Fecundity and Wife Age and Educational Hypogamy: A Biological Basis for the Gender Wage Gap

Solomon W. Polachek*
State University of New York at Binghamton and IZA
polachek@binghamton.edu

Xu Zhang
State University of New York at Binghamton
xzhang2@binghamton.edu

Xing Zhou
Nankai University
hsingchou@gmail.com

Original Version: July 2009
Revised: September 2009
This Version: November 2009

Key Words: gender wage gap; marital patterns; age at marriage; husband-wife age gap; husband-wife educational gap; homogamy; division of labor in the home; household economics

JEL Classifications: J1, J2, J3, J43, J7, J8, N3, N9, O5, Y8, Z13

Abstract

This paper models how a longer fecundity horizon for males than females leads to age and educational differences between husbands and wives. Empirical support is given first based on cross-national data from over 60 countries, second based on US data from the Panel Study of Income Dynamics, third based on historical Swedish data from the 18th and 19th centuries, and fourth based on data from a natural experiment commencing before and ending after China's 1980 one-child law. Each implies slightly over a ½ year bigger husband age advantage and about a 1/3 year larger husband schooling advantage for each extra child. These husband-wife age and educational differences are important to explain the division of labor in the home often given as a cause for differential male and female human capital investments which result in the gender wage gap.

* We thank David Hacker, Subal Kumbhakar, Shelly Lundberg, Haim Ofek, Susan Wolcott, as well as seminar participants at Rutgers and Cornell Universities for valuable comments.

Then Abraham … said … shall a child be born to me, a one-hundred year old man, and to Sarah a ninety year old women? *(Genesis 17:17)*

1. Introduction

One explanation given for the gender wage gap is the division of labor in the home. According to this argument husbands specialize in market work whereas their wives specialize more in home activities. As a result, husbands work a greater proportion of their lives, invest more in human capital, and attain higher wages, which perpetuate themselves throughout the marriage. The relatively larger wage gap found between married men and married women (especially those with children) compared to the almost nonexistent wage gap found for singles (especially never-been-married men and women) is consistent with this household division of labor hypothesis. Also consistent with this division of labor is the secularly declining wage gap coming about as fertility rates fell, divorce rates rose, and female labor force participation rates increased over the last century. These same patterns are generally observed in all countries for which there are data. However, the phenomenon which is not well understood is why household division of labor occurs in the first place. This is the question addressed in this paper.

The standard reason for division of labor is comparative advantage. Comparative advantage can come about at the outset of marriage if husbands have higher wages than wives. While discrimination is one explanation for higher husband wages, another explanation is the mating process – how men and women meet and marry – and the resulting differences in demographic characteristics each spouse brings to the marriage. One of these demographic differences between spouses is age, as the biblical quote above indicates. Another is educational background usually measured by years of schooling. A husband's age and educational advantage translates to wage disparities which could lead to division of labor, even in the absence of discrimination. Thus the study of husband-wife age and educational differences is important.

Social scientists use the singulate mean age at marriage (SMAM) to compute the average age individuals marry. In the SMAM data reported in the United Nations World Marriage Patterns (2000) based on 236 countries, husbands are older than their wives in all but one country.[1] This husband-wife age gap tends to be larger in developing countries especially African nations, while in developed countries it tends to be smaller. In the US, husbands are jut over 2 years older than their wives and at least in the 1960s were almost ½ year more educated (Polachek, 1975). As a result of these age and educational advantages, husbands potentially earn more than their wives from the outset of their marriages. These earnings differences widen throughout the marriage as comparative advantage causes husbands to specialize in market activities, whereas wives tend to specialize more in home production (Becker, 1985). Further these husband-wife wage differences are exacerbated as each additional child is born (Harkness and Waldfogel, 2003, and Bertrand, Katz and Golden, 2009). Understanding why most men marry younger less educated women than themselves, and correspondingly why women often marry older more educated men, should shed light on the division of labor, and hence help explain the gender (and family) wage gap so prevalent in the US and all other countries.

In a series of papers beginning in 1973, Gary Becker developed an economics approach to the mating process. Given the usual principles of families maximizing household utility, he showed how couples positively sort based on complementary traits and negatively sort based on substitutes. Using the approach and taking into account the biological constraint that women are fecund for shorter time durations than men, Frank Vella and Sean Collins (1990) as well as Aloysius Siow (1998) argued that fecund women are relatively scarce. As a result, they demonstrated that the average age at first marriage is lower for women than men. By employing a two-sided search model Eugenio Giolito (2003) proved that the husband-wife age gap is larger the larger the difference in fecundity horizons. Our paper builds on this

[1] www.un.org/esa/population/publications/worldmarriage/worldmarriage.htm

literature. We adopt a two-sided matching model along with the biological fact that men have a longer fecundity horizon than women. In addition, we assume that schooling is so time and effort intensive that those in school put off having children. Our model shows (1) that the husband-wife age gap is smaller the lower the demand for children, and (2) that husband-wife schooling differences are smaller the lower the demand for children. These results are consistent with cross-national, cross-sectional, historical, and time-series patterns observed in the data. For example, as will be shown more formally, in China the husband-wife age difference declined by as much as 1.2 years from before to after China instituted its one-child policy in 1980. Similarly in China, the husband-wife education gap decreased by about 1.4 years. Worldwide, countries with higher infant mortality and higher fertility, such as the African nations, have marriage age gaps about five years bigger than Western countries.[2] In the US, a decrease of one extra child is associated with about a one-half year smaller husband-wife age difference and about a 0.12 year smaller schooling differential. And finally in 18th century Sweden increases in the birth rate are directly associated with increases in the husband-wife age gap, as well.

At this point, it might be worth mentioning that our results are consistent with long-term secular declines in the husband-wife marital age gap which we explain by the more or less consistent decline in fertility. On the other hand, current theories of marriage that explain the recent 1970-2000 increases in marriage age based on declining fertility are hard pressed to show how overall long-term declines in fertility explain cyclical changes in the age at first marriage exhibited over the last several centuries. More on this later.

The rest of the paper is organized as follows. Section 2 is a brief literature review about the theory of marriage. A two-period model in which males and females search for potential partners based on women having shorter fecundity horizons than

---

[2] United Nations World Marriage Patterns, (2000).

men is introduced in section 3. Section 4 presents some stylized facts. Section 5 empirically tests the predictions first using cross-country data, second using US micro-data from the PSID, third using Swedish data in a historical context from the 18^{th} and 19^{th} centuries, and finally fourth using changes in husband and wife age and educational differences resulting from China's one-child law as a natural experiment . Section 6 concludes.

2. Literature Review

An equilibrium search model is a useful tool to analyze how a union between two entities forms. Search models can apply to the job market where potential employers and perspective job applicants are looking for particular job matches, and it can apply to consumer markets where buyers and sellers try to match each other for specific commodities. In the marriage market, search can be used to determine who marries whom. The development of the equilibrium search model started with one-sided search which emphasized how one participant determines whether to form a union from a pool of available potential partners. In these one-sided search models, the other party was considered to be a passive receiver of the decision regarding who matches with whom. Gary Becker's theory is usually taken to consider a woman who tries to select a partner from a pool of marriageable men by comparing the potential utility gained from matching compared to one's current utility. The one-sided search model ignores the bilateral nature of matching, therefore now two-sided search models are more prevalent (i.e. Gale and Shapley (1962), Mortensen (1988), Burdett and Wright (1998)). Marriage is a process where women and men simultaneously search for partners and make a decision by comparing gains from marriage with their current utility.

The theory of marriage as developed by Becker (1973, 1991) implies several sources of gains from marriage. First, it is assumed that men have a comparative advantage in the labor market while women have a comparative advantage in home production or childcare. Therefore, by forming a partnership, both men and women are better off from specialization. Second, Becker views the family as an entity producing and rearing of children. In this case, a large part of gains from marriage arises from having children. Third, by combining a couple's resources, gains from marriage also come about from economies of scale.

Vella and Collins (1990) as well as Siow (1993) use Becker's notions of marital selection to derive additional results. Utilizing the fact that men remain fertile longer than women, Vella and Collins (1990) argue that older men become relatively more valuable. This leads to "a positive age differential in favor of husbands" (p. 363). Siow (1998) puts it another way: Young fecund women become relatively scarce by being fertile a shorter period of their lives. As such, young fertile women become more costly. This leads to an age disparity whereby husbands are older than their wives because high wage fertile men can better afford these young women. Giolito (2003) investigates the impact of different male and female fecundity horizons in the context of a two-period two-sided search model. He finds fecundity by itself can explain the age gap at first marriage.[3]

A marital characteristic economists do not readily consider is the educational gap, also prevalent between husbands and wives.[4] Educational differences between husbands and wives, while narrowing and even reversing in a number of countries, continue to pervade (UN State of the World Population Report, 1997 and Quisumbing and Hallman, 2005). Educational differences lead to specialization in the same way as age differences do. As such, it is important to model not only the husband-wife *age*

---

[3] This contrasts with Bagnoli and Bergstrom (1993) who reach the same conclusion about the gender age gap via a waiting game in which "males who regard their prospects as unusually good choose to wait until their economic success is revealed before choosing a bride." A number of sociologists deal with the gender age gap in marriage. Their explanations are more descriptive. For example, Shorter (1975: pp. 337-339) presents an extensive table with cross-national historical data spanning 1655-1970 indicating that the percentage of husbands more than five years older than their wives averages about 50% whereas the percentage of wives five or more years older than husbands for the same countries and same dates averages only about 14%. Knodel (1988: p. 138) examines husband wife age differences which vary between 3.1 and 4.8 across four regions of Germany between 1700 and 1899, and during this time period, from 2.0 for unskilled husbands to 6.8 for farmers. Poppel et al. (2001: p. 12) looks at historical age homogamy in the Netherlands, finding that "age differences between spouses … have become much smaller … [in] the last century and a half."

[4] One paper which predicts that education can differ between spouses is Chiappor, Iyigun and Weiss (2008). In contrast to our paper which is motivated by limited female fecundity, a biological constraint, that paper is motivated by greater female returns to education coupled with a home technology and division of labor that yield differing household roles. On the other hand, a number of sociologists have examined educational differences more descriptively. For example, Rockwell (1976) attributes 1910-1970 declines in the US educational homogamy across marital cohorts to overall male and female educational distributions becoming more similar. Mare (1991) extends this analysis of the homogamy trends through the 1980s claiming "homogamy "increased … from the 1930s to the 1980s (p. 15). Kalmijn (1991) argues that this increased educational homogamy is at the expense of religious homogeneity.

gap, but also to model why men tend to be more *educated* than their wives. To do so, we also make use of the fact that females have shorter fecundity horizons than men. But, in addition, we make use of the fact that schooling takes time to acquire. In the extreme two-period case, one can assume education takes the full first time period, which means the educated put off children to the second period.[5] For women, this means foregoing children entirely, given women's fecundity limitation.

Our model yields a number of theorems regarding the impact of changes in the demand for children. Most relevant is that husbands are older than their wives and husbands are more educated than their wives the more children they aspire to have. Further, changes in government policies that influence the demand for children, such as China's one-child policy, can influence husband-wife age and educational gaps. Thus after 1980 when the Chinese government initiated a "one-child policy" in order to control its large population growth, we predict the age at first marriage to rise, the husband-wife age gap at first marriage to decline, and husband-wife educational differences to narrow. Similarly, any other policies that affect the demand for children will influence these marital demographics. Such policies might entail lump-sum taxes or subsidies which change the cost of having children, such as tax credits for daycare. Also, factors could include institutional considerations such as living environments. In this regard, farm families usually value children more than non-farm families. In contrast, urban areas often make children more costly. Thus we would predict smaller husband-wife age and educational disparities among urban families.

3. A Two-period Model

In this section we develop a two sided search model. Similar to Vella and Collins (1990), Siow (1993) and Giolito (2003) we postulate male and female heterogeneity comes from different fecundity horizons. Further we expand Giolito's (2003) model by introducing education along with the demand of children into the marriage search model.

3.1 Assumptions

[5] Gustafsson and Kalwij (2006) serves as an example illustrating that education delays fertility.

We assume a continuum of single women of measure F(t), and of single men, M(t). We focus on the steady state. In time t, there are F females and M males. Males and females of a given age and education are homogeneous except for their potential fecundity. Further, we assume individuals (males and females) are of either high or low ability. Ability affects the proclivity one goes to school, and going to school puts off marriage (Atkinson and Glass, 1985). For a woman, putting off marriage decreases her capacity to have children. All participants in the marriage market sort based on their age and education levels which are related to their fecundity horizons. For simplicity, we assume both men and women live for two periods. Men are fertile for both periods (at all ages), but women are fertile only during the first (when they are young). Since education directly affects a woman's capability of having children, and since children affect the utility gained from marriage, we view education as another factor that affects marital decisions. We assume all young people are low educated but some of them are more intelligent (high ability) than their peers. We assume these highly intelligent young men and women can (but not necessarily) acquire schooling by the time they become old. We assume the young low intelligent men and women do not have the mental capacity for additional schooling, and thus remain less educated.

3.2 Payoffs

As was indicated, both men and women can live two periods, but women are assumed to have shorter fecundity horizon than men, that is, only young women are fertile while both young and old men are fertile. A single man or woman will meet only one member of the opposite sex at each period. They decide whether to propose or not by comparing current utility while being single with the possible utility obtained from matching. When a woman matches with a man and vice versa, the specific utility that the woman obtains from the man and the man from the woman are considered as an independent random draw from uniform distributions $G_m(y)$ and $G_f(x)$ respectively. Assume y ~ [0,1] and x ~ [0,1]. y and x refers to "type" of men and women, which contains observed or unobserved characteristics.

One sets a reservation value of one's spouse based on the maximization of expected utility. We assume an individual's potential marital payoff results from four aspects of the marriage: the marriage partner's quality, the marriage duration, the utility of having children, and one's own and one's spouse's education. Payoff matrices are given in Tables 1 and 2. We assume zero (marital) utility during the period the individual remains single. We define the parameter (k) to be a multiplicative factor indicating how utility is augmented through marriage. If a fertile woman marries, the derived utility from marriage will increase by (k-1) percent ($k>1$). Thus k is a parameter designated to measure the extra utility from having children within marriage. We define k as the "demand for children". It is proportional to the number of children couples want to have. We assume education to enter utility in either of two ways. First, education increases a person's desirability because education is positively related to income, obviously an appealing marriage market characteristic. We denote the extra utility from a partner's high education level to be the parameter r. Second, education raises opportunity costs of children and serves as a substitute to the benefits children bring. This latter effect is denoted as e ($e>1$) in the denominator of the male payoff matrix in Table 2. The parameter β is the discount rate so that ($0<\beta<1$).

3.3 The Population Composition

We assume the meeting technology----the number of contacts between single females (F) and single males (M) follows a constant return to scale meeting function developed by Pissarides (1990):

$$\eta = \mu M^{\theta} F^{1-\theta}$$

where $0 < \theta < 1$ and μ a positive constant, also less than 1.

We also assume every non-married person will only meet at most one member of the opposite sex per period. The probability that a single person meets with a single member of the opposite sex per period depends on the relative availability in the pool of potential partners. From the above, the probability that a single woman meets a single man is

$$\eta_f = \mu\left(\frac{M}{F}\right)^{\theta} = \frac{\eta}{F}.$$

The probability that a single man meets with a single woman is

$$\eta_m = \mu\left(\frac{M}{F}\right)^{\theta-1} = \frac{\eta}{M}.$$

The composition of single men (***M***) and women (**F**) can be depicted as

$$M = m_{1,l} + m_{1,h} + m_{2,l} + m_{2,h}$$

$$F = f_{1,l} + f_{1,h} + f_{2,l} + f_{2,h}$$

where the first subscript refers to age (1 or 2) and the second low (l) or high (h) ability for the young and low (l) or high (h) education for the old. Single men comprise low and high ability young men, and low and high educated old men. The same breakdown applies for women. The fractions of singles of each group are as follows:

$$p_{m_{1,l}} = \frac{m_{1,l}}{M} \quad p_{m_{1,h}} = \frac{m_{1,h}}{M} \quad p_{m_{2,l}} = \frac{m_{2,l}}{M} \quad p_{m_{2,h}} = \frac{m_{2,h}}{M}$$

$$p_{f_{1,l}} = \frac{f_{1,l}}{F} \quad p_{f_{1,h}} = \frac{f_{1,h}}{F} \quad p_{f_{2,l}} = \frac{f_{2,l}}{F} \quad p_{f_{2,h}} = \frac{f_{2,h}}{F}$$

3.4.1 Utility of Marriage for Old Men (Age 2)

The probabilities that a low and high ability young man receives a marriage offer from a low and high ability young woman are

$$\alpha_{m_{1,l}}^{f_{1,l}} = \eta_m p_{m_{1,l}} p_{f_{1,l}} \left(1 - G_m\left(R_{m_{1,l}}^{f_{1,l}}\right)\right)$$

$$\alpha_{m_{1,l}}^{f_{1,h}} = \eta_m p_{m_{1,l}} p_{f_{1,h}} \left(1 - G_m\left(R_{m_{1,l}}^{f_{1,h}}\right)\right)$$

$$\alpha_{m_{1,h}}^{f_{1,l}} = \eta_m p_{m_{1,h}} p_{f_{1,l}} \left(1 - G_m\left(R_{m_{1,h}}^{f_{1,l}}\right)\right)$$

$$\alpha_{m_{1,h}}^{f_{1,h}} = \eta_m p_{m_{1,h}} p_{f_{1,h}} \left(1 - G_m\left(R_{m_{1,h}}^{f_{1,h}}\right)\right)$$

where $R_{m_{i,j1}}^{f_{i,j}}$ (i=1,2 and j=l,h) is the reservation value that a woman (i,j) sets for a man (i,j).

