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Endogenous gender power, household labor supply and the demographic transition

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Abstract

We present a microeconomic model of the household in which there exists no difference in spousal preferences but childrearing is more time costly for women. Bargaining between the wife and the husband forms the basis of household decisions. Marital bargaining power is determined according to the incomes of the spouses, which in turn help to determine their reservation utility levels outside the marriage. The endogeneity of bargaining power introduces a non-cooperative element to the couples' decision-making problem because both the husbands and the wives take into account how their pre-marital education decisions affect their marital power and the share they extract from household resources in the future. The model predicts that wives invest more than is Pareto efficient in their education in order to increase their bargaining power in marriage. As a consequence, couples have fewer children and consume more when exogenous structural changes lead women to invest more in education. A corollary of the model is that empowering women directly through social reforms such as a lower gender wage gap leads to lower fertility and higher spousal consumption and leisure.

JEL classification: J13; O11; O33; O40
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1. Introduction

The allocation of resources within the family, in general, and household choices regarding education and fertility, in particular, are household decisions that potentially influence economic

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development. Economists have traditionally modelled these marital decisions using unified models of the household where by design differences between the spouses are ignored. Yet there are inherent biological differences between the sexes in the requirements of parental time investment.[1] While these differences are most pronounced in the earlier stages of reproduction, during which the time and energy consumed for child birth is far greater for women than they are for men, there is evidence to suggest that the disparity continues after birth.[2] Hence, it is quite natural for this biological disparity to manifest itself in a potential marital conflict over optimal fertility and education. Coupled with a departure from the unitary model of the household, the existence of such gender differences render marital decision-making power relevant for economic development.

The intra-household bargaining framework has been utilized by development and labor economists to address other issues pertinent to the process of development, such as female labor supply, intra-household transfers, child labor and so on.[3] However, there are only a few models that attempt to evaluate how such a framework—together with inherent biological differences between the sexes—can help to explain changes in fertility and education. The model presented below is intended to fill this gap by investigating how the marital decision-making dynamics can interact with the economy-wide demographic dynamics. It presents a model of the household where there exists no difference in spousal preferences but where childrearing is more time costly for women. Bargaining between the wife and the husband forms the basis of household decisions. Marital bargaining power is determined endogenously according to the spousal reservation levels of utility, which are in turn influenced by the relative income of the spouses. The endogeneity of bargaining power introduces a non-cooperative element to the couples' decision-making problem because both partners take into account how their education decisions affect their marital power and the shares they extract from household resources in the future.

Even when spouses exhibit identical preferences, as they do below, changes in marital gender power are shown to influence fertility and other household allocations within the household. The reason for this is that, as women invest more in their education, their marital bargaining power will rise and this will result in their families to subsequently have fewer children because the opportunity cost of having and rearing children will be higher for more educated women. Moreover, when bargaining power is endogenous and the time cost of childrearing is relatively higher for women, women get educated more than is Pareto optimal. This is the mechanism through which the wives maintain their marital bargaining power, but it is also the reason why their families end up having fewer children in marriage. As a consequence, shifts in gender power entail changes in fertility and the educational attainment of children.

Our model produces several other interesting implications. First, since there exists biological differences between men and women in the requirements of parental time investment, the extent to which wives' optimal choices are reflected in family decisions influences economic progress.[4] Second, empirical studies generally find that households in which wives have more marital power choose to invest more per child. For instance, Thomas (1990) and Lundberg, Pollak, and

[1] Trivers (1972) and Wright (1994).

[2] See, for instance, Wright (1994).

[3] Please refer to Section 3 for a survey of the related literature.

[4] The role of marriage emphasized here–that of a gender bargain about fertility–introduces a new dimension through which marriage affects an economy. A number of recent papers, including Aiyagari, Greenwood, and Guner (2000), Fernandez, Guner, and Knowles (2001), and Greenwood, Guner, and Knowles (2003) show how other features of marriage, such as the process of marital matching and divorce, might be influencing economic performance through the channels of income distribution, mobility, and inequality.

Wales (1997) have shown that women tend to spend more on child health and clothing when they exercise more marital power. These findings may be driven purely by gender differences in preferences towards quantity and quality of children. Nonetheless, our model's emphasis on the biological gender differences in childrearing time costs, together with the endogenous nature of marital bargaining power, provides a plausible biological basis for the empirical observations.

