015). Table 2 compares weekly hours spent on housework by a husband and wife in East Asian societies with those in other societies. On average, the fraction of housework provided by a wife is 80 percent for Japan, South Korea, Hong Kong, Taiwan, and China, which is 20 percentage points higher than for the US, UK, and Canada. This fraction is also higher than that for developing countries. Importantly, the fraction has consistently remained at a high level in East Asian societies over past decades. Furthermore, we find from the Korean Time Use Survey (KTUS) that the gender division of housework within a married household in South Korea does not systematically vary across couples' education levels (Table 3). We thus conclude that the gender ideology in Confucian culture has persistently regulated the gender division of housework—for which childcare is a major component for young married couples.

The norm of stigma attached to out-of-wedlock births This stigma attached to out-of-wedlock births had traditionally been the norm in both Eastern and Western societies (Akerlof et al., 1996; Dommaraju and Jones, 2011; Ochiai, 2011; Fernández-Villaverde et al., 2014; Raymo et al., 2015). The stigma has gradually faded in Western societies, however, along with industrialization and economic development, and particularly with the advent of female contraception and the legalization of abortion (Akerlof et al., 1996; Fernández-Villaverde et al., 2014). In modern East Asian societies, by contrast, childbearing outside of marriage is still considered a social stigma (Dommaraju and Jones, 2011; Ochiai, 2011; Raymo et al., 2015). Consistent with this norm, column (6) of Table 1 shows that almost no single women have any children in these societies, which stands in sharp contrast to the fertility pattern of single women in Western and other societies. In addition, among all OECD countries, Japan and South Korea have the lowest proportions of birth outside marriage: 2.3 percent and 1.9 percent in 2014, respectively; the average proportion for the remaining 33 OECD countries is 42.3 percent.[9]

The sociology and demographic literature (Greenhalgh, 1985; Qian and Sayer, 2015; Fuwa, 2004; Raymo et al., 2015) conjectures that these two social norms may be key to explaining the three facts about marriage and fertility in East Asian societies. In Confucian culture, having offspring to carry on one's family blood is a social responsibility.[10] Because out-of-wedlock births are attached to a social stigma, single women would not likely give birth but rather get married to have children. Thus, these societies could have high marriage rates, low childlessness rates for married couples, and high childlessness rates for single women. On the other hand, as women have got more educated in modern East Asian societies, the opportunity cost of their time spent on childcare has increased. This cost increase could have been further exacerbated by the social norm of unequal gender roles. To relieve tension between the boom in women's education and the social norm of unequal gender roles, women choose to have a small number of children. Thus, these modern Asian societies could have low fertility. We develop a structural model to test the conjecture and quantitatively evaluate the importance of the two social norms in marriage and fertility decisions.

3 The Model

We need a model that endogenizes marriage and fertility decisions simultaneously and distinguishes between the extensive and intensive margins of fertility. Baudin et al. (2015) provide such a framework. We further incorporate the two social norms in the model.

3.1 Model Setup

The model is composed of heterogeneous individuals who are characterized by a triplet of state variables: gender $i = (m \text{ [man]}, \ f \text{ [woman]})$, wage w_i, and non-labor income a_i. Each individual

[9] The data is based on the fertility indicator from OECD.

[10] "There are three ways to be unfilial; having no sons is the worst," as stated by Mencius, who has been considered as the "second Sage" after Confucius.

enters a two-stage game. In the first stage, individuals are not aware of whether they are naturally sterile, and are randomly matched with possible partners for marriage; they decide whether to marry or not after comparing values of being married and single.[11] In the second stage, individuals discover their sterility status and decide how many children, if any, to have and how much to consume.

The utility of an individual of gender i and marital status $J = (M[\text{married}],\ S[\text{single}])$ is

$$u(c_i^J, n) = ln(c_i^J) + ln(\nu + \varepsilon^J n), \tag{2}$$

where c_i^J is individual i's consumption when his/her marital status is J, and n is the number of children individual i has ($n \geq 0$). Following Baudin et al. (2015), we assume that single women can have children and single men cannot. That is, men have to get married to have children.[12] The preference parameter $\nu(> 0)$ determines the utility of having no children. The parameter $\varepsilon^J(> 0)$ determines the marginal utility of having children, which depends on marital status J. Utility increases as the number of children increases. Baudin et al. (2015) use the same value of ε for both married and single women, but we use different values of ε to allow for different utilities of having children for married and single women. If single mothers are associated with the social stigma attached to out-of-wedlock births, the estimated value of ε^S would be lower than that of ε^M.

We use χ_m and χ_f to denote the fraction of men and women, respectively, who are naturally sterile. Natural sterility is assumed to be uniformly distributed across education levels. Childlessness may also be driven by poverty: A minimum amount of consumption $\hat{c}$ is required for women to be able to give birth:

$$c_f < \hat{c} \Rightarrow n = 0. \tag{3}$$

We introduce more types of childlessness in Section 3.6.

[11] Weiss (1997), Siow (1998), Weiss (2008), Choo and Siow (2006), and Choo (2015) have extensively studied assortative matching in the marriage market. In Appendix A, we allow for assortative matching in the model following Fernández-Villaverde et al. (2014). Our main results remain robust.

[12] Cohabitation with children is rare in East Asian societies.

When an individual gets married, s/he has one unit of labor endowment, which is divided between work and childcare. A single individual of gender i is endowed with $1-\delta_i$ unit of labor, where δ_i is the time cost of being single. The wage rate, w_i, depends on education and gender. Besides labor income, each individual has non-labor income $a_i > 0$, which follows a log-normal distribution of mean m_a and variance σ_a^2, independent of gender, education, and marital status. Furthermore, each household has to pay a goods cost μ^J, which depends on marital status.

3.2 Home Production of Childcare

Having children entails costs in terms of foregone labor income. For married households, childcare service (L^M) is produced by a husband and wife's labor, denoted by l_m and l_f, respectively. The home production function for childcare is in a CES form:

$$L^M(l_m, l_f) = A^M \left({l_m}^{\psi} + {l_f}^{\psi} \right)^{\frac{1}{\psi}}, \tag{4}$$

where $\psi \leq 1$.

For single mothers, the home production function for childcare service (L^S) becomes linear in l_f, as follows:

$$L^S = A^S l_f. \tag{5}$$

We allow different levels of productivity for married households and single mothers such that $A^S \neq A^M$.

We further assume that the total amount of childcare required for raising n children is

$$F(n) = \phi n, \tag{6}$$

where ϕ is a variable cost of each child.

The cost-minimization problem for married households, given that they have n children, is

$$\min_{l_m, l_f} w_m l_m + w_f l_f, \tag{7}$$

subject to

$$A^M (l_m{}^{\psi} + l_f{}^{\psi})^{\frac{1}{\psi}} = \phi n, \tag{8}$$

$$0 \le l_m \le 1, \quad 0 \le l_f \le 1. \tag{9}$$

Using first-order conditions with respect to l_m and l_f, we have

$$\left(\frac{l_m}{l_f}\right) = \left(\frac{w_m}{w_f}\right)^{\frac{1}{\psi-1}}. \tag{10}$$

And the optimal l_m^* and l_f^* for married couples are, respectively,

$$l_m^* = \frac{w_m^{\frac{1}{\psi-1}}}{\left(w_m^{\frac{\psi}{\psi-1}} + w_f^{\frac{\psi}{\psi-1}}\right)^{\frac{1}{\psi}}} \frac{1}{A^M} \phi n, \tag{11}$$

$$l_f^* = \frac{w_f^{\frac{1}{\psi-1}}}{\left(w_m^{\frac{\psi}{\psi-1}} + w_f^{\frac{\psi}{\psi-1}}\right)^{\frac{1}{\psi}}} \frac{1}{A^M} \phi n. \tag{12}$$

Let α be the fraction of the wife's labor l_f in the total amount of household labor in childcare: $\alpha = l_f/(l_f + l_m)$. Following eq. (10), the optimal fraction of time spent on childcare by the wife, denoted by α^*, strictly decreases in her relative wage. That is, $\partial \alpha^* / \partial (w_f/w_m) < 0$.

3.3 The Cost of Social Norm on Unequal Gender Division of Childcare

By contrast, the social norm plays a dominant role in the gender division of childcare in East Asian Societies, as discussed in Section 2. Table 3 shows that intrahousehold time allocation between a husband and wife does not vary across spousal education. This fact indicates that the gender division of childcare is not optimally determined in these societies. Although other factors might contribute to the gender division, for simplicity we assume in our model that α is governed by the social norm.[13] Denote α' as the fraction of the wife's labor governed by the norm, and $l_m(\alpha')$ and $l_f(\alpha')$ as the amounts of labor from the husband and wife following α', respectively. It follows from eq. (4) that

$$l_m(\alpha') = \zeta_1 \frac{1}{A^M} \phi n, \tag{13}$$

$$l_f(\alpha') = \zeta_2 \frac{1}{A^M} \phi n, \tag{14}$$

where $\zeta_1 = 1/\left\{\left[(\alpha'/(1-\alpha'))^{\psi}+1\right]^{1/\psi}\right\}$ and $\zeta_2 = \alpha'/\left\{(1-\alpha')\left[(\alpha'/(1-\alpha'))^{\psi}+1\right]^{1/\psi}\right\}$, both of which are constants.

The social norm of unequal gender division of childcare within a household can incur unnecessarily large costs of raising children. Denote $C(\alpha^*)$ as the cost of childcare when spouses follow the optimal division rule α^*. That is, $C(\alpha^*) = w_m l_m(\alpha^*) + w_f l_f(\alpha^*)$. Similarly, $C(\alpha') = w_m l_m(\alpha') + w_f l_f(\alpha')$ is the cost when spouses follow the social norm. We define $C(\alpha') - C(\alpha^*)$ as the social norm cost, which arises from the deviation of the optimal gender division of childcare from that governed by the social norm. It has two properties:

1. $\frac{\partial[C(\alpha')-C(\alpha^*)]}{\partial\psi}|_{\alpha',\alpha^*} < 0$. The cost increases when ψ, the degree of substitutability between l_f and l_m in eq. (4), decreases for a given pair of (α', α^*).

2. $\frac{\partial[C(\alpha')-C(\alpha^*)]}{\partial\alpha^*}|_{\psi<1,\alpha'>\alpha^*} < 0$. The cost decreases with α^* when l_m and l_f are imperfect substitutes in producing childcare and $\alpha' > \alpha^*$.[14] As women's education increases relative to men's in modern societies, their optimal fraction of time spent on childcare decreases

[13]Using data from the 1999, 2004, and 2009 Korean Time Use Surveys, we estimate the equation $\alpha = \iota_0 + \iota_1(w_f/w_m) + \varepsilon$, and fail to reject the null hypothesis that $\iota_1 = 0$ at the ten percent level. We also estimate the equation $\alpha = \omega_0 + \omega_1 edu_f + \omega_2 edu_m + \varepsilon$, and fail to reject the null hypothesis that $\omega_1 = \omega_2 = 0$ at the ten percent level. These results support that the social norm plays a dominant role in intrahousehold time allocation in South Korea.

[14]As women provide most of childcare in Confucian societies, the condition ($\alpha' > \alpha^*$) holds for most married households.

(α^*), and thus the cost increases.

3.4 Fertility and Consumption Decisions

We solve the model by backward induction. First, we consider individuals' fertility and consumption decisions, taking marriage status as given. When the gender division of childcare is regulated by the social norm, budget constraints for a single man $b_m\left(c_m^S\right)$, a single woman $b_f\left(c_f^S, n\right)$, and a married household $b\left(c_f^M, c_m^M, n\right)$ are, respectively,

$$
\begin{aligned}
b_m\left(c_m^S\right) &= c_m^S - (1-\delta_m)\,w_m - a_m + \mu^S \leq 0, && (15)\\
b_f\left(c_f^S, n\right) &= c_f^S + \frac{\phi}{A^S} w_f n - \left(1-\delta_f\right) w_f - a_f + \mu^S \leq 0, && (16)\\
b\left(c_f^M, c_m^M, n\right) &= c_f^M + c_m^M + \frac{\phi}{A^M}\left(\zeta_1 w_m + \zeta_2 w_f\right) n - w_m - w_f - a_f - a_m + \mu^M \leq 0. && (17)
\end{aligned}
$$

We assume a collective decision model for married households. The husband and wife jointly decide on how much to consume, c_m^M, c_f^M, and how many children to have, n, to maximize the following objective function:

$$
U\left(c_f^M, c_m^M, n\right) = \theta(w_f, w_m) u\left(c_f^M, n\right) + [1-\theta(w_f, w_m)] u\left(c_m^M, n\right), \tag{18}
$$

where $\theta(w_f, w_m)$ is the wife's bargaining power. It is given by

$$
\theta\left(w_f, w_m\right) \equiv \frac{1}{2}\underline{\theta} + (1-\underline{\theta})\frac{w_f}{w_f + w_m}, \tag{19}
$$

where $\underline{\theta}/2$ is the lower bound of the bargaining power of a wife.

Married couples make fertility and consumption decisions to maximize eq. (18) subject to eq. (17). Single women maximize eq. (2) subject to eq. (16). Single men only make consumption decisions to maximize $ln(c_m^M) + ln(v)$ subject to eq. (15). The maximum number of children a single and a married woman can have are, respectively,

$$n^S = \frac{A^S(1-\delta_f)}{\phi},\ n^M = \frac{A^M}{\zeta_2\phi}, \tag{20}$$

which are derived from their labor-endowment constraints.

3.5 Marriage Decision

We then turn to individuals' marriage decisions. Single men have three options once they are randomly matched with a possible spouse in the marriage market: (i) single with no children; (ii) married with no children; and (iii) married with children. The value functions are, respectively,

$$V_m^S \equiv \left\{\max\ \ln(c_m^S) + \ln(\nu) \quad s.t \quad b_m\left(c_m^S\right) \le 0\right\}, \tag{21}$$

$$V_m^{M,N} \equiv \left\{\max\ \ln(c_m^M) + \ln(\nu) \quad s.t \quad b\left(c_f^M, c_m^M, 0\right) \le 0\right\}, \tag{22}$$

$$V_m^{M,Y} \equiv \left\{\max\ \ln(c_m^M) + \ln(\nu + \varepsilon^M n) \quad s.t \quad b\left(c_f^M, c_m^M, n\right) \le 0\right\}, \tag{23}$$

where the second superscript indicates whether the individual has any children (Y) or not (N).

Men choose to marry with the randomly matched partner if and only if

$$\left[\chi_m + (1-\chi_m)\chi_f\right] V_m^{M,N} + (1-\chi_m)(1-\chi_f) V_m^{M,Y} \ge V_m^S. \tag{24}$$

On the left-hand side, the first term is the expected value of being married with no children due to natural sterility, and the second term is the expected value of being married with the possibility of having children. That is, men choose to marry when the expected value of being married is no smaller than the value of being single.

Single women have four options once they are randomly matched with a possible spouse in the marriage market: (i) single with no children; (ii) single with children; (iii) married with no children; and (iv) married with children. The value functions are, respectively,

$$V_f^{S,N} \equiv \left\{\max \ \ln(c_f^S) + \ln(\nu) \quad s.t \quad b_f\left(c_f^S, 0\right) \leq 0\right\}, \tag{25}$$

$$V_f^{S,Y} \equiv \left\{\max \ \ln(c_f^S) + \ln(\nu + \varepsilon^S n) \quad s.t \quad b_f\left(c_f^S, n\right) \leq 0\right\}, \tag{26}$$

$$V_f^{M,N} \equiv \left\{\max \ \ln(c_f^M) + \ln(\nu) \quad s.t \quad b\left(c_f^M, c_m^M, 0\right) \leq 0\right\}, \tag{27}$$

$$V_f^{M,Y} \equiv \left\{\max \ \ln(c_f^M) + \ln(\nu + \varepsilon^M n) \quad s.t \quad b\left(c_f^M, c_m^M, n\right) \leq 0\right\}. \tag{28}$$

Similarly, women choose to marry if and only if

$$\left[\chi_f + (1-\chi_f)\chi_m\right] V_f^{M,N} + (1-\chi_f)(1-\chi_m)V_f^{M,Y} \geq \chi_f V_f^{S,N} + (1-\chi_f)V_f^{S,Y}. \tag{29}$$

A randomly matched pair would get married if and only if both the man and woman agree to do so; that is, both eq. (24) and (29) hold.

3.6 Decomposition of Childlessness

We have so far introduced natural sterility and poverty-driven childlessness for both married and single women. One type of childlessness *exclusive* for single women is driven by the social stigma discussed in Section 2.2. The condition for the social-stigma-driven childlessness is given by

$$V_f^S(n \geq 1 | \varepsilon^S = \varepsilon^M, w_f, a_f) > V_f^S(n = 0 | \varepsilon^S = \varepsilon^M, w_f, a_f), \tag{30}$$

$$V_f^S(n = 0 | \varepsilon^S < \varepsilon^M, w_f, a_f) \geq V_f^S(n \geq 1 | \varepsilon^S < \varepsilon^M, w_f, a_f), \tag{31}$$

$$c_f^S \geq \hat{c}. \tag{32}$$

That is, if a single woman with w_f and a_f who would prefer having children in the absence of the social stigma (i.e., $\varepsilon^S = \varepsilon^M$) choose not to have any children in the presence of the social stigma, we call this type of childlessness social-stigma-driven childlessness.

Another type of childlessness is driven by high opportunity costs. For married women with w_f

and a_f , the condition for this type of childlessness is given by

$$\begin{aligned} V_f^M(n \geq 1|w_f, a_f) &\leq V_f^M(n=0|w_f, a_f), & (33) \\ c_f^M &\geq \hat{c}. & (34) \end{aligned}$$

For single women with w_f and a_f, the condition for this type of childlessness is given by

$$\begin{aligned} V_f^S(n \geq 1|\varepsilon^S = \varepsilon^M, w_f, a_f) &\leq V_f^S(n=0|\varepsilon^S = \varepsilon^M, w_f, a_f), & (35) \\ c_f^S &\geq \hat{c}. & (36) \end{aligned}$$

That is, even without the social stigma, a single woman whose consumption is above $\hat{c}$ chooses to be childless because of the high opportunity cost associated with high wage rate w_f. The technical details of the decomposition of sources of childlessness for single women are presented in Appendix B.

3.7 Discussion: Incorporating the Two Social Norms

Compared to prior work, our model provides a more suitable setting to study marriage and fertility in East Asian societies, because our model incorporates the two social norms discussed in Section 2.2. As for the first social norm of unequal gender roles, we assume that all households divide childcare between a wife and a husband according to a fixed share α' imposed by the social norm. On the other hand, the optimal time allocation without social norm α^* is determined by the elasticity parameter ψ and the ratio of a wife's wage rate to that of her husband in the CES home production function. The wedge between the optimal allocation of childcare and realized allocation can be measured by comparing α' and α^*. This generalization enables us to perform quantitative analyses on the effects of the social norm, and to conduct counterfactual and policy experiments. Furthermore, we are able to estimate the heterogeneous effect of the social norm and various policies on marriage and fertility simultaneously by socioeconomic status. These counterfactual and policy analyses allow us to understand why pro-natal policies such as childcare subsidies have failed to increase fertility in East Asian societies.