The probabilities that an old low-educated man and an old high-educated man receive a marriage offer from a young woman are

$$\alpha_{m_2,l}^{f_{1,l}} = \eta_m p_{m_{2,l}} p_{f_{1,l}} \left(1 - G_m\left(R_{m_{2,l}}^{f_{1,l}}\right)\right)$$

$$\alpha_{m_2,l}^{f_{1,h}} = \eta_m p_{m_{2,l}} p_{f_{1,h}} \left(1 - G_m\left(R_{m_{2,l}}^{f_{1,h}}\right)\right)$$

$$\alpha_{m_2,h}^{f_{1,l}} = \eta_m p_{m_{2,h}} p_{f_{1,l}} \left(1 - G_m\left(R_{m_{2,h}}^{f_{1,l}}\right)\right)$$

$$\alpha_{m_2,h}^{f_{1,h}} = \eta_m p_{m_{2,h}} p_{f_{1,h}} \left(1 - G_m\left(R_{m_{2,h}}^{f_{1,h}}\right)\right).$$

Since old women prefer accepting all potential proposals to dying single, old women will accept any proposal they receive. Therefore, the probabilities that a young man with high or low ability and an old man (low or high-educated) receives a marriage offer from an old low or high-educated woman are respectively

$$\alpha_{m_{1,l}}^{f_{2,l}} = \eta_m p_{m_{1,l}} p_{f_{2,l}}$$

$$\alpha_{m_{1,l}}^{f_{2,h}} = \eta_m p_{m_{1,l}} p_{f_{2,h}}$$

$$\alpha_{m_{1,h}}^{f_{2,l}} = \eta_m p_{m_{1,h}} p_{f_{2,l}}$$

$$\alpha_{m_{1,h}}^{f_{2,h}} = \eta_m p_{m_{1,h}} p_{f_{2,h}}$$

$$\alpha_{m_{2,l}}^{f_{2,l}} = \eta_m p_{m_{2,l}} p_{f_{2,l}}$$

$$\alpha_{m_{2,l}}^{f_{2,h}} = \eta_m p_{m_{2,l}} p_{f_{2,h}}$$

$$\alpha_{m_{2,h}}^{f_{2,l}} = \eta_m p_{m_{2,h}} p_{f_{2,l}}$$

$$\alpha_{m_{2,h}}^{f_{2,h}} = \eta_m p_{m_{2,h}} p_{f_{2,h}}$$

Based on these probabilities and the values given in the payoff matrices, the utility of marriage for an old low-educated man is

$$U_{m_{2,l}} = (\alpha_{m_{2,l}}^{f_{1,l}} k + \alpha_{m_{2,l}}^{f_{1,h}} k + \alpha_{m_{2,l}}^{f_{2,l}} + \alpha_{m_{2,l}}^{f_{2,h}} r)\bar{x} .$$

The utility of marriage for an old high-educated man is

$$U_{m_{2,h}} = (\alpha_{m_{2,h}}^{f_{1,l}} \frac{k}{e} + \alpha_{m_{2,h}}^{f_{1,h}} \frac{k}{e} + \alpha_{m_{2,h}}^{f_{2,l}} + \alpha_{m_{2,h}}^{f_{2,h}} r)\bar{x} .$$

3.4.2 Utility of Marriage for Young Men (Age 1)

The utility of marriage for a young man with low ability or high ability comes from the utility that this young man marries a young woman with low ability or high ability, an old low-educated woman and an old high-educated woman, that is

$$U_{m_{1,l}} = \alpha_{m_{1,l}}^{f_{1,l}} (1+\beta)k \int_{R_{f_{1,l}}^{m_{1,l}}}^{1} xdx + \alpha_{m_{1,l}}^{f_{1,h}} (1+\beta)k \int_{R_{f_{1,h}}^{m_{1,l}}}^{1} xdx + \alpha_{m_{1,l}}^{f_{2,l}} \int_{R_{f_{2,l}}^{m_{1,l}}}^{1} xdx + \alpha_{m_{1,l}}^{f_{2,h}} r \int_{R_{f_{2,h}}^{m_{1,l}}}^{1} xdx$$

$$U_{m_{1,h}} = \alpha_{m_{1,h}}^{f_{1,l}} (1+\beta)k \int_{R_{f_{1,l}}^{m_{1,h}}}^{1} xdx + \alpha_{m_{1,h}}^{f_{1,h}} (1+\beta)k \int_{R_{f_{1,h}}^{m_{1,h}}}^{1} xdx + \alpha_{m_{1,h}}^{f_{2,l}} \int_{R_{f_{2,l}}^{m_{1,h}}}^{1} xdx + \alpha_{m_{1,h}}^{f_{2,h}} r \int_{R_{f_{2,h}}^{m_{1,h}}}^{1} xdx$$

3.4.3 **Optimization Problem for Young Men**

A young man maximizes his total discounted utility by choosing optimal reservation value that he sets for a young woman and an old woman. Thus, the optimization problems for low and high ability young men are

$$V_{m_{1,l}} = \max[U_{m_{1,l}} + (1-\gamma_{m_{1,l}})\beta U_{m_{2,l}}]$$

$$\gamma_{m_{1,l}} = \alpha_{m_{1,l}}^{f_{1,l}} (1 - G_f(R_{f_{1,l}}^{m_{1,l}})) + \alpha_{m_{1,l}}^{f_{1,h}} (1 - G_f(R_{f_{1,h}}^{m_{1,l}})) + \alpha_{m_{1,l}}^{f_{2,l}} (1 - G_f(R_{f_{2,l}}^{m_{1,l}})) + \alpha_{m_{1,l}}^{f_{2,h}} (1 - G_f(R_{f_{2,h}}^{m_{1,l}}))$$

and

$$V_{m_{1,h}} = \max[U_{m_{1,h}} + (1-\gamma_{m_{1,h}})\beta U_{m_{2,h}}]$$

$$\gamma_{m_{1,h}} = \alpha_{m_{1,h}}^{f_{1,l}} (1 - G_f(R_{f_{1,l}}^{m_{1,h}})) + \alpha_{m_{1,h}}^{f_{1,h}} (1 - G_f(R_{f_{1,h}}^{m_{1,h}})) + \alpha_{m_{1,h}}^{f_{2,l}} (1 - G_f(R_{f_{2,l}}^{m_{1,h}})) + \alpha_{m_{1,h}}^{f_{2,h}} (1 - G_f(R_{f_{2,h}}^{m_{1,h}}))$$

where $\gamma_{m_{1,l}}$ and $\gamma_{m_{1,h}}$ are the probabilities that a young low ability man and a young high ability man get married at age 1.

3.4.4 The Utility of Marriage for Old Women (Age 2)

Similarly, the probabilities that a young low or high ability woman and an old low-educated or high-educated woman receives a marriage offer from a young low or high ability man are respectively

$$\alpha_{f_{1,l}}^{m_{1,l}} = \eta_f p_{f_{1,l}} p_{m_{1,l}} \left(1 - G_f\left(R_{f_{1,l}}^{m_{1,l}}\right)\right)$$
$$\alpha_{f_{1,l}}^{m_{1,h}} = \eta_f p_{f_{1,l}} p_{m_{1,h}} \left(1 - G_f\left(R_{f_{1,l}}^{m_{1,h}}\right)\right)$$
$$\alpha_{f_{1,h}}^{m_{1,l}} = \eta_f p_{f_{1,h}} p_{m_{1,l}} \left(1 - G_f\left(R_{f_{1,h}}^{m_{1,l}}\right)\right)$$
$$\alpha_{f_{1,h}}^{m_{1,h}} = \eta_f p_{f_{1,h}} p_{m_{1,h}} \left(1 - G_f\left(R_{f_{1,h}}^{m_{1,h}}\right)\right)$$
$$\alpha_{f_{2,l}}^{m_{1,l}} = \eta_f p_{f_{2,l}} p_{m_{1,l}} \left(1 - G_f\left(R_{f_{2,l}}^{m_{1,l}}\right)\right)$$
$$\alpha_{f_{2,l}}^{m_{1,h}} = \eta_f p_{f_{2,l}} p_{m_{1,h}} \left(1 - G_f\left(R_{f_{2,l}}^{m_{1,h}}\right)\right)$$
$$\alpha_{f_{2,h}}^{m_{1,l}} = \eta_f p_{f_{2,h}} p_{m_{1,l}} \left(1 - G_f\left(R_{f_{2,h}}^{m_{1,l}}\right)\right)$$
$$\alpha_{f_{2,h}}^{m_{1,h}} = \eta_f p_{f_{2,h}} p_{m_{1,l}} \left(1 - G_f\left(R_{f_{2,h}}^{m_{1,h}}\right)\right)$$

An old man will prefer accepting any proposal from women instead of dying single. Thus, the probabilities that a young woman and an old woman receives a marriage offer from an old man are

$$\alpha_{f_{1,l}}^{m_{2,l}} = \eta_f p_{f_{1,l}} p_{m_{2,l}}$$

$$\alpha_{f_{1,l}}^{m_{2,h}} = \eta_f p_{f_{1,l}} p_{m_{2,h}}$$

$$\alpha_{f_{1,h}}^{m_{2,l}} = \eta_f p_{f_{1,h}} p_{m_{2,l}}$$

$$\alpha_{f_{1,h}}^{m_{2,h}} = \eta_f p_{f_{1,h}} p_{m_{2,h}}$$

$$\alpha_{f_{2,l}}^{m_{2,l}} = \eta_f p_{f_{2,l}} p_{m_{2,h}}$$

$$\alpha_{f_{2,l}}^{m_{2,h}} = \eta_f p_{f_{2,l}} p_{m_{2,h}}$$

$$\alpha_{f_{2,l}}^{m_{2,l}} = \eta_f p_{f_{2,l}} p_{m_{2,l}}$$, and

$$\alpha_{f_{2,h}}^{m_{2,h}} = \eta_f p_{f_{2,h}} p_{m_{2,h}}$$

The utility of marriage for old low-educated women is

$$U_{f_{2,l}} = \left(\alpha_{f_{2,l}}^{m_{1,l}} + \alpha_{f_{2,l}}^{m_{1,h}} + \alpha_{f_{2,l}}^{m_{2,l}} + \alpha_{f_{2,l}}^{m_{2,h}} r\right)\overline{y}.$$

The utility of marriage for old high-educated women is

$$U_{f_{2,h}} = V_{f_{2,h}} = \left(\alpha_{f_{2,h}}^{m_{1,l}} + \alpha_{f_{2,h}}^{m_{1,h}} + \alpha_{f_{2,h}}^{m_{2,l}} + \alpha_{f_{2,h}}^{m_{2,h}} r\right)\overline{y}.$$

3.4.5 Utility of Marriage for Young Women (Age 1)

The utilities of marriage for low and high ability young women are

$$U_{f_{1,l}} = \alpha_{f_{1,l}}^{m_{1,l}}(1+\beta)k\int_{R_{m_{1,l}}^{f_{1,l}}}^{1} ydy + \alpha_{f_{1,l}}^{m_{1,h}}(1+\beta)k\int_{R_{m_{1,h}}^{f_{1,l}}}^{1} ydy + \alpha_{f_{1,l}}^{m_{2,l}} k\int_{R_{m_{2,l}}^{f_{1,l}}}^{1} ydy + \alpha_{f_{1,l}}^{m_{2,h}} kr\int_{R_{m_{2,h}}^{f_{1,l}}}^{1} ydy$$

and

$$U_{f_{1,h}} = \alpha_{f_{1,h}}^{m_{1,l}}(1+\beta)k\int_{R_{m_{1,l}}^{f_{1,h}}}^{1} ydy + \alpha_{f_{1,h}}^{m_{1,h}}(1+\beta)k\int_{R_{m_{1,h}}^{f_{1,h}}}^{1} ydy + \alpha_{f_{1,h}}^{m_{2,l}} k\int_{R_{m_{2,l}}^{f_{1,h}}}^{1} ydy + \alpha_{f_{1,h}}^{m_{2,h}} kr\int_{R_{m_{2,h}}^{f_{1,h}}}^{1} ydy$$

3.4.6 The Optimization Problem for Young Women

A young woman maximizes her total discounted utility by choosing an optimal reservation value that she sets for all potential partners, that is,

$$V_{f_{1,l}} = \max[U_{f_{1,l}} + \left(1-\gamma_{f_{1,l}}\right)\beta U_{f_{2,l}}]$$

$$\gamma_{1,l} = \alpha_{f_{1,l}}^{m_{1,l}}\left(1-G_m\left(R_{m_{1,l}}^{f_{1,l}}\right)\right) + \alpha_{f_{1,l}}^{m_{1,h}}(1-G_m(R_{m_{1,h}}^{f_{1,l}})) + \alpha_{f_{1,l}}^{m_{2,l}}\left(1-G_m\left(R_{m_{2,l}}^{f_{1,l}}\right)\right) + \alpha_{f_{1,l}}^{m_{2,h}}(1-G_m(R_{m_{2,h}}^{f_{1,l}}))$$

$$V_{f_{1,h}} = \max[U_{f_{1,h}} + \left(1-\gamma_{f_{1,h}}\right)\beta U_{f_{2,h}}]$$

$$\gamma_{f_{1,h}} = \alpha_{f_{1,h}}^{m_{1,l}}\left(1-G_m\left(R_{m_{1,l}}^{f_{1,h}}\right)\right) + \alpha_{f_{1,h}}^{m_{1,h}}(1-G_m(R_{m_{1,h}}^{f_{1,h}})) + \alpha_{f_{1,h}}^{m_{2,l}}\left(1-G_m\left(R_{m_{2,l}}^{f_{1,h}}\right)\right) + \alpha_{f_{1,h}}^{m_{2,h}}(1-G_m(R_{m_{2,h}}^{f_{1,h}}))$$

where $\gamma_{f_{1,l}}$ and $\gamma_{f_{1,h}}$ are the probabilities that a young low ability woman and young high ability woman get married at age 1.

3.5 Steady State Equilibrium

3.5.1 Reaction Functions

The solutions to the optimization problems are the equilibrium reservation values $R_{f_{i,j}}^{mi,j}$ set by different groups of men and women. They are $R_{f_{1,l}}^{m_{1,l}}, R_{f_{1,h}}^{m_{1,l}}, R_{f_{2,l}}^{m_{1,l}}, R_{f_{2,h}}^{m_{1,l}}, R_{f_{1,l}}^{m_{1,h}}, R_{f_{1,h}}^{m_{1,h}}, R_{f_{2,l}}^{m_{1,h}}, R_{f_{2,h}}^{m_{1,h}}, R_{m_{1,l}}^{f_{1,l}}, R_{m_{1,h}}^{f_{1,l}}, R_{m_{2,l}}^{f_{1,l}}, R_{m_{2,h}}^{f_{1,l}}, R_{m_{1,l}}^{f_{1,h}}, R_{m_{1,h}}^{f_{1,h}}, R_{m_{2,l}}^{f_{1,h}}$, and $R_{m_{2,h}}^{f_{1,h}}$. High and low ability young men should set an optimal reservation value so that they are indifferent between marrying when young and remaining single until the second period, that is,

$$k(1+\beta)R_{f_{1,l}}^{m_{1,l}} = k(1+\beta)R_{f_{1,h}}^{m_{1,l}} = R_{f_{2,l}}^{m_{1,l}} = rR_{f_{2,h}}^{m_{1,l}} = \beta U_{m_{2,l}}$$

$$k(1+\beta)R_{f_{1,l}}^{m_{1,h}} = k(1+\beta)R_{f_{1,h}}^{m_{1,h}} = R_{f_{2,l}}^{m_{1,h}} = rR_{f_{2,h}}^{m_{1,h}} = \beta U_{m_{2,h}}$$

Similarly, for low and high ability young women,

$$k(1+\beta)R_{m_{1,l}}^{f_{1,l}} = k(1+\beta)R_{m_{1,h}}^{f_{1,l}} = kR_{m_{2,l}}^{f_{1,l}} = krR_{m_{2,h}}^{f_{1,l}} = \beta U_{f_{2,l}}$$

$$k(1+\beta)R_{m_{1,l}}^{f_{1,h}} = k(1+\beta)R_{m_{1,h}}^{f_{1,h}} = kR_{m_{2,l}}^{f_{1,h}} = krR_{m_{2,h}}^{f_{1,h}} = \beta U_{f_{2,h}}$$