Third, changes in the gender wage gap alter marital decisions, which in turn influence investment in children. Ceteris paribus, a lower wage gap levels the marital playing field by leading to higher female education, labor supply and more marital power for the wives. Fourth, the degree to which an economy is predisposed towards gender equality is important.[5] This is simply due to the fact that the transfer of decision-making power from men to women is by itself important for the economy-wide demographic outcomes.

The remainder of the paper is organized as follows. In Section 2, we briefly present some related historical facts. In Section 3, we discuss the existing related literature. In Section 4, we highlight the important pillars of our model and provide some supporting evidence. In Section 5, we incorporate these assumptions into a microeconomic model of the household to show how endogenous bargaining influences household choices. In Section 6, we provide a numerical example to highlight some of our main findings. In Section 7, we conclude.

2. Historical facts

In the late-19th and early-20th centuries, industrialized countries entered a "demographic transition" era during which educational attainment began to rise rapidly, and–contrary to Malthusian predictions–population growth started to slow down and decline. Partly as a consequence, standards of living in the Western Hemisphere have risen at unprecedented rates since the turn of the 20th century.[6]

During this demographic transition, households underwent significant changes in terms of relative wage earnings, division of labor, the degree of specialization, and the balance of power between the sexes. For instance, Boserup (1970, p. 49) documents that women's labor force participation, their education relative to men, and value in marriage follow a U-shaped pattern throughout the process of economic development. Along the same lines, Goldin (1990) finds that the US labor force participation rates first declined over a period beginning in the late 18th century and then started to rise in the mid 20th century. She also documents that the relative wages of women began to rise in the early 19th century and continued to do so at a rapid pace throughout the 20th century. Table 1 illustrates the extent to which life expectancy and women's earnings relative to men's rose in the United States during the past one century and a half.

3. Related literature

This paper sits at the juncture of three strands in the economic literature. The first strand is on household choices regarding fertility and educational attainment. This work includes

[5] This result complements those discussed in Landes (1998, 2000) by identifying a gender- and household-centric approach to why culture and ideology should affect economic development.

[6] Conservative estimates show, for example, that the average income in the United States rose tenfold in the last 125 years. Sharp increases in educational attainment, improvements in life expectancy, and significant declines in fertility and mortality also characterized this period of rapid wealth accumulation in industrialized countries (for more details, see Weil, 2005).

Table 1
US life expectancy, gender gap, and labor force participation rates

Year	Life expectancy (years)	Earnings (percent of men's hourly w.)
1820	–	34
1832	–	44
1850	38.5	48
1880	40.5	54
1890	46.8	54
1900	51.8	56
1914	–	58
1920	57.4	57
1930	60.8	58
1940	64.9	54
1950	69.0	–
1960	70.7	54
1970	71.6	57
1980	74.5	59
1990	76.1	66

Compiled from Goldin (1990) and Haines and Steckel (2000).

microeconomic models of household demand formulated by Becker (1960) where a unitary framework is utilized to analyze family choices regarding the quantity–quality tradeoff.

The second strand in the literature to which this paper is related includes "collective" household models, and early- and late-generation marital bargaining models. These allow for differences between spouses to affect the choices households make by relying on a sharing-rule or an intra-household bargaining mechanism. The common assumption of papers in this strand is that family members with potentially different preferences make Pareto-efficient household decisions. Among the earliest examples of the collective models are Becker (1981) and Chiappori (1988, 1992). Early examples of the special case of exogenous marital bargaining models include Manser and Brown (1980), McElroy and Horney (1981), and Sen (1983).

While what we present below is related to this strand and represents a departure from the unitary model, it is technically not in the class of the collective or household bargaining models. As it shall become apparent below, our model yields inefficient extra- and intra-marital choices as well as intra-household allocations. In contrast, the collective models are based on the premise that households make Pareto efficient choices. In two related papers–Iyigun and Walsh (2003) and Iyigun (2004)–we argue that the process of spousal matching in the marriage markets and the existence of pre-marital investments prior to spousal matching generate Pareto efficient outcomes in the collective model. In the model below, we do not endogenize the process of spousal matching and, as a result, the household bargaining process fails to yield Pareto efficient outcomes. Hence, it is important to note that the main results we derive below would remain qualitatively intact as long as there exist in the marriage markets some frictions, which prohibit the spouses from using their potential payoffs from remarriage–instead of their singles payoffs–as their reservation threat-points.

