Sons or Daughters? Endogenous Sex Preferences and the Reversal of the Gender Educational Gap

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Sons or Daughters?
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Abstract

This paper provides a new explanation for the long-run decline in fertility, the narrowing of the gender educational gap and its reversal, which has recently occurred in many countries. It highlights the indirect effect of technological progress on the bias in parents' preferences for sons and the impact of this bias on the demand for children and their education. We extend a standard household decision model regarding the quantity and quality of its offspring along two dimensions. First, we explicitly allow parents to value daughters and sons differently. Second, we model fertility choice as a sequential process. It is assumed that males have relative advantage in physical labor tasks and females have relative advantage in mental labor tasks, which are associated with education. For a low technological level, returns to mental labor are low and returns to physical labor are relatively high, which implies a high gender wage gap. Consequently, bias in parents' preferences towards sons is high, which implies that families with daughters are larger and left with less education. As technology progresses, the returns to mental labor increases, gender wage gap declines, fertility becomes less uncertain, causing households to choose smaller families. As a result, relative advantages of women in education becomes more important until it dominates differences in family sizes, which, ultimately, triggers the reversal in gender educational gap.

1 Introduction

Two salient features of the process of development are the decline in fertility and the rise in education. These features have been widely discussed in growth literature.[1] This literature, however, has not analyzed the interplay between gender differences, fertility and education decisions. A relatively new phenomenon that is characterizing the modern process of development is the reversal of gender educational gap. The dynamics of education has been increasing, gender wage gap has been narrowing. These features have been studied separately in the labor literature.
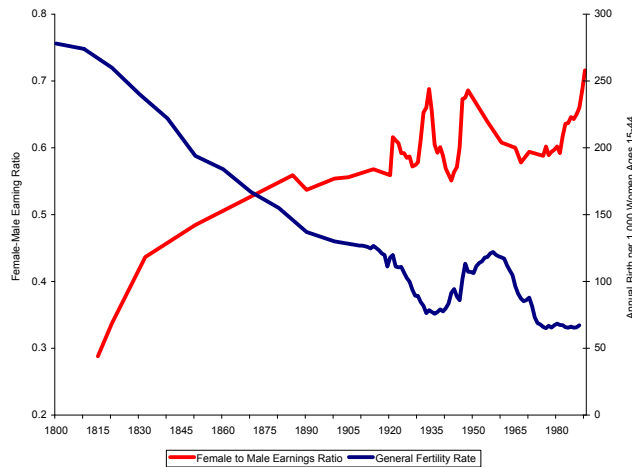

Figure 1: Female relative wages and fertility rates, United States 18001990. Source: Galor 2005

In this research we study the indirect effect of technological progress on parents' preferences for sons and their impact on the growth process through their effect on the demand for children and their education. In particular, we provide a new explanation for the long-run decline in fertility, the narrowing of the gender educational gap and its reversal, which has, recently, occurred in many countries. Figure 1 presents the long-run increase in women's relative wage and decline in fertility.[2] Figure 2 shows the fraction of individuals who are in the

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[1]For a survey of this literature, see Galor (2005)

[2]Galor and Weil (1996) argue that capital accumulation increased the relative wages of women,

age group 25-34 who have more than 12 years of schooling. The cross occurs in 1990, which implies that for individuals born prior to 1960, men's education outweighed women's and for those born after 1960, women's education outweighed men's.[3]