The resulting reaction functions are as follows:

$$R_{f_{1,l}}^{m_{1,l}} = \beta\eta_m p_{m_{1,l}} \frac{p_{f_{1,l}}(1-R_{m_{2,l}}^{f_{1,l}})k + p_{f_{1,h}}(1-R_{m_{2,l}}^{f_{1,h}})k + p_{f_{2,l}}(1-R_{m_{2,l}}^{f_{2,l}}) + p_{f_{2,h}}(1-R_{m_{2,l}}^{f_{2,h}})r}{2k(1+\beta)}$$

$$R_{f_{1,h}}^{m_{1,l}} = \beta\eta_m p_{m_{1,l}} \frac{p_{f_{1,l}}(1-R_{m_{2,l}}^{f_{1,l}})k + p_{f_{1,h}}(1-R_{m_{2,l}}^{f_{1,h}})k + p_{f_{2,l}}(1-R_{m_{2,l}}^{f_{2,l}}) + p_{f_{2,h}}(1-R_{m_{2,l}}^{f_{2,h}})r}{2k(1+\beta)}$$

$$R_{f_{2,l}}^{m_{1,l}} = \beta\eta_m p_{m_{1,l}} \frac{p_{f_{1,l}}(1-R_{m_{2,l}}^{f_{1,l}})k + p_{f_{1,h}}(1-R_{m_{2,l}}^{f_{1,h}})k + p_{f_{2,l}}(1-R_{m_{2,l}}^{f_{2,l}}) + p_{f_{2,h}}(1-R_{m_{2,l}}^{f_{2,h}})r}{2}$$

$$R_{f_{2,h}}^{m_{1,l}} = \beta \eta_m p_{m_{1,l}} \frac{p_{f_{1,l}}(1-R_{m_{2,l}}^{f_{1,l}})k + p_{f_{1,h}}(1-R_{m_{2,l}}^{f_{1,h}})k + p_{f_{2,l}}(1-R_{m_{2,l}}^{f_{2,l}}) + p_{f_{2,h}}(1-R_{m_{2,l}}^{f_{2,h}})r}{2r}$$

$$R_{f_{1,l}}^{m_{1,h}} = \beta \eta_m p_{m_{1,h}} \frac{p_{f_{1,l}}(1-R_{m_{2,h}}^{f_{1,l}})\frac{k}{e} + p_{f_{1,h}}(1-R_{m_{2,h}}^{f_{1,h}})\frac{k}{e} + p_{f_{2,l}}(1-R_{m_{2,h}}^{f_{2,l}}) + p_{f_{2,h}}(1-R_{m_{2,h}}^{f_{2,h}})r}{2k(1+\beta)}$$

$$R_{f_{1,h}}^{m_{1,h}} = \beta \eta_m p_{m_{1,h}} \frac{p_{f_{1,l}}(1-R_{m_{2,h}}^{f_{1,l}})\frac{k}{e} + p_{f_{1,h}}(1-R_{m_{2,h}}^{f_{1,h}})\frac{k}{e} + p_{f_{2,l}}(1-R_{m_{2,h}}^{f_{2,l}}) + p_{f_{2,h}}(1-R_{m_{2,h}}^{f_{2,h}})r}{2k(1+\beta)}$$

$$R_{f_{2,l}}^{m_{1,h}} = \beta \eta_m p_{m_{1,h}} \frac{p_{f_{1,l}}(1-R_{m_{2,h}}^{f_{1,l}})\frac{k}{e} + p_{f_{1,h}}(1-R_{m_{2,h}}^{f_{1,h}})\frac{k}{e} + p_{f_{2,l}}(1-R_{m_{2,h}}^{f_{2,l}}) + p_{f_{2,h}}(1-R_{m_{2,h}}^{f_{2,h}})r}{2}$$

$$R_{f_{2,h}}^{m_{1,h}} = \beta \eta_m p_{m_{1,h}} \frac{p_{f_{1,l}}(1-R_{m_{2,h}}^{f_{1,l}})\frac{k}{e} + p_{f_{1,h}}(1-R_{m_{2,h}}^{f_{1,h}})\frac{k}{e} + p_{f_{2,l}}(1-R_{m_{2,h}}^{f_{2,l}}) + p_{f_{2,h}}(1-R_{m_{2,h}}^{f_{2,h}})r}{2r}$$

$$R_{m_{1,l}}^{f_{1,l}} = \beta \eta_f p_{f_{1,l}} \frac{p_{m_{1,l}}(1-R_{f_{2,l}}^{m_{1,l}}) + p_{m_{1,h}}(1-R_{f_{2,l}}^{m_{1,h}}) + p_{m_{2,l}}(1-R_{f_{2,l}}^{m_{2,l}}) + p_{m_{2,h}}(1-R_{f_{2,l}}^{m_{2,h}})r}{2k(1+\beta)}$$

$$R_{m_{1,h}}^{f_{1,l}} = \beta \eta_f p_{f_{1,l}} \frac{p_{m_{1,l}}(1-R_{f_{2,l}}^{m_{1,l}}) + p_{m_{1,h}}(1-R_{f_{2,l}}^{m_{1,h}}) + p_{m_{2,l}}(1-R_{f_{2,l}}^{m_{2,l}}) + p_{m_{2,h}}(1-R_{f_{2,l}}^{m_{2,h}})r}{2k(1+\beta)}$$

$$R_{m_{2,l}}^{f_{1,l}} = \beta \eta_f p_{f_{1,l}} \frac{p_{m_{1,l}}(1-R_{f_{2,l}}^{m_{1,l}}) + p_{m_{1,h}}(1-R_{f_{2,l}}^{m_{1,h}}) + p_{m_{2,l}}(1-R_{f_{2,l}}^{m_{2,l}}) + p_{m_{2,h}}(1-R_{f_{2,l}}^{m_{2,h}})r}{2k}$$

$$R_{m_{2,h}}^{f_{1,l}} = \beta \eta_f p_{f_{1,l}} \frac{p_{m_{1,l}}(1-R_{f_{2,l}}^{m_{1,l}}) + p_{m_{1,h}}(1-R_{f_{2,l}}^{m_{1,h}}) + p_{m_{2,l}}(1-R_{f_{2,l}}^{m_{2,l}}) + p_{m_{2,h}}(1-R_{f_{2,l}}^{m_{2,h}})r}{2kr}$$

$$R_{m_{1,l}}^{f_{1,h}} = \beta \eta_f p_{f_{1,h}} \frac{p_{m_{1,l}}(1-R_{f_{2,h}}^{m_{1,l}}) + p_{m_{1,h}}(1-R_{f_{2,h}}^{m_{1,h}}) + p_{m_{2,l}}(1-R_{f_{2,h}}^{m_{2,l}}) + p_{m_{2,h}}(1-R_{f_{2,h}}^{m_{2,h}})r}{2k(1+\beta)}$$

$$R_{m_{1,h}}^{f_{1,h}} = \beta \eta_f p_{f_{1,h}} \frac{p_{m_{1,l}}(1-R_{f_{2,h}}^{m_{1,l}}) + p_{m_{1,h}}(1-R_{f_{2,h}}^{m_{1,h}}) + p_{m_{2,l}}(1-R_{f_{2,h}}^{m_{2,l}}) + p_{m_{2,h}}(1-R_{f_{2,h}}^{m_{2,h}})r}{2k(1+\beta)}$$

$$R_{m_{2,l}}^{f_{1,h}} = \beta \eta_f p_{f_{1,h}} \frac{p_{m_{1,l}}(1-R_{f_{2,h}}^{m_{1,l}}) + p_{m_{1,h}}(1-R_{f_{2,h}}^{m_{1,h}}) + p_{m_{2,l}}(1-R_{f_{2,h}}^{m_{2,l}}) + p_{m_{2,h}}(1-R_{f_{2,h}}^{m_{2,h}})r}{2k}$$

$$R_{m_{2,h}}^{f_{1,h}} = \beta \eta_f p_{f_{1,h}} \frac{p_{m_{1,l}}(1-R_{f_{2,h}}^{m_{1,l}}) + p_{m_{1,h}}(1-R_{f_{2,h}}^{m_{1,h}}) + p_{m_{2,l}}(1-R_{f_{2,h}}^{m_{2,l}}) + p_{m_{2,h}}(1-R_{f_{2,h}}^{m_{2,h}})r}{2kr}$$

From the above reaction functions, we obtain

$$\frac{\partial R_{f_{1,l}}^{m_{1,l}}}{\partial k} < 0 \quad \frac{\partial R_{f_{1,h}}^{m_{1,l}}}{\partial k} < 0 \quad \frac{\partial R_{f_{2,l}}^{m_{1,l}}}{\partial k} > 0 \quad \frac{\partial R_{f_{2,h}}^{m_{1,l}}}{\partial k} > 0$$

$$\frac{\partial R_{f_{1,l}}^{m_{1,h}}}{\partial k} < 0 \quad \frac{\partial R_{f_{1,h}}^{m_{1,h}}}{\partial k} < 0 \quad \frac{\partial R_{f_{2,l}}^{m_{1,h}}}{\partial k} > 0 \quad \frac{\partial R_{f_{2,h}}^{m_{1,h}}}{\partial k} > 0$$

$$\frac{\partial R_{m_{1,l}}^{f_{1,l}}}{\partial k} < 0 \quad \frac{\partial R_{m_{1,h}}^{f_{1,l}}}{\partial k} < 0 \quad \frac{\partial R_{m_{2,l}}^{f_{1,l}}}{\partial k} < 0 \quad \frac{\partial R_{m_{2,h}}^{f_{1,l}}}{\partial k} < 0$$

$$\frac{\partial R_{m_{1,l}}^{f_{1,h}}}{\partial k} < 0 \quad \frac{\partial R_{m_{1,h}}^{f_{1,h}}}{\partial k} < 0 \quad \frac{\partial R_{m_{2,l}}^{f_{1,h}}}{\partial k} < 0 \quad \frac{\partial R_{m_{2,h}}^{f_{1,h}}}{\partial k} < 0$$

These imply that the more important it is to have children (higher k), the lower reservation value a young man will set to an young woman than to an old woman, meaning young men prefer young women to old women; the same applies to old men as well. As for young women, the more important to have children, the lower reservation value they would set in order to marry early.

3.5.2 The Relationship Between Demand For Children and Age and Education Gap Between Husbands and Wives

Let $p_{f_1}^{m_2}$ represent the probability that a young woman marries an old man. Let $p_{m_1}^{f_2}$ be the probability that a young man marries an old woman.

$$p_{f_1}^{m_2} = \eta_m \eta_f [p_{f_{1,l}} p_{m_{2,l}} (1-R_{m_{2,l}}^{f_{1,l}}) + p_{f_{1,l}} p_{m_{2,h}} (1-R_{m_{2,h}}^{f_{1,l}}) + p_{f_{1,h}} p_{m_{2,l}} (1-R_{m_{2,l}}^{f_{1,h}}) + p_{f_{1,h}} p_{m_{2,h}} (1-R_{m_{2,h}}^{f_{1,h}})]$$

$$p_{m1}^{f_2}=\eta_m\eta_f[p_{f_{2,l}}p_{m_{1,l}}(1-R_{f_{2,l}}^{m_{1,l}})+p_{f_{2,h}}p_{m_{1,l}}(1-R_{f_{2,h}}^{m_{1,l}})+p_{f_{2,l}}p_{m_{1,h}}(1-R_{f_{2,l}}^{m_{1,h}})+p_{f_{2,h}}p_{m_{1,h}}(1-R_{f_{2,h}}^{m_{1,h}})]$$

$$\frac{\partial p_{f_1}^{m_2}}{\partial k}=-\frac{\partial R_{m_{2,l}}^{f_{1,l}}}{\partial k}-\frac{\partial R_{m_{2,h}}^{f_{1,l}}}{\partial k}-\frac{\partial R_{m_{2,l}}^{f_{1,h}}}{\partial k}-\frac{\partial R_{m_{2,h}}^{f_{1,h}}}{\partial k}>0$$

$$\frac{\partial p_{m_1}^{f_2}}{\partial k}=-\frac{\partial R_{f_{2,l}}^{m_{1,l}}}{\partial k}-\frac{\partial R_{f_{2,h}}^{m_{1,l}}}{\partial k}-\frac{\partial R_{f_{2,l}}^{m_{1,h}}}{\partial k}-\frac{\partial R_{f_{2,h}}^{m_{1,h}}}{\partial k}<0$$

$\frac{\partial p_{f_1}^{m_2}}{\partial k}>0$ implies the greater demand for children, the greater possibility that a young woman marries an old man; $\frac{\partial p_{m_1}^{f_2}}{\partial k}<0$ means the greater demand for children, the lower possibility that an old woman marries a young man. Therefore, the greater demand for children the greater age gap at first marriage between husbands and wives.

Let $p_{f_h}^{m_l}$ represent the probability that a high-educated woman marries a man with low ability or low-educated. Let $p_{m_h}^{f_l}$ represent the probability that a high-educated man marries a woman either low ability or low-educated.

$$p_{f_h}^{m_l}=\eta_m\eta_f[p_{f_{2,h}}p_{m_{1,l}}(1-R_{f_{2,h}}^{m_{1,l}})+p_{f_{2,h}}p_{m_{2,l}}]$$

$$p_{m_h}^{f_l}=\eta_m\eta_f[p_{f_{1,l}}p_{m_{2,h}}(1-R_{m_{2,h}}^{f_{1,l}})+p_{f_{2,l}}p_{m_{2,h}}]$$

$\frac{\partial p_{f_h}^{m_l}}{\partial k}=-\frac{\partial R_{f_{2,h}}^{m_{1,l}}}{\partial k}<0$ (because $\frac{\partial R_{f_{2,h}}^{m_{1,l}}}{\partial k}>0$) implying the greater demand for children, the lower possibility that an old high educated woman marries a man either low ability or low-educated, which will decrease the education gap between husband and wife.

$\frac{\partial p_{m_h}^{f_l}}{\partial k}=-\frac{\partial R_{m_{2,h}}^{f_{1,l}}}{\partial k}>0$ (because $\frac{\partial R_{m_{2,h}}^{f_{1,l}}}{\partial k}<0$) meaning the greater demand for children, the greater possibility that an old high educated man marries a woman either low ability or low-educated, which will increase the education gap between husband and wife. Therefore, the greater demand for children the greater education gap between husband and wife.

We now test these propositions.

4. Stylized Facts Regarding Husband and Wife Age and Educational Differences

Demographers use the singulate mean age at marriage (SMAM) to compute a population's mean age at marriage. The SMAM formulation, developed by Hajnal (1953), uses census type data on the proportion of a population's single people at each age (assuming all first marriages have taken place by age 50). It is the sum, up to age 50, of the difference between the proportion single at age x and the proportion single at age 50 divided by 1.0 minus the proportion single at age 50

$$SMAM = \frac{1}{1 - p_{50}} \sum_{x=0}^{50} (p_x - p_{50}) .$$

Intuitively, this is the weighted average of the ages at which individuals get married up to age 50.

SMAM data are widely available for many countries. In a recent United Nations compilation, the female SMAM varies from 17.6 (Niger) to 31.8 (Sweden) and for men from 22 (Nepal) to 35.4 (Dominica). Typically husbands are older than their wives, but the gender age gap varies widely. In Gambia it is 9.2 years. In San Marino the mean marital age gap is -0.2 years. It is the only country out of 235 where wives are older than their husbands. Africa is the continent with the highest average age gap at first marriage (Table 3). Of the 20 countries with the highest husband-wife age gaps, 16 are in Africa. Africa also has one of the highest fertility levels in the world. Worldwide the average SMAM difference between males and females is around 5 years.

Though the overall fertility level is decreasing worldwide, there are a number of countries experiencing meager declines in fertility. These latter countries constitute 21 developing countries where fertility rates declined by less than one child per woman since 1970. Of these 13 countries are from sub-Saharan Africa. The large age gap at first marriage and the high fertility level in Africa are basically associated with low healthcare conditions and fewer family planning policy controls.

The average SMAM difference between males and females in Asia is around 3 years. Within Asia the age gap at first marriage varies dramatically with a minimum of around 1 year in Myanmar and a maximum of around 7 years in Afghanistan and Bangladesh. Developed countries such as Japan, Korea and Singapore are experiencing low fertility levels due to rapid growth in their economies and religious beliefs that do not necessarily promote fertility. China has reduced her fertility level by 4 children per women since 1970 by taking on family planning policies.

Europe is the continent with lowest SMAM difference between males and females. As mentioned above, the data shows a minimum of -0.2 years in San Marino (meaning that in San Marino wives are actually on average 0.2 years older than their husbands) and a maximum of 4.9 in Greece. North Europe is an area with a low age gap at first marriage and high social welfare.

The SMAM difference is smaller in Latin America and the Caribbean than in Africa or Asia. Similar to the North European countries, there are many consensual unions in this area, therefore, the data may not exactly reflect the true age at first marriage.

The mean age at marriage also varies over time. In the US (Figure 1) male mean age at first marriage was 26.1 in 1890 but dipped to 22.5 in 1956, only to rise again to 26.9 in 2002. For women the mean age at first marriage was 22.0 in 1890, but fell to 20.1 in 1956, and like men rose to 25.3 in 2002. However, interestingly, the husband-wife age gap has not exhibited the same cyclicality, but instead declined relatively steadily from 4.1 in 1980 to 1.6 in 2002.[6] Note, this decline in the husband-wife age gap is consistent with our hypothesis of a direct relation between fertility and the marital age gap.

Historical data for Canada (Figure 2) is very similar to the US. Age at first marriage behaves cyclically. It falls for both men and women until the early 1930s, rises for both until 1940, then falls until the 1970s, and finally rises through the 1990s. As with the US, the husband-wife age gap declined steadily.

Swedish historical data indicate a slightly different pattern (Figure 3). The SMAM is cyclical as observed above, but the husband-wife age gap rises and wanes, peaking in 1760, 1790, 1830, with a low in 1854, and then rising to about 2.1 years at least until 1880.