All of the collective or household bargaining models assume that the sharing rule or the bargaining power of the two sexes are determined exogenously and that couples have potentially different preferences over the choice sets. Basu (in press) suggests a model that treats the bargaining power of the sexes as determined endogenously according to actual relative earnings. While allowing for endogenously determined bargaining power, his approach assumes that both parties treat bargaining as exogenous in the determination of their labor supply. In general, these

papers maintain spousal differences in preferences to address a wide range of microeconomic issues such as female labor supply, fertility, child labor and so on. Our work is most related to Basu because of the endogenous nature of marital bargaining in both models. Our model differs from Basu's, however, in three important aspects: First, we specifically address the role of endogenous bargaining in the quantity–quality tradeoff. Second, we do not consider gender differences in preferences. Instead, we explore whether the combination of endogenous gender power and differential requirements of parental time investment plays a role in educational attainment and fertility. We also assume that agents recognize the endogeneity of bargaining power.

Finally, this work is related to papers that address various aspects of demographic change and economic development in the long run. A non-exhaustive list includes Becker, Murphy, and Tamura (1990), Galor and Weil (1996, 2000), Galor and Moav (2002, 2004), Moav (2002), Greenwood, Seshadri, and Yorukoglu (2005), Hansen and Prescott (2002), Jones (2001), and Iyigun (2000). The present effort is most related to two of these: Galor and Weil (1996) explore how skill-biased technological change induces women–who are full-time stay home moms when the return to skills is relatively low–to eventually join the labor force. They show that such a change in women's labor supply leads to lower fertility and faster growth. Greenwood, Seshadri, and Yorukoglu (2005) examine how the variety of durable consumer goods might affect household specialization and the female labor supply. Utilizing a model of household production, they show that the rapid expansion of durable consumer goods at the turn of the 20th century can account for the subsequent rise of married female labor-force participation. The effort below complements these findings by identifying the role of marital decision-making power in influencing the household labor supply and the quantity–quality tradeoff.

4. The building blocks and potential extensions

The model rests on the following assumptions:

(I) Parents value leisure as well as having children. Individuals in this model operate in the Beckerian mold.[7] Their utility is derived from their own consumption and leisure as well as the having offspring. In line with the standard Beckerian approach to household fertility, individuals decide the optimal number of their children subject to a budget constraint that reflects the allocation of time between work, leisure, and childrearing.

(II) The time cost of childrearing is higher for women. By assumption, the time cost of childrearing is greater for women than it is for men. There exists a strong biological basis for this assumption. Trivers (1972) was the first to identify the imbalance of time investment between the two sexes to focus on patterns of sexual behavior and social interactions. Elaborating on this point, Wright (1994, p. 42) states, "Parental investment includes the time and energy consumed in producing an egg or a sperm, achieving fertilization, gestating or incubating the egg, and rearing of the offspring. Plainly, females will generally make the higher investment up until birth, and, less plainly but in fact typically, this disparity continues after birth." For additional supporting evidence, see also Becker (1981, p. 4) and Boserup (1970, p. 144).

(III) Household decisions are made based on an endogenous balance of power. A novelty of what is presented below is its departure from the unitary model of household in examining

[7] Becker (1981).

the fertility and education choices made by individuals. A number of papers have emphasized a departure from the unitary approach in other contexts.[8] This view recognizes that men and women who make up households can differ in their preferences, and that household choices reflect not only these differences but also the bargaining power of the two sexes.

(IV) Spouses choose their educational attainment levels in youth recognizing how their choices impact the household balance of power. With the marital balance of power being determined endogenously according to spousal earnings power, rational individuals take into account how their educational choices in youth impact—via the bargaining process—the household decisions regarding consumption, leisure, and fertility. This sets up a two-stage decision problem with variable threat points: In the first stage, when individuals are young and single, they get educated. The educational levels of the spouses, in turn, determine their labor earnings and, hence, help to establish the options outside the marriage (i.e., for each of the spouses, the reservation levels of utility as singles). Then, in the second stage, couples play a Nash bargaining game with their reservation levels of utility having been determined in the first stage.