Percent of American Men and Women aged 25-34 with at Least Some College Education
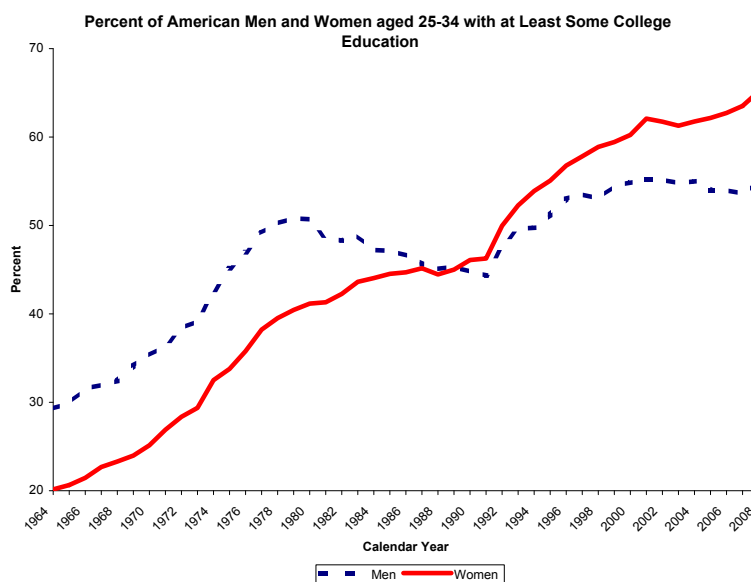
Figure 2: Fraction of individuals who are in the age group 25-34 who have more than 12 years of schooling. Source:

We extend a standard household decision model regarding the quantity and quality of its offspring along two dimensions. First, we explicitly allow parents to value daughters and sons differently. Since ex-ante, the gender of each child is unknown, fertility choice becomes uncertain. Second, we model fertility choice as a sequential process, making parents' decision rule (whether to have additional child or not) depends on the current number of children and their gender composition.

Imagine first a regime in which, for some exogenous reasons, parents value sons more than daughters. Consequently, since the gender of a child is known only

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which increase the price of children, causing parents to have fewer number of children and increased female labor force participation.

[3]Goldin, Katz and Kuziemko (2006) shows that this reversal has occurred not only in the United States but also in 15 OECD countries.

after the decision to have additional child is taken, parents who obtain daughters in their first birth may end up with more children. Thus, uncertainty regarding children's gender induces higher fertility. In contrast, imagine now a different regime in which parents value sons and daughters equally. Consequently, the uncertainty regarding the gender of a forthcoming child is irrelevant to fertility choice, and therefore, parents choose lower fertility. Our first contribution is to provide a new explanation for the demographic transition based on the changing role played by the uncertainty regarding gender composition of children.

Building on 1970 Census in the United States, Ben-Porath and Welch (1976) summarizes data that show that families do care about the sex of their children. For families with n children the probability of having another child depends on the number of boys in the first n children.[4]

Moreover, we would like to have a theory in which parents react to changes in "exogenous forces" mentioned above, that reinforce this process, such that future generations become even more gender neutral. To this end, we assume that parents care about their own consumption and the full income of their children. To capture differences between the genders, we adopt the framework of Galor and Weil (1996) by assuming that men have more brawn than women and that men and women are equal otherwise. Our theory is also consistent with Becker and Tomes (1976) who assume that offspring are not endowed with equal endowments. These differences can emerge through ability, public support, luck and other factors. For the sake of our story, differences are driven by nature that grants men and women with different endowments. Consistent with Becker and Tomes (1976), these different endowments induce parents to invest differently between sons' quality and daughters'. By assuming that parents derive utility from the full income of their offspring, however, we transfer differences in children endowments to differences in parents' preferences. By this, we depart from Becker and Tomes (1976), who assume "child-neutral preferences".[5]

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[4]Angrist, Lavy and Schlosser (2005) finds that Asia-Africa Jewish population in Israel have preferences for boys. They find that an all-female sibling sex composition leads to sharp rise in the number of children born to this subpopulation group

[5]As will be apparent later, this assumption yield different qualitative results from ours. Due to "child-neutral preferences", Becker and Tomes derive a result that "Differences in parental contributions would fully compensate for differences in endowments." P. S153, which they define

Consider an economy in a backward technological environment. In this environment, the rewards to brawn are important and, therefore, potential earnings of men are higher than those of women. Under these circumstances, ex-ante equal parents end up with different family size and child-quality. Parents who get sons in the first births, stop at a lower parity, and invest more in their offspring's education, compared to parents who get daughters in the first births. Interestingly, parents do not discriminate among siblings, but, at the aggregate level, average education of boys outweighs that of girls. In contrast, in an advanced technological environment, the rewards for brain dominate. In this environment, the decision on family size is no-longer gender dependant. Furthermore, since men are still rewarded for their brawn, the average education increases in the number of daughters within family. Thus, while within families parents provide equal education to their offspring, at the aggregate, women's average education outweighs men's.[6]

The theory has policy implications which are directly related to health and well-being of young females in the developing world. In particular, it relates the well-being of girls to parental expectations about future labor market opportunities for women relative to men's. These expectations can be "manipulated" for example by policies which support women's position in society. Policies which reduce the relative costs of schooling for girls, be it direct or indirect costs, could serve as another policy instrument to counter-balance preferences for sons.