As for the social stigma attached to out-of-wedlock births, we allow for different values of ε, the marginal utility of having children, for single and married households. With the help of the structural model, we can decompose sources of childlessness to see how much the social stigma accounts for the high childlessness rate of single women.

4 Model Estimation

In this section, we estimate model parameters using the data from South Korea's censuses and household surveys.[15] We have a total of 17 parameters, which are categorized into two groups: one group of parameters estimated directly from the data, and the other estimated from the model using the simulated method of moments (SMM). Appendix C describes all data sources and defines the data samples used for the estimations.

4.1 Parameters Estimated Directly from the Data

Of the 17 model parameters, six are estimated directly from the data and are listed in Panel A, Table 5. The table compares the parameter estimates with their counterparts in Baudin et al. (2015) for the US and those in Baudin et al. (2018) for 36 developing countries.

The following Mincerian wage equation is used to compute wage:

$$w_e = \gamma z \exp(\rho e), \tag{37}$$

where e denotes years of schooling in each education category. The gender wage gap γ and the

[15] Because of data availability, our estimation is conducted using South Korea's census and survey data. Population censuses in Taiwan, Hong Kong, Singapore, Macau, and Japan either do not contain information on fertility or are not publicly available. Population censuses in China have fertility information for women aged 15-45, but Chinese have been subjected to strict population control polices since 1979.

Mincerian rate of return to schooling ρ are estimated to be 0.77 and 0.076, respectively, from the 2000 Labor Conditions by Type of Employment (SLCTE) data. Our estimated value of γ is lower than that for the US (0.869) and the mean value of the estimates for the developing countries (0.79). Our value of ρ is lower than that for the US (0.092) but is greater than that for the developing countries (0.05). We use z as a normalization factor to capture the trend in TFP when we conduct historical simulations in Section 7 below.

Using the 1999 Korean Time Use Survey (KTUS), we obtain the fraction of time spent by a wife on childcare governed by the social norm $\alpha' \equiv l_f/(l_f + l_m)$. We find that α' ranges from 0.78 to 0.87 for different groups of households.[16] We use the most conservative value of 0.78. Thus, our quantitative results below should be considered to provide the lower bound of the effects on fertility and marriage of the social norm of unequal gender roles.

To estimate the elasticity parameter ψ in the CES home production function (eq. (4)), we use the first-order condition derived from the cost-minimization problem (eq. (10)) :

$$ln(\frac{l_m}{l_f}) = \frac{1}{\psi - 1}[ln(w_m) - ln(w_f)]. \tag{38}$$

We use α' to pin down l_m/l_f. We use the wage rates of men and women for the 1920 birth cohort from the SLCTE to compute ψ for the following reason. The 1920 cohort is the first generation in South Korea who started working and forming households after the independence of Korea in 1945 and the Korean War in 1950. They completed their education before the economic take-off. For this cohort, women's education is much lower than men's, and the gender wage gap is large. Thus, we assume that the unequal gender division of childcare is efficient for this cohort. This unequal gender division might have formed in the pre-industrialization period as a social norm, and since then it has persisted in modern South Korea. The estimated value of ψ is 0.385, which is in line with Knowles (2013); l_f and l_m are imperfect substitutes. The implied elasticity of substitution, however, is 1.62, which is lower than 3.03 in Knowles (2013). The first property of the social norm

[16] Table C4 in Appendix C tabulates the average values of α''s for different groups of households.

cost on the unequal gender division of childcare in Section 3.3 implies a large cost with a small ψ. In Appendix A, we use different values of α' and ψ, and find that our results remain robust.

The ratio of the household-maintenance-goods cost for single households to that for the married, μ^S/μ^M, is estimated to be 0.733, using the 2000 Household Income and Expenditure (HIE) data. In Appendix A, we conduct a robustness check using different values of μ^S/μ^M.

Natural sterility parameters χ_f and χ_m are set to be identical and fixed at 0.5 percent, which implies the natural sterility rate for married households, $\chi_f + (1-\chi_f)\chi_m$, is 0.998 percent. Baudin et al. (2015) set both parameters at 1.21 percent for the US, and Baudin et al. (2018) at 1 percent for the 36 developing countries. Both values, however, give us the natural sterility rate larger than 1.56 percent, South Korea's childlessness rate for married couples.

4.2 Simulated Method of Moments

The remaining 11 parameters are estimated using SMM by minimizing the distance between empirical and simulated moments. The objective function is

$$f(p) = [d - s(p)]W[d - s(p)]', \tag{39}$$

where d is a vector of empirical moments, and $s(p)$ is a vector of simulated moments using a vector of model parameters p. The weight matrix W is a diagonal matrix with $1/d^2$ as elements. We have a total of 35 empirical moments. Table 4 lists 32 of them: completed fertility of married mothers, childlessness rates for married women, and marriage rates for men and women in eight education categories. These empirical moments are obtained from the two percent sample of the 2000 South Korea population and housing census. The remaining three empirical moments are completed fertility for single mothers, the maximum number of children for single mothers, and the childlessness rate for single women. Completed fertility for single mothers and the maximum number of children for single mothers are 1.15 and 3.0, respectively, based on the 2015 Single Parent Family Status Survey (SPFS). The childlessness rate for single women is 0.982, based on the 2015 South Korea census. When minimizing the objective function, we impose the constraint of matching the average simulated childlessness rate for single women to its empirical counterpart perfectly. We impose this constraint, because we will later conduct a decomposition of sources of childlessness for single women so as to investigate the role of the social stigma in accounting for the high childlessness rate of single women in South Korea.

When simulating the model, 100,000 women are drawn from each education category. Each woman is matched with a potential husband randomly drawn from the empirical distribution of education levels for men. Besides labor income, which is obtained from eq.(37), both men and women randomly draw a non-labor income. We then calculate simulated moments for each education category by averaging fertility and marriage outcomes across these 100,000 women.

4.3 Parameters Estimated from Simulated Method of Moments

Panel B, Table 5 presents the remaining 11 parameters estimated from SMM and compares them with their counterparts in Baudin et al. (2015) for the US and those in Baudin et al. (2018) for the developing countries. Appendix D shows how each parameter is identified from the fertility and marriage facts of South Korea.

The mean and variance of non-labor income, m_a and σ_a^2, are 0.234 and 0.333, respectively. The goods cost for maintaining a married household μ^M is estimated to be 0.343, and accordingly μ^S is 0.252. The minimum consumption level to be able to procreate, $\hat{c}$, is estimated at 0.200.

The preference parameter that determines the utility of remaining childless ν is estimated to be 7.645, which is smaller than 9.518—the mean value of the estimates for 36 developing countries—and 9.362, the estimate for the US.

The time costs of being single for men δ_m and women δ_f are 0.1 and -0.03, respectively. Both values are within the range of the estimates for the 36 countries. $\delta_m > \delta_f$ implies that men are less capable of doing housework, so that marriage is more beneficial for men than women. The parameter that determines a wife's bargaining power for consumption, $\underline{\theta}$, is estimated to be 0.232, which is much lower than 0.545 for the developing countries and 0.864 for the US.

The productivity parameter for the home production function for married households A^M is normalized to be one, and that for single households A^S is estimated to be 1.916. The parameter determining the variable cost of raising each child ϕ is estimated to be 0.542, so that the effective variable time costs of raising each child for single mothers and married couples are 0.276 ($= \phi/A^S$) and 0.151 ($= \phi(\zeta_1 + \zeta_2)$), respectively. This indicates that couples are more efficient in raising children than single mothers, because l_f and l_m are imperfect substitutes in producing childcare ($\psi = 0.385$).

Finally, the social stigma parameter ε^S is estimated to be 0.853 when ε^M is normalized to be one. Single mothers thus have lower marginal utility of having children than married mothers, consistent with the social stigma associated with single mothers in South Korea.

4.4 Model Fitness

Our estimated model well matches the marriage and fertility facts of South Korea. Figure 2 (a) compares simulated childlessness rates for married women across education levels with those in the data. The childlessness rate for married women in South Korea shows a U-shaped pattern, although its overall level is much lower than those for other countries. This pattern implies that for lowly educated women in South Korea, childlessness is still driven by poverty. Figure 2 (b) compares simulated completed fertility for married mothers across education levels with that in the data. Completed fertility shows a monotonically decreasing pattern in education levels. Figures 2 (c) and (d), respectively, compare simulated marriage rates for women and men across education levels with those in the data. Our model well reproduces the negative correlation between marriage and education for women and the positive correlation for men. The negative relationship between marriage and education for women is different from the hump-shaped relationship for women in the US. The simulated childlessness rate for single women, completed fertility for single mothers, and the maximum number of children for single mothers are 0.982, 1.29, and 3.0, respectively.

Their empirical counterparts are 0.982, 1.15, and 3.0.[17]

5 Counterfactual Analyses

In this section, we conduct two types of counterfactual analyses: First, we quantitatively investigate the roles of the two social norms in marriage and fertility in South Korea. Second, we investigate differences in marriage and fertility patterns between South Korea and the US by conducting three counterfactual experiments using the parameter estimates for the US from Baudin et al. (2015).

5.1 Social Norm on Unequal Gender Division of Childcare

What are the effects on fertility and marriage of the social norm of unequal gender division of childcare? To answer this question, we conduct a counterfactual experiment, assuming that each spouse optimally shares childcare. That is, α', a wife's fraction of childcare governed by the social norm, is replaced by α^*, the optimal fraction based on the relative wage of a wife to her husband in each household, holding other parameters to their estimated values.

Based on our model estimates, the average social norm cost ($C(\alpha') - C(\alpha^*)$) is 0.0036, which amounts to 5.12 percent of the average cost of rearing one child (Appendix E). The optimal division of childcare removes the social norm cost, which has positive effects on both the extensive and intensive margins of fertility: The average childlessness rate decreases from 1.2 percent in the benchmark simulation to 1 percent in the counterfactual simulation, and the average completed fertility of married mothers increases by about 10 percent from 3.113 to 3.434. Note that this 10-percent increase in completed fertility should be considered as a lower bound of the effect of the social norm, because we use the most conservative value of α' (Section 4.1). When we set $\alpha' = 0.87$, which is the average fraction of childcare provided by a wife for households with

[17] In Figure 2 (b), the gap between the data and the model prediction in completed fertility of highly educated married mothers is due to our assumption that the rate of return to schooling (ρ) is constant at different education levels. In Figure 2 (d), the gap in marriage rates of lowly educated men is due to our assumption of random marriage matching.

unmarried children from the 1999 KTUS, the average completed fertility of married mothers would increase by 25 percent without the social norm (Table A1 in Appendix A).

Figure 3 (a) compares model predictions for childlessness rates with and without the social norm by education. The solid line with squares and dashed line with circles denote, respectively, the childlessness rates in the benchmark simulation and those in the counterfactual simulation without the social norm. In the absence of the social norm, the childlessness rates for married women with primary education or below remain the same; however, the childlessness rate decreases for those with secondary education or above. The decrease is bigger for higher educated women: The childlessness rate for women with a Ph.D. decreases from 3.5 percent to 1 percent.

Figure 3 (b) shows that removing the social norm also has differential effects on completed fertility of married mothers across education. For those with no schooling, completed fertility decreases from 4.516 to 4.172; but it increases for those with primary education or above. The increase is bigger for higher educated women. Completed fertility for those with a Ph.D. increases by around 110 percent from 1.442 to 3.039.

The differential effects on childlessness rates and completed fertility of the social norm are consistent with the second property of the social norm cost in Section 3.3: The cost, on average, increases with women's education. Table E2 in Appendix E presents the estimated social norm costs ($C(\alpha') - C(\alpha^*)$) by education levels of a married couple. The percentage of the social norm cost in the total cost of rearing a child increases from 2.1 for women with primary education to 22.5 for those with a Ph.D.

Figures 3 (c) and (d) compare model predictions for marriage rates of men and women with and without the social norm. The average marriage rate would increase from 0.971 to 0.984 in the absence of the social norm, but the effects of removing the social norm on marriage rates differ by gender and education. In the absence of the social norm, the marriage rate increases more for higher educated women as the social norm cost is higher for them. By contrast, the marriage rate increases more for less educated men. The reason is as follows. For lowly educated men, women who likely accept their marriage offers are those with low income. Their potential wife's consumption may not exceed the minimum amount to procreate ($\hat{c}$), thus making marriage not very attractive to these men; one of the main reasons for marriage for men is to have children. Removing the social norm leads to efficient spousal time allocation between work and childcare, so they can consume more with an expanded budget set. This increase in consumption reduces the poverty-driven childlessness for these households, thus making marriage more attractive to these lowly educated men.

In the absence of the social norm, the change in completed fertility of married mothers increases total fertility by 10 percent, and the changes in marriage and childlessness rates for single and married women increase total fertility by 1.2 percent. Overall, total fertility in South Korea would be 11.2 percent higher without the social norm, when we take into account all the endogenous changes in marriage and fertility.

5.2 Social Stigma Attached to Out-of-Wedlock Births and Decomposition of Childlessness for Single Women

In this counterfactual experiment, we investigate the effects on marriage and fertility of the social stigma attached to out-of-wedlock births. We set both ε^S and ε^M equal to one, thus assuming that single and married women have the same marginal utility of having a child. All other parameters are the same as their estimated values.

Childlessness rates of married women, completed fertility of married mothers, and marriage rates for men and women in the counterfactual experiment are almost identical to those in the benchmark simulation. Only childlessness rates of single women and completed fertility of single mothers would change without the social stigma, but not substantially. Table 6 reports childlessness rates of single women and completed fertility of single mothers across education in the counterfactual simulation: The average childlessness rate of single women would decrease from 0.982 to 0.954, and completed fertility of single mothers would increase from 1.29 to 1.32. The social stigma has negative effects on fertility of single women—mainly for lowly educated single women—but they seem quantitatively small.

The small effects of the social stigma on marriage and childlessness of single women contradict the conjecture in Section 2.2. The sociology and demography literature conjectures that the unusually high childlessness rates of single women and high marriage rates in East Asian societies might be related to the social stigma attached to out-of-wedlock births. To understand why the conjecture is incorrect, we use our structural model to conduct a decomposition of childlessness for single women. The decomposition allows us to identify the main driver of the high childlessness rate of single women in South Korea. The results show that the social stigma accounts for only 2.25 percent of the total childlessness rate of 98.2 percent for single women, whereas the opportunity cost of childcare accounts for 91.70 percent. Appendix B presents the technical details on the decomposition of childlessness for single women.

Why is the proportion of social-stigma-driven childlessness is so low, whereas that of opportunity-cost-driven childlessness is so high for single women in South Korea? The reason is related to South Korea's distinctive marriage pattern for women: The marriage rate of women monotonically decreases with education, which is different from the US's hump-shaped relationship between marriage and women's education.

Figure 4 illustrates how a single woman chooses to remain childless, depending on her wage rate (w_f), given that her non-labor income is high enough so that $c \geq \hat{c}$ (i.e., no poverty-driven childlessness). The top panel in Figure 4 depicts the case without the social stigma (i.e., $\varepsilon^S = \varepsilon^M$): Single women whose wage rate is above $\bar{w_f}(n=1, \varepsilon^S = \varepsilon^M)$ choose to remain childless due to high opportunity cost, whereas those whose wage rate is below $\bar{w_f}(n=1, \varepsilon^S = \varepsilon^M)$ have at least one child. Threshold wage rates for stigma-driven and opportunity-driven childlessness are defined in Appendix B. The bottom panel depicts the case with the social stigma: Single women whose wage rate ranges from $\bar{w_f}(n=1, \varepsilon^S < \varepsilon^M)$ to $\bar{w_f}(n=1, \varepsilon^S = \varepsilon^M)$ remain childless due to the social stigma; without the stigma, they would have had at least one child. Most single women in the benchmark simulation are highly educated, so that their wage rates exceed $\bar{w_f}(n=1, \varepsilon^S = \varepsilon^M)$, and thus choose to remain single and childless. The 2000 census data also confirm our model's prediction that single women on average have 2.24 more schooling years than married women in South Korea. Because most single women's fertility decisions are opportunity-cost driven, little space remains for the social stigma to step in.

5.3 Counterfactual Analyses Using US Parameter Estimates

Marriage and fertility patterns differ widely between East Asian and Western societies (Table 1). Besides the two social norms, are there any other factors which drive these differences? To answer this question, we conduct three counterfactual experiments. In each experiment, we replace one of the following three parameter estimates with that for the US from Baudin et al. (2015): the gender wage gap (γ); the preference parameter that determines the utility of remaining childless (ν); and the parameter that determines a wife's bargaining power for consumption ($\underline{\theta}$), holding other parameter estimates constant at their estimated values. Of the 17 parameter estimates, South Korea and the US mainly differ in these three. We find, however, that these differences alone cannot systematically explain the main differences in marriage and fertility patterns between the two countries. Appendix F presents the details of the counterfactual analyses.

6 Explaining the Three Facts about Marriage and Fertility

Our model estimation and counterfactual analyses enable us to explain the three facts about marriage and fertility in East Asian societies described in Table 1 of Section 2.

High Marriage Rates Men benefit greatly from marriage and therefore find it very attractive. First, marriage is the only way for men to have children, and having children gives them high utility (small ν). Second, marriage leads to a gain in time endowment, which is larger for men than women ($\delta_m > 0$ and $\delta_m > \delta_f$). Finally, they generally have a high bargaining power for consumption sharing within a household; a husband who on average earns more than a wife due to the large gender wage gap (small γ) does not have to share much of his income with her (small $\underline{\theta}$).

On the other hand, lowly educated women also find marriage attractive because (1) they have high utility gain from having children (small ν) and (2) marriage may be the only way for most of them to have children, because their labor income is not high enough for their consumption to reach the minimum consumption level to procreate ($\hat{c}$). Overall, these characteristics lead to high marriage rates in South Korea.

Low Total Fertility for Married Mothers As shown in the counterfactual analysis in Section 5.1, the social norm on unequal gender division of childcare significantly raises the cost of childcare, thus leading to low fertility for married mothers.

Low Childlessness Rates for the Married The estimate of ν, the utility of remaining childless, is much smaller for South Korea than its counterparts for other countries including the US. This low value of ν implies a high utility gain from having children in South Korea, consistent with the Confucian value that having offspring is a social responsibility, which explains why childlessness rates for married couples in East Asia are low.

High Childlessness for Single Women Given the overall high tendency to marry, women who choose to remain single are those who are very highly educated and those who find marriage very costly because of their high wage rates and the social norm of unequal gender roles. Furthermore, for very highly educated *single* women, the opportunity cost of having children is also high, so they choose to remain childless.

We conclude that the tension between persistent Confucianism and socioeconomic development results in three notable facts about marriage and fertility in East Asian societies. The Confucian cultural factors are the family and social responsibility of having offspring, the low intrahousehold bargaining power for women, and the social norm of unequal gender division of childcare. Socioeconomic development entails a substantial increase in education attainment for women, and a decreasing gender wage gap.