Our solution method, under which spouses play a two-stage game and they choose their pre-marital levels of education non-cooperatively in the first stage, is similar to the one introduced by Lundberg and Pollak (1993). In their model, spouses behave non-cooperatively because the credible threat points in marriage are driven not by the threat of divorce but by spouses who, due to transactions costs, choose to remain married and not cooperate with their spouses. In our model, by contrast, spouses choose their levels of education non-cooperatively because they recognize the impact of their education on their marital power, and hence, on the intra-marital allocation of family resources.

5. The model

The economy is made up of men and women who live for two periods. All individuals are endowed with one unit of time in both periods. In the first period, when individuals are young and single, they derive utility from leisure and decide how to allocate their one unit time between education and leisure. In the second period, when individuals value consumption, leisure and having offspring, they first decide whether to get married or remain single. If they choose to remain single, they have no children and supply their labor inelastically. Men earn w_{m} per efficiency units of labor supply and women earn w_{f} for each unit of their efficiency labor supply.[9]

Married couples decide the optimal number of their children subject to a budget constraint that reflects the allocation of time between work, leisure, and childrearing. To formalize, let τ_i, $i=\mathrm{f}, \mathrm{m}$, denote the time costs of rearing one child. We assume that the time cost of childrearing is greater for women, so that $\tau_{\mathrm{f}} \equiv \tau > \tau_{\mathrm{m}} \equiv 0$.[10] Then, denoting the number of children the couple

[8] A partial list of such papers would include Manser and Brown (1980), McElroy and Horney (1981), Sen (1983), Chiappori (1988, 1992), Bourguignon and Chiappori (1994), Udry (1996), and Basu (1999). See Basu (in press) for a more complete list.

[9] We allow the wage rates paid to men and women to differ in order to explore the effects of changes in the gender wage gap on household dynamics.

[10] The assumption that the time cost of child rearing is zero for men is made purely for convenience. The qualitative nature of the results below remains intact as long as $\tau_{\mathrm{f}} > \tau_{\mathrm{m}}$.

chooses to have by n, τn would represent the total time cost of childrearing for the wife. Consequently, for a couple with n number of offspring, the total amount of time available for work and leisure would equal $(1-\tau n)$ for the wife and one for the husband.

Let l_1^i, $i=$f, m, denote the leisure of individual i when he or she is young, e^i, $i=$f, m, represent his or her time investment in education, and let c^i and l_2^i, $i=$f, m, respectively denote his or her levels of leisure and consumption when old.[11] Also let s_2^i denote the labor supply of individual i in period two. Preferences of i are represented by the following lifetime utility function:

$$U_i = \ln l_1^i + \ln c^i + \ln l_2^i + k^i; \qquad i = \mathrm{f}, \mathrm{m}; \tag{1}$$

where k^i denotes the total utility derived from being married. We assume that k^i equals zero for singles and that it has two components for couples:

$$k^i = \max(0, k + \alpha \ln n), \tag{2}$$

where k, $k>0$, represents the marital gain from the state of being married that is independent of the choices made and where α, $\alpha>0$, measures the value attached to the number of offspring relative to leisure and consumption. By construction, note that Eq. (1) reflects no difference between the two sexes in preferences.

5.1. Singles' problem

Now consider the optimal choices of single men and women, all of whom would have no kids. That is, for all singles, we have $k^i=0$, $i=$f, m. Single men and women maximize (1) subject to the time constraint that their first-period leisure and time allocation to education cannot exceed their one unit of time endowment: $\psi^i e^i + s_1^i \le 1$, where ψ^i, $i=$f, m, denotes the time cost per unit of education. Under the assumption that each unit of time invested in education generates one unit of efficiency units of labor, they also face the following budget constraint in the second period: $w_i l_2^i + c^i \le w^i e^i$, $i=$f, m. Given these two constraints and Eqs. (1) and (2) and the assumption that $\psi^{\mathrm{m}}=1<\psi=\psi^{\mathrm{f}}$,the optimal levels of education, leisure and consumption equal, $\forall i$, $i=$f, m,

$$e^{\mathrm{m},s} = \frac{1}{2}, \qquad e^{\mathrm{f},s} = \frac{1}{2\psi}, \qquad l_1^{i,s} = l_2^{i,s} = \frac{1}{2}, \qquad c^{\mathrm{m},s} = \frac{w^{\mathrm{m}}}{4}, \qquad c^{\mathrm{f},s} = \frac{w^{\mathrm{f}}}{4\psi}. \tag{3}$$