The rest of the paper is organized as follows.

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as the "wealth effect". However, our result is consistent with their "price effect", which is driven by assuming that the cost of adding to quality of children is lower for abler ones.

[6]Chiappori, Murat and Weiss (2009) explains the reversal in education gap by assuming that women suffer from statistical discrimination and that this discrimination is weaker against educated women because they are expected to stay longer in the labor market than uneducated women. As a result, in spite the fact that women earn lower market wage the investment in women's education may be higher than men's because women face higher return to schooling education since education can serve as a mean to escape discrimination.

2 The Model

Individuals live for two periods. In the first period, childhood, they acquire human capital. In the second period, adulthood, they are endowed with one unit of time which they allocate between child rearing and labor force participation. The preferences of adults are represented by the utility function

$$u_t = \ln(c_t) + \ln(n^f I_{t+1}^f + n^m I_{t+1}^m),\tag{1}$$

where, c_t is consumption, and I_{t+1}^f and I_{t+1}^m are the full income of each daughter and son as adults in the next period, respectively. n^f and n^m are the number of daughters and sons, respectively and we assume that n^f and $n^m \in \mathbb{N}_0$.

The full income of the children, upon become adult men and women, I_{t+1}^m and I_{t+1}^f, is determined by the skills they supply to the labor market and the wage rate per unit of each skill. We follow Galor and Weil (1996) by assuming that men have more brawn than women. Specifically, we assume that men are endowed with one unit of raw physical labor while women do not possess any raw physical labor. In contrast to brawn, men and women have the same "brain". Specifically, we assume that men and women have the same learning capacity which determines their human capital. For simplicity, we assume that human capital is determined solely by the time parents allocate to education according to the production function,

$$h_{t+1} = h(e) = De^\theta\tag{2}$$

where e is the time spent on education, $D > 0$ and θ are parameters of the human capital production function and satisfy $D > 0$ and $\theta \in (0,1)$.

The full income of men and women, I_{t+1}^m and I_{t+1}^f are then given by:

$$I_{t+1}^m = w_{t+1}h_{t+1} + b\tag{3}$$

and,

$$I_{t+1}^f = w_{t+1}h_{t+1}\tag{4}$$

where w_{t+1} is the wage rate per one unit of human capital and b is the wage rate per one unit of raw physical labor. As we will see later, w_{t+1} which is the return to human capital will be a key to the results.

Let A denote total household resources, the budget constraint of the household is given by

$$A = c_t + \tau A(n^f + n^m) + An^f e^f + An^m e^m. \tag{5}$$

The budget constraint implies that τ is the time cost associated with raising a child, irrespective of her/his education and e^f and e^m are the time allocated to the education of each daughter and son, respectively. Note that the time costs are evaluated in proportion to total resources, A, that is we think of A as the full income of the parents. Note also that e^f and e^m need not be equal for households who have both daughters and sons.

The household's objective is to maximize (1) subject to the budget constraint (5) and the human capital production function (2). Note, however, that the household cannot choose the gender of its offspring. Since in general I_{t+1}^f and I_{t+1}^m need not equal, the marginal utility from having a daughter differs from the marginal utility from having a son, and, consequently, the household chooses its level of fertility sequentially, depending on the gender of their currently lived children. Note also that in doing so, the household takes into account the optimal education it plans to invest in each daughter or son it may have. Thus, it will be convenient to describe the value function of the household as a function of the state variables, n^f and n^m:

$$V(n^f, n^m) = \max \left\{ u^*(n^f, n^m), \frac{1}{2}V(n^f + 1, n^m) + \frac{1}{2}V(n^f, n^m + 1) \right\}, \tag{6}$$

where

$$u^*(n^f, n^m) = \ln[c(n^f, n^m)] + \ln[n^f w_{t+1} h(e^f(n^f, n^m)) + n^m(w_{t+1} h(e^m(n^f, n^m)) + b)]$$

and $c(n^f, n^m)$, $e^f(n^f, n^m)$ and $e^m(n^f, n^m)$ are the optimal consumption and educational level for the daughters and sons, respectively, for any given pair (n^f, n^m). In the next section we analyze the optimal educational level for the daughters