7 Historical Simulations

We have shown that our estimated model well accounts for the three facts of marriage and fertility in East Asian societies. In this section, we use our model to explain the demographic transition in South Korea over the past decades. Specifically, we answer the following two questions by conducting historical simulations: First, what are the main factors driving the rapid decline in fertility in South Korea over the past decades? Second, what is the role of the social norm of unequal gender division of childcare in the rapid decline of fertility? To conduct historical simulations, we use four waves of two percent Korea census data (1985, 1990, 2000, 2010) to obtain the empirical moments of marriage rates and fertility for birth cohorts from 1920 to 1970. For details, see Appendix A. Table 7 tabulates marriage rates and fertility for different birth cohorts.

7.1 Education Boom, Economic Growth, and Gender Wage Inequality

We examine three major factors documented in the literature, which are known to influence demographic transition: an increase in educational attainment, economic growth (proxied by growth in TFP), and a decrease in the gender wage gap. These three factors are represented by e, z, and γ, respectively, in eq. (37).

In the benchmark historical simulation, we combine changes in all three main factors—education, TFP, and the gender wage gap—in a single simulation. We obtain the empirical distribution of education levels (e), the estimated gender wage gap (γ), and TFP levels (z) for each cohort using the following data sets. The education distribution of each cohort comes from the 1985-2010 two percent census data. The gender wage gap is estimated from the 1980-2013 SLCTE data using eq. (37). The data source for the TFP in South Korea is World Development Indicators from World Bank. For each cohort, we use the 30-year average of TFP's to proxy for the mean life-cycle wage rate, as in Baudin et al. (2015). For example, for the cohort born in the 1920s, the wage is indexed on the average TFP for the period 1950-1980. For cohorts born in the 1960s and 1970s, we use forecast future TFP under the assumption that the same growth rate over the last 10 years continues, following Baudin et al. (2015). Finally, the TFP for the 1920 cohort is normalized so that the average completed fertility of married mothers for the 1920 cohort in the simulation matches that in the data.

The solid line in Figure 5 (a) plots completed fertility of married mothers in the data for the 1920-1970 cohorts, and the dashed line with circles plots simulated fertility for these birth cohorts. These two lines are close to each other, showing a decreasing trend in fertility. Specifically, fertility drops from 5.443 to 1.897 in the data, and from 5.443 to 2.354 in the simulation. Hence, the three main factors account for 87.1 percent of the fertility decline in South Korea across the five birth cohorts. Given that the model is simple and static, our historical simulation result seems remarkable.

Next, we investigate how much each factor *separately* contributes to the fertility decline in South Korea. To quantify the effect of the change in education alone, we simulate the model using the empirical distribution of education levels for each cohort, but holding the gender wage gap and TFP level constant at those values for the 1920 cohort. The solid line with hollow circles shows the simulated fertility when we change education only. We observe that the increase in educational attainment leads to a decrease in fertility across cohorts; it alone accounts for 33.61 percent of the total fertility decline. Lastly, we simulate the model using the empirical distribution of education levels and the historical TFP level for each cohort, but holding the gender wage gap at the value for the 1920 cohort. The dotted line shows the simulated fertility in this experiment: Fertility decreases from 5.443 to 2.987, accounting for 69.21 percent of the total fertility decline. This finding implies that the growth in TFP and the decrease in the gender wage gap, respectively, account for 35.60 percent and 17.89 percent of the total fertility decline in South Korea across the 1920-1970 cohorts.

7.2 Social Norm of Unequal Gender Role and Demographic Transition in South Korea

In the counterfactual analyses conducted in Section 5, we showed the important role of the social norm of unequal gender division of childcare in marriage and fertility outcomes, although the role of the social stigma attached to out-of-wedlock births is minimal. We now investigate the effects of the social norm of unequal gender roles on completed fertility for the 1920-1970 cohorts. Specifically, what would have happened to fertility across the five cohorts if the fraction of a wife's labor in childcare had not been governed by the social norm? To answer this question, we conduct a historical simulation in which we replace α' with α^*, holding other parameter estimates constant in the benchmark historical simulation. We estimate w_f and w_m in each household for each cohort, and then calculate the optimal fraction of the wife's labor in childcare α^* based on eq. (10).

The solid line with squares in Figure 5 (b) plots completed fertility of married mothers for the 1920-1970 cohorts in the benchmark historical simulation, and the dotted line with circles plots completed fertility of married mothers in the simulation in which α' is replaced by α^*. The dotted line is consistently above the solid line, indicating that fertility would have been higher across all five cohorts if married spouses in South Korea had optimally divided childcare. This result is consistent with our counterfactual experiment conducted on the cross-section of households in Section 5.1: The social norm has significantly negative effects on fertility.

Furthermore, fertility would have increased more for younger cohorts in the absence of the social norm. Figure 5 (c) shows the percentage difference in completed fertility of married mothers between the benchmark historical simulation and the simulation without the social norm for each cohort. The percentage difference in fertility monotonically increases across the birth cohorts, reaching a peak of 17.5 percent for the 1970 cohort. That is, if each couple had optimally divided childcare, fertility for married mothers would have been 17 percent higher, reaching 2.767 for the 1970 cohort.

This increase in the fertility differential in Figure 5 (c) results mainly from the rapid increase in educational attainment for South Korean women over the past decades. As women get more educated relative to men, α^* decreases. Consequently, the cost of the social norm increases. Figure 6 (a) plots the average wage rates of men and women (w_m and w_f) , and Figure 6 (b) the ratio of w_f to w_m across the cohorts. The ratio increases from 0.427 for the 1920 cohort to 0.843 for the 1970 cohort. This increase corresponds to the decrease of α^* from 0.796 to 0.569, as shown in Figure 6 (c). Therefore, the cost of the social norm in rearing children increases across the cohorts (Figure 6 (d)), indicating that the boom in women's education has heightened the tension between the Confucian culture and socioeconomic development.

8 Policy Analyses and Conclusion

We have shown that the social norm of unequal gender roles significantly contributes to low fertility, and its effect varies across education: It lowers fertility for highly educated women, but raises it for the less educated. We now investigate two pro-natal policies that could potentially mitigate the negative fertility effects of this social norm.

The first policy is for the government to share a fraction τ of childcare cost—for example, by building public childcare centers. The cost of childcare required to raise n children for a family then becomes

$$F(n) = (1-\tau)\phi n, \tag{40}$$

where $F(n)$, ϕ, and n are the same as in eq. (6). We find that if the government were to provide 4.6 percent of total childcare ($\tau = 0.046$), total fertility would be the same as that in the absence of the social norm. The effects of this policy at different education levels are, however, different from those of removing the social norm. Figure 7 plots the marriage rates of women and completed fertility of married mothers in the benchmark simulation (dashed line), the counterfactual experiment without the social norm (solid line), and the policy experiment (dotted line). Figures 7 (a) and (b) show that although the policy increases marriage rates and fertility of women at all education levels, it cannot completely mitigate the role of this norm as its effect is not large enough for highly educated women.

The second policy is to provide households with a_{sub} amount of subsidy in cash for each child. We find that if $a_{sub} = 0.0035$, total fertility would be the same as that without the social norm. In our model, an average married household spends 0.074 units of the consumption good as the childcare cost for each child.[18] Thus, $a_{sub} = 0.0035$ translates to 4.77 percent of the childcare cost for each child. Similar to the first policy experiment, this subsidy policy has differential effects on marriage rates and fertility different from those without the social norm. Figures 7 (c) and (d) show that the subsidy policy increases average marriage rates and fertility, but it is not effective in mitigating the role of this norm for highly educated women.

Our study has major policy implications for East Asian societies. First, our two policy experiments show that a government's pro-natal policies are insufficient in boosting fertility for highly educated women. For this group, the government may need to promote a social-norm revolution by advocating for equal gender roles within a household. This proposition is challenging because the social norm has been persistent for thousands of years in this region. Second, as long as the social norm of unequal gender roles persists, pro-natal policies based on government subsidy would be less and less effective over time. Our historical experiment result shows that the negative effect of the social norm on fertility is more significant for younger cohorts. As the gender wage gap shrinks in tandem with the increase in women's education, the optimal fraction of a wife's labor in childcare (α^*) decreases. Consequently, the cost of the social norm increases, which would significantly offset the effect of existing pro-natal policies in these societies.

Our study has limitations. First, marriage matching is not endogenous in our model. Second, the model abstracts from labor force participation decisions. Third, the gender ideology regulated by Confucianism has influences on many aspects of life besides intrahousehold time allocation; for example, gender inequality and motherhood penalties in the workplace. Fourth, we do not consider

[18]The time costs of rearing one child for a wife and husband are $l_f = 0.151$ and $l_m = 0.042$, respectively. We convert the time costs in terms of the consumption good using w_f and w_m for an average married household.

childcare provided by grandparents and domestic helpers. Fifth, we do not introduce the child quantity-quality tradeoff in our model. Finally, the marriage behavior has changed dramatically in East Asian societies since the 2010s. Nowadays, a non-trivial percentage of women either delay marriage or do not get married at all. This phenomenon can be understood as a rational response to the heightened tension between the social norm of unequal gender roles and the boom in female education, as our theory suggests. We relegate these potential extensions to future studies.

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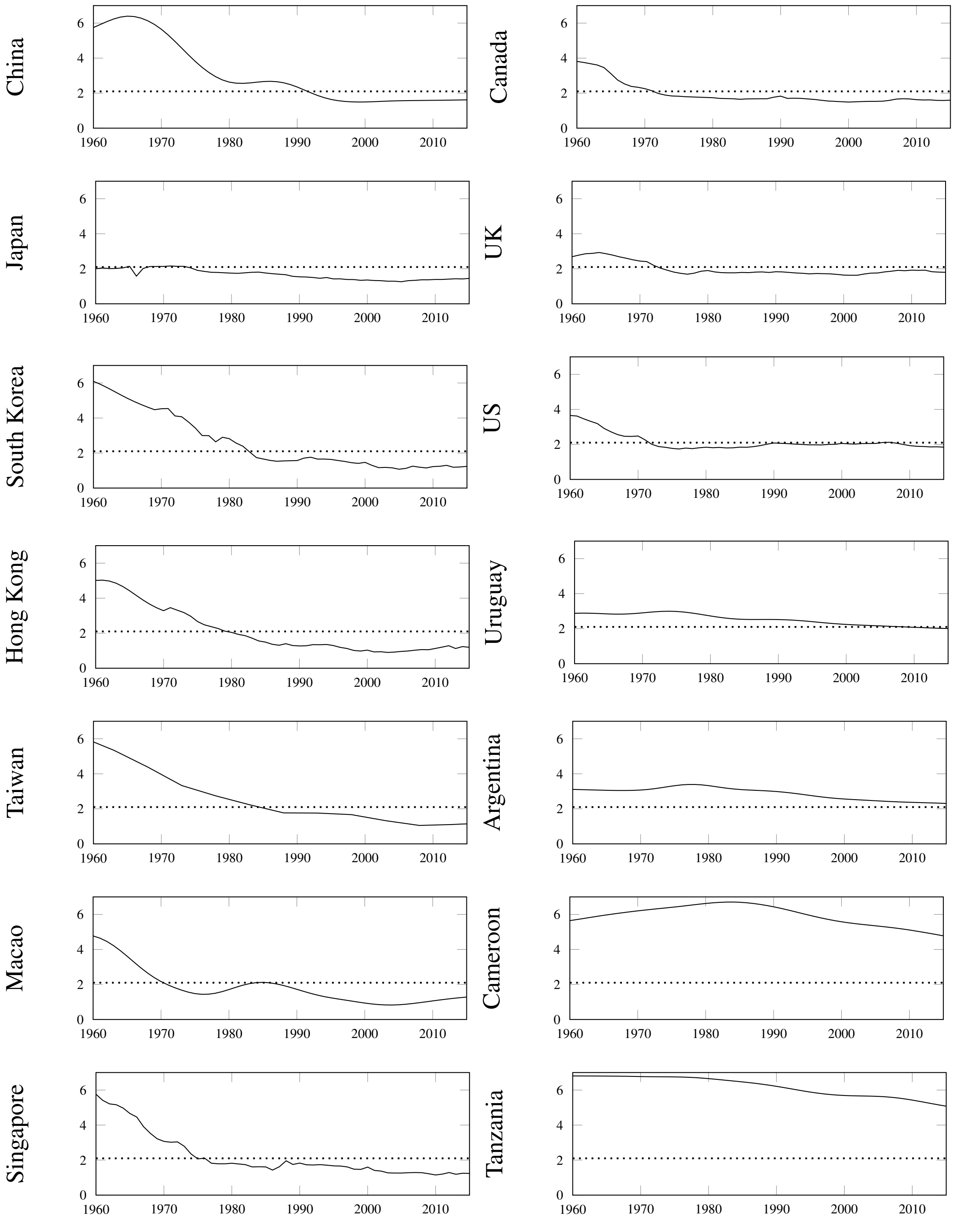
Figure 1: Changes in the Total Fertility Rate over the Past 50 Years



Note: The total fertility rate is measured by the average number of children that would be born per woman if all women were to live to the end of their childbearing period and give birth according to a given fertility rate at each age. The dotted line is the replacement rate of population (2.1). Data for Taiwan are from the World Population Review. Data for all other countries are from the World Bank.

Figure 2: Model Fitness: Childlessness Rates of Married Women, Completed Fertility of Married Mothers, and Marriage Rates of Women and Men, by Years of Schooling

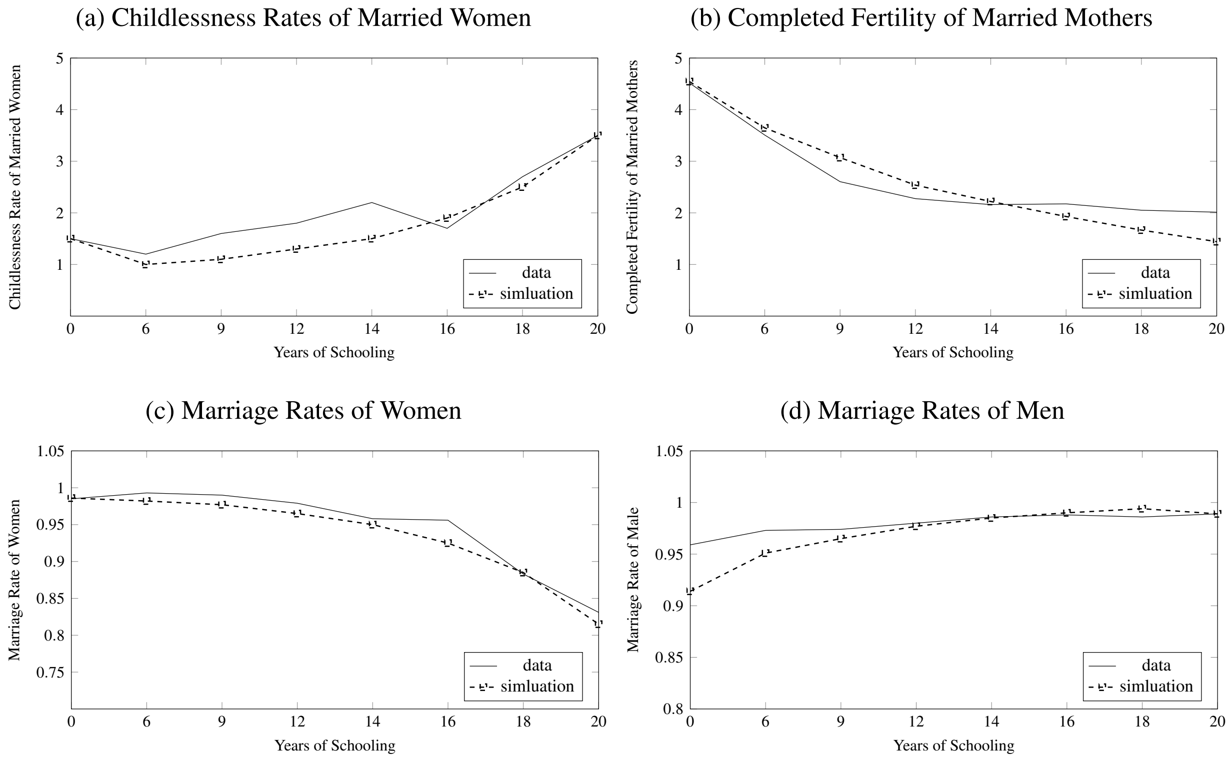
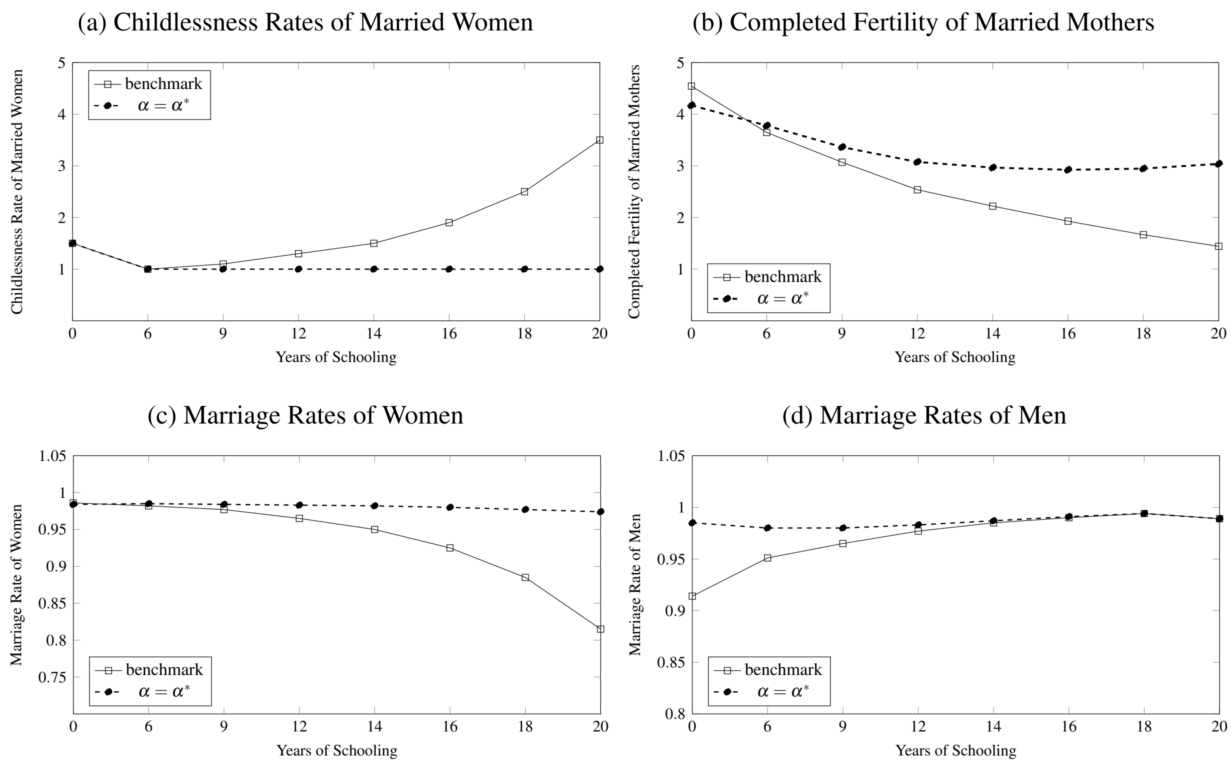


Figure 3: Counterfactual Analysis: Marriage Rates and Completed Fertility of Married Mothers without Social Norm on Unequal Gender Division of Childcare



Note: $\alpha = \alpha^*$ refers to the counterfactual simulation in the absence of the social norm of unequal gender division of childcare.