Based on (1) and (2) and these optimal choices, we can determine the second-period utility of single men and women. Let the former be denoted by $\bar{U}_{\mathrm{m}}$ and the latter be denoted by $\bar{U}_{\mathrm{f}}$, we have

$$\overline{U}_f = \ln\left(w^{\mathrm{f}} e^{\mathrm{f}}/4\right) = \ln\left(w^{\mathrm{f}}/8\psi\right) \text{ and } \overline{U}_m = \ln(w^{\mathrm{m}} e^{\mathrm{m}}/4) = \ln(w^{\mathrm{m}}/8). \tag{4}$$

For the marriage of a man and a woman to be stable, both spouses should at least receive utility levels associated with those in (4) in the second period. That is, for both the husband and the wife, $\bar{U}_i$, $i=$f, m, sets the reservation levels of utility (and, hence, their threat points) in marriage.

5.2. Couples' problem

Now take the problem of married couples. Let θ, $\theta \in (0,1)$, denote the marital bargaining power of women. We shall discuss below how the bargaining power of the spouses would be

[11] Children are public goods in marriage.

influenced by their reservation levels of utility derived above, but for a given θ, the spousal education levels chosen when young, $\bar{e}^{\mathrm{f}}$ and $\bar{e}^{\mathrm{m}}$, and the utility specification in (1), each couple maximizes the following in the second period:

$$\Omega = \theta\left(\ln l_2^{\mathrm{f}} + \ln c^{\mathrm{f}}\right) + (1-\theta)\left(\ln l_2^{\mathrm{m}} + \ln c^{\mathrm{m}}\right) + k + \alpha \ln n \tag{5}$$

A married couple allocates the sum of their potential income to consumption, leisure, and childrearing in the second period, taking as given both spouses' investment in education in the first period. Thus, they jointly face the following budget constraint and individual time constraints:

$$c^{\mathrm{f}} + c^{\mathrm{m}} + w_{\mathrm{f}} l_2^{\mathrm{f}} + w_{\mathrm{m}} l_2^{\mathrm{m}} \leq w_{\mathrm{f}} s_2^{\mathrm{f}} + w_{\mathrm{m}} s_2^{\mathrm{m}} = w_{\mathrm{f}}(1-\tau n)\bar{e}^{\mathrm{f}} + w_{\mathrm{m}}\bar{e}^{\mathrm{m}},\ \ l_2^{\mathrm{m}} \leq 1 \ \text{ and } \ l_2^{\mathrm{f}} + \tau n \leq 1. \tag{6}$$

Given that the husband's education level is fixed at $\bar{e}^{\mathrm{m}}$, his efficiency units of labor is fixed at $\bar{e}^{\mathrm{m}}$. In contrast, due to the fact that the time costs of childrearing are borne by the wife, her efficiency units of labor supply equals $(1-\tau n)\bar{e}^{\mathrm{f}}$ and depends on the number of children the couple chooses to have. Our first-order conditions with respect to the spousal consumption levels, c_{f} and c_{m}, leisure, l_2^{f} and l_2^{m}, and optimal fertility, n, are given by[12]

$$\frac{\theta}{c^{\mathrm{f}}} = \frac{1-\theta}{c^{\mathrm{m}}} \tag{7}$$

$$\frac{\theta}{w_{\mathrm{f}} l_2^{\mathrm{f}}} = \frac{1-\theta}{w_{\mathrm{m}} l_2^{\mathrm{m}}} \tag{8}$$

$$\frac{\alpha}{n} = \frac{(1-\theta)\tau w_{\mathrm{f}} \bar{e}^{\mathrm{f}}}{c^{\mathrm{m}}} \tag{9}$$

where $c^{\mathrm{m}} = w_{\mathrm{f}}(1-\tau n)\bar{e}^{\mathrm{f}} + w_{\mathrm{m}}\bar{e}^{\mathrm{m}} - w_{\mathrm{f}} l_2^{\mathrm{f}} - w_{\mathrm{m}} l_2^{\mathrm{m}} - c^{\mathrm{f}}$.