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and sons for a given pair of (n^f, n^m), and then we analyze the optimal fertility choice.

3 Optimization

We begin this section by analyzing the optimal educational choice the household plans to choose for any pair of $(n^f, n^m) \in \mathbb{N}_0$. We then turn to the optimal fertility choice.

3.1 The Educational Choice

Substituting for c_t from the budget constraint, (5), into the utility function, (1), and differentiating with respect to e^f and e^m we get:

$$\frac{An^f}{A[1 - \tau(n^f + n^m) - n^f e^f - n^m e^m]} = \frac{n^f w_{t+1} h'(e^f)}{n^f w_{t+1} h(e^f) + n^m[w_{t+1} h(e^m) + b]} \quad (7)$$

and

$$\frac{An^m}{A[1 - \tau(n^f + n^m) - n^f e^f - n^m e^m]} = \frac{n^m w_{t+1} h'(e^m)}{n^f w_{t+1} h(e^f) + n^m[w_{t+1} h(e^m) + b]} \quad (8)$$

Notice that both the marginal cost (the left-hand side of (7) and (8)) and marginal utility of education (the right-hand side of (7) and (8)) are proportional to the number of offspring of the relevant gender. Note that the proportionality of the marginal cost arises from the assumption that all children of the same gender receive the same level of eduction and the proportionality of the marginal utility arises from the assumption that parents maximize the full income of their offspring.

Three possible cases may arise in equilibrium. The household may either have children of both genders, only daughters or only sons. We will now analyze these three cases in turn.

3.1.1 Households with Daughters and Sons

In this case, $n^f > 0$ and $n^m > 0$ and therefore, both (7) and (8) have to hold. Given the proportionality of the marginal cost and marginal benefit of educating daughters and sons, it follows from (7) and (8) that parents who have children of both genders do not discriminate neither gender. Specifically, (7) and (8) collapse and yield

$$h'(e^f) = h'(e^m) \tag{9}$$

While the non-discriminatory policy of the household is an interesting result by itself, we would also like to understand the level of education that households with both daughters and sons provide to their offspring to compare that to the level of education that households with only sons or only daughters provide to their children. Denote the level of education of offspring in households with both daughters and sons by e^{fm}, and substitute this into either (7) or (8) to get:

$$\frac{1}{1 - \tau(n^f + n^m) - e^{fm}(n^f + n^m)} = \frac{w_{t+1}h'(e^{fm})}{(n^f + n^m)w_{t+1}h(e^{fm}) + n^m b} \tag{10}$$

3.1.2 Households with only Daughters

When $n^f > 0$ and $n^m = 0$ only (7) is relevant. Substituting $n^m = 0$ into (7) and rearranging yields:

$$\frac{1}{1 - \tau n^f - e^f n^f} = \frac{h'(e^f)}{n^f h(e^f)} \tag{11}$$

Notice that one can find an explicit solution to e^f using (2) in (11). However, since we cannot obtain an explicit solution in the cases where either the household has both daughters and sons or only sons, it will be more convenient to analyze this case by expressing the optimal level of education using (11).

3.1.3 Households with only Sons

When $n^f = 0$ and $n^m > 0$ only (8) is relevant. Substituting $n^f = 0$ into (8) and rearranging yields:

$$\frac{1}{1 - \tau n^m - e^m n^m} = \frac{w_{t+1} h'(e^m)}{n^m [w_{t+1} h(e^m) + b]} \tag{12}$$

The following proposition summarizes the results regarding the effect of gender composition of the children on the optimal investment in education for a given number of children.