Reaching conclusions about age at marriage based solely on data from the last five decades may lead to misleading inferences. For example, typical marriage models argue age at marriage to be related to the demand for children. As evidence, they claim the currently rising age at first marriage trend is consistent with the decline in fertility. However, as exhibited above, as well as in Figures 1-3, age at first marriage has *not* risen steadily despite steady declines in fertility. To illustrate, U.S. fertility declined since 1800 from 7.04 (births per 1000 woman) to 2.22 in 1940. Yet the age at marriage *declined* (not rose) more or less steadily during this time period. From 1960-1990, age at first marriage rose dramatically, but fertility rates declined *modestly* from 2.98 to 2.00 (when compared to the gigantic 1800-1940 decline). In short, the cyclicality in age at marriage does not mirror the more or less monotonically declining time trend in fertility, as argued by many theories of marriage.[7] On the

[6] This pattern is consistent with Rolf and Ferrie (2008) who examine three other measures of age homogamy besides the average husband-wife age gap we adopt in this paper.

[7] Early studies on the gender wage gap suffered from a similar fault. These studies all relied on 1960-1980 U.S. Census and Survey of Economic Opportunity data. Using these data researchers concluded a constant male-female wage gap because women earned roughly 59 cents on the dollar throughout this time period. It was not until

other hand, historical patterns indicate the husband-wife age *gap* has narrowed as fertility rates declined. This pattern is easily seen in Figures 1 and 2, but not so easily in Figure 3. Thus, later in the paper (Section 5.3), we utilize the data from Figure 3 along with information on birth rates to show our theory to be consistent with Swedish long-term historical data, as well.

We have not found long-term data on husband-wife educational differences. However, there are international data on overall male-female educational differences that can be culled from the World Resources Institute EarthTrends website.[8] We summarize these in Table 3 along with the data on the husband-wife age gap based on United Nations SMAM data. These educational differences go from a 1.7 male advantage in Middle Africa to a 1.58 female advantage in Northern Europe. In the US married women now have a .67 year advantage. According to our theory both husband and wife age and educational differences should be positively correlated if the underlying factor determining each is related to fecundity. To the extent the schooling differences we observe reflect husband-wife mean levels of education, we should see a positive correlation across regions, and we do ($\rho = .73$). Those regions with high fertility have both a high husband-wife age gap as well as a large gap in schooling between men and women. This significant positive correlation is also illustrated in Figure 4.

5.0 Empirical Strategy

Goldin's (1990) book along with an examination of post -1980 data that scholars found out women's wages increased secularly, with 1960-1980 being the exception.

[8] EarthTrends's website is: http://earthtrends.wri.org. Information on female and male education levels can be found at:
http://earthtrends.wri.org/searchable_db/results.php?years=all&variable_ID=1116&theme=4&country_ID=all&country_classification_ID=all
and
http://earthtrends.wri.org/searchable_db/results.php?years=all&variable_ID=1117&theme=4&country_ID=all&country_classification_ID=all.

Our empirical strategy is to find statistical evidence supporting our two main theorems. We seek confirmation (1) that husband-wife age differences are positively related to fertility, and (2) that husband-wife educational differences are positively related to fertility. To substantiate these propositions, we adopt a four pronged approach. First we examine *cross-country* evidence utilizing a number of data sets; second, we employ *cross-individual* evidence based on the US Panel Study on Income Dynamics (PSID); third, we look at *historical* evidence using 18th century Swedish data; and finally fourth, and most compelling, we explore evidence based on a *natural experiment* using Chinese data from before and after the "one-child" law China instituted in 1980. As will be seen, each supports the theoretical proposition that age and educational differences are positively related to number of children. Whereas any *one* of our empirical tests may have shortcomings, taken together they yield consistent and comprehensive support especially given the differences in approach of each methodology and each data set.

5.1 Cross-Country Analysis of the Marital Age Gap

One way to test our propositions concerning husband-wife age and educational differences is to use cross-country international data. If our model is accurate, countries with the highest fertility rates should exhibit largest husband-wife age gaps and husband-wife educational differences. To test this we run two sets of regression analyses. One examines husband-wife age differences and the other cross-country variations in male and female schooling levels.[9] Both contain fertility as well as control variables to adjust for measureable country-specific heterogeneity. Also because fertility might be caused by husband-wife age and educational differences in the first place, we repeat both analyses using a simultaneous equations framework. Given that some religions are more pro-natalist than others, and given that children

[9] Note because of the unavailability of husband-wife data (only for this cross-country analysis) we substitute data for overall male-female educational differences. As will be explained, in the empirical work we attempt to get around resulting biases by adjusting for marital differences in each country.

are valuable on the farm, we instrument fertility using religion and the proportion of a country's economy devoted to agriculture. Arguably, both factors are determined long before families make decisions concerning number of children. At the same time, it is not obvious either religion or agriculture determine spousal age or educational differences.

To our knowledge there is only one cross-country analysis of the gap in husband and wife age and education. Groot, Maassen and Brink (2002) look at the effect spousal age and educational differences have on happiness. They find that a positive age gap between husband and wife increases both male and female life satisfaction, whereas female life satisfaction increases if the education gap is smaller; but this study does not examine the root causes of why husbands are older and more educated. Saardchom and Lemaire (2005) look only at age differences. They do a sociological study which estimates the correlation between economic modernization (GDP per capita, percentage of GDP from the services sector, persons per car, and the percentage of individuals who have access to safe water) and education (literacy rates and school enrollments). Jointly, both these factors (economic modernization and education) significantly delay female marriages and reduce the gender age difference at marriage[10]

5.1.2 Data Sources and Definitions

Our study compiles data from the World Bank's *World Development Indicators 2006*, the World Bank's, *World Marriage Pattern 2000*, from United Nations *World Fact Book*, from the UNESCO Institute for Statistics, and the US CIA website

[10] A number of studies examine marriage probabilities. Such studies necessarily have implications concerning age at marriage. For example, Kalmijn (2007) finds that gender roles, secularization, unemployment, and educational expansion are important for understanding differences among countries. Stevenson and Wolfers (2007) examine changes in wage and legal structures structure. They argue that the increasing US wage structure raises the importance for "searching for Mr. Right" (Gould and Paserman, 2003) thereby delaying the age at first marriage, whereas as the current trend of rising female labor force participation leads to "increasingly sexually integrated workplaces" (McKinnish, 2007) which creates more opportunities for men and women to meet. However, our interest is not age at marriage, but the husband-wife age *gap*. *Differences* in husband-wife attributes motivate division of labor in the home, and not each spouse's attribute levels, per se.

(www.cia.gov). The variable names and summary statistics are given in Appendix Table A.1.

The age gap at first marriage is measured by differences in male and female SMAM. The gender education gap is measured as the difference in mean levels of education between men and women in each country. Unfortunately, these educational differences reflect schooling differences within the entire population and not simply those married. Such schooling measures would not be a problem if married men and women had the same education as single men and women, but this is not the case. According to our theory high educated women are more likely to remain single. Nor would these measures be a problem if 100% of the population married, but again this is not the case either, since not everyone marries. Though the mean marriage rate is 93%, the proportion married is as low as 52% in Jamaica, 60% in Grenada, and 63% in Barbados. To help alleviate the problem, we adjust the educational difference analysis by incorporating the proportion married in each country into the analysis. This is not necessary for the age gap analysis since SMAM differences measure the age gap in marriage.

5.1.3 Empirical Specification and Estimated Results

Before specifying the multivariate framework to test our propositions, it is useful to examine the simple bivariate relationships between fertility and the husband-wife age gap and the educational difference data. These are given in columns1 and 4 of Table 4 and in Figures 5 and 6. In each case strong positive relationships between the gender SMAM age gap and fertility and the gender educational differences and fertility emerge.

Our more detailed econometric specifications estimates age and educational differences based on two basic regression specifications. The first examines the average husband-wife age gap in country *i* as a function of fertility in country *i*, holding other country attributes (X_i) constant.

$$Agegap_i = \beta_0 + \beta_1 Fertility_i + \beta_2 X_i + \varepsilon_i \,. \qquad (1)$$

As mentioned above, $Agegap_i$ is the SMAM difference between men and women in country *i*. The control variables X_i hold constant each country's level of development so we can account for at least some aspects of measureable heterogeneity.[11] These include gross domestic product per capita, population, and the population's sex ratio, as indicated in the notes of Table 4. The second specification examines the average schooling differences by gender in country *i* ($Educgap_i$) as a function of fertility, holding other country *i* attributes (X_i) constant

$$Educgap_i = \beta_0 + \beta_1 Fertility_i + \beta_2 P_i^M + \beta_3 P_i^F + \beta_4 X_i + \varepsilon_i \qquad (2)$$

where P_i^M and P_i^F represent the proportion of men and women married.

Our theoretical model espouses a positive relationship between the husband-wife age gap and fertility. Thus we predict a bigger age gap in countries where children are more prevalent, all else constant. The same is true for husband-wife educational differences. Based on the single equation specifications, we find that each extra child per woman is associated with about a 0.36-0.60 year larger husband-wife age gap and about a 0.4 year extra schooling advantage for males. With the exception of the proportion of men married (in the education gap regression) which predictably is significantly positive, the other independent variables turn out statistically insignificant. Adding an African categorical dummy variable to get at the greater demand for children African nations have to compensate for their high infant mortality rates yields a significantly positive coefficient (not shown). Similarly adding a variable measuring the proportion of GDP emanating from agriculture to get at the higher demand for children in agrarian societies, yields positive coefficients on both age and education differences. In a similar vane, religion dummy variables for Islam

[11] The lack of time-series data preclude our ability to adjust for unobserved heterogeneity. Besides the annual time-series data for these variables necessarily change too slowly to obtain meaningful results.

and Catholicism reflect the positive impact of pronatalist philosophies. Further because multicollinearity may exist if a number of the variables capture similar information, we computed VIF diagnostics for each coefficient. All VIF values turned out less than 10 implying a tolerance greater than 0.1 for each coefficient.

Two-stage least-squares estimation (columns 3 and 6) yield comparable results. Fertility rates instrumented by religion and the proportion of an economy devoted to agriculture yield a similar positive relationship with both age and educational differences. Here a country with one extra birth per woman is associated with a 0.336 year higher husband-wife age spread and a 0.4 year larger gender education gap. These patterns are consistent with the theory we exposited concerning how asymmetric fecundity horizons explain why older men tend to marry younger women and why also the husband-wife educational gap is positively related to desired fertility.

At least two problems mar cross-national results. First, the education data do not specifically measure husband-wife differences. Although adjusting by the proportion married mitigates the problem, it is not clear that this approach completely solves the mismeasurement problem for married couples. Second, fertility rates similarly apply to the country as a whole and not solely to married couples. Thus these fertility measures also can be biased if for example there is a high proportion of out-of-wedlock births. For these reasons it makes sense to try another approach to further substantiate the theoretical predictions. One such approach is to use individual family data containing specific information pertaining to husbands and wives. In the next section, we do so using the U.S. Panel Study of Income Dynamics. These data contain ages, schooling levels, fertility, and other associated demographic characteristics for each spouse.

5.2 US Cross-Sectional Data from the PSID

This section presents a cross-sectional analysis. It constitutes an examination parallel to the cross-country analysis, just presented above. However, it uses the family as the unit of observation instead of countries, which were the units of observation in the last section. As in the previous section, we begin with a simple graphical analysis showing how husband-wife age and educational differences rise with number of children. We follow this with multivariate single equation and simultaneous equations models. We end the section with fixed-effects estimates comparing second to first marriages to get at unmeasured individual heterogeneity. As before, we seek to examine whether husband-wife age and educational differences are related to completed number of children.

As is well known, the PSID is a nationally representative database. It contains information on families and family members pertaining to marriage, children, income, education, occupation and other labor market and demographic variables. The family file consists of information pertaining to the family unit, particularly the head and head's spouse. The individual file contains such basic information as birth date, level of education completed (up to the point in time when the survey was taken), as well as other labor market variables. Each respondent can be identified by a family ID and a person number in each year of the survey. At this stage, we focus on married once intact husband-wife families, then later in this section we deal with second marriages compared to first.

For comparability we adopt a similar statistical model as used in the previous section detailing our cross-national analysis. As such, we exploit both single equation and simultaneous equation models using essentially the same type demographic variables. Therefore, the two dependent variables we selected are: (1) ***the age gap between husband and wife,*** which we calculated as the difference between age at first marriage of the head and the age at first marriage of the wife; and (2) ***the husband-wife education gap***, which we computed as the difference in husband's and wife's years of schooling completed. As such, we rule out examining single parent families which include female-head family with no partner and male-headed families with no wife. Thus our study focuses primarily on traditional families with a male head and a female wife, both of whom married only once. However, to get at issues concerning unobserved heterogeneity, we also consider a sample of families whose head (husband) has married twice. Same-sex marriage and cohabitation are not considered. Our main explanatory variable is the ***number of children born to the family***, but we adjust for other demographic and economic variables, as well. The completed number of children variable is used exogenously and predicted endogenously employing religion and each spouse's number of siblings as instruments. To get at completed fertility we concentrate on households containing wives over 45 years old. Summary statistics for the PSID variables used in the analysis are given in Appendix Table A.2.

Before presenting the estimation model, it is instructive to examine the data graphically (Figure 7) to see in broad terms if they fit the hypotheses generated by the theory. To do so, we average husband-wife age and educational differences for (married once) households containing one, two, three, four, five, six and seven children. To measure completed fertility we limit the analysis to households where the wife is over 45 years old.[12] As can be seen, both relationships are positive. A larger number of children is associated with larger husband-wife age and educational differences. The slope of the age-gap curve is 0.27 meaning each extra child is associated with about a ¼ year larger husband-wife age disparity. The slope of the education gap with respect to number of children is 0.06.

Next we run regression models based on (1) and (2) which estimate the difference in husband-wife ages and schooling levels as a function of the number of children holding constant aspects of measureable heterogeneity

$$Agegap_{ij} = \beta_0 + \beta_1 Children_{ij} + \beta_2 Children_{ij}^2 + \beta_3 X_i + \beta_4 X_j + \varepsilon_{ij} \qquad (3)$$

[12] When we use the whole PSID sample includes wives under 45 years old who have not necessarily completed their fertility, we also find a positive relationship between husband-wife age gap and the number of children, but a statistically insignificant relationship with respect to educational differences.

and

$$Educgap_{ij} = \beta_0 + \beta_1 Children_{ij} + \beta_2 Children_{ij}^2 + \beta_3 X_i + \beta_4 X_j + \varepsilon_{ij} . \qquad (4)$$

The subscript *i* refers to the husband and *j* to the wife. We include a linear and quadratic term for number of children to get at possible nonlinearities of the effect of children. Included in X are husband and wife siblings, husband and wife religion, and current husband and wife labor market variables. As with the cross-national analysis we estimate (3) and (4) treating completed fertility both as an exogenous and endogenous variable. The results are in Table 5.

Columns 1-6 contain results for the husband-wife age gap and columns 7-12 the education gap. The bivariate results indicate a 0.27 year marginal impact per child on the husband-wife age gap (column 1) and a 0.12 year marginal impact on the husband-wife educational difference (column 7). Both confirm the positive 0.26 and 0.06 slopes observed Figure 7, though our new estimate for the relationship between children and educational differences is about double. Taking into account nonlinearities, the slopes of the age gap - children and the education gap - children relationships increase to 0.37 and 0.15 respectively (columns 2 and 8). Adding adjustments for measureable heterogeneity decreases these marginal effects of children to between 0.17 and 0.24 for the age gap (columns 3 and 4) and to 0.08 and 0.11 for the educational gap (columns 9 and 10). These results are robust to various heterogeneity adjustments.

Causality might be even more relevant when using families as the unit of observation than countries (as in the previous section). First, marriage occurs long before completed fertility. The fact marriage precedes fertility enables one to argue that variations in cross-household marital patterns such as differences in husbands' and wives' age and education potentially induce variations in fertility, rather than the reverse. Second there is a whole literature beginning with seminal work by Becker

(1960) and Willis (1973) that opportunity costs affect fertility. Here again, one might suspect age and education to determine fertility since each affects wage and the value of time. Of course, the argument against a causality bias is we use age and educational *differences* rather than age and educational *levels*. Nevertheless, husband-wife differences in age and education reflect potential household specialization, so relative opportunity costs *can* still be a consideration, again leading to concerns about causality. As such, husband-wife age and educational differences can possibly affect a family's fertility decisions since both affect relative husband and wife opportunity costs. As such, one may be wary of the single equation results since they may contain a simultaneous equations bias.

Normally one can use time-series panel data to test for causality by determining whether one variable preceded another. Such Granger causality-type tests are not an option for married-once husbands and wives simply because within marriage husbands and wives cannot change their age gap. The age gap is simply constant throughout the marriage. Thus we must rely on cross-sectional simultaneous equations estimation to account for this simultaneity.[13] To get at simultaneity, we need some variables that affect household number of children without affecting husband or wife age or educational differences. As was the case with the cross-country analysis described in the previous section, religion is the obvious candidate. Certain religions are known to be pronatalist, and religion is clearly exogenous since it is usually passed on from parents at birth long before fertility decisions are made. Since it is well known that individual tastes are in part determined by nurture, another exogenous variable candidate is the number of each spouse's siblings. Number of siblings is determined by each spouse's parents and parental behavior can mold the behavior of their children. Thus a child coming from a family with a lot of children might likely have a lot of children, as well. Further, as with religion, number of brothers and sisters is determined long before one's own fertility

[13] Relative husband-wife education levels can change, but these are relatively infrequent. Later we will make use of second marriages to show how these gaps widen in second marriages when the number of children rises.

decisions are made, and thus number of siblings is exogenous to the individual. At the same time, it is not obvious that religion or spousal siblings directly affect husband-wife age and educational differences. For these reasons we choose each spouse's religion and number of siblings to identify fertility decisions. In short these "first generation" variables determine "second generation" outcomes.