Using (7)–(9), we substitute for $c_{\mathrm{f}}, l_2^{\mathrm{f}}$ and l_2^{m} in the preceding equation for c_{m}. Then we can establish that

$$c^{\mathrm{m}} = \frac{1-\theta}{2+\alpha}\left(w_{\mathrm{f}}\bar{e}^{\mathrm{f}} + w_{\mathrm{m}}\bar{e}^{\mathrm{m}}\right), \tag{10}$$

$$c^{\mathrm{f}} = \frac{\theta}{2+\alpha}\left(w_{\mathrm{f}}\bar{e}^{\mathrm{f}} + w_{\mathrm{m}}\bar{e}^{\mathrm{m}}\right), \tag{11}$$

$$l_2^{\mathrm{m}} = \frac{1-\theta}{2+\alpha}\,\frac{w_{\mathrm{f}}\bar{e}^{\mathrm{f}} + w_{\mathrm{m}}\bar{e}^{\mathrm{m}}}{w_{\mathrm{m}}\bar{e}^{\mathrm{m}}}, \tag{12}$$

$$l_2^{\mathrm{f}} = \frac{\theta}{2+\alpha}\,\frac{w_{\mathrm{f}}\bar{e}^{\mathrm{f}} + w_{\mathrm{m}}\bar{e}^{\mathrm{m}}}{w_{\mathrm{m}}\bar{e}^{\mathrm{f}}}, \tag{13}$$

$$n = \frac{\alpha}{2+\alpha}\,\frac{w_{\mathrm{f}}\bar{e}^{\mathrm{f}} + w_{\mathrm{m}}\bar{e}^{\mathrm{m}}}{\tau w_{\mathrm{f}}\bar{e}^{\mathrm{f}}}. \tag{14}$$

[12] These first-order conditions assume that the individual time constraints of Eq. (6) are not binding. As we discuss below, there are interesting cases under which the wife's time constraint is binding.

Note that Eqs. (10)–(14) explicitly define the optimal consumption of the wife and the husband, their leisure, and household fertility as functions of the couple's education levels, $\bar{e}^{\mathrm{f}}$ and $\bar{e}^{\mathrm{m}}$. Moreover, the education levels of the wives and husbands influence the spouses' relative bargaining power in marriage because, as we have shown in the subsection above, they determine their reservation levels of utility as singles. Consequently, when choosing their education levels in the first period, both spouses take into account how their educational decisions affect not only the household choices regarding consumption, leisure and fertility, but also the shares they can extract from marital production. We deal with these issues in the next two subsections.

5.3. Maritally sustainable spousal Pareto weights

Of course, not all values of the bargaining parameter, θ, will be acceptable to both spouses and hence maritally sustainable. Specifically, only those values that yield, for both the husband and wife, utility levels at least as high as those in Eq. (4) will be incentive compatible. In the following section, we derive the main results for the limiting case in which one spouse (in what follows, the husband) captures all of the marital surplus and the other (the wife) receives her reservation utility in marriage. We use this special case (in which we are able to solve all of our endogenous variables except the husband's optimal education level analytically) to highlight our main findings. Then, in Section 6, we generalize our analysis by letting the intra-marital bargaining process yield allocations that split the marital surplus between the two spouses according to some sharing rule. For these cases, we employ simulation techniques to fully characterize the household equilibrium.