Figure 4: Decomposition of Childlessness for Single Women: Social Stigma vs. Opportunity Cost

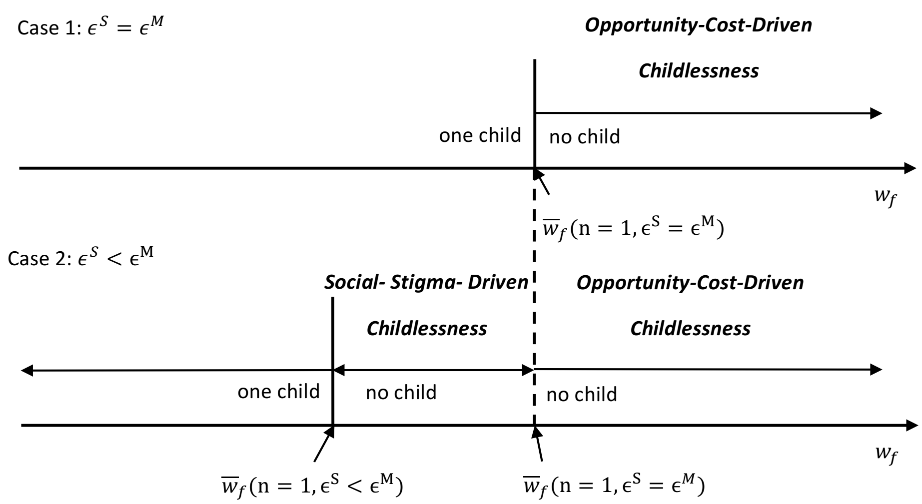
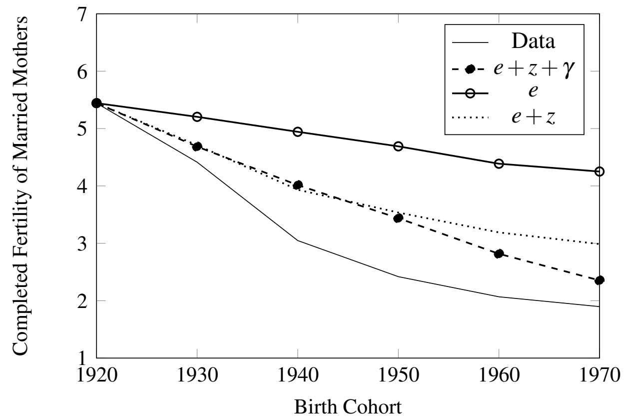
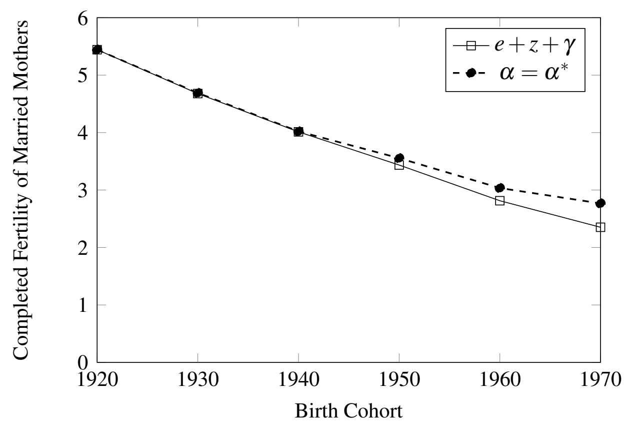


Figure 5: Historical Simulations: Completed Fertility of Mothers by Birth Cohorts, Married Only

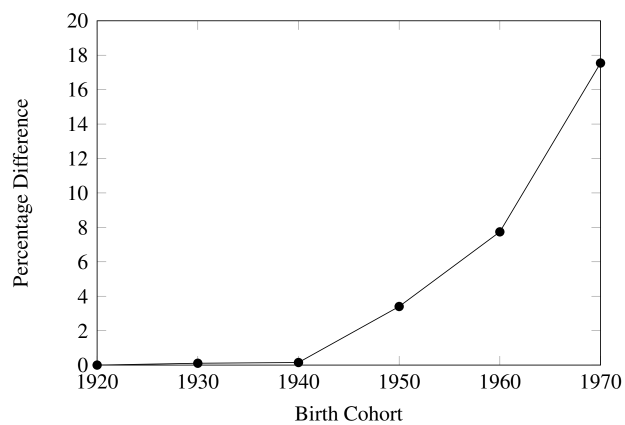
(a) Completed Fertility of Married Mothers



(b) Completed Fertility of Married Mothers



(c) Percentage Difference in Fertility between $(e+z+\gamma)$ and $\alpha=\alpha^*$



Note: e refers to the simulation with changes in the education (e) *only* for each cohort. $e+z$ refers to the case with changes in education (e) and TFP (z). $e+z+\gamma$ refers to the case with all three changes. $\alpha=\alpha^*$ refers to the simulation when α' is replaced with α^* (i.e., no social norm of unequal gender division of childcare.)

Figure 6: Gender Wage Gap, Optimal Division of Childcare (α^*), and Social Norm Costs

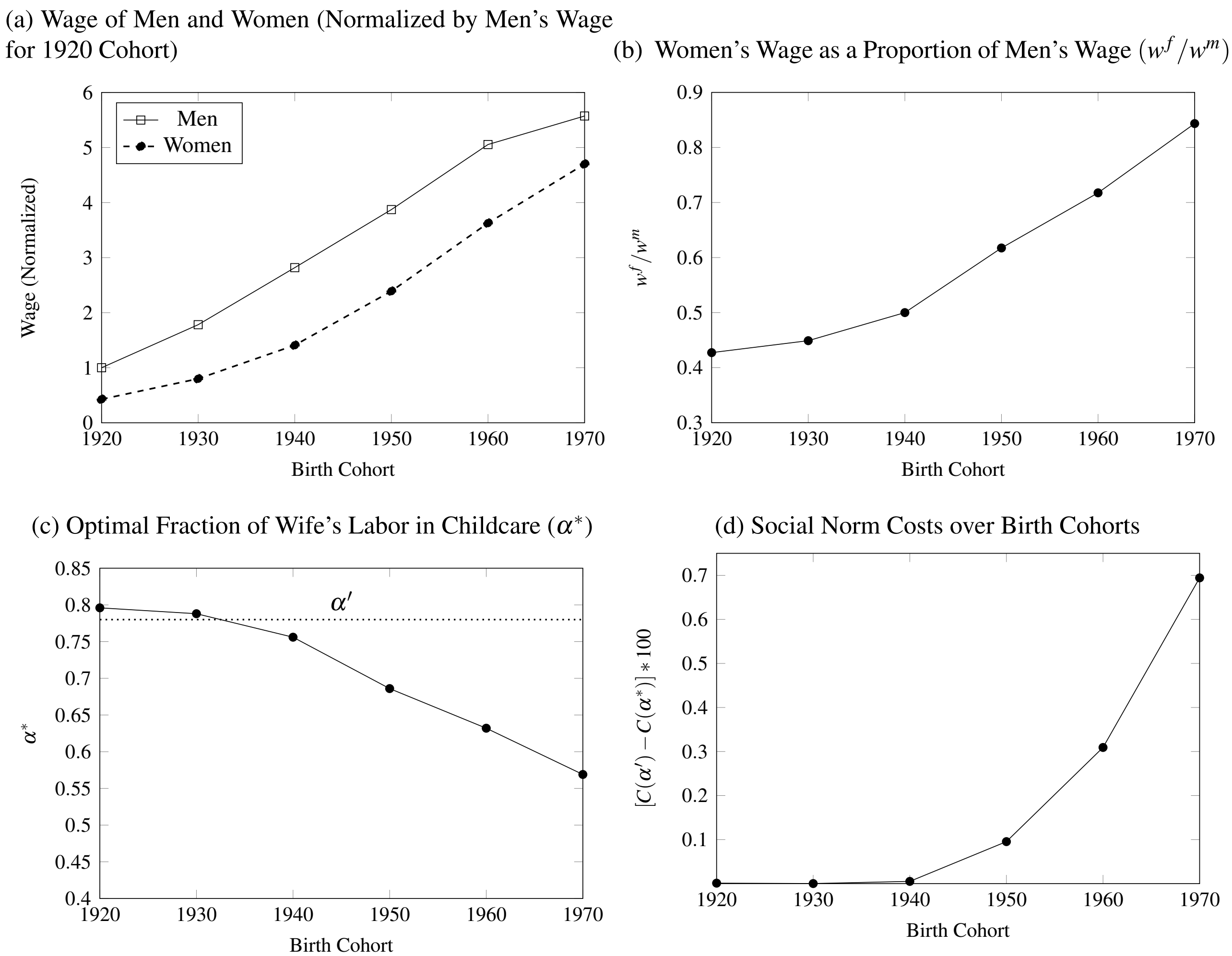
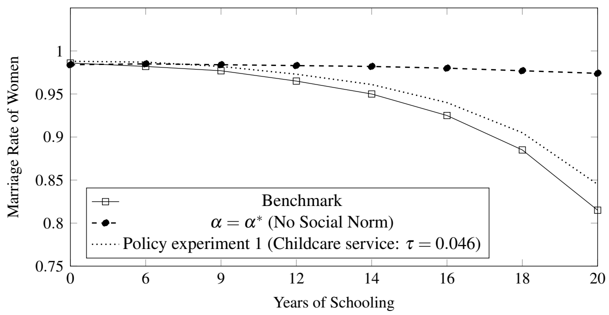
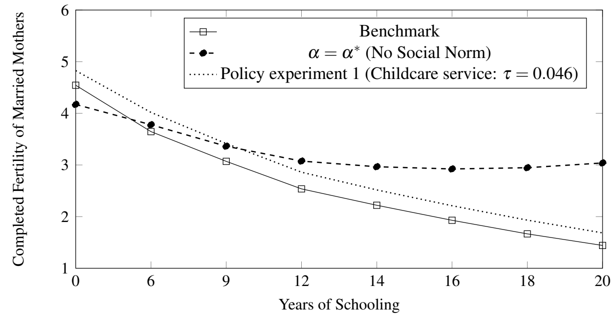


Figure 7: Policy Experiments

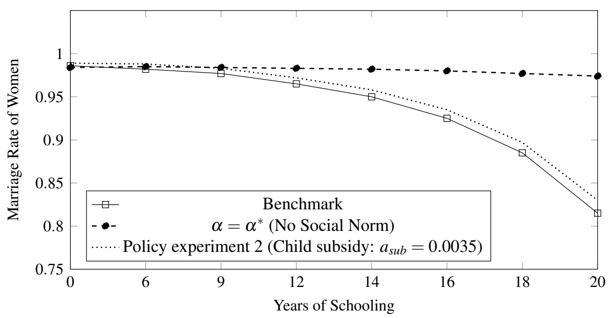
(a) Policy 1: Marriage Rates of Women



(b) Policy 1: Completed Fertility of Married Mothers



(c) Policy 2: Marriage Rates of Women



(d) Policy 2: Completed Fertility of Married Mothers

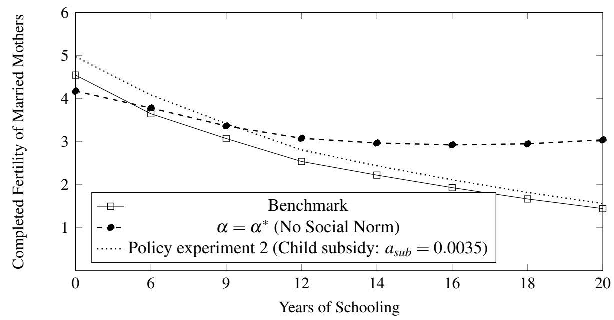


Table 1: Marriage and Fertility Rates across Countries/Regions

Countries/regions	TFR	Rank	Marriage Rate		Childlessness Rate		GDP per capita
		/#224	Men	Women	Married	Single	(USD)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
East Asian							
China	1.60	182	0.900	0.922	0.007	0.983	8,123
Japan	1.41	209	0.840	0.853	0.034	0.984	38,972
South Korea	1.26	220	0.920	0.861	0.016	0.989	27,539
Hong Kong	1.19	221	0.908	0.898	0.026	0.951	43,741
Taiwan	1.13	222	0.873	0.839	0.019	0.979	24,577
Macau	0.95	223	0.925	0.845	N.A.	N.A.	74,017
Singapore	0.83	224	0.859	0.789	0.042	0.985	52,963
Average	1.20		0.890	0.858	0.024	0.979	38,562
Western							
Canada	1.60	183	0.662	0.650	0.093	0.262	42,348
US	1.87	143	0.694	0.654	0.118	0.389	57,638
UK	1.88	142	0.684	0.681	0.108	0.433	40,412
Average	1.78		0.680	0.662	0.105	0.361	46,799
Developing							
Uruguay	1.80	150	0.686	0.649	0.060	0.670	15,221
Argentina	2.26	93	0.705	0.662	0.070	0.740	12,440
Cameroon	4.64	21	0.887	0.727	0.170	0.220	1,375
Tanzania	4.77	18	0.814	0.686	0.040	0.200	878
Average	3.37		0.773	0.681	0.085	0.458	7,479

Note. Columns (1) and (2) show the total fertility rate (TFR) and its rank among 224 countries and territories. The TRF is the average number of children that would be born per woman if all women were to live to the end of their childbearing years and give birth to children according to a given fertility rate at each age. The data are from the World Factbook 2016 by the Central Intelligence Agency. Columns (3) and (4) show marriage rates of men and women, respectively. The marriage rate is defined as the share of the married out of the total population aged 45-49. The data are from the World Marriage Data 2012 by the UNDP except for Taiwan. We use the 2000 census to calculate the marriage rate of Taiwan. The reference year for each country is as follows: China (2000), Japan (1995), South Korea (2000), Hong Kong (1991), Macau (2001), Singapore (2000), France (1999), US (2000), UK (2001), Canada (2001), Uruguay (1996), Argentina (1991), Tanzania (2002), and Cameroon (2004). If we consider a consensual union as a marriage, the marriage rate for men (women) is 92.7% (95.7%) in China, 72.2% (67.1%) in the US, 76.9% (75.5%) in the UK, 76.4% (74.3%) in Canada, 84.1% (77.4%) in Argentina, 80.4% (74.4%) in Uruguay, and 86.2% (72.2%) in Tanzania. Column (5) reports the childlessness rate for married women. The data sources are as follows: China (2000 census, women aged 40-50), Japan (12th Japanese National Fertility Survey 2002, married couples whose duration of marriage is between 15-19 years), South Korea (2000 census, women aged 40-75), Hong Kong (Demographic Trends in Hong Kong 1986-2016, the childlessness rate of the 1951 birth cohort women), Taiwan (2010 census, women aged 40-50), Singapore (2000 census, the childlessness rate among ever-married women aged 40-49), UK (CLS 1970 British Cohort, women aged 42), US (NLSY 79, women aged 50-57), Canada (1991 census, women aged 40-75), Argentina (Baudin et al., 2018), Uruguay (Baudin et al., 2018), Tanzania (Baudin et al., 2018), and Cameroon (Baudin et al., 2018). Column (6) reports the childlessness rate for single women. For China, South Korea, Taiwan, the US, the UK, and Canada, we use the same data as in column (5). Childlessness rates for single women for Hong Kong (1999 Hong Kong Council of Social Science), Japan (2000 OECD data), and Singapore (2010 census) are calculated based on the out-of-wedlock birth rates. Column (7) reports GDP per capita for each country. Data for GDP per capita are from the World Bank except for Taiwan. Taiwan's GDP per capita is from the IMF.

Table 2: Time Spent on Housework (Husband vs. Wife)

East Asian	China		Japan		South Korea		Hong Kong		Taiwan	
Year	1991	2012	2001	2011	2004	2014	2002	2013	1995	2004
Wife (hours/week) (a)	26.2	25.4	21.4	21.5	20.71	20.79	19.80	15.60	21.28	16.68
Husband (hours/week) (b)	5.3	5.0	4.51	4.20	3.90	4.69	6.60	4.80	5.38	3.73
(a)/(a+b)	0.83	0.84	0.83	0.84	0.84	0.82	0.75	0.76	0.80	0.82
Western and Developing	US		UK		Canada		Argentina		Tanzania	
Year	2003	2015	2001	2005	2005	2010	2005	2013	2006	2014
Wife (hours/week) (a)	19.30	18.71	21.50	18.00	22.80	23.30	24.11	34.10	21.20	23.80
Husband (hours/week) (b)	12.10	12.20	12.80	10.09	14.40	14.90	8.80	11.79	7.20	6.39
(a)/(a+b)	0.61	0.61	0.63	0.64	0.61	0.61	0.73	0.74	0.75	0.79

Note. Housework consists of unpaid domestic and care work. We calculate housework time based on the UN Sustainable Development Goal Indicator, except for China and Taiwan. For China, we use the China Health and Nutrition Survey 1987-2012. For Taiwan, we refer to Hu and Kamo (2007) and the 2004 Survey of Social Development.

Table 3: Fraction of Childcare Provided by a Wife by Education Levels

	Husband					
Wife	0	6	9	12	14	16+
0 (no schooling)	0.871	0.730	0.899	N.A.	N.A.	N.A.
6 (primary school)	0.824	0.832	0.884	0.884	N.A.	N.A.
9 (middle school)	N.A.	0.850	0.903	0.935	0.837	0.926
12 (high school)	N.A.	0.778	0.890	0.905	0.917	0.895
14 (some college)	N.A.	N.A.	N.A.	0.891	0.881	0.877
16 (four-year college and more)	N.A.	N.A.	N.A.	0.852	0.937	0.872

Note. The table shows the average fraction of childcare provided by a wife by education levels of a husband and a wife. Data are for married households with unmarried children from the 1999, 2004, and 2009 KTUS.

Table 4: Marriage Rates and Fertility from the 2000 South Korea Census

			Childlessness rate	Completed fertility of mothers	Marriage rate	
Education level	*e*	Observations	Married	Married	Women	Men
1. No school	0	15,501	0.0155	4.516	0.985	0.959
2. Primary school	6	60,322	0.0119	3.507	0.993	0.973
3. Middle school	9	52,015	0.0156	2.604	0.990	0.974
4. High school	12	85,074	0.0180	2.275	0.979	0.980
5. Some college	14	11,925	0.0218	2.160	0.958	0.986
6. 4-year college	16	27,426	0.0170	2.174	0.956	0.988
7. Master's	18	4,782	0.0268	2.051	0.883	0.986
8. PhD	20	1,618	0.0348	2.013	0.831	0.989
All		258,663	0.0156	2.899	0.983	0.979

Note. Completed fertility is the number of children of mothers aged 40-75, and the childlessness rate is the proportion of married women aged 40-75 without a child. The years of schooling that correspond to each education level are denoted as e. Data source is the two percent sample of the 2000 Population and Housing Census of South Korea.