Columns 5 and 11 provide these simultaneous equations results. Again we observe a positive relationship between children and the husband-wife age and educational gaps. Here each additional child is associated with a 0.67 year larger age gap and a 0.56 year larger educational difference. A Wu test indicates the new coefficients to be significantly different from OLS so as not to rule out endogeneity. These latter figures are surprisingly similar to the cross-national results of Table 4.

One pitfall is cross-sectional data may contain unobserved individual heterogeneity. Individual heterogeneity implies that unmeasureable individual characteristics may affect husband and wife age and schooling differences, rather than both these differences being determined by the expected number of children both spouses desire. The common approach to get at individual unobserved heterogeneity is to utilize panel data to estimate changes in the dependent variable associated with changes in the independent variables, holding unmeasurable characteristics constant (providing these unmeasurable variables do not change overtime). But in our context taking first differences is tricky because as already mentioned the husband-wife age gap does not change from year-to-year (and similarly the husband-wife education gap rarely changes, as well). On the other hand, both these variables can change when a marriage ends and a new one begins. Thus one can hold constant unobservable individual characteristics by comparing a spouse's second (or higher order) marriages to his or her first marriage. Obviously, in a world of no-divorce, marriage would be a one-time decision with no opportunities to observe changes in these relevant variables. However, with divorce one can get at such unobserved heterogeneity by examining differences in age and educational gaps in second compared to first marriages.

To get at these unobserved heterogeneity biases, we pull off couples from the 2003 PSID data who were married twice. We then can compare age and educational differences between these couples' first and second marriages. Again, we concentrate on couples over age 40 to get at completed fertility, and again we expect both the age and education gaps to be higher in the second marriage than the first if number of children increase in the second marriage.[14] To test this, we extract all husbands married twice in the 2003 PSID for whom we could identify characteristics of the first and second wife.[15] This amounted to a sample of 84 husbands. We then regressed the change in marital age and educational differences between the second and first marriages against the increase in the number of children from the second compared to the first marriage. As such, unobserved husband characteristics are held constant. This yielded positive coefficients for each (Columns 6 and 14 of Table 5, labeled FE). A one child increase was associated with a 2.6 larger age gap and a 0.36 larger education gap.

In summary, data from the PSID verify that in the US, families with more children are associated with a greater husband-wife age gap. The same holds true of husband-wife educational differences. One extra child implies about a .446 year spousal age gap, and about a decrease in the spousal education gap by about .23 years. This is true when children are measured exogenously as well as endogenously using religion and number of siblings as instruments.

5.3 Swedish Historical Data

Another approach to give credence to the hypotheses that desired fertility is related to husband-wife age differences is to use historical data. As was the illustrated in Section

[14] We lowered the cutoff wife's age from 45 to 40 to assure a sufficient sample given the smaller number of those married twice in the data compared to those married once.

[15] We pull off husbands so we can get the associated data on wives. Pulling off wives in second marriages would not easily permit us to obtain associated information on the husbands.

4, SMAM statistics are available historically for a number of countries. Of these, the earliest data we found was for Sweden from 1740 through the 1800s. First, we describe how the data were obtained, then second, we describe how we use them to corroborate our hypotheses.

Christopher Lundh, a Swedish demographer, compiled comprehensive historical data on age at first marriage. He did so by calculating the SMAM from yearly population tables reconstructed in 1907 by Gustav Sundbärg (1907). Age at first marriage follows a cyclical pattern for Sweden, as it does for Canada, the US and other countries; but as already mentioned, unlike the US and Canada, the age gap is not monotonically declining, which further makes Sweden an interesting case study to analyze. In addition, Lundh (2001) extended these data to obtain SMAM for various regions of Sweden from 1750-1900. Following Lundh, Tommy Bengtsson and Patrick Svensson (2002) produced historical demographic data for Scarria, the most southern Swedish province. Combining Lundh's results with Bengtsson and Sundbärg's data yield another finding consistent with our hypothesized positive relation between children and the husband-wife age gap. Unfortunately, to the best of our knowledge historical gender-specific literacy rate data are not available to corroborate the effect of children on husband-wife educational differences.

First it is well known that rural areas are agricultural and urban areas are not. It is also well known that fertility rates are higher in agricultural areas. If our theory is correct the age gap in agricultural areas should exceed the age gap in urban areas (Self, 2008). For example, the 1992 urban SMAM age gap in West Bengal is 5.8 whereas the rural SMAM age gap is 6.9. The mean family size is respectively 4.6 in urban and 5.1 in rural West Bangalian areas.[16] In Thailand in 2001 rural grooms are 4.3 years older than brides whereas in urban areas grooms are only 2.0 years older (Napaporn Chayovan and Noriko Tsuya (2003). Lundh presents urban-rural results for four areas of Sweden. As indicated in Table 6, the results for Sweden between 1880 and 1900 are

[16] http://www.nfhsindia.org/data/wb/wbchap2.pdf

similar. In rural areas husbands' ages exceeds wives' by about 0.7 years in each Swedish region. This is consistent with a higher demand for children motivating a wider husband-wife age gap.

Second, combining the Lundh (2001) and Bengtsson-Svensson (2002) data sets yields historical time-series data on spousal age differences and birth rates. If it is true that birth rates mirror the demand for children, then one can test our hypothesis by comparing how birth rates and spousal age gaps change over time. Presumably increases in birth rates should be positively correlated with increases in the spousal age gap, providing Bengtsson-Svensson's Southern Sweden birth rate data emulate Sweden as a whole. To test this we first difference the age gap and birth rate data to concentrate on changes. Next we smooth the data somewhat by taking two-year moving averages. Both data sets are plotted in Figure 8. Finally, we regress the change in fertility on the change in the husband-wife age gap (with and without a constant term). Both regressions (Table 7) yield a 0.58 coefficient indicating that an increase in fertility by one child is associated with a rise in the husband-wife age gap by about 0.6. Surprisingly, this 0.6 is identical to the 0.60 estimate obtained in the cross-national regressions (Table 4) earlier in the paper, and between the 0.27 and 0.92 estimate obtained in Table 5 for US micro-data. Experimenting with various lag structures did not yield indications of causality. Thus in the next section we use Chinese data based on a natural experiment to yield compelling results.

5.4 China as a Natural Experiment

5.4.1 Introduction

Perhaps a natural experiment coming about from China's "one-child" policy yields the most persuasive evidence that husband-wife age and educational differences are associated with the demand for children. As is well known, China adopted a law in 1980 essentially outlawing more than one child per family. The law effectively decreases the demand for children. As such, China's 1980 legislation permits one to study marital patterns before and after the law went into effect. To better understand why this is an ideal natural experiment enabling us to treat the law as an exogenous event we give a history of the one-child policy. Following this history, we describe the relevant data and outline the difference-in-difference approach we use to measure the law's impact.

5.4.2 A Simple Summary of China's Family Planning Policy

In the 1950s, Mao Zedong urged the Chinese people to procreate in order to strengthen the country. In 1949, the population on the mainland was only about 542 million. However, under the slogan "more people more power" China's population grew rapidly increasing to about 807 million by 1969. In 1970s when the baby boomers of the 1950s and 1960s were entering their reproductive years, the Chinese government viewed strict population containment as essential to alleviate social, economic, and environmental problems. At that time, a birth control campaign was launched by the central government advocating each citizen delay marriage, have fewer births, and space children widely apart. The policy was not compulsory but nevertheless had a moderate effect decreasing fertility from 5.8 per woman in 1970 to 2.8 in 1979, but still well above the replacement rate. For that reason, by the end of 1970s, it was replaced by legislation directly targeting the number of children per family. The Chinese National People's Congress proposed the "family planning policy" in its third session of the fifth National People's Congress in September 1980.

Contrary to popular belief, this so-called "one child policy" isn't completely a one child per family policy. In the early 1980s, the central government advocated one child per family in urban areas. For rural area couples, one child was deemed impractical because it caused difficulties particularly in agriculture; therefore, the law was tailored in 1984 to meet the living needs of people in different regions of the country. Provinces and autonomous regions decided specific family planning measures and regulations for minorities in accord with local conditions. As such, in many rural areas, couples were eligible for having two children if their first child was a girl. In some communities, all couples were eligible for having two children. Couples of national minority groups could also be eligible for having two children, and could even be completely exempted from the "one child policy" in some communities such as Tibet.

To put meat on the policy, so to speak, and make it more effective, one child families were rewarded while violators were punished. The rewards generally included subsidies and the punishments usually entailed levying fines on above-quota-births. Because the overall amount of subsidies were limited, the reward was less effective than the punishment, especially in rural areas. As a result, the family planning policy rapidly changed the Chinese population structure and traditional family composition. Since the implementation of the family planning policy from the end of 1970s, China's female TFR (Total Fertility Rate) decreased from 5.80 in the 1970s to 1.33 by 2005 (2005 National 1% Population Sample Survey of China). Since rural fertility was initially higher in the first place, rural fertility declined at a greater pace than urban fertility (though there may be some bias in this comparison because of the hukou system of classifying residence). Taking China's experience as a case study, a natural experiment seems logical given the relatively rapid and unexpected change in policy from Chairman Mao's pronatalist "more people more power" to the 1980 "one child' policy.

Of course, during this time period, fertility rates in the rest of the world also decreased; but Chinese fertility decreased more rapidly. This greater fertility decline in China makes the law exogenous and unexpected in the sense that Chinese fertility behavior differed from the rest of the world. In addition, China's fertility trend differed from India, also a high population country very similar to China with regard to development and growth. Figure 9 best illustrates these trends. World fertility declined modestly from 1955-1970 as did India's. China's fertility, on the other hand, increased slightly given Chairman Mao's edict to increase birth rates. From 1970-2005 world and Indian fertility rates declined at a slightly faster rate than between 1955-1970. In contrast, China's fertility rate declined more quickly from 1970-1990, then from 1990 conformed more to the world and to Indian trends. In short, China's fertility rate differed from the rest of the world, as well as from India. Instead it conforms to expectations based on unique government pro then anti-natalist policies, thus making China an ideal case study for a natural experiment.[17]

5.4.3 Data Source and Definitions

To conduct our empirical analysis, we extract marriage、fertility and education data from the China Health and Nutrition Survey (CHNS). The CHNS is funded jointly by the Carolina Population Center at the University of North Carolina at Chapel Hill, the National Institute of Nutrition and Food Safety and Chinese Center for Disease Control and Prevention. The China Health and Nutrition Survey (CHNS) was designed to examine the effects of the economic, health, nutrition, and family planning policies and programs implemented by national and local governments to see how the social and economic transformation of Chinese society is affecting the economic, demographic, health and nutritional status of its population. The survey contains a sample of about 4400 households with a total of 19,000 individuals in nine provinces. Although the CHNS sample is not nationally representative, it covers both less developed mountain provinces such as Guizhou and Guangxi, and developed coastal provinces such as Jiangsu and Shandong. The survey was first conducted in 1989; follow-up surveys were carried out in 1991, 1993 1997, 2000, 2004 and 2006.

Our analysis is primarily based on the 1993 survey for it has several advantages over other years' surveys, but as will be explained we also use other years' information, as well. First, the total number of children born can only be accurately constructed from the survey of ever married women (SEMW), which was begun in 1993. Follow-up surveys were carried after 2000. Second, the 1993 survey has enough individuals who married before 1979 to enable us to analyze how the one

[17] See McElroy and Yang (2000) who find similar effects of the Chinese government's policies regarding fertility.

child policy affected husband-wife age gap.

The SEMW contains information on all live births for ever-married women aged under 52 in the 1993 survey. We use the total number of children a woman gave birth to until 1993 to measure her fertility rate. We view the fertility rate as a proxy for the real demand for children, given that a greater fertility rate is indicative of a higher demand for children. Husband-wife age and educational differences are easily computed given we have individual data. We present descriptive statistics in Appendix Table A.3. As argued in the previous sections, because the demand for children is smaller in urban than rural areas and because urban areas might be affected differently by the one-child law, we present one column for rural areas and another for urban areas. We see rural residents have more children than urban dwellers, and at the same time we observe rural residents to be less educated and marry younger. The husband-wife education gap is larger in rural areas as expected, but the husband-wife age gap is not. Nevertheless, plotting husband-wife age and educational differences by number of children yield the predicted positive slope in both rural and urban areas (Figures 10 and 11).

5.4.4 Empirical Methods

Our empirical approach is two-pronged. First, we show fertility is positively related to husband-wife age and educational differences. Second, because of some issues regarding causality raised in the previous sections, we examine age and educational differences before and after China's "one child" policy. In doing so, we examine the raw data before and after the policy change for rural and urban areas first using descriptive statistics, second using a regression framework, and third using difference-in-difference estimation.

First we test whether fertility and husband-wife age and educational differences are related. To do so, we adopt the following model

$$Agegap_i = \alpha_0 + \alpha_1 fertility_i + \varepsilon_i \qquad (5)$$

$$Educgap_i = \beta_0 + \beta_1 fertility_i + \varepsilon_i \qquad (6)$$

where *i* depicts the individual family. As in previous sections we predict $\alpha_1, \beta_1 > 0$. These results are given in columns (1) and (4) of Table 8. As predicted we observe a positive sign between fertility and both husband-wife age and educational differences. The higher the number of children, the bigger the age gap and the larger are husband-wife educational differences. These results are consistent with Figure 10 and 11 alluded to above.

To identify the impact of the one child policy, we divide the data into three groups depending on marriage date: couples married before 1979 which were not affected by one child policy; couples married after 1985 which were affected by one child policy and couples married between 1979 and 1985 which are assumed partly affected by one child policy.[18] See Table 9. Since the Chinese government implemented a different one child policy in rural and urban areas, we also divide all samples by their place of household registry (known as hukou), and use difference-in-difference estimates to prove that the one child policy had different effects on fertility between rural and urban areas.

First we identify the impact of the one-child policy on fertility. We employ the following regression

$$Fer_i = \gamma_0 + \gamma_1 \mathrm{Pr}\, e_i + \gamma_2 Post_i + \gamma_3 Rural_i + \gamma_4 (Post \cdot Rural_i) + \varepsilon_i \qquad (7)$$

The variable $\mathrm{Pr}\,e$ indicates whether the couple married before 1979 and *Post* indicates the couple married after 1985. Observing $\gamma_2 < \gamma_1$ implies the policy decreased fertility. The variable *Rural* indicates a rural household. The coefficient

[18] Based on Figure 9 we also redid the analysis redefining the Pre and Post variables to be Pre1970 and Post 1970 to reflect the fact that anti-natalist policies actually began in 1970 with the less formal "Birth Control Campaign." Also to distinguish the "Birth Control Campaign" from the "One-Child Policy" we performed additional analysis with a set of categorical dummy variables: Pre-1970, 1970-1980, 1980-1990, and Post-1990. Each of the results turned out comparable. Thus here we only present the pre- and post- one-child law since these results are the easiest to exposit.

on the interaction between *Post* and *Rural* estimates the difference in the one child policy between rural and urban areas. A negative γ_4 implies a bigger effect in rural areas where fertility rates were initially highest. Because the one child policy allows rural families to have more children than people urban families, the sign of the coefficient of γ_3 can be positive or negative.

If, as we expect, the one child policy is related to fertility, one could go on to test whether the husband-wife age and education gaps change, as well. These specifications are given as

$$Agegap_i = \alpha_0 + \alpha_1 \Pr e_i + \alpha_2 Post_i + \alpha_3 Rural_i + \alpha_4 (Post \cdot Rural_i) + \varepsilon_i \quad (8)$$

$$Educgap_i = \beta_0 + \beta_1 \Pr e_i + \beta_2 Post_i + \beta_3 Rural_i + \beta_4 (Post \cdot Rural_i) + \varepsilon_i \quad (9)$$

The underlying variables and underlying logic are the same. The effect of the one child policy on the husband-wife age and education gaps can be estimated by comparing the changes in the husband-wife age gap and the education gap before and after the implementation of one child policy between the areas which are differently affected by the one child policy. Indeed one can surmise age and education gaps are affected by the one-child law if we find the α and β coefficients mirror the γ coefficients. In other words, a higher (in absolute value) $\gamma_2 - \gamma_1$ should imply a larger $\alpha_2 - \alpha_1$ and $\beta_2 - \beta_1$. In addition, rural areas should exhibit a decrease in the age and educational gaps if fertility there decreases more.