When the wife receives her reservation utility in the second period, her utility from the marriage equals $\bar{U}_{\mathrm{f}}=\ln(w^{\mathrm{f}}/8\psi)$. This utility corresponds to choices made during marriage according to Eqs. (11), (13), and (14). Specifically, we have

$$\ln\left[\frac{\theta}{2+\alpha}\left(w_{\mathrm{f}}\bar{e}^{\mathrm{f}}+w_{\mathrm{m}}\bar{e}^{\mathrm{m}}\right)\right]+\ln\left[\frac{\theta}{2+\alpha}\,\frac{w_{\mathrm{f}}\bar{e}^{\mathrm{f}}+w_{\mathrm{m}}\bar{e}^{\mathrm{m}}}{w_{\mathrm{f}}\bar{e}f}\right]+k+\alpha\ln\left[\frac{\alpha}{2+\alpha}\,\frac{w_{\mathrm{f}}\bar{e}^{\mathrm{f}}+w_{\mathrm{m}}\bar{e}^{\mathrm{m}}}{\tau w_{\mathrm{f}}\bar{e}^{\mathrm{f}}}\right]=\bar{U}_{\mathrm{f}}. \tag{15}$$

We can then use (15) to solve for the endogenous bargaining power parameter $\bar{\theta}_{\mathrm{f}}$ that is consistent with the wife receiving $\bar{U}_{\mathrm{f}}$ in the second period:

$$\bar{\theta}_{\mathrm{f}}=\frac{(2+\alpha)w_{\mathrm{f}}\bar{e}^{\mathrm{f}}}{2\left(w_{\mathrm{f}}\bar{e}^{\mathrm{f}}+w_{\mathrm{m}}\bar{e}^{\mathrm{m}}\right)}\sqrt{\exp(-k)\left(\frac{(2+\alpha)\tau w_{\mathrm{f}}\bar{e}^{\mathrm{f}}}{\alpha\left(w_{\mathrm{f}}\bar{e}^{\mathrm{f}}+w_{\mathrm{m}}\bar{e}^{\mathrm{m}}\right)}\right)^{\alpha}}. \tag{16}$$

5.4. Optimal spousal education levels

We can now turn to the first period during which the husband and wife choose their education levels taking each other's education decisions and the determination of optimal household choices listed above as given. Since the wife will receive her reservation utility in the second period, she maximizes her utility by choosing the education level that maximizes her singles utility. Thus, as identified in Eq. (3), we find that $\bar{e}^{\mathrm{f}}=1/2\psi$.

What about the optimal education level of the husband? Using (1) (2) (10) (12) (14) and $\bar{e}^{\mathrm{f}}=1/2\psi$, we determine that he faces the following problem:

$$\max_{e^{\mathrm{m}}} \ln(1-e^{\mathrm{m}}) + \ln\left[\frac{1-\bar{\theta}_{\mathrm{f}}}{2+\alpha}\left(\frac{w_{\mathrm{f}}}{2\psi}+w_{\mathrm{m}}\bar{e}^{\mathrm{m}}\right)\right] + \ln\left[\frac{1-\bar{\theta}_{\mathrm{f}}}{2+\alpha}\,\frac{w_{\mathrm{f}}+2\psi w_{\mathrm{m}}\bar{e}^{\mathrm{m}}}{w_{\mathrm{f}}}\right] + k + \alpha\ln\left[\frac{\alpha}{2+\alpha}\,\frac{w_{\mathrm{f}}+2\psi w_{\mathrm{m}}\bar{e}^{\mathrm{m}}}{\tau w_{\mathrm{f}}}\right] \tag{17}$$

where $\overline{\theta}^{f}$ is given by Eq. (16) evaluated at $\bar{e}^{\mathrm{f}}=1/2\psi$.

The solution to (17) is given by the following first-order condition:

$$\frac{1}{1-e^{\mathrm{m}}} = \frac{(2+\alpha)2\psi w_{\mathrm{m}}}{w_{\mathrm{f}}+2\psi w_{\mathrm{m}}e^{\mathrm{m}}} - \frac{1}{e^{\mathrm{m}}} - \frac{2}{1-\overline{\theta}_{\mathrm{f}}}\,\frac{\partial\bar{\theta}_{\mathrm{f}}}{\partial e^{\mathrm{m}}}, \tag{18}$$

where

$$\frac{\partial\overline{\theta}_{\mathrm{f}}}{\partial\overline{e}^{\mathrm{m}}} = -\frac{\psi\exp(-k/2)}{2}\left[\frac{(2+\alpha)w_{\mathrm{f}}}{(w_{\mathrm{f}}+2\psi w_{\mathrm{m}}\overline{e}^{\mathrm{m}})}\right]^{2}\sqrt{\left(\frac{(2+\alpha)\tau w_{\mathrm{f}}}{\alpha(w_{\mathrm{f}}+2\psi w_{\mathrm{m}}\overline{e}^{\mathrm{m}})}\right)^{\alpha}} < 0. \tag{19}$$

Eqs. (18) and (19) implicitly define a response function for the husband's optimal education level given the wife's optimal education level, which equals $1/2\psi$.