Table 5: Model Parameters

Panel A: a priori information							
Description	Parameter	Value	Source	Comparison to Literature			
				Baudin *et al.* (2015)		Baudin *et al.* (2018)	
					Mean	Min	Max
Return to schooling	ρ	0.0764	2000 SLCTE	0.092	0.05	0.05	0.05
Gender wage gap	γ	0.770	2000 SLCTE	0.869	0.794	0.67	0.88
Fraction childcare provided by women	α'	0.780	1999 KTUS	0.524	0.754	0.506	0.974
Elasticity parameter	ψ	0.385	1999 KTUS	1.0	1.0	1.0	1.0
Ratio of good costs: singles vs. married	μ^S/μ^M	0.733	2000 HIE	1.0	1.0	1.0	1.0
Natural sterility parameter	$\chi_f = \chi_m$	0.005	-	0.0121	0.01	0.01	0.01
Panel B: Parameters estimated by SMM							
Description	Notation	Value	s.e.	Comparison to Literature			
				Baudin *et al.* (2015)		Baudin *et al.* (2018)	
					Mean	Min	Max
Mean of non-labor income	m_a	0.234	0.0044	0.435[a]	0.302	0.042	0.533
Standard deviation of non-labor income	σ_a	0.333	0.0108	0.247	0.111	0.034	0.220
Goods cost to support a household (married)	μ^M	0.343	0.0434	0.272	0.302	0.042	0.533
Minimum consumption level to procreate	$\hat{c}$	0.200	0.0212	0.399	0.342	0.099	0.521
Preference parameter	ν	7.646	0.0477	9.362	9.518	6.367	10.967
Time cost of being single (men)	δ_m	0.100	0.0118	0.256	0.141	-0.031	0.367
Time cost of being single (women)	δ_f	-0.034	0.0073	0.077	0.080	-0.051	0.272
Bargaining parameter	$\underline{\theta}$	0.232	0.0464	0.864	0.545	0.002	0.996
Productivity for home production (single)	A^S	1.916	0.0369	1.0	1.0	1.0	1.0
Variable cost of raising a child[b]	ϕ	0.524	0.0068	0.206	0.188	0.154	0.206
Social norm of stigma	ε^S	0.854	0.0154	1.0	1.0	1.0	1.0

Note. Panel A presents parameters estimated directly from the data. Panel B presents the parameters estimated from the SMM. For parameters estimated from the SMM, we compare our estimates to those from the literature. Parameters estimated in Baudin et al. (2015) are for the 1990 US sample, whereas parameters estimated from Baudin et al. (2018) are for 36 developing countries.

[a]: Because $m_a = 1.01$ in Baudin et al. (2015) is the average ratio of non-labor income to labor income (women's average wage), we compute the mean non-labor income for Baudin et al. (2015) by multiplying the average wage of the women by 1.01 .
[b]: The estimate of ϕ implies that the effective variable time costs of raising each child for single mothers and couples are 0.276 (=ϕ/A^S) and 0.151 (=$\phi(\zeta_1+\zeta_2)$, respectively. Comparable effective variable time costs are 0.206 for the US (Baudin et al, 2015) and 0.188, the mean estimate for the 36 developing countries (Baudin et al, 2018).

Table 6: Counterfactual Analyses: Childlessness Rates for Single Women and Completed Fertility of Single Mothers without the Social Stigma Attached to Out-of-Wedlock Births ($\varepsilon^S = \varepsilon^M = 1$)

Childlessness Rate of Single Women			Completed Fertility of Single Mothers	
Women's Education	Benchmark	$\varepsilon^S = \varepsilon^M = 1$	Benchmark	$\varepsilon^S = \varepsilon^M = 1$
	(1)	(2)	(3)	(4)
0	0.697	0.437	1.389	1.455
6	0.974	0.909	1.071	1.204
9	0.996	0.980	1.000	1.071
12	1.000	0.997	0.0	1.000
14	1.000	0.999	0.0	1.000
16	1.000	1.000	0.0	0.0
18	1.000	1.000	0.0	0.0
20	1.000	1.000	0.0	0.0
Average	0.982	0.954	1.290	1.324

Table 7: Marriage Rates and Fertility in South Korea, by Birth Cohorts

Cohort	Married women		Marriage Rate	
	Completed fertility	Childlessness rate	Women	Men
1920	5.443	0.0164	0.999	0.999
1930	4.414	0.0115	0.997	0.998
1940	3.057	0.0120	0.992	0.992
1950	2.290	0.0145	0.981	0.969
1960	2.048	0.0200	0.967	0.919
1970	1.882	0.0352	0.931	0.837

Note. Completed fertility is the number of children of mothers aged 40-75, and the childlessness rate is the proportion of women aged 40-75 without a child. The sample for each cohort is defined in Appendix C

Social Norms and Fertility

Appendix for Online Publication

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Appendix A Robustness Checks

In this section, we perform four robustness checks.

A.1 Social Norm of Unequal Division of Childcare within a Household

In the first robustness check, we set α' at a value different from that used in the paper, re-estimate the model by minimizing eq (39), and conduct the counterfactual analysis with the new estimates. The average α ($\equiv l_f/(l_f + l_m)$) obtained from the 1999 KTUS ranges from 0.78 to 0.87 for different types of households. In the paper, we set $\alpha' = 0.78$, which is the average fraction of childcare provided by a wife for dual-earner households with unmarried children, for which a wife's age ranges from 20 to 29. In the robustness check, we set $\alpha' = 0.87$, which is the average fraction of childcare provided by a wife for households with unmarried children. The first column of Table A1 shows the estimation result. A larger value of α' implies more unequal gender division of childcare within a household, which increases the social norm cost. Completed fertility of married mothers would increase by 25% without the social norm when $\alpha' = 0.87$. This finding is consistent with the second property of the social norm cost in Section 3.3.

A.2 Elasticity Parameter in Home Production Function

The elasticity parameter in the home production function (ψ) is estimated to be 0.385, which implies (1) that l_f and l_m are imperfect substitutes and (2) that the elasticity of substitution between l_f and l_m is 1.62. In the second robustness check, we set $\psi = 1/3$ ($\psi = 1/2$), which implies that the elasticity is 1.5 (2). Columns (2) and (3) show the results. With a higher (lower) value of ψ, the estimates for the variable cost of raising a child ϕ and for the productivity parameter for the home production of single mothers A^S decrease (increase). When $\psi = 1/3$ ($\psi = 1/2$), completed fertility of married mothers would increase by 11.66% (7.23%) without the social norm. The result is consistent with the first property of the social norm cost that a higher elasticity of substitution associated with a larger value of ψ, given that l_f and l_m are imperfect substitutes, lowers the cost of the social norm.

A.3 Household-Maintenance-Goods Cost

We assume that the goods cost for maintaining a married household is different from that for a single household. A larger value of μ^S/μ^M implies greater economy of scale in marriage, which increases gains from marriage in our model. In the benchmark estimation, we use median expenditures on housing, clothes, and food of married and single households in the 2000 Household Income and Expenditure to obtain $\mu^S/\mu^M = 0.733$.

In the third robustness check, we first assume greater economy of scale by setting $\mu^S/\mu^M = 0.836$, which is based on the average expenditures on these goods instead of the median expenditures. Column (4) shows the result. In this case, the time cost of being single for men (δ_m) decreases from 0.100 to 0.081, lowering men's incentives to get married.

We then assume no economy of scale in marriage by setting $\mu^S/\mu^M = 0.5$. Column (5) reports the result. In this case, marriage would be less attractive for both men and women. The time costs of being single for both men and women increase, thus increasing their incentives to get married. Moreover, the percentage of poverty-driven-childlessness increases from 3.5% in the benchmark simulation to 16% in the robustness check, because the minimum consumption required to procreate $\hat{c}$ increases from 0.200 to 0.217.

A.4 Assortative Matching

In the benchmark model, we assume random matching in the marriage market. In the fourth robustness check, we allow assortative matching in the marriage market with respect to education levels following Fernández-Villaverde et al. (2014): A fraction λ of the female population draws a possible match from her education category, whereas 1-λ draws from the total population. We try two different values of λ's: 20% and 50% in the robustness check. The last two columns in Table A1 report the results.

When assortative matching exists in the marriage market, lowly educated women are more likely to be matched with lowly educated men. In this case, poverty-driven childlessness rates for lowly educated married women increase. We find that different degrees of assortative matching do not significantly change the effects of the two social norms on both margins of fertility. Hence, our main quantitative results remain robust whether we assume random matching or assortative matching in the marriage market.

In sum, our results on the effects of the two social norms remain robust in a series of robustness checks, except for the case with a larger value of $\alpha' \equiv l_f/(l_f + l_m)$ (i.e., more unequal gender roles in childcare).

Because we use the most conservative value of 0.78, our quantitative results for the effect of the social norm of the unequal gender role in Section 5.1 should be regarded as the lower bound of the effects the social norm has on fertility and marriage in South Korea.

Table A1: Robustness of the Model

		α	ψ		μ^S/μ^M		marriage matching	
benchmark		0.780	0.385		0.733		random	
Robustness checks		0.870	0.333	0.500	0.500	0.836	assortative 20%	assortative 50%
structural parameters	benchmark	(1)	(2)	(3)	(4)	(5)	(6)	(7)
m_a	0.234	0.226	0.234	0.234	0.232	0.236	0.220	0.216
σ_a	0.333	0.335	0.334	0.334	0.301	0.278	0.396	0.385
ν	7.646	7.645	7.651	7.651	7.622	7.643	7.670	7.686
$\hat{c}$	0.200	0.178	0.199	0.199	0.217	0.210	0.158	0.134
μ^M	0.343	0.386	0.343	0.343	0.343	0.343	0.304	0.322
δ_m	0.100	0.078	0.100	0.100	0.141	0.081	0.093	0.089
δ_f	-0.034	-0.038	-0.034	-0.034	0.081	-0.035	-0.043	-0.025
$\underline{\theta}$	0.232	0.189	0.233	0.233	0.240	0.231	0.078	0.064
A^S	1.916	1.523	2.513	1.295	2.154	1.887	1.842	1.902
ϕ	0.524	0.418	0.687	0.354	0.525	0.523	0.522	0.522
ε^S	0.854	0.860	0.853	0.853	0.852	0.845	0.853	0.863
objective function $f(p)$	0.513	0.828	0.513	0.513	0.978	1.411	0.571	0.662
Effect of removing the social norm on the completed fertility of married mothers (% increase)	10.12	24.93	11.67	7.23	9.51	10.79	10.71	11.78
Decomposition of the childlessness (single women)								
poverty-driven (%)	3.50	4.82	3.50	3.40	16.00	1.98	1.37	1.70
social-stigma-driven (%)	2.25	1.99	2.35	2.40	1.96	2.28	2.14	1.93
opportunity-cost-driven (%)	91.70	90.70	91.60	91.70	79.50	93.20	93.94	93.38
natural sterility (%)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
total (%)	98.20	98.20	98.20	98.20	98.20	98.20	98.20	98.20

Note. The table shows how the estimates for structural parameters, the model fit, the effect of removing the social norm on the completed fertility of married mothers, and the decomposition of sources of childlessness for single women change when we change the values of the parameters $(\alpha, \psi, \mu^S/\mu^M)$ that we estimate directly from the data, and when we assume assortative marriage matching by education level.

Appendix B Technical Details of The Decomposition of Childlessness

Our model contains four types of childlessness: natural, poverty-driven, social-stigma-driven, and opportunity-cost-driven childlessness. In this section, we show how a woman's childlessness depends on her wage rate w_f given her non-labor income a_f.

Natural sterility is determined exogenously regardless of an individual's characteristics. The probability of being naturally sterile is uniformly distributed across education levels; for each w_f, a fraction χ_f of single women are childless because of natural sterility. A woman who is not naturally sterile can remain childless for the following three reasons.

A woman remains childless because of poverty if her consumption is lower than the minimum amount of consumption $\hat{c}$ required to procreate. **Poverty-driven childlessness** is defined as follows:

$$c_f < \hat{c} \Rightarrow n = 0. \tag{1}$$

The budget constraint for a single woman is given by

$$b_f\left(c_f^S, n\right) = c_f^S + \frac{\phi}{A^S} w_f n - (1-\delta_f) w_f - a_f + \mu^S \leq 0.$$

Given a_f, we can find a cutoff value of w_f, below which a single woman is childless because of poverty. Let $\overline{W}_f^{\,P}$ be the wage rate such that $c_f^S = \hat{c}$ with $n = 1$. Then we have

$$\overline{W}_f^{\,P} = \frac{\hat{c} - a_f + \mu^S}{1 - \delta_f - \frac{\phi}{A^S}}.$$

A single woman with a_f is childless because of poverty iff her wage rate is lower than the cutoff of $\overline{W}_f^{\,P}$:

$$w_f < \overline{W}_f^{\,P} = \frac{\hat{c} - a_f + \mu^S}{1 - \delta_f - \frac{\phi}{A^S}}. \tag{2}$$

Next, a single woman with w_f and a_f can choose to remain childless because of the social stigma. **Social-**

stigma-driven childlessness for a single woman is defined as follows:

$$\begin{aligned} V_f^S(n \geq 1|\varepsilon^S = \varepsilon^M, w_f, a_f) &> V_f^S(n = 0|\varepsilon^S = \varepsilon^M, w_f, a_f), && (3) \\ V_f^S(n = 0|\varepsilon^S < \varepsilon^M, w_f, a_f) &\geq V_f^S(n \geq 1|\varepsilon^S < \varepsilon^M, w_f, a_f), && (4) \\ c_f^S &\geq \hat{c}. && (5) \end{aligned}$$

That is, if a single woman who would have at least one child in the absence of the social stigma chooses not to have any children in the presence of the social stigma, we call this type of childlessness social-stigma-driven childlessness.

Finally, if a single woman with w_f and a_f chooses not to have children because of the high opportunity cost of childrearing even without the social stigma, we call this type of childlessness **Opportunity-cost-driven childlessness**, which is defined as follows:

$$\begin{aligned} V_f^S(n \geq 1|\varepsilon^S = \varepsilon^M|w_f, a_f) &\leq V_f^S(n = 0|\varepsilon^S = \varepsilon^M|w_f, a_f), && (6) \\ c_f^S &\geq \hat{c}. && (7) \end{aligned}$$

Let $\overline{W}_f(n = k|\varepsilon^S)$ be the cutoff wage rate that satisfies the following condition:

$$V_f^S(n = k|\varepsilon^S) = V_f^S(n = 0|\varepsilon^S). \tag{8}$$

Then $\overline{W}_f(n = k|\varepsilon^S)$ is given by:

$$\overline{W}_f(n = k|\varepsilon^S) = \frac{a_f - \mu^S}{\frac{\phi}{A^S}\left(\frac{\nu}{\varepsilon^S} + 2k - 1\right) - (1 - \delta_f)}.$$

For a single woman to be childless because of high opportunity costs, her wage rate must be high enough that it is optimal for her not to have a child, even in the absence of the social stigma. Thus, for a given a_f, a single woman is childless because of high opportunity costs iff

$$w_f > \overline{W}_f(n = 1|\varepsilon^S = \varepsilon^M).$$

On the other hand, a single woman is childless because of the social stigma iff

$$w_f \leq \overline{W}_f(n=1, \varepsilon^S = \varepsilon^M) \quad \text{and}$$

and

$$w_f > \overline{W}_f(n=1, \varepsilon^S < \varepsilon^M).$$

Note that $\overline{W}_f(n=1|\varepsilon^S < \varepsilon^M)$ is always less than $\overline{W}_f(n=1|\varepsilon^S = \varepsilon^M)$. Therefore, as long as $\varepsilon^S < \varepsilon^M$, we have a non-degenerate range of w_f, for which stigma-driven childlessness exists.

Figure B1 graphically illustrates how a single woman's childlessness depends on her wage (w_f), given that her non-labor income is high enough so that $c \geq \hat{c}$ (i.e., no poverty-driven childlessness). Table B1 shows the decomposition of sources of childlessness for single women. Column (1) is the decomposition result based on the benchmark simulation. Column (2) is the decomposition result from Baudin et al. (2015).

Figure B1: Social-Stigma-Driven Childlessness

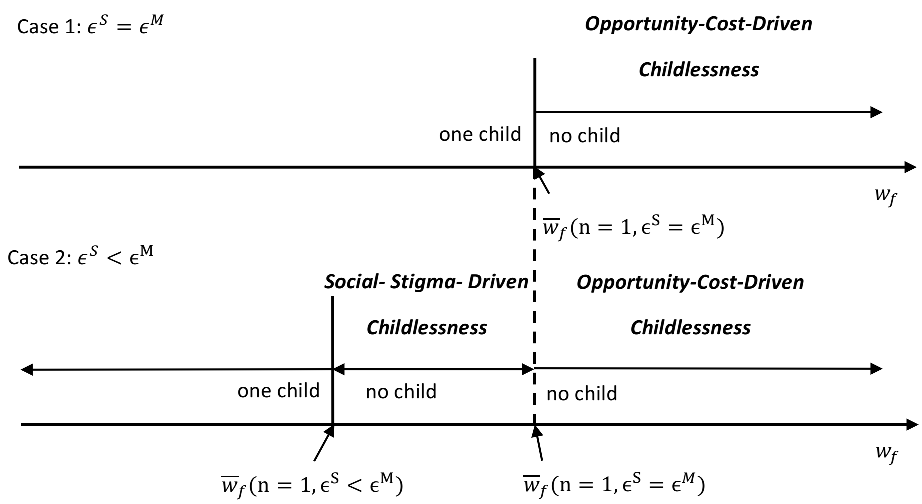


Table B1: Decomposition of Sources of Childlessness for Single Women

	South Korea (1)	US (2)
Poverty Driven (%)	3.50	29.71
Stigma Driven (%)	2.25	N.A.
Opportunity Driven (%)	91.70	46.69
Natural Sterility (%)	0.74	2.30
Total (%)	98.20	78.70

Note. The table shows the decomposition of sources of childlessness for single women. Column (1) is the decomposition result based on the benchmark simulation. Column (2) is the decomposition result from Baudin et al. (2015).

Appendix C Data and Sample Construction

Table C1 lists the datasets used in our estimation. The main dataset for the SMM estimation is the 2% sample of the 2000 population and housing census of South Korea, which contains 881,591 individuals. When we restrict our sample to individuals who are either household heads or their spouses, the sample size reduces to 623,031. To calculate completed fertility, we further restrict the sample to "ever-married, spouse present" and "never-married" individuals aged 40-75, similar to Baudin et al. (2015); our final sample contains 258,667 individuals. The census provides information on sex, marital status, the number of children of married women, and educational attainment of household members. The educational attainment is the highest grade attended which is divided into eight categories: no schooling, primary school, middle school, high school, two-year college, four-year college, master's degree, and doctoral degree, which correspond to 0, 6, 9, 12, 14, 16, 18, and 20 years of schooling, respectively. Table 3 summarizes marriage rates of men and women, completed fertility of married mothers, and childlessness rates of married women by educational attainment in our sample. Because the 2000 census survey collects fertility information only for individuals ever married (married, widowed, or divorced), fertility information for singles is not available. To obtain the average fertility of single women, we use the summary statistics for a population sample from the 2015 census.