5.4.5 Empirical result

Columns 2,3,4, and 5 of Table 8 contain the regression results. Begin with the effect on fertility. Clearly $\gamma_2 - \gamma_1$ shows a statistically significant 1.18 decline in urban fertility. This decline in fertility virtually equals the 1.16 (2.34-1.18) births per woman unadjusted (for other variables) figure given in the descriptive statistics Table 9. Similarly the -.31 post-law*rural interaction term implies a 0.31 birth per woman greater decline in fertility in rural compared to urban areas. Again this is about equal the 0.34 [(2.97-1.47)-(2.34-1.18)] amount implied by Table 9.[19]

Column (3) gives the results for the husband-wife age gap regression. Again the difference ($\alpha_2 - \alpha_1$) is statistically significant (though α_2 is not) indicating a decline in the age gap of about 0.65 years which is about half the value indicated in Table 9. The coefficient on the interaction between *Post* and *Rural* (α_4) is also negative consistent with the one-child policy having a greater impact in rural than urban areas. Thus as predicted by the theoretical model, the negative impact on the husband-wife age gap is similar to the decrease in fertility.

The impact on education (column 5) is also apparent. The coefficient difference $\beta_2 - \beta_1$ indicates an overall decrease in the husband-wife years of schooling to be about 1.74 years. This decline corresponds to the 1.87 decline in Table 9 (2.35-0.48). On the other hand, the interaction term between post-law and rural is positive though insignificant.[20] This coefficient implies the decline in the husband-wife education gap before and after the implementation of one child policy is smaller in rural than in urban areas which is inconsistent with our prediction based on a larger decline in rural area fertility. One explanation is societal discrimination brought on either by families' or the government's slow response to the changing needs of women's education, what some might call a "boy preference" in rural areas. However, as the economic situation in rural areas improved, replications of the statistical experiment become more consistent with expectations. Column (6) contains the same regression using the 2000 Chinese data, and column (7) the 2004 data. Both yield stronger effects of the one-child law in rural areas.

[19] Mismeasurement of individuals in the rural areas can help explain the larger observed fertility decline in rural areas. Larger effects can be observed for rural residents to the extent rural residents migrate to urban areas but cannot change their hukou. We have no way of estimating the extent of this bias.

[20] This is similar to the results in Table 9 which indicates a 0.70 smaller decline in education in rural compared to urban areas (2.35-0.48)-(2.60-1.42).

6. Summary and Conclusions

In the United States and virtually all other countries, men earn more than women. In 1960 women earned 59 cents on the dollar. Now the wage ratio is 0.78. For single-never-married men and women the gap is approximately 5%, but for married men and women the gap still hovers around 40%. The gender gap for marrieds increases with number of children as well as with the spacing of children. One explanation consistent with these patterns is division of labor in the home. Husbands specialize in market activities and wives in household activities. As a result men invest more in human capital and earn higher wages than their wives. Indeed the husband-wife wage gap widens with years of marriage until children are old enough to leave the home. Household specialization is most likely greatest the higher the number of children and the more widely children are spaced. But why is there division of labor in the first place?

One reason for division of labor is discrimination. If the market rewards men disproportionately more than women for comparable skills it pays for the husband to specialize in market work and women in home work. But specialization can occur even without discrimination.

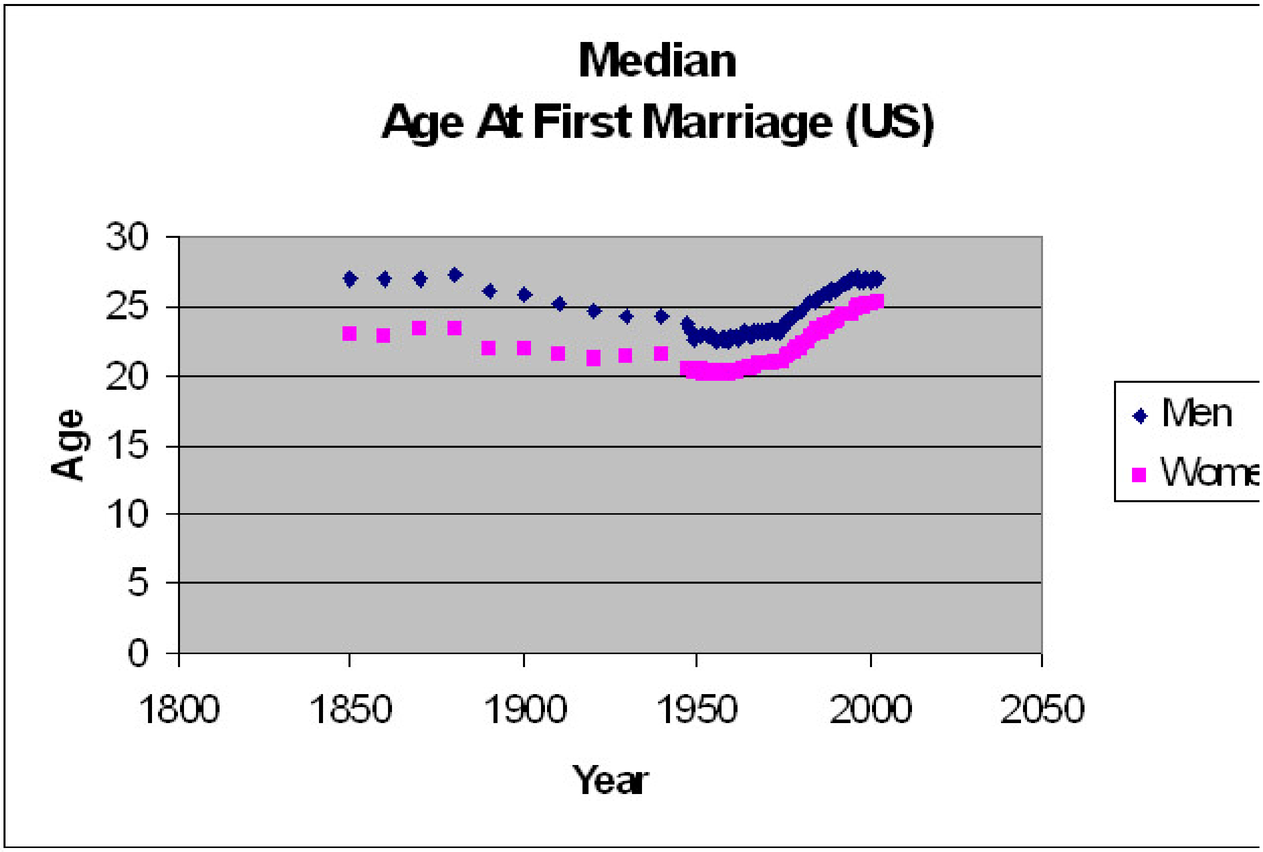
In virtually all countries and in most marriages men are older than their wives. At least in the past the same was true for schooling. Age and educational advantages imply higher earnings potential. Household specialization makes sense if families maximize household income given higher husband relative earnings. This paper examines two patterns inherent in today's marriages, namely husband and wife age and educational differences, both of which are in part responsible for division of labor.

Few would argue that children do not form a basis for the desire to marry. Most would also agree the biological clock ticks differently for men and women. This paper makes use of both facts to illustrate that each lead to age and educational differences between husbands and wives. We employ a two-sided search model to show that the greater the desire for children, the larger the husband-wife age gap and the more likely husbands attain greater schooling levels than their wives.

We give credence to these suppositions using four separate empirical strategies. First, we utilize cross-national data to show that the average age difference between men and women at first marriage is greater in countries the higher the fertility rate. Similarly a higher fertility rate is associated with larger schooling differences between the genders. Second, these results are substantiated when using micro data on husbands and wives in the US. Here, one extra child is associated with between a ¼ and a two year larger husband-wife age gap, as well as a larger schooling difference between one-tenth and one-half a year. Third, historical data from Sweden between 1700 and 1840 show that increases in fertility are associated with wider husband-wife age difference at first marriage. Interestingly the magnitude is virtually identical to the cross-national and family cross-sectional results, namely about a one-half year increase in age gap with a one-child per women increase in fertility. Finally fourth, taking China's one-child policy as a natural experiment illustrates both a decrease in fertility and an increase in husband-wife age and schooling differences. And again, the magnitudes of the effects in China, the US, and across countries are roughly comparable. An increase in fertility of one child per women increases the age gap by about 0.8 years and the schooling gap by about one-year. In short, changes in fertility are associated with changes in marital patterns that affect division of labor in the home.

More specifically, fecundity differences between men and women can lead to the age and educational gaps associated with division of labor in the home which in turn can help exacerbate the gender wage gap. Hence the plausibility of a biological basis for gender wage differences. As fertility declines, as has been the historical trend, marital differences diminish; and as these marital differences diminish so does the division of labor in the home and the gender wage gap.

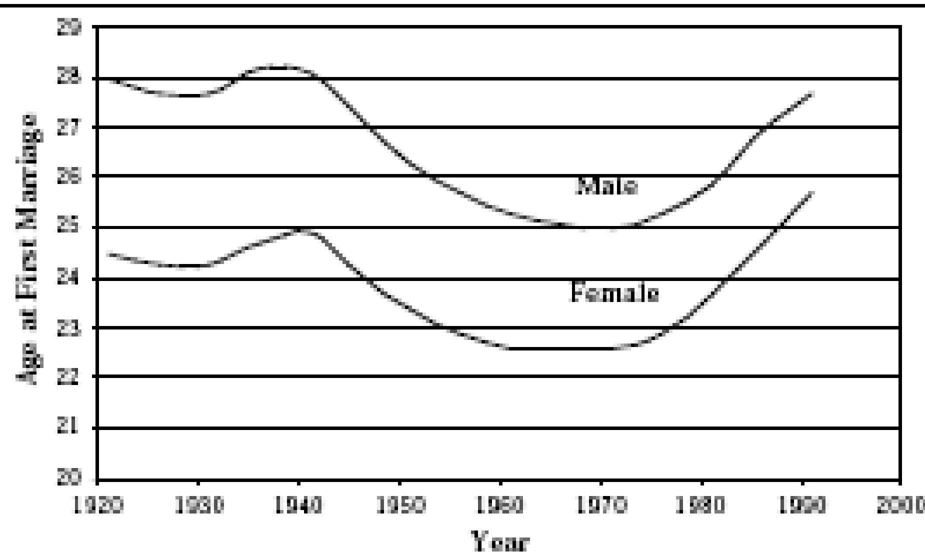
Figure 1



Notes: Figures for 1947 to 1999 are based on Current Population Survey data. Figures for years prior to 1947 are based on decennial censuses. A standard error of 0.1 years is appropriate to measure sampling variability for any of the above estimated median ages at first marriage, based on Current Population Survey data.

Source: http://www.census.gov/population/socdemo/hh-fam/tabMS-2.pdf

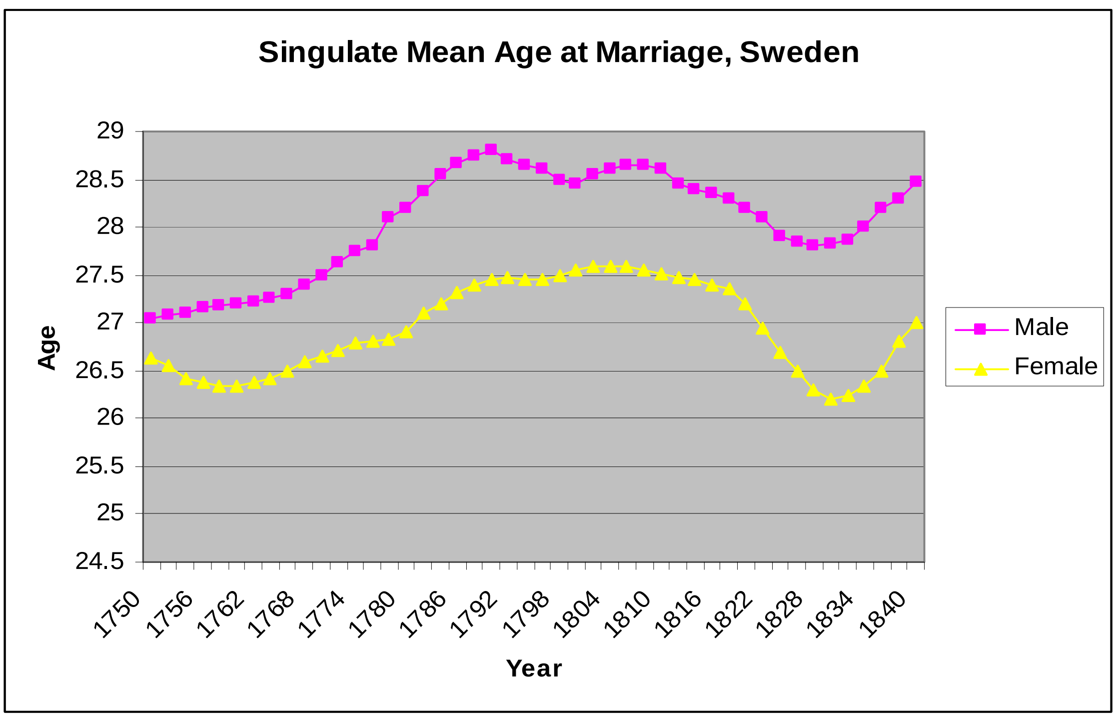
Figure 2: Age at First Marriage: Canada, 1921-1991



Source: Canadian Vital Statistics.

Obtained From: Wu Zheng (1998) "Recent Trends In Marriage Patterns In Canada Policy," *Options* September 1998, p.4.

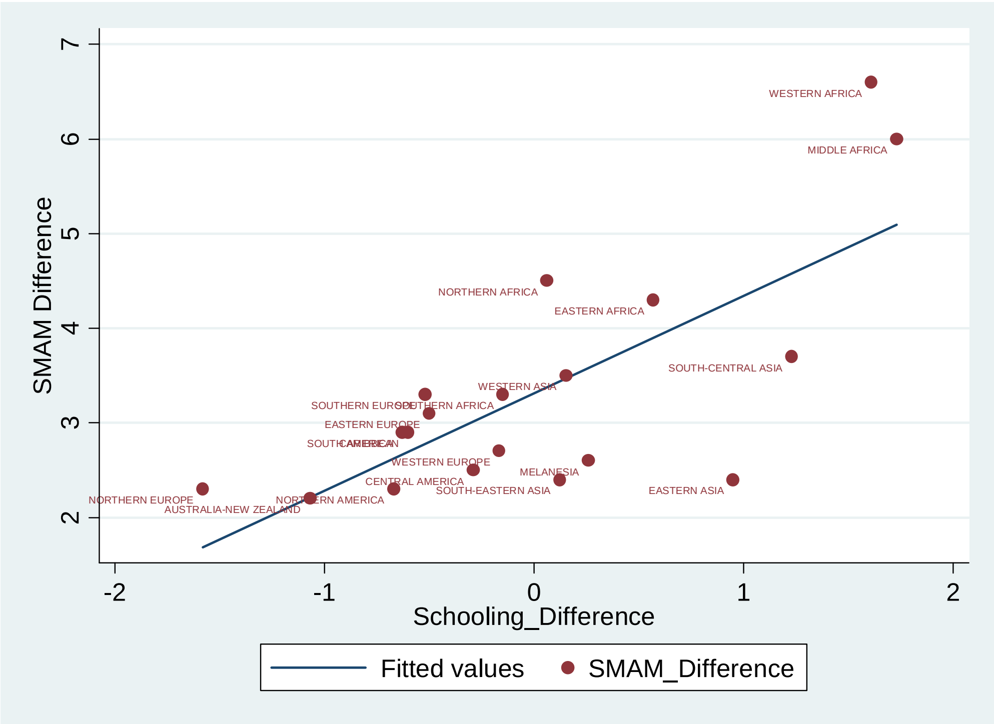
Figure 3



Source: Christer Lundh, "Trends and Regional Variations in Age at First Marriage in Sweden, 1750-1900" Paper presented at the 14th Nordic Demographic Symposium in Tjøme, Norway, May 2001.

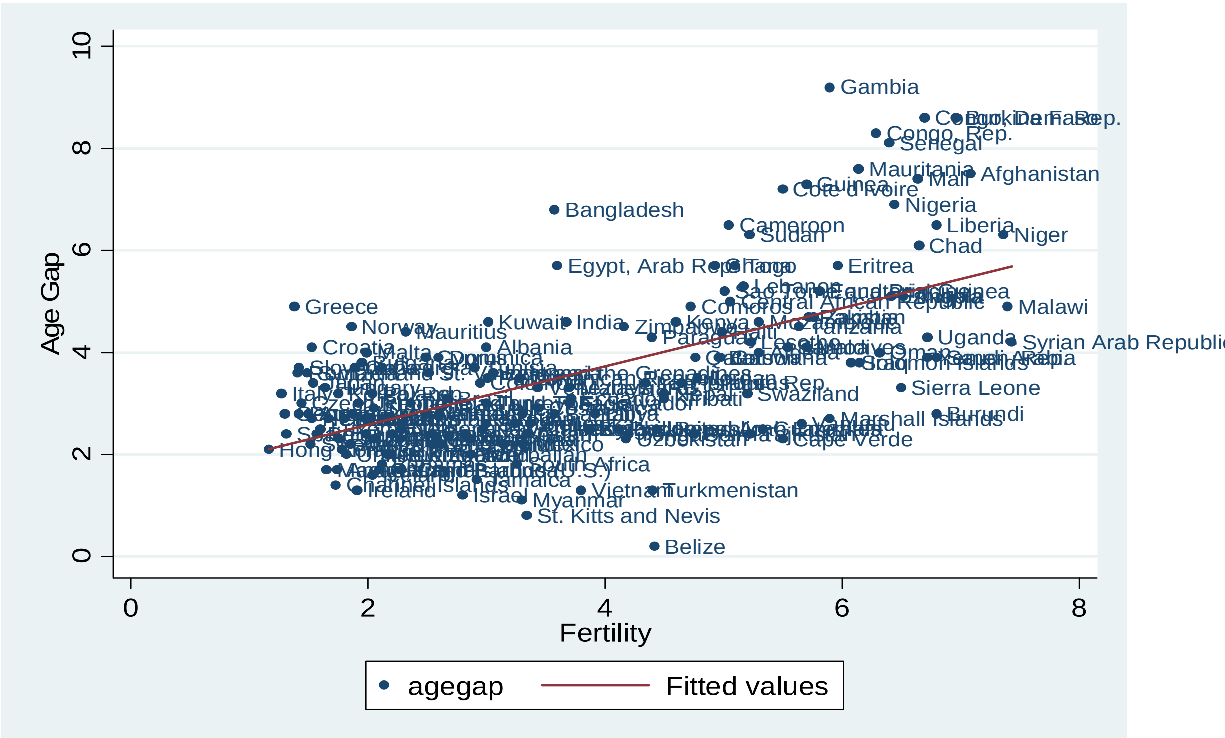
Figure 4

Husband-Wife Age and Gender Educational Differences*



* Computed by authors based on Table 3.