In general, we define the response function for individual i as a function of the education level of the spouse (who is denoted by $-i$) as in Eq. (20):

$$e^{i}\left(e^{-i}\right) = \arg\max U_{i}\left(e^{i}|\bar{e}^{-i}\right) = \arg\max\left[\ln l_{1}^{i} + \ln l_{2}^{i} + \ln c^{i} + k + \alpha\ln n\right]; \quad i=f,m. \tag{20}$$

Given that the optimal values of l_1^i, l_2^i, c^{f}, c^{m} and n are all functions of the spouses' education levels, e^{f} and e^{m}, the solution to (20) implicitly yields two response functions: $e^{\mathrm{f}}=e(e^{\mathrm{m}})$and $e^{\mathrm{m}}=e(e^{\mathrm{f}})$. We can now define the household equilibrium:

Definition. A household equilibrium is such that

$$\begin{aligned}
&e^{\mathrm{f}} = e(e^{\mathrm{m}}) \quad \text{and} \quad e^{\mathrm{m}} = e\left(e^{\mathrm{f}}\right),\\
&\overline{\theta}_{\mathrm{f}} = \overline{\theta}_{\mathrm{f}}\left(e^{\mathrm{f}},\ e^{\mathrm{m}}\right) \quad \in \quad [0,1],\\
&l_1^{\mathrm{f}} = 1-e^{\mathrm{f}}, \qquad l_1^{\mathrm{m}} = 1-e^{\mathrm{m}},\\
&l_2^{\mathrm{f}} = l\left(e^{\mathrm{f}},\ e^{\mathrm{m}}\right) \qquad l_2^{\mathrm{m}} = l\left(e^{\mathrm{f}},\ e^{\mathrm{m}}\right),\\
&c^{\mathrm{f}} = c\left(e^{\mathrm{f}},\ e^{\mathrm{m}}\right), \qquad c^{\mathrm{m}} = c\left(e^{\mathrm{f}},\ e^{\mathrm{m}}\right)\\
&n = n\left(e^{\mathrm{f}},\ e^{\mathrm{m}}\right).
\end{aligned} \tag{21}$$

The marital equilibrium as defined above generates the optimal spousal education levels, e^i, i=f, m. And as explicitly defined by Eqs. (10)–(14), those spousal education levels jointly determine the intra-marital allocations of consumption and leisure between the two spouses as well as the optimal number of their offspring.

Eqs. (18) and (19) do not enable us to solve for the equilibrium education level of the husband analytically. Nonetheless, Eqs. (10)–(14) and (16) allow us to highlight how structural changes

that induce women to get more educated relative to men would alter the intra-household allocations in equilibrium. In particular, as women invest more in their education, their marital bargaining power will rise and this will result in their families to subsequently have fewer children because the opportunity cost of having and rearing children will be higher for more educated women. The next remark summarizes this main point:

Remark. Ceteris paribus, a more educated wife has (i) higher marital bargaining power, $\partial\overline{\theta}_{\mathrm{f}}/\partial e^{\mathrm{f}}>0$; (ii) more intra-marital consumption and leisure relative to her husband, $\partial(c^{\mathrm{f}}/c^{\mathrm{m}})/\partial e^{\mathrm{f}}>0, \partial(l_2^{\mathrm{f}}/l_2^{\mathrm{m}})/\partial e^{\mathrm{f}}>0$; and (iii) fewer children, $\partial n/\partial e^{\mathrm{f}}<0$.

This link between educational investment and the allocation of resources within the marriage has implications for the efficiency of the wife's education decision. As we show in the numerical examples below, because women devote more time to childrearing than do men and therefore provide fewer units of labor, Pareto efficiency requires that women obtain relatively less education than do men. However, the endogeneity of the marital sharing rule leads equilibrium outcomes in which women invest in their education at inefficiently high levels in order to protect their marital welfare.

5.5. Coasian