The four sets of censuses (1985, 1990, 2000, and 2010) of South Korea are used for the historical simulation of demographic transition in Section 7.[1] Table C2 summarizes how we construct cohort-specific data. The earliest cohort in our historical simulation is the 1920 birth cohort. We do not include previous birth cohorts in the analysis, because the Korean War could have had nontrivial impacts on marital status and completed fertility for those who were born before 1920. Table C3 presents the distribution of educational attainments and marriage rates by education levels across different cohorts are used in the historical simulation. Figure C1 plots the average educational attainment of men and women by birth cohorts in South Korea and the US.

Second, to document the intra-household division of childcare between a husband and a wife, we use the 1999 Korean Time Use Survey (KTUS). The 1999 KTUS collects detailed time-use information from 42,973 individuals in 17,000 households. We restrict our sample to married individuals who are household

[1] We do not use the 1975, 1980, and 1995 census data in the historical simulation, because they do not have fertility information for both married and single women. We also do not use the two percent sample of the 2015 census, because of missing information on childlessness by education levels.

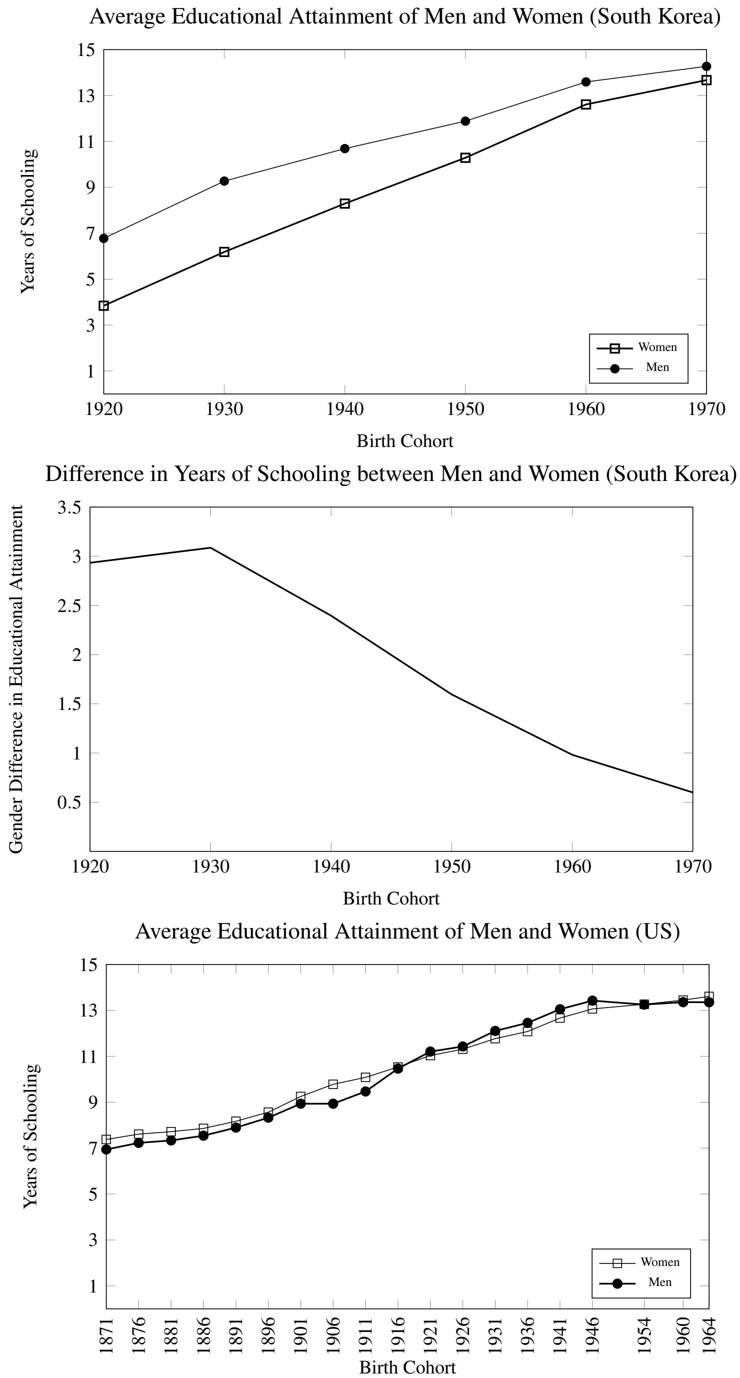
heads or spouses of household heads in the survey. Individuals in the survey kept a time diary over two days regarding 125 different housework activities. Routine housework includes 21 activities, such as meal preparation, dishwashing, washing clothes, cleaning, and house maintenance. Childcare includes seven activities, such as reading books to children, caring for preschool children, bathing children, and helping with homework. Table C4 presents average weekly time spent on housework or childcare by a husband and wife in different types of households.

Third, to estimate the gender wage gap and returns to schooling, we use annual Surveys on Labor Conditions by Type of Employment (SLCTE) conducted on full-time workers in South Korea from 1980 to 2013. The surveys contain information on the employee's demographic characteristics (gender, age, education, and work type), working hours, and monthly income for workers in 32,000 establishments for the sample period. To estimate the Mincer equation, we run an OLS regression of the log hourly wage on sex, years of schooling, age, and age squared. To estimate the gender wage gap coefficient (γ) used for the model estimation in Section 4 , we use the SLCTE 2000. For the cohort-specific Mincer estimation for the historical simulation in Section 7, we pool data from 1980-2013 SLCTE and construct cohorts by birth year and normalize the wages using the CPI of South Korea. Table C5 summarizes estimation results for the cohort-specific Mincer coefficients.

Fourth, we use the 2000 Household Income and Expenditure (HIE) survey in South Korea to estimate the ratio of the goods cost for maintaining single households to that for married households (μ^S/μ^M). The 2000 HIE contains information on marital status, age, education, employment status, monthly income, and monthly expenditures of 6,412 households. The expenditure is divided into 418 categories following the Classification of Individual Consumption by Purpose. To compute μ^S and μ^M, we use the median value of the sum of household expenditures on food, clothing, and housing. Table C6 summarizes goods cost of households by marital status.

Finally, we use the 2015 Single Parent Family Status Survey (SPFS) to get information on the average number of children and the maximum number of children of single mothers. The SPFS 2015 collects information about 2,552 single-headed households on the family structure of a household, childcare arrangements, and employment status.

Figure C1: Average Educational Attainment of Men and Women by Birth Cohorts: South Korea vs. US



The first graph plots the historical trend in average years of schooling of men and women in South Korea. The second graph plots differences in average years of schooling between men and women in South Korea. The third graph plots the historical trend in average years of schooling of men and women in the US from Baudin et al. (2015). Data sources are the 1985, 1990, 2000, 2010 censuses of South Korea.

Table C1: Data Used for the SMM Estimation

Data Source	Year	Moment
Population and Housing Census (census)	2000	Marriage rate, fertility, education share
Korean Time Use Survey (KTUS)	1999	Fraction of childcare provided by a wife
Labor Conditions by Type of Employment (SLCTE)	2000	Gender wage gap (γ), returns to schooling ρ
Household Income and Expenditure (HIE)	2000	Goods cost for maintaining single households relative to that for married households (μ^S/μ^M)
Single Parent Family Status Survey (SPFS)	2015	Number of children of single mothers
		Maximum number of children for single mothers
Population and Housing Census (administrative data)	2015	Childlessness rate of single women

Table C2: Sample Construction for Each Birth Cohort

Cohort	Birth Years	Age	Census	Sample	Observations
1920	1921-1930	55-64	1985	2%	33,767
1930	1931-1940	50-59	1990	2%	60,237
1940	1941-1950	50-59	2000	2%	73,978
1950	1951-1960	50-59	2010	2%	110,968
1960	1961-1970	40-49	2010	2%	132,613
1970	1971-1980	35-39	2010	2%	61,601

Note. The table shows sample construction for 1920-1970 birth cohorts from the 1985, 1990, 2000, and 2010 censuses of South Korea.

Table C3: Education Share (%) by Birth Cohorts

Cohort	Sex	Years of Schooling								Sum (%)
		0	6	9	12	14	16	18	20	
1920	Women	45.99	41.39	6.56	4.86	0.29	0.92	0	0	100
	Men	21.50	42.25	15.08	11.66	1.75	7.75	0	0	100
1930	Women	19.48	52.00	15.21	10.70	2.66	2.35	0	0	100
	Men	5.67	33.88	19.89	25.70	0.61	14.26	0	0	100
1940	Women	6.98	40.32	24.03	21.07	2.24	4.87	0.40	0.08	100
	Men	2.17	20.35	21.98	34.93	4.06	13.06	2.58	0.88	100
1950	Women	1.59	21.71	24.83	37.54	4.49	8.03	1.44	0.38	100
	Men	0.87	11.22	17.85	40.52	7.33	15.88	4.50	1.82	100
1960	Women	0.38	3.91	9.84	52.70	11.21	18.45	2.87	0.66	100
	Men	0.26	2.10	5.55	42.26	13.97	27.77	5.97	2.12	100
1970	Women	0.15	0.41	1.88	45.46	21.53	25.46	4.36	0.76	100
	Men	0.09	0.29	1.52	35.35	20.27	32.48	7.94	2.05	100

Note. The table shows the percentage of educational attainment of men (women) for each birth cohort. The highest education level recorded for the old cohorts (the 1920 and 1930 birth cohorts) is the four-year college education. Data sources are the 1985, 1990, 2000, and 2010 censuses of South Korea, and Table C2 shows the sample construction.

Table C4: Average Weekly Time Spent on Housework or Childcare by a Husband and Wife

Panel A: Married couples living with unmarried children				
Task	Wife	Husband	Total	Wife's fraction
Childcare	2.710	0.403	3.113	0.870
Routine housework	28.272	2.666	30.937	0.914
All housework	30.982	3.069	34.051	0.910
Panel B: Dual-earner households				
Task	Wife	Husband	Total	Wife's fraction
Childcare	3.083	0.719	3.802	0.811
Routine housework	18.716	2.378	21.095	0.887
All housework	21.800	3.097	24.897	0.876
Panel C: Dual-earner households (Different Age Groups)				
Child care by age groups	Wife	Husband	Total	Wife's fraction
Age 20-29	7.327	2.060	9.387	0.781
Age 30-39	5.822	1.137	6.959	0.837
Age 40-49	1.281	0.275	1.556	0.823
Age 20-59	3.289	0.747	4.035	0.815

Note. The table shows average weekly hours spent on routine housework and childcare. All housework consists of routine housework, childcare, and caring for other family members. Panel A and B are for married couples in which a wife's age ranges from 20 to 59. The data source is the 1999 KTUS.

Table C5: Mincer Earnings Regression by Birth Cohort

Cohort	Female	Years of Schooling	Age	Age Squared	Constant
1920	-0.421	0.127	0.153	-0.00095	0.478
1930	-0.478	0.104	0.266	-0.00217	-1.308
1940	-0.473	0.093	0.255	-0.00230	0.125
1950	-0.351	0.079	0.207	-0.00194	2.055
1960	-0.253	0.079	0.185	-0.00188	3.055
1970	-0.126	0.072	0.125	-0.00119	4.593

Note. The table reports estimates for the Mincer earnings regression for each birth cohort. We run an OLS regression of the logged hourly wage on sex, years of schooling, age, and age squared for each birth cohort. We normalize the wage by using the CPI. The data source is the annual SLCTE from 1980 to 2013.

Table C6: Goods Cost of Households by Marital Status

Average Monthly Consumption by Households						
Consumption	(1) Total	(2) Food	(3) Clothing	(4) Housing	(5) (2)+(3)+(4)	Ratio (I)/(III)
Single or Divorced (I)	1,227,203	197,246	79,377	159,816	436,439	**0.836**
Married and Separated (II)	1,504,972	218,363	117,581	136,813	472,757	
Married and Live Together (III)	1,520,950	262,310	107,256	152,599	522,165	

Median Monthly Consumption by Households						
Consumption	(1) Total	(2) Food	(3) Clothing	(4) Housing	(5) (2)+(3)+(4)	
Single or Divorced	956,589	179,307	54,935	99,017	333,258	**0.733**
Married and Separated	1,289,522	219,186	86,253	129,774	435,213	
Married and Live Together	1,381,243	250,807	81,958	121,804	454,569	

Note. The table shows average (median) monthly household expenditures by households in South Korea on food, clothing, and housing. The unit is the Korean Won. The data source is the HIE 2000.

Appendix D Identification

In this section, we illustrate how model parameters are identified in the SMM estimation. For each structural parameter, we change this parameter and keep others constant at their estimated values, and show how this change affects the simulated moments of the model.

D.1 μ^M and m_a

Figure D1 shows the response of the simulated moments to a 20% increase in the goods cost of maintaining a married household (μ^M) and a 20% decrease in the mean of non-labor income (m_a). Both parameters affect available income for household consumption. The increase in μ^M and the decrease in m_a have negative effects on both margins of fertility through the negative income effect. However, we can separately identify μ^M and m_a because of their different effects on marriage rates of women with different levels of education. While the increase in μ^M raises marriage rates of women at all education levels, the decrease in m_a raises marriage rates of the lowly educated but lowers marriage rates of the highly educated.

Because $\mu^S = 0.773\mu^M$, the goods cost per person in a single household is greater than the goods cost per person in a married household. Due to this economy of scale in marriage, a larger μ^M makes being single less attractive, thus raising marriage rates of women at all education levels. By contrast, smaller m_a raises the marriage rates of lowly educated women but lowers the marriage rates of highly educated women. The lowly educated women get more dependent on their husbands' income when m_a becomes smaller. Thus, marriage becomes more attractive for them. On the other hand, when m_a becomes smaller, the highly educated women have less incentives to have children, because the relative importance of the opportunity cost of childcare increases. Thus, they are less attractive in the marriage market.

D.2 ν and ϕ

Figure D2 shows the response of simulated moments to a 10% increase in the preference parameter that determines the utility from having no children (ν) and a 10% increase in the variable cost of each child (ϕ). Both the increase in ν and the increase in ϕ lower the marriage rates of women and raise the childlessness rates of married women, especially for the highly educated. However, ν and ϕ have different effects on completed fertility of single mothers: Higher ϕ reduces completed fertility of single mothers, whereas higher ν raises it. The former is due to a higher variable cost of childcare (higher ϕ). The latter is due to a higher utility from having no children (higher ν), which changes the composition of single mothers: Now only single women with high non-labor income have children, but they have almost the same number of children as before. In sum, our simulations show that higher ϕ reduces the average fertility and maximum fertility of single mothers, whereas higher ν raises the average fertility of single mothers.

D.3 $\underline{\theta}$, δ_m, and δ_f

Figures D4 and D3 show the response of simulated moments to an increase in the bargaining parameter ($\underline{\theta}$) from 0.232 to 0.864[2], an increase of δ_f by 0.1, and a decrease of δ_m by 0.1. All three parameters change marriage rates, but their effects differ among women with different levels of education. Furthermore, their effects on childlessness rates differ as well: The increase in $\underline{\theta}$ lowers childlessness rates of married women at all education levels; the decrease in δ_m has no effect on childlessness rates; and the increase in δ_f raises childlessness rates of highly educated married women.

The increase in the bargaining parameter $\underline{\theta}$ has non-monotonic effects on marriage rates of women: It lowers marriage rates of women with low and high education, because the increase in $\underline{\theta}$ raises the bargaining power of lowly educated women but decreases that of highly educated women. As a result, marriage offers from lowly educated women are more likely to be rejected, but highly educated women are more likely to reject men's offers. Then $\underline{\theta}$ is identified from the concavity of the relationship between marriage and education. Different effects of $\underline{\theta}$, δ_f, and δ_m on the childlessness rates of married women and the marriage rates across different levels of education help to separately identify these three parameters.

D.4 $\hat{c}$ and σ_a

Figure D5 shows the response of simulated moments to a 20% increase in $\hat{c}$ and a 20% decrease in σ_a. Neither an increase in $\hat{c}$ nor a decrease in σ_a has any significant effect on the completed fertility of married mothers. However, they have different effects on the marriage rates and childlessness rates of lowly educated married women. Therefore, these two parameters can be separately identified. Because $c_f < \hat{c}$ binds only for very poor households, an increase in $\hat{c}$ has negligible effects on marriage rates, except for women with no schooling. Moreover, an increase in $\hat{c}$ raises childlessness rates of lowly educated married women due to

[2] 0.864 is the estimate of $\underline{\theta}$ for the US (Baudin et al. (2015)).

poverty-driven childlessness. Thus, $\hat{c}$ is identified from the decreasing part of the U-shaped childlessness rate of married women in education levels. On the other hand, because non-labor income follows a log-normal distribution, the decrease in σ_a lowers the mean non-labor income of individuals. In this case, marriage becomes more attractive due to its economy of scale. Thus, marriage rates of women at all education levels increase.

D.5 A^S and ε^S

Figure D6 shows the response of simulated moments to a 20% increase in the productivity level of the home production function of single households A^S and the removal of the social stigma attached to out-of-wedlock births (i.e., $\varepsilon^S = \varepsilon^M = 1$). A 20% increase in A^S reduces childlessness rates of single women. Likewise, removing the social norm by assuming $\varepsilon^S = 1$ reduces childlessness rates of single women. However, the increase in A^S raises both the average and maximum fertility of single women (eq (20)). By contrast, removing the social stigma attached to out-of-wedlock births increases the average fertility of single women, but has no effect on the maximum number of children. The maximum number of children as the moment condition in our estimation thus helps to separately identify A^S and ε^S.