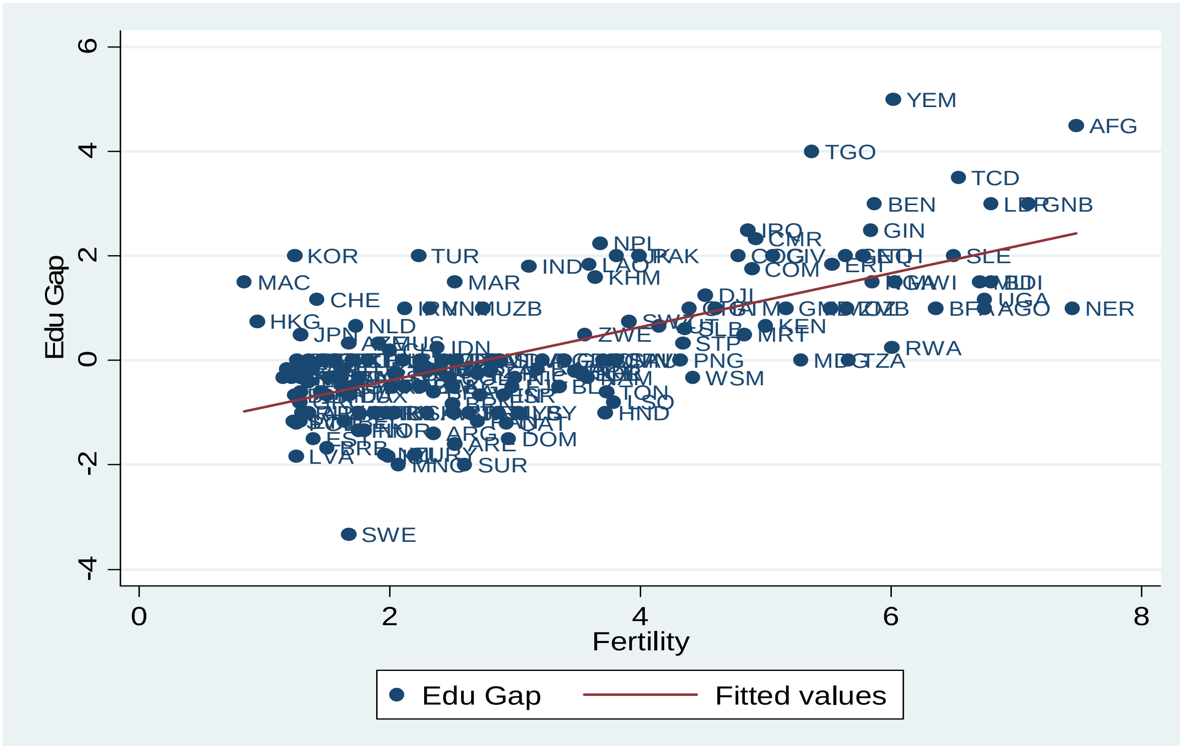
Figure 5
A Cross-National Depiction of Fertility and the Husband-Wife Age Gap*



* Computed by authors based on cross-national data described in text.

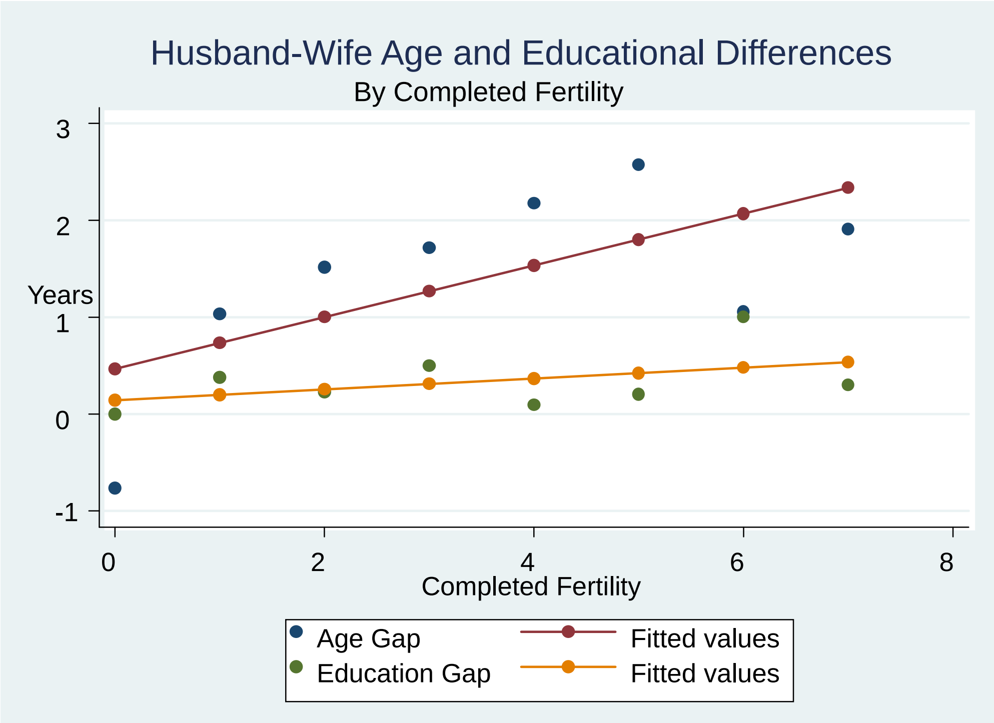
Figure 6

A Cross-National Depiction of Fertility and Male-Female Educational Differences*



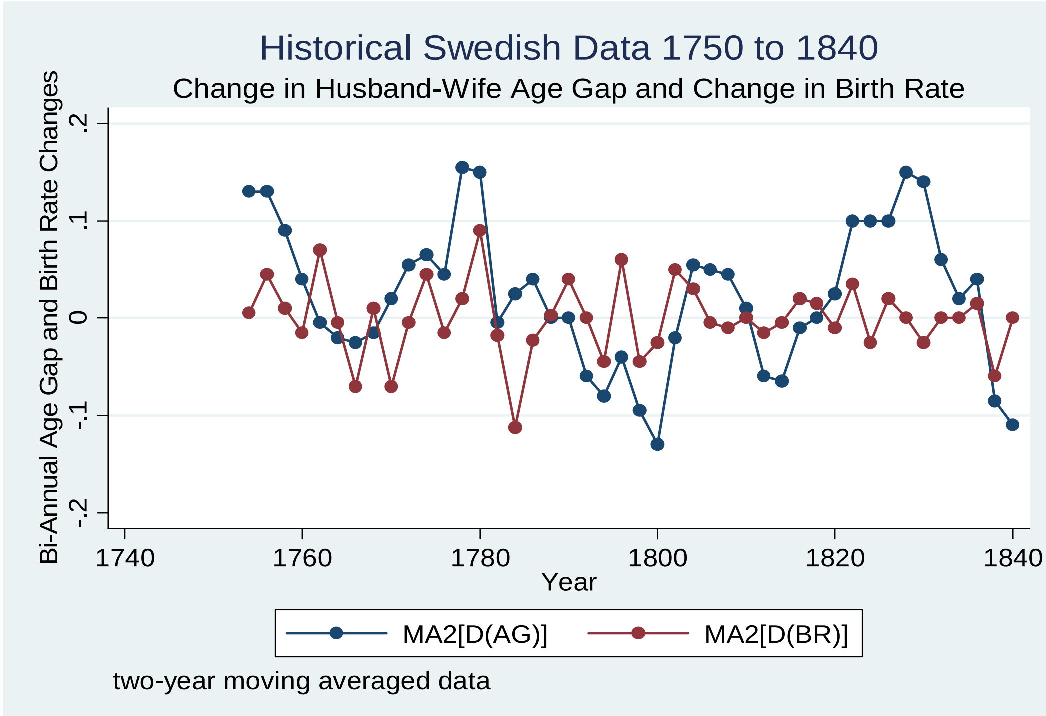
* Computed by authors based on cross-national data described in text.

Figure 7*



* Computed by authors based on PSID data.

Figure 8



Legend: MA2[D(AG)] = two-year moving average of the change in the husband-wife age gap; MA2[D(BR)] = two-year moving average of the change in the Swedish birth rate.

Figure 9: A Comparison of Fertility Rates Over Time

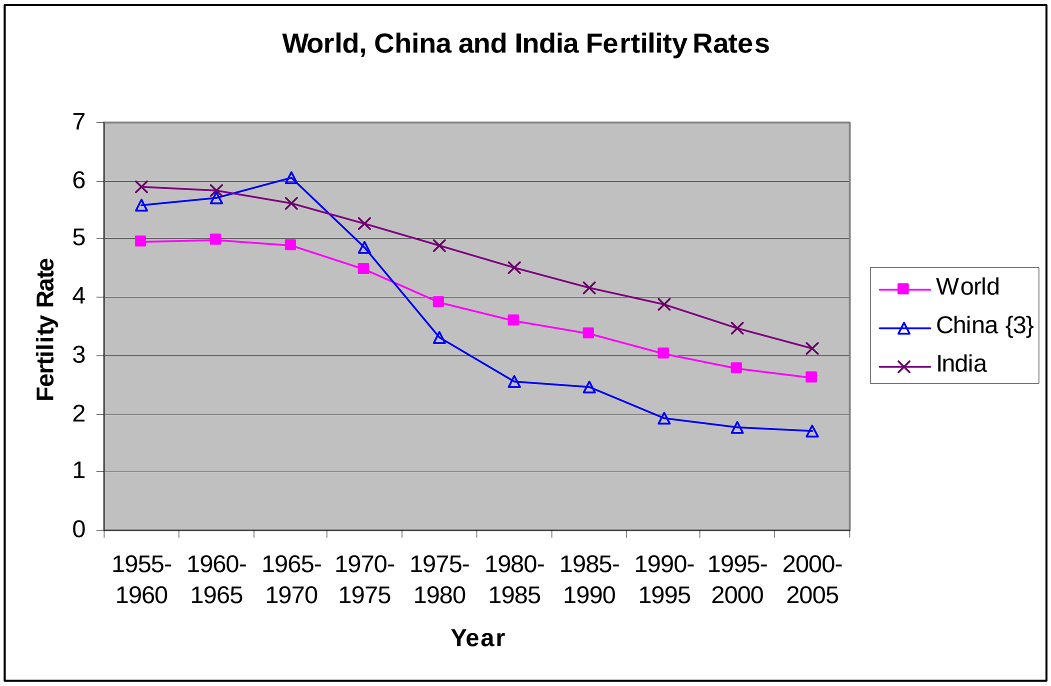
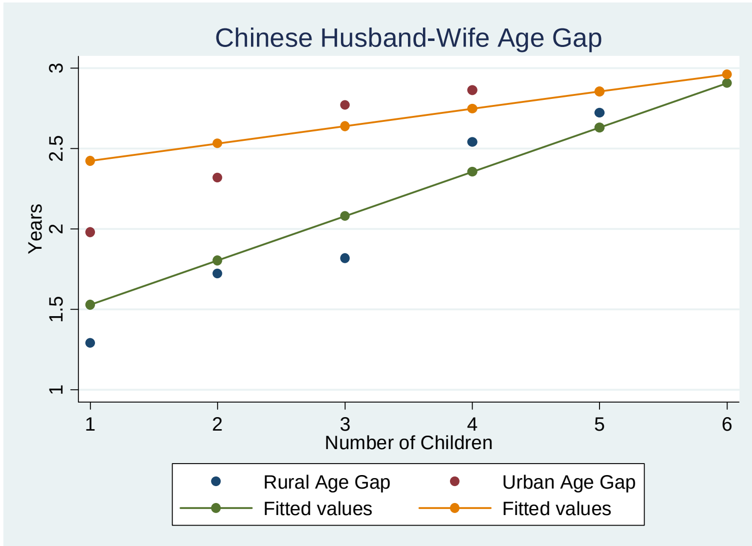
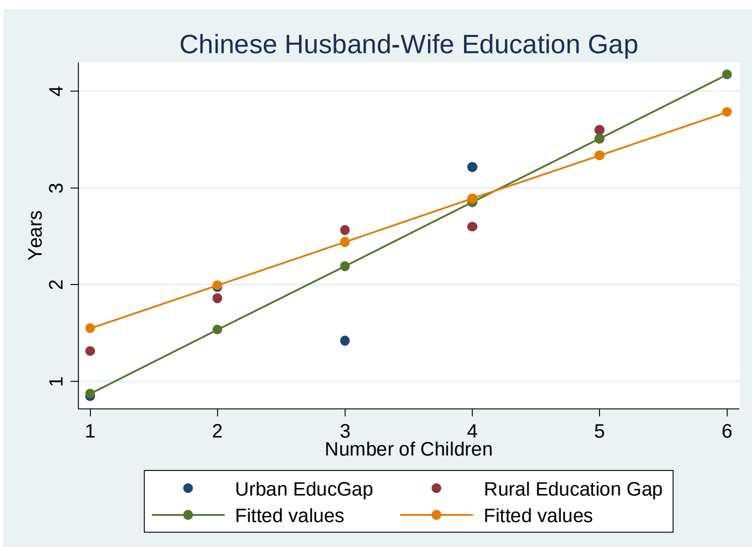


Figure 10*



*Computed by authors based on 1993 China Health and Nutrition Survey

Figure 11*



*Computed by authors based on 1993 China Health and Nutrition Survey

Table 1
Women's Payoff Matrix

Wife / Husband	High intelligence young women	Low intelligence young women	High educated old women	Low educated old women
High intelligence young men	$k(1+\beta)y$	$k(1+\beta)y$	y	y
Low intelligence young men	$k(1+\beta)y$	$k(1+\beta)y$	y	y
High educated old men	kyr	kyr	yr	yr
Low educated old men	ky	ky	y	y

Table 2
Men's Payoff Matrix

Husband / Wife	High intelligence young men	Low intelligence young men	High educated old men	Low educated old men
High intelligence young women	$k(1+\beta)x$	$k(1+\beta)x$	$\frac{k}{e}x$	kx
Low intelligence young women	$k(1+\beta)x$	$k(1+\beta)x$	$\frac{k}{e}x$	kx
high educated old women	xr	xr	xr	xr
Low educated old women	x	x	x	x

Table 3

Husband-Wife Age Gap at First Marriage and Male-Female Schooling differences

Area	Difference SMAM	Difference EDUC
EASTERN AFRICA	4.3	0.57
MIDDLE AFRICA	6	1.73
NORTHERN AFRICA	4.5	0.06
SOUTHERN AFRICA	3.3	-0.15
WESTERN AFRICA	6.6	1.61
EASTERN ASIA	2.4	0.95
SOUTH-CENTRAL ASIA	3.7	1.23
SOUTH-EASTERN ASIA	2.4	0.125
WESTERN ASIA	3.5	0.153
EASTERN EUROPE	3.1	-0.5
NORTHERN EUROPE	2.3	-1.58
SOUTHERN EUROPE	3.3	-0.52
WESTERN EUROPE	2.7	-0.167
CARIBBEAN	2.9	-0.6
CENTRAL AMERICA	2.5	-0.29
SOUTH AMERICA	2.9	-0.63
NORTHERN AMERICA	2.3	-0.67
AUSTRALIA-NEW ZEALAND	2.2	-1.07
MELANESIA	2.6	0.26
MICRONESIA	3.9	NA
POLYNESIA	3.2	NA

NA denotes unavailable data.