Proposition 1 *For a given number of children in the household, $n = n^f + n^m$, n^f and $n^m \in \mathbb{N}_0$:*

1. *Households with both daughters and sons provide the same level of education to their offspring regardless of their gender.*

2. *The level of education is decreasing in the number of sons in the household*

Proof: Part one follows immediately from (9). Part two follows from (10), (11) and (12). Consider first the education of children with only daughters and only sons. Suppose that e^f solves (11) and assume that $e^f = e^m$. Then the left-hand side of (11) and (12) are equal, but the right-hand side (12) is smaller than the left-hand side of (12) because $b > 0$. Note that since the left-had side of (12) is increasing in e^m and the right-hand side of (12) is decreasing in e^m, it must be that $e^f > e^m$. Consider now the case where the household has both daughters and sons. Equation (10) suggests that this is an "intermediate" case. If all children are sons, (10) collapses to (12) and if all children are daughters, (10) collapses to (11). Thus for a given number of children, the optimal level of education declines in the number of sons. □

Proposition 1 suggests that as long as fertility is unaffected by the gender of the children, on average, women's education should outweighs men's. However, as we will now show, fertility is affected by the gender composition of the children, as long as the returns to human capital, relative to the returns to physical ability, are not sufficiently large.

3.2 The Optimal Fertility Choice

Equation (6) suggests that fertility choice, $n = n^f + n^m$, can be stated as a dynamic optimization characterized by a stopping rule. As long as the expected value of continuing to the next child, $\frac{1}{2}V(n^f + 1, n^m) + \frac{1}{2}V(n^f, n^m + 1)$ is larger than the value attained at (n^f, n^m), $u^*(n^f, n^m)$, parents continue their fertility. Formally, the stopping rule satisfies:

$$u^*(n^f, n^m) \geq \frac{1}{2}V(n^f + 1, n^m) + \frac{1}{2}V(n^f, n^m + 1) \tag{13}$$

Proposition 2 *If equation 13 holds then*

$$u^*(n^f, n^m) \geq \frac{1}{4}V(n^f + 2, n^m+) + \frac{1}{2}V(n^f + 1, n^m + 1) + \frac{1}{4}V(n^f, n^m + 2)$$

also holds.

4   Simulation

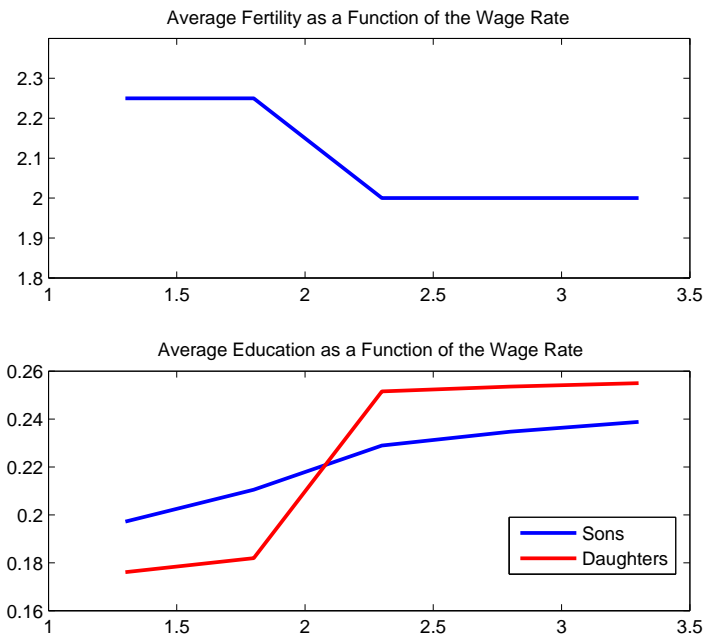We simulate our model with the following parameter values: $A = 21, b = 1, D = 3, theta = 0.5, tau = 0.26$

Figure 3: Equilibrium number of children and education investment in sons vs. daughters. Top panel: optimal fertility choice as a function of w; bottom panel: investment in sons' education, blue line, and investment in daughters' education, red line.

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