Figure D1: Identification of μ^M and m_a

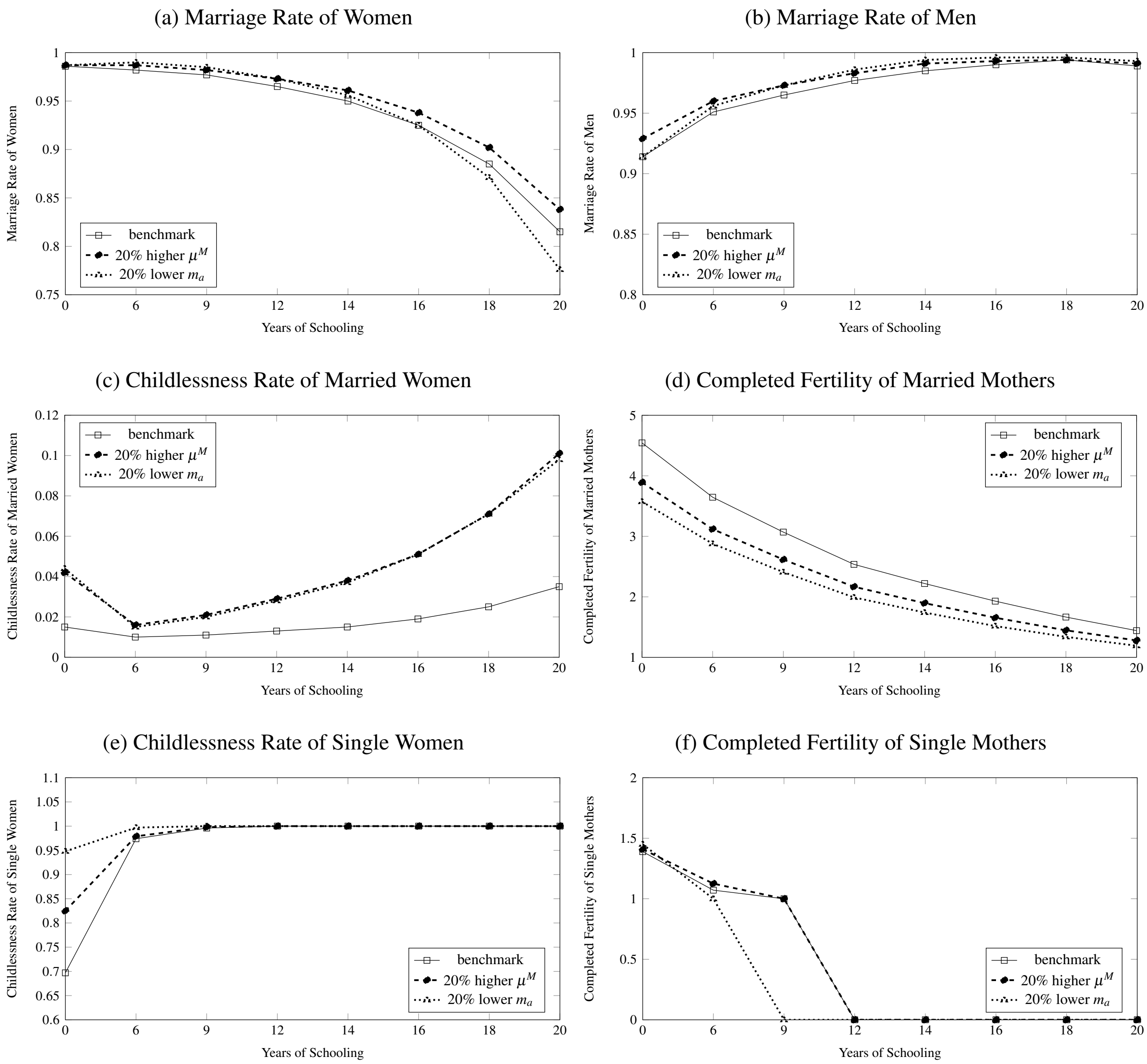


Figure D2: Identification of ν and ϕ

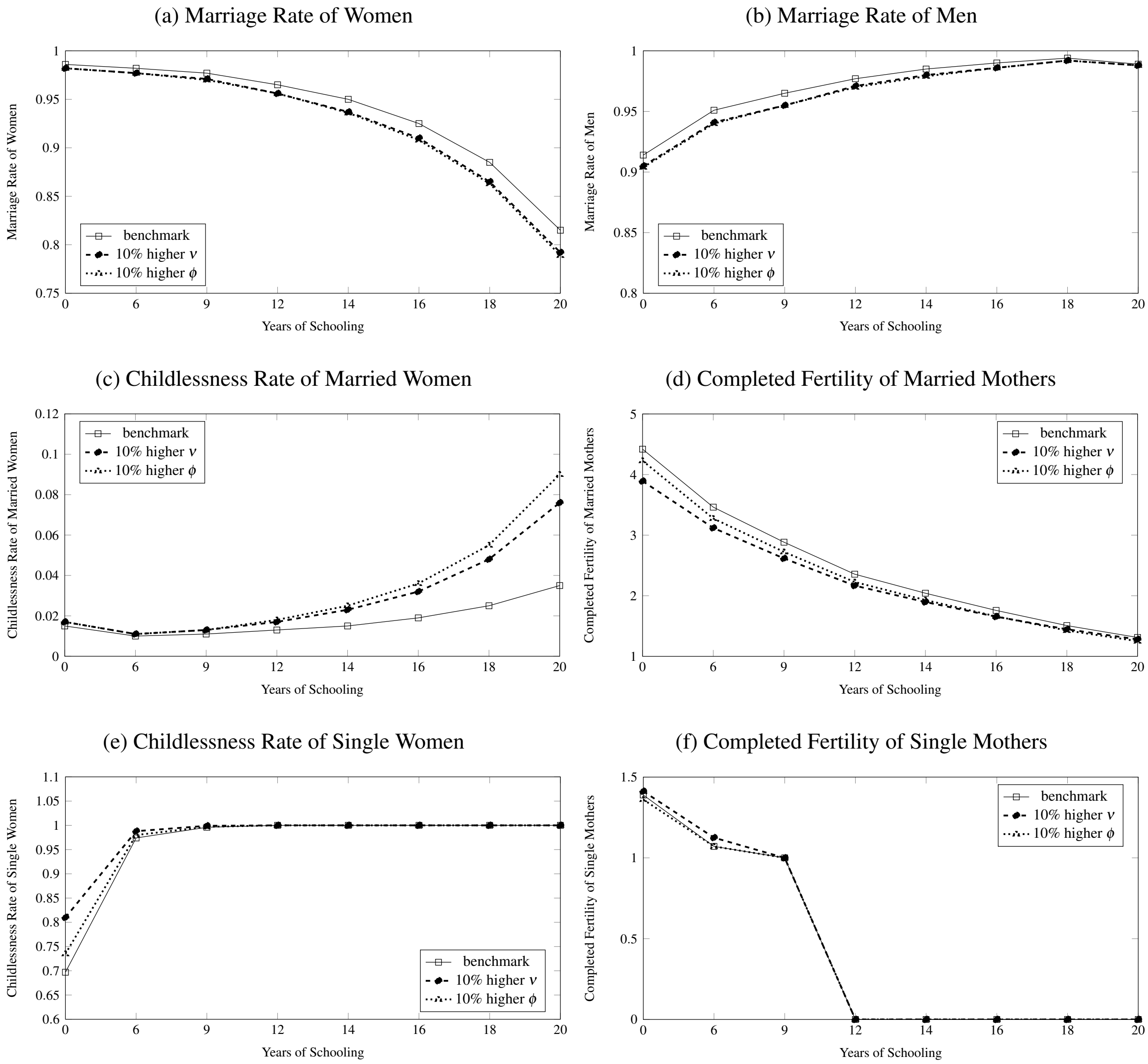
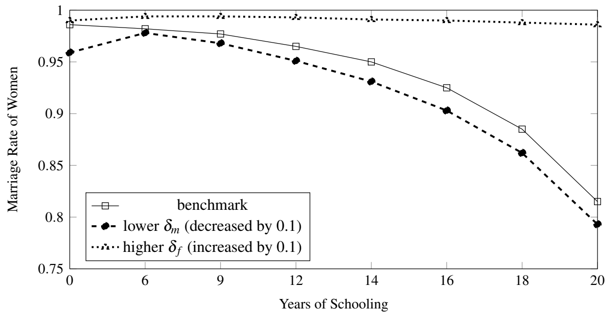
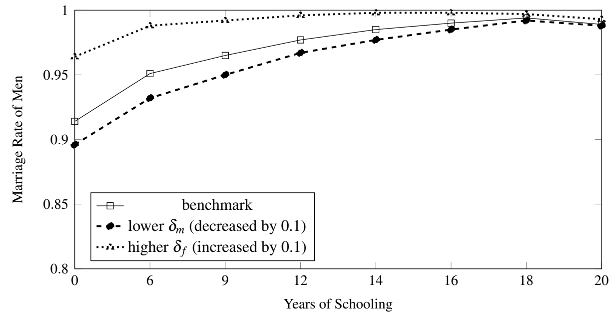


Figure D3: Identification of δ_m and δ_f

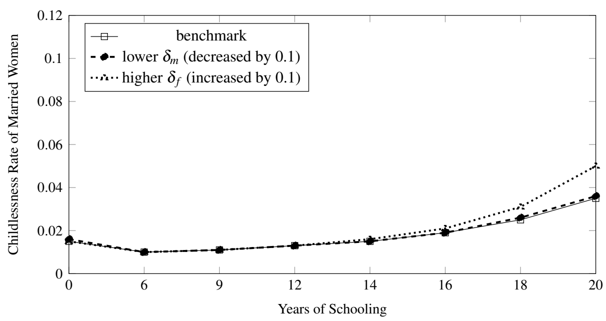
(a) Marriage Rate of Women



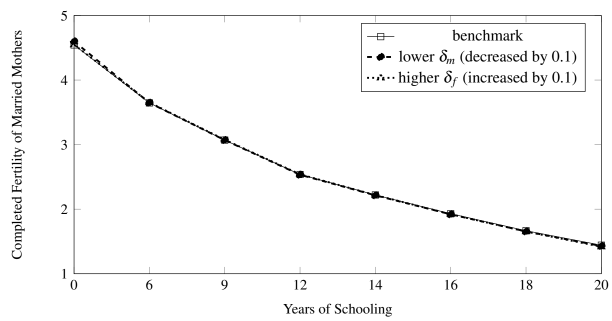
(b) Marriage Rate of Men



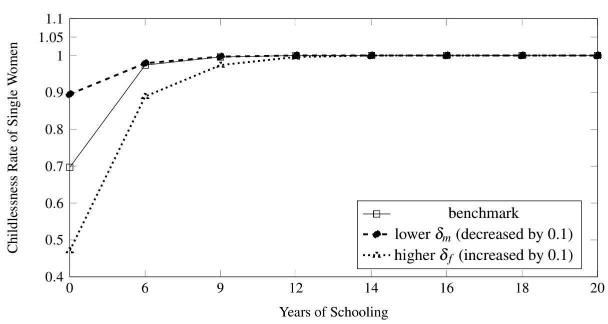
(c) Childlessness Rate of Married Women



(d) Completed Fertility of Married Mothers



(e) Childlessness Rate of Single Women



(f) Completed Fertility of Single Mothers

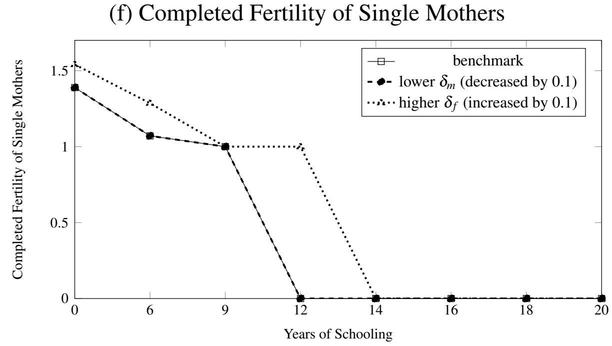


Figure D4: Identification of $\underline{\theta}$

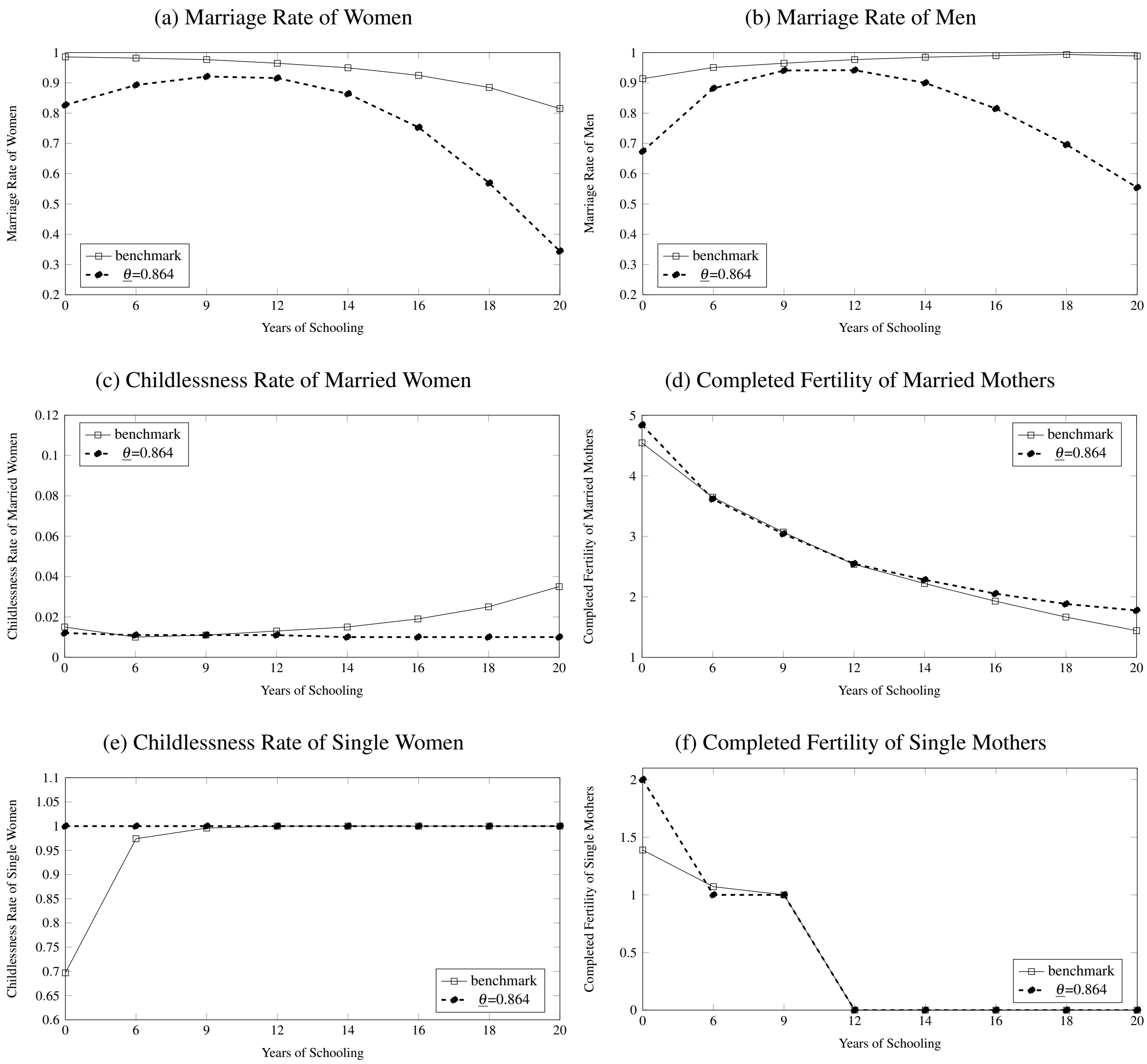
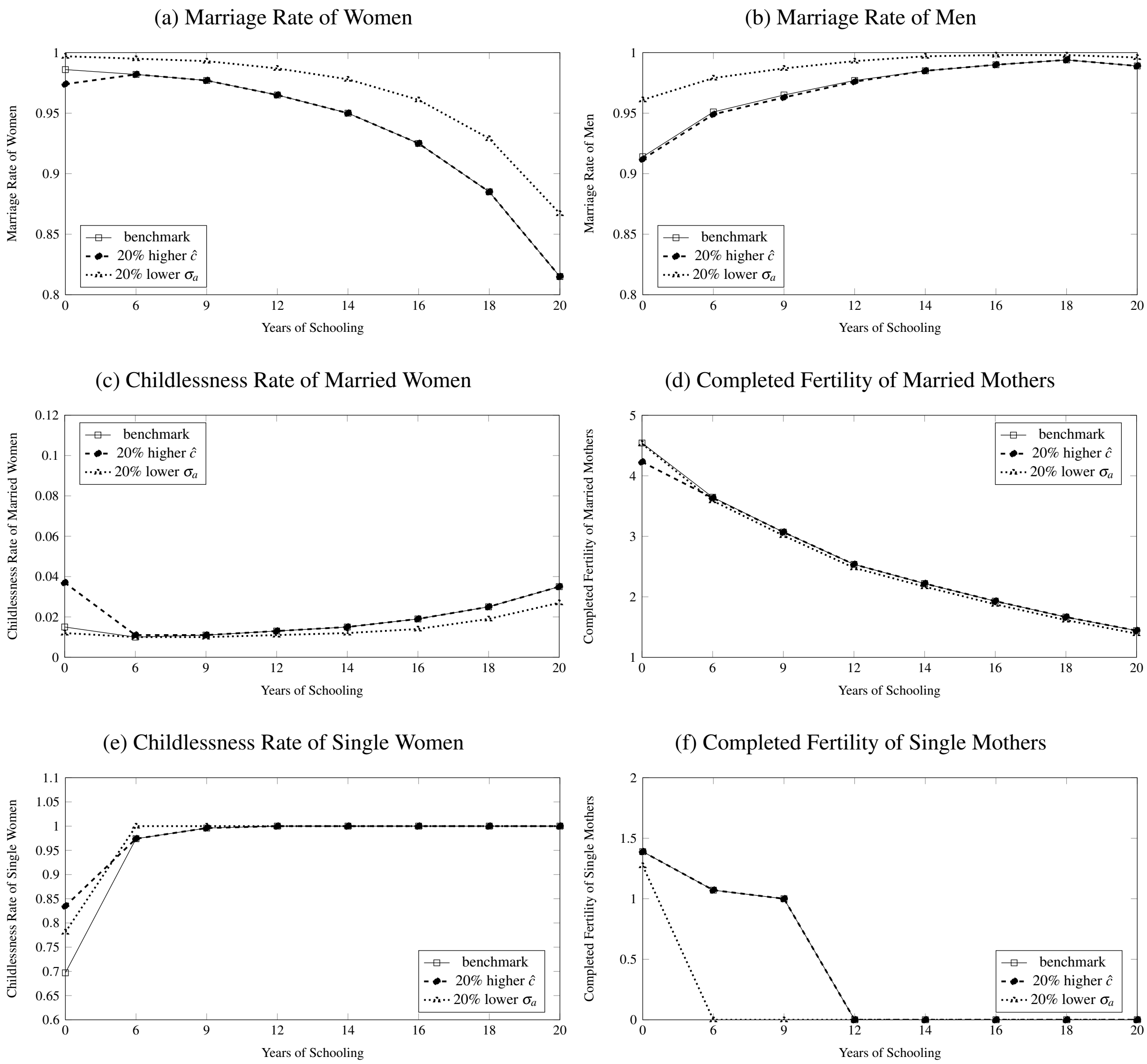
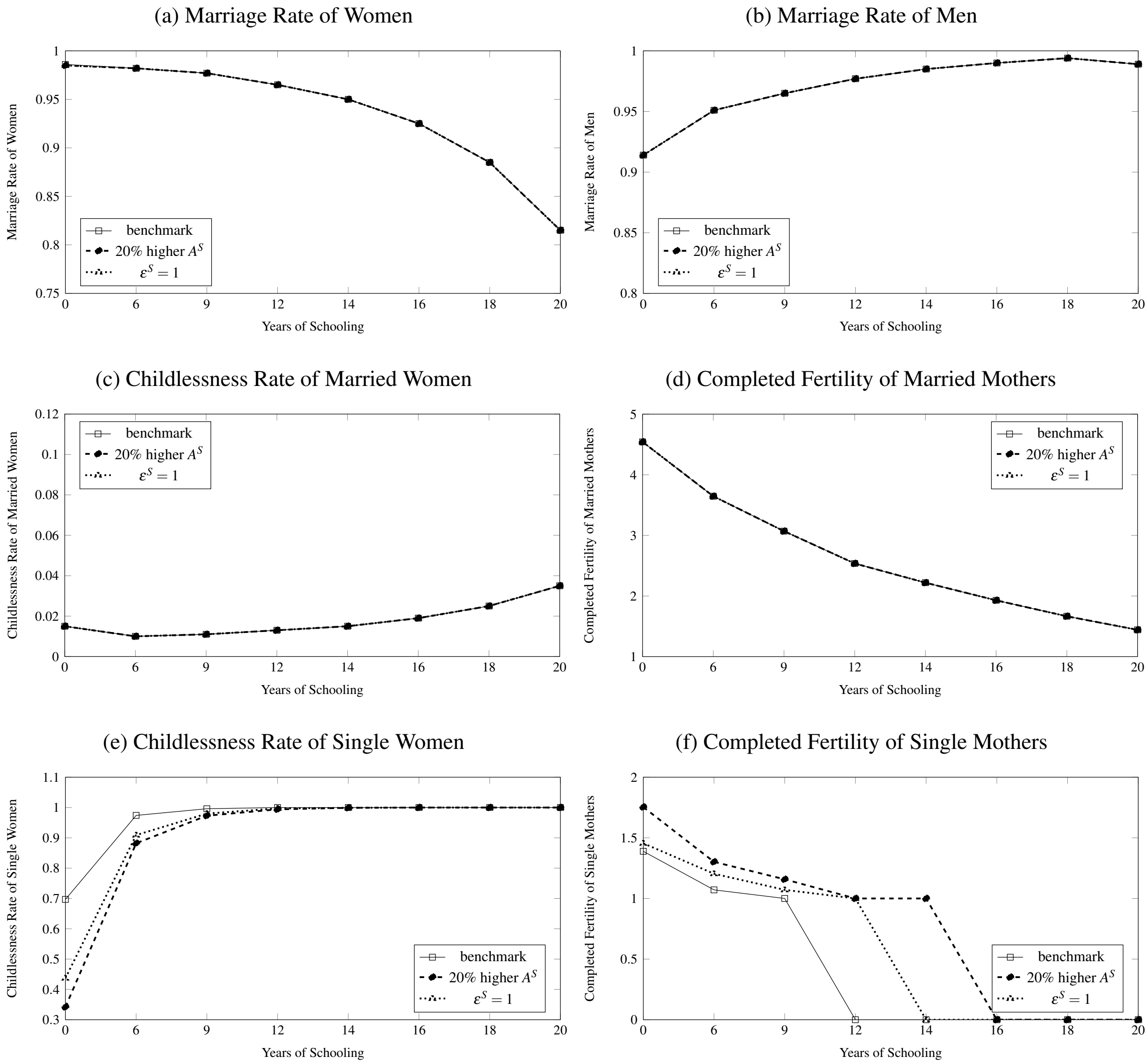