Computed from data contained in:

http://www.un.org/esa/population/publications/worldmarriage/WorldMarriagePatterns2000Table.xls

http://earthtrends.wri.org/searchable_db/results.php?years=all&variable_ID=1117&theme=4&country_ID=all&country_clas

http://earthtrends.wri.org/searchable_db/results.php?years=all&variable_ID=1116&theme=4&country_ID=all&country_clas

Table 4

The Relationship Between Fertility on the Husband-Wife Age Gap and on Gender Differences in Education, Cross-National Results*

	Age Gap at Marriage			Gender Education Gap		
VARIABLES	**OLS**	**OLS**	**2SLS**	**OLS**	**OLS**	**2SLS**
fertility	0.600***	0.362***	0.336	0.520***	0.443***	0.380***
	(0.0616)	(0.136)	(0.214)	(0.045)	(0.0906)	(0.126)
Constant	1.774***	-12.59	-1.444	-1.424***	-4.361	-9.014
	(0.208)	(9.95)	(11.99)	(0.158)	(6.643)	(7.093)
Observations	147	77	67	167	77	67
R-squared	0.395	0.501	0.456	0.447	0.572	0.636

***p<0.01, **p<.005, *p<0.1; standard errors in parentheses

* Based on data compiled from the World Bank's *World Development Indicators 2006*, the World Bank's, *World Marriage Pattern 2000*, from United Nations *World Fact Book*, from the UNESCO Institute for Statistics, and the US CIA website (www.cia.gov). Columns (1) and (4) depict bivariate OLS regressions. Columns (2) and (5) multivariate OLS regressions that include controls for male SMAM, agricultural production relative to GNP, per capita GNP in constant 2000 US Dollars, total population, the ratio of males to females, the proportion Muslim, the proportion males and females ever married, and a measure of female labor force participation. Columns (3) and (6) are 2SLS regressions in which fertility is treated as endogenous and identified by religion and the proportion of the economy devoted to agriculture.

Table 5

Completed Fertility and Husband-Wife Age and Educational Differences*

	Husband's Age Minus Wife's Age						Husband's Education minus Wife's Education					
Variables	OLS				2SLS	FE	OLS				2SLS	FE
nochild	0.273***	0.919***	0.173**	0.585***	0.669*	2.593***	0.122**	0.350**	0.0752	0.340**	0.560*	0.365
	(0.07)	(0.21)	(0.07)	(0.21)	(0.40)	(0.99)	(0.06)	(0.16)	(0.06)	(0.16)	(0.31)	(0.59)
nochild_square		-0.111***		-0.0714**				-0.0395		-0.0460*		
		(0.03)		(0.03)				(0.03)		(0.03)		
Constant	0.959***	0.233	1.154***	0.733	-0.346	0.82	-0.0269	-0.281	0.16	-0.115	-1.478	-1.09
	(0.21)	(0.30)	(0.41)	(0.45)	(1.20)	(0.92)	(0.16)	(0.23)	(0.32)	(0.36)	(0.93)	(0.57)
Observations	949	949	865	865	865	81	907	907	836	836	836	56
R-squared	0.014	0.025	0.059	0.064	.	0.079	0.005	0.008	0.046	0.05	.	0.007

* Columns 1-5 and 7-11 contain coefficients from regressions (3) and (4) indicating the relationship between the indicated variables and the husband-wife age and education gaps measured in years. Columns 6 and 14 contain coefficients for a first-difference regression comparing husbands' second to first marriages. Standard errors in parentheses.

Table 6

Singulate Mean Age Difference at Marriage in Rural and Urban Sweden, 1880-1900

	Eastern Sweden	Western Sweden	Northern Sweden	Southern Sweden
Rural	2.3	1.8	2.4	2
Urban	1.6	1.1	1.6	1.4
Difference	0.7	0.7	0.8	0.6

Source: Lundh, Christer (2001) “Trends and Regional Variations in Age At First Marriage in Sweden, 1750-1900,” Paper presented to the session “Historical Fertility and Nuptiality Patterns (1700-1900)” At the 14th Nordic Demographic Symposium in Tjøme, Norway, 3-5 May 2001.

Table 7

The Biannual Change in Husband-Wife Age Gap (in Years) as a Function of the Biannual Change in Birth Rates

Swedish Data, 1750-1840

	Change in Husband-Wife Age Gap	
Change in Birth Rate	0.589** (0.28)	0.581* (0.30)
Constant	0.0233** (0.01)	
Observations	44	44
R-squared	0.094	0.083

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses

Table 8

Fertility, Husband-Wife Age and Schooling Differences

Pre- and Post- Chinese One-Child Law*

	1993 Chinese Census					2000 Chinese Census	2004 Chinese Census
	H-W Age Gap	Fertility	H-W Age Gap	H-W Educa Gap	H-W Educa Gap	H-W Educa Gap	H-W Educa Gap
Fertility	0.19			0.51			
	(0.06)			(0.06)			
Pre-Law		0.96	0.65		1.14	1.14	1.12
		(0.05)	(0.15)		(0.18)	(0.21)	(0.30)
Post-Law		-0.22	0.02		-0.60	-0.41	-0.84
		(0.09)	(0.30)		(0.35)	(0.29)	(0.24)
Rural		0.61	-0.34		0.43	0.75	0.76
		(0.05)	(0.16)		(0.19)	(0.20)	(0.23)
Post-law*Rural		-0.31	-0.76		0.52	-0.33	-0.23
		(0.11)	(0.34)		(0.40)	(0.35)	(0.29)
cnst	1.48	3.20	1.95	0.75	1.08	1.12	1.29
	(0.14)	(0.21)	(0.16)	(0.16)	(0.19)	(0.17)	(0.19)
R2	0.01	0.31	0.03	0.03	0.04	0.04	0.04
NOBS	2268	2268	2268	2228	2268	1901	2352

* Based on regression equations (5)-(9). See text for details. Standard errors in parentheses.

Table 9
Descriptive Statistics by Time and Area*

Variable	Pre-1979			1979-1985			Post-1985		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Husband Education	6.22	7.97	6.66	8.18	9.56	8.59	8.72	9.68	9.01
Wife Education	3.61	5.63	4.12	6.61	8.64	7.21	7.30	9.21	7.86
Fertility	2.97	2.34	2.81	1.99	1.42	1.83	1.47	1.18	1.39
Age Gap	2.27	2.59	2.35	1.60	1.97	1.71	0.87	1.96	1.19
Education Gap	2.60	2.35	2.54	1.88	0.92	1.38	1.42	0.48	1.14
Number of Obs	**784**	**265**	**1049**	**499**	**208**	**707**	**361**	**151**	**512**

* Source 1993 China Health and Nutrition Survey (CHNS). Age and education data measured in years; fertility data measured as births per woman.

References

Atkinson, Maxine and Becky Glass (1985) "Marital Age Heterogamy and Homogamy, 1900-1980," *Journal of Marriage and the Family* 47: 685-691.

Becker, Gary S. (1960) "Economic Analysis of Fertility," in Universities National Bureau of Economic Research, *Demographic and Economic Change in Developed Countries*, (Princeton, NJ: Princeton University Press).

Becker, Gary S. (1973) "A Theory of Marriage: Part I," *Journal of Political Economy* 81(4): 813-846.

Becker, Gary S. (1985) "Human Capital, Effort, and the Sexual Division of Labor," *Journal of Labor Economics* 3: 33-38.

Becker, Gary S. (1991) *A Treatise on the Family*, (Cambridge, MA, Harvard University Press).

Bengtsson, Tmooy and Patrick Svensson (2002) "Economic Development, Formation of Human Capital and the Demographic Transition: Southern Sweden 1750 – 1900," Paper for session 53 "The demographic transition and human capital: comparative perspectives of the developed and the developing world" at the 13th Congress of the International Economic History Association, Buenos Aires, Argentina, 22-26 July 2002.

Bergstrom, Theodore and Mark Bagnoli (1993) "Courtship as a Waiting Game," *Journal of Political Economy* 101(1):185-202.

Bertrand, Marianne, Claudia Goldin, and Lawrence Katz (2009) "Dynamics of the Gender Gap for Young Professionals in the Corporate and Financial Sectors," National Bureau of Economic Research, Inc, NBER Working Papers: 14681.

Brien, Michael (1997) "Racial Differences in Marriage and the Role of Marriage Markets," *Journal of Human Resource* 32(4): 741-78.

Burdett, Kenneth and Randell Wright (1998) "Two-sided Search with Nontransferable Utility," *Review of Economic Dynamics* 1(1): 220-45.

Chiappori, Pierre-Andre, Murat Iyigun and Yoram Weiss (2008) "Investment in Schooling and the Marriage Market," Columbia University Working Paper.

Gale, David and Lloyd Shapley (1962) "College Admission and the Stability of Marriage," *American Mathematical Monthly* 69(1): 9-15.

Giolito, Eugenio P. (2003) "A Search Model of Marriage with Differential Fecundity," IZA Bonn Discussion Paper No.1082.

Goldin, Claudia Dale (1990) *Understanding the Gender Gap : An Economic History* *of American Women* (New York : Oxford University Press).

Gould, Eric D.and M. Daniele Paserman (2003) "Waiting for Mr. Right: Rising Inequality and Declining Marriage Rates," *Journal of Urban Economics* 53(2): 257-81.

Groot, Wim and Henriette Maassen Van Den Brink (2002) "Age and Education Differences in Marriages and Their Effects on Life Satisfaction," *Journal of Happiness Studies* 3(2): 153-65.

Gustafsson, Siv and Adriaan Kalwij, eds. (2006), *Education and Postponement of Maternity: Economic Analyses for Industrialized* (Dordrecht: Springer, Kluwer Academic).

Hajnal, J. (1953) "Age at Marriage and Proportions Marrying," *Journal of Population Studies* 7: 115-136.

Harkness, Susan and Jane Waldfogel (2003) "The Family Gap in Pay: Evidence From Seven Industrialized Countries," *Research in Labor Economics* 22:369-413.

Kalmijn Matthijs (1991) "Shifting Boundaries: Trends in Religious and Educational Homogamy," *American Sociological Review* 56: 786-800.

Kalmijn, Matthijs (2007) "Explaining Cross-National Differences in Marriage, Cohabitation, and Divorce in Europe, 1990-2000," *Population Studies* 61(3): 243-63.

Knodel, John (1988) *Demographic Behavior in the Past: A Study of Fourteen German Village Populations in the Eighteenth and Nineteenth Centuries* (Cambridge: Cambridge University Press.

Lundh, Christer (2001) "Trends and Regional Variations in Age At First Marriage in Sweden, 1750-1900," Paper presented to the session "Historical Fertility and Nuptiality Patterns (1700-1900)"at the 14th Nordic Demographic Symposium in Tjøme, Norway, 3-5 May 2001.

Mare, Robert (1991) "Five Decades of Educational Assortative Mating," *American Sociological Review* 56: 15-32.

McElroy, Marjorie and Dennis Tao Yang (2000) "Carrots and Sticks: Fertility Effects of China's Population Policies," *The American Economic Review* 90(2): 389-392.

McKinnish, Terra (2007) "Sexually-Integrated Workplaces and Divorce: Another Form of On-the-Job Search" *Journal of Human Resources* 42(2): 331-52.

Mortensen, Dale (1988) "Matching: Finding a Partner for Life or Otherwise," *American Journal of Sociology* 94:215-40

Napaporn Chayovan and Noriko Tsuya (2003) "Demographic Situation in Thailand"

Paper presented at the COE Conference on the Asian financial Crisis and Its Macroeconomic Responses, Keio University, September 2003, http://www.coe.gsec.keio.ac.jp/2003/11Tsuya.pdf

Pissarides, Christopher (1990) *Equilibrium Unemployment Theory* (Cambridge, Mass. and Oxford: Blackwell).

Polachek, Solomon (1975) "Potential Biases in Measuring Male-Female Discrimination," *Journal of Human Resources* 10(2): 205-29.

Quisumbing, Agnes and Kelly Hallman (2005) "Marriage in transition: Evidence on age, education, and assets from six developing countries," in Jere Behrman, Barney Cohen, Cynthia B. Lloyd, Nelly Stromquist (eds). The Transition to Adulthood in Developing Countries: Selected Studies. Washington, DC: National Academies Press.

Rockwell, Richard (1976) "Historical Trends and Variations in Educational Homogamy," *Journal of Marriage and the Family* 38:83-96.

Rolf, Karen and Joseph Ferrie (2008) "The May-December Relationship Since 1850: Age Homogamy in the U.S." Paper presented at the Population Association of America Annual Convention, New Orleans.

Saardchom, Narumon and Jean Lemaire (2005) "Causes of Increasing Age at Marriage: An International Regression Study," *Marriage and Family Review* 37(3):73-97.

Self, Sharmistha (2008) "Developing Countries and Fertility: Role of Agricultural Technology," *International Journal of Development Issues* 7(1): 62-75.

Shorter, Edward (1975) *The Making of the Modern Family* (New York: Basic Books).

Siow, Aloysius (1998) "Differential Fecundity, Markets, and Gender Roles," *Journal of Political Economy* 106(2): 334-354.

Stevenson, Betsey and Justin Wolfers (2007) "Marriage and Divorce: Changes and Their Driving Forces," *Journal of Economic Perspectives* 21(2): 27-52.

Sundbärg, G. (1907) "Fortsatta bidrag till en svensk befolkningsstatistik för åren 1750-1900," *Statistisk tidskrift*, häfte 139.

UNESCO Institute of Statistics, *World Fact Book*.

United Nations (1997) *State of the World Population Report*.

United Nations (2000) *World Marriage Patterns*.

U.S. Bureau of Census. *The United States Median Age at First Marriage, 1890-2002.*

US CIA website (www.cia.gov)

Van Poppel, Frans, Aart Liefbroer, and Jeroen Vermunt (2001) "Love, Necessity and Opportunity: Changing Patterns of Marital Age Homogamy in the Netherlands, 1850-1993," *Population Studies* 55:1-13.

Veevers, Jean E. (1984) "Age-Discrepant Marriages: Cross-National Comparisons Of Canadian-American Trends," *Social Biology* 31(1-2): 18-27.

Vella, Frank and Sean Collins (1990) "The Value of Youth: Equalizing Age Differentials in Marriages," *Applied Economics*, 22(3): 359-73.

Willis, Robert J (1973)" A New Approach to the Economic Theory of Fertility Behavior," *Journal of Political Economy*, Part 2 81(2): S14-64.

World Bank (2006) *World Development Indicators, 2006.*

Appendix Table A.1
Variables Used in Cross-National Analysis

Variable Name	Observations	Mean	Std. Dev
SMAM Men	201	26.999	2.668
SMAM Women	211	23.557	3.252
Age gap(Men-Women)	196	3.358	1.615
Average Education of Males	167	11.686	3.117
Average Education of Females	167	11.512	3.976
Education gap	167	0.174	1.315
Fertility	167	3.075	1.691
Child Labor (% children 10-14)	155	11.306	14.829
Agriculture, value added (% of GDP)	149	19.411	14.450
Fertility rate, total (births per woman)	98	3.198	1.735
GDP per capita (constant 2000 US$)	154	5481.452	8161.894
Labor force, female (% of total labor force)	166	38.637	9.209
Life expectancy at birth, female (years)	97	70.373	11.283
Life expectancy at birth, male (years)	97	64.702	10.220
Mortality rate, infant (per 1,000 live births)	62	30.574	31.132
Population, total	177	28700000	110000000
Literacy rate	67	77.586	21.180
School enrollment, secondary (%)	29	66.469	24.862
School enrollment,primary (%)	112	94.597	20.051
Tertiary female education (%females)	123	3.050	3.089
Sex ratio(at birth,male/female)	202	1.049	0.020
Proportion Catholic	166	0.336	0.343
Proportion Jewish	124	0.015	0.101
Proportion Muslim	137	0.191	0.331
African dummy variable	169	0.230	0.432

Appendix Table A.2
PSID Variable Summary Statistics*

Variable	Obs	Mean	Std.Dev
nochild	949	2.52	1.33
noyrs_wrkd_since18_wf	893	14.03	8.45
noyrs_wrked_fulltime_wf	827	11.64	8.00
noyrs_wrkd_since18_hd	925	23.64	10.44
noyrs_wrked_fulltime_hd	911	22.15	10.86
laborincome_hd ($)	949	40187	83884
laborincome_wf ($)	949	19519	25634
yrs_schooling_hd	922	13.41	2.99
nosibling_hd	947	3.70	2.95
nosibling_wf	949	3.64	2.92
age_youngestchild	949	2.66	5.36
yrs_schooling_wf	923	13.18	2.64
age_at_first_marriage_hd	943	23.48	4.50
age_at_first_marriage_wf	943	21.84	4.92
edugap	907	0.28	2.25
black_hd (%)	943	0.17	0.38
black_wf (%)	942	0.17	0.38
jewish_hd (%)	879	0.05	0.23
jewish_wf (%)	912	0.05	0.22
white_hd (%)	943	0.76	0.43
white_wf (%)	942	0.75	0.43
catholic_hd (%)	879	0.27	0.44
catholic_wf (%)	912	0.27	0.44
muslim_other_wf (%)	912	0.01	0.10
muslim_other_hd (%)	879	0.01	0.12
agegap	949	1.65	3.06
agewf	949	56.98	9.71
agehd	949	58.63	10.41

* Sample consists of married-once families in which the wife is older than 45

Appendix Table A.3
Descriptive Statistics*

Variable	Rural	Urban
Husband's Education	7.37	8.92
	(0.08)	(0.15)
Wife's Education	5.34	7.50
	(0.10)	(0.16)
Husband-Wife Education Gap	2.03	1.42
	(0.09)	(0.13)
Fertility	2.35	1.75
	(0.03)	(0.04)
Husband's Age at Marriage	23.82	25.14
	(3.66)	(3.66)
Wife's Age at Marriage	22.09	22.91
	(2.78)	(2.86)
Age Gap	1.76	2.23
	(0.07)	(0.13)
Number of Observations	**1644**	**624**

* Source 1993 China Health and Nutrition Survey (CHNS). Age and education data measured in years; fertility data measured as births per woman. Standard deviation of data given in parentheses.