Figure D5: Identification of $\hat{c}$ and σ_a



(a) Marriage Rate of Women (b) Marriage Rate of Men (c) Childlessness Rate of Married Women (d) Completed Fertility of Married Mothers (e) Childlessness Rate of Single Women (f) Completed Fertility of Single Mothers

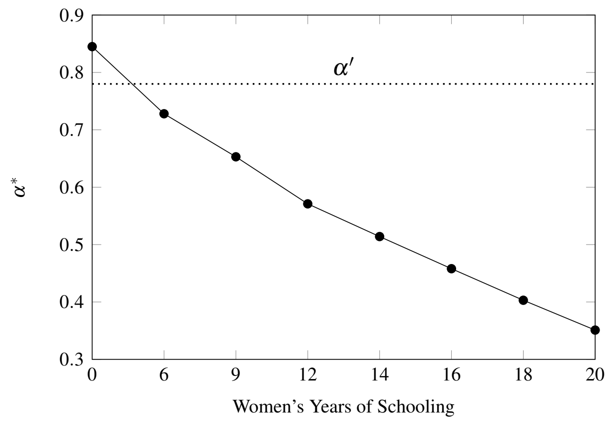
Figure D6: Identification of A^S and ε^S



Appendix E Social Norm Costs by Education Level

In this section, we compute the optimal fraction of childcare provided by a wife (α^*), the social norm cost ($C(\alpha') - C(\alpha^*)$), and the percentage of social norm cost in the total cost of rearing a child ($\frac{C(\alpha')-C(\alpha^*)}{C(\alpha')}$) by education levels of a married couple in our benchmark simulation, and present the results in Tables E1-E3, respectively. Figure E1 compares the optimal fraction of childcare provided by a wife (α^*) conditional on their schooling years with the fraction governed by the social norm (α').

Figure E1: Optimal Fraction of Wife's Labor in Childcare (α^*) Conditional on Women's Education



The figure plots the mean of α^* for married women for each education level, which is computed using the simulated distribution of education pairs of married households in the model.

Table E1: Optimal Alpha (α^*) by Education Level (Model)

	Husband								
Wife	0	6	9	12	14	16	18	20	Conditional Mean
0 (no schooling)	0.605	0.763	0.824	0.872	0.897	0.918	0.935	0.948	0.844
6 (primary school)	0.421	0.605	0.689	0.763	0.805	0.841	0.872	0.897	0.727
9 (middle school)	0.333	0.513	0.605	0.689	0.740	0.785	0.824	0.857	0.653
12 (high school)	0.256	0.421	0.513	0.605	0.662	0.715	0.763	0.805	0.571
14 (some college)	0.212	0.362	0.451	0.544	0.605	0.662	0.715	0.763	0.514
16 (four-year college)	0.173	0.306	0.391	0.482	0.544	0.605	0.662	0.715	0.457
18 (master)	0.141	0.256	0.333	0.421	0.482	0.544	0.605	0.662	0.402
20 (doctoral)	0.113	0.212	0.281	0.362	0.421	0.482	0.544	0.605	0.351

The conditional mean refers to the mean of α^*'s conditional on married women's years of schooling. The conditional mean is computed using the simulated distribution of education pairs of married households.

Table E2: Social Norm Cost ($C(\alpha') - C(\alpha^*)$) by Education Level (Model)

	Husband							
Wife	0	6	9	12	14	16	18	20
0 (no schooling)	0.00169	0.00003	0.00024	0.00147	0.00299	0.00518	0.00817	0.01207
6 (primary school)	0.00782	0.00267	0.00091	0.00004	0.00011	0.00083	0.00232	0.00473
9 (middle school)	0.01359	0.00634	0.00335	0.00114	0.00027	0.00000	0.00485	0.00185
12 (high school)	0.02193	0.01236	0.00797	0.00421	0.00223	0.00080	0.00006	0.00018
14 (some college)	0.02928	0.01805	0.01264	0.00773	0.00491	0.00260	0.00093	0.00007
16 (four-year college)	0.03835	0.02539	0.01889	0.01274	0.00901	0.00572	0.00303	0.00109
18 (master)	0.04945	0.03469	0.02703	0.01955	0.01484	0.01049	0.00667	0.00353
20 (doctoral)	0.06292	0.04630	0.03744	0.02855	0.02278	0.01729	0.01223	0.00777

Table E3: Percentage of Social Norm Cost ($\frac{C(\alpha')-C(\alpha^*)}{C(\alpha')}$) (%) by Education Level (Model)

	Husband								
Wife	0	6	9	12	14	16	18	20	Conditional Mean
0 (no schooling)	4.89	0.66	0.56	3.04	5.73	9.15	13.22	17.80	3.65
6 (primary school)	15.90	4.89	1.56	0.07	0.17	1.17	3.04	5.73	2.10
9 (middle school)	22.87	9.78	4.89	1.56	0.35	0.01	0.56	2.00	4.06
12 (high school)	30.31	15.90	9.78	4.89	2.48	0.85	0.07	0.17	7.36
14 (some college)	35.37	20.48	13.75	8.00	4.89	2.48	0.85	0.07	10.76
16 (four-year college)	40.40	25.31	18.15	11.71	8.00	4.89	2.48	0.85	14.35
18 (master)	45.34	30.31	22.87	15.90	11.71	8.00	4.89	2.48	18.30
20 (doctoral)	50.12	35.37	27.80	20.48	15.90	11.71	8.00	4.89	22.45

The population-weighted average of the percentage of the social norm cost is 5.12%. The conditional mean refers to the mean of the percentages of the social norm cost conditional on married women's schooling years.

Appendix F Details of Counterfactual Analyses Using US Parameter Estimates

Marriage and fertility patterns differ widely between East Asian and Western societies (Table 1). Besides the two social norms, are there any other factors which drive these differences? To answer this question, we conduct three counterfactual experiments. In each experiment, we replace one of the following three parameter estimates with that for the US from Baudin et al. (2015): the gender wage gap (γ); the preference parameter that determines the utility of remaining childless (ν); and the parameter that determines a wife's bargaining power for consumption ($\underline{\theta}$), holding other parameter estimates constant at their estimated values. Of the 17 parameter estimates, South Korea and the US mainly differ in these three.

In Figure F1, we set γ equal to the US estimate of 0.869, thus lowering the gender wage gap. We find that both marriage rates and fertility decrease. The lower gender wage gap implies a higher opportunity cost of raising children for women, so that more women would rather remain single and childless, and married women would have fewer children.

The estimate of ν for South Korea (7.646) is much smaller than that for the US (9.362), meaning that the utility of remaining childless in South Korea is much lower than in the US. When we set ν equal to 9.362 (Figure F2), both fertility and marriage rates significantly decrease. As the utility of remaining childless gets higher, men have fewer incentives to get married. Accordingly, more people choose to remain single and childless, and married couples have fewer children.

The estimate of a wife's intrahousehold bargaining parameter for consumption ($\underline{\theta}$) is smaller for South Korea (0.232) than that for the US (0.864). The low value of $\underline{\theta}$ means that a wife's consumption share significantly depends on her wage relative to that of her husband. When we set $\underline{\theta} = 0.864$ and simulate our model (Figure F3), the marriage rates of men and women decrease, especially for those with high and low levels of education. The reason is that the high value of $\underline{\theta}$, which renders a wife's consumption share less dependent on her wage, makes marriage less attractive for lowly educated *men* and highly educated *women*. Lowly educated men would be less likely to make marriage offers to lowly educated women, and highly educated women would be more likely to decline marriage offers from men. We thus have a hump-shaped relationship between marriage and education for women, which is also observed in the US data. The general effect on both margins of fertility is, however, negligible.

In sum, the differences in the three parameter estimates alone cannot systematically explain the main differences in marriage and fertility between East Asian and the US.

Figure F1: Counterfactual Analysis: Marriage Rate and Fertility Rate When $\gamma = \gamma_{US}$

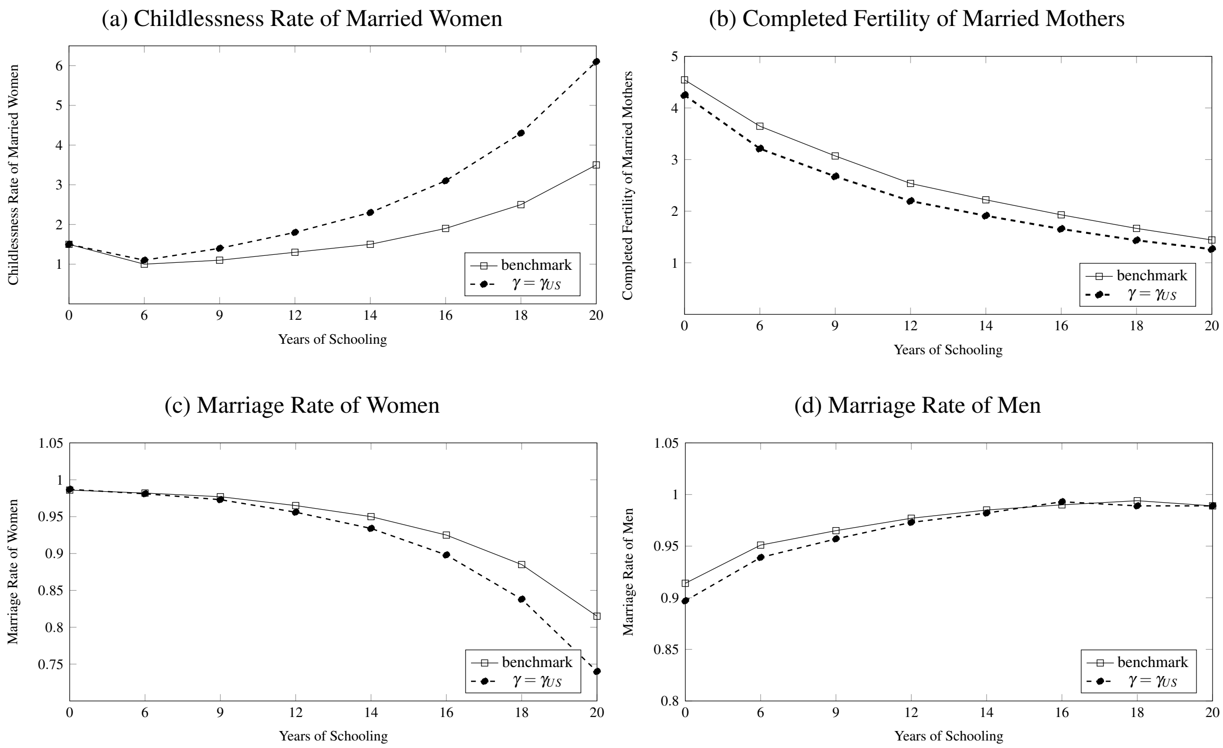


Figure F2: Counterfactual Analysis: Marriage Rate and Fertility Rate When $\nu = \nu_{US}$

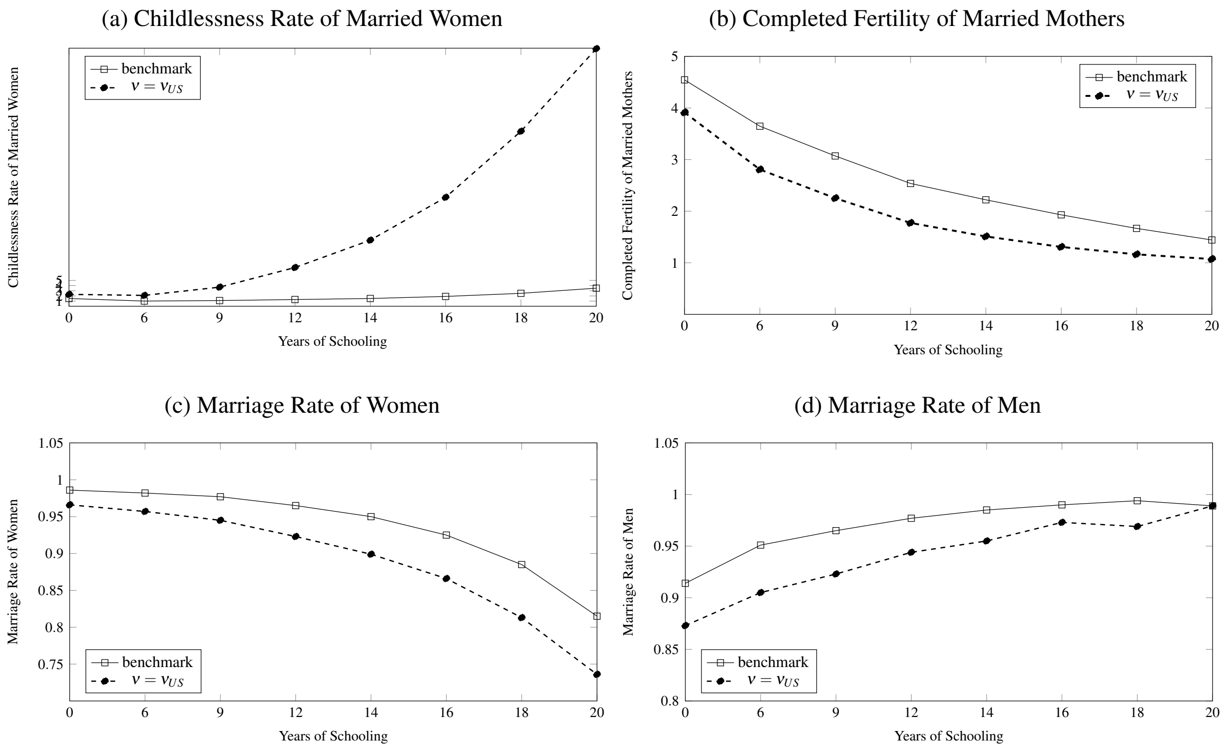
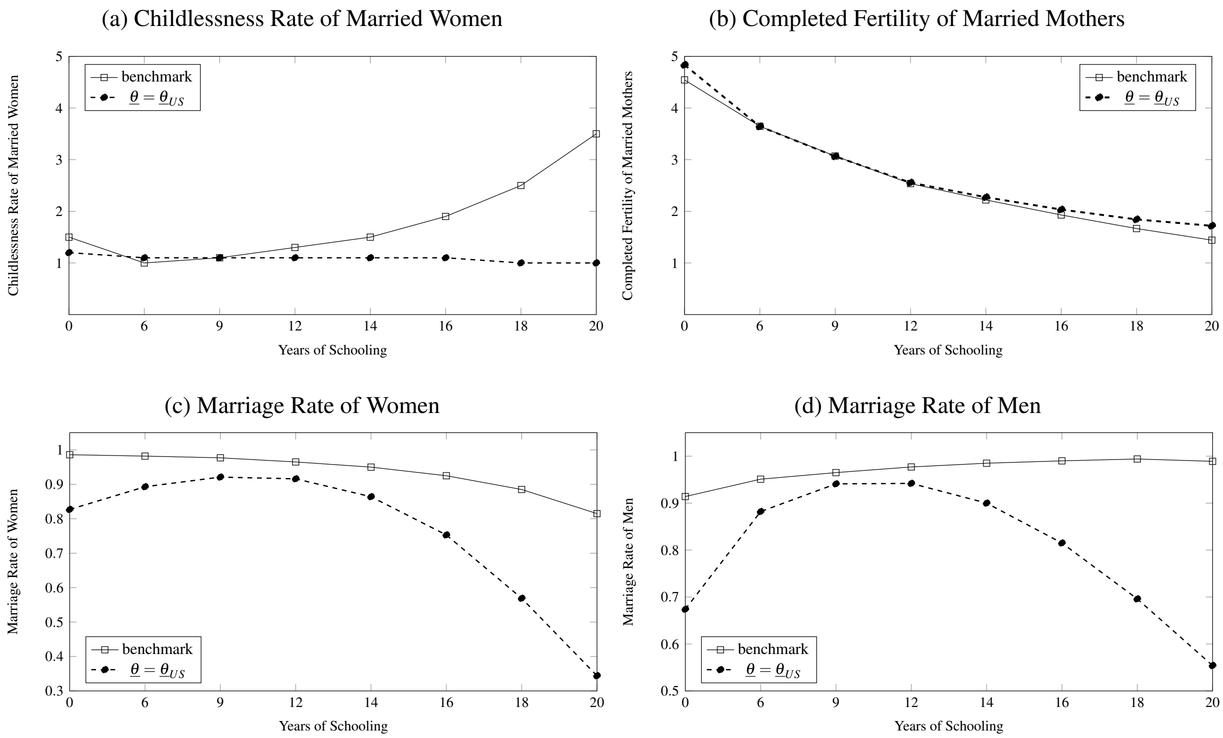


Figure F3: Counterfactual Analysis: Marriage Rate and Fertility Rate When $\underline{\theta} = \underline{\theta}_{US}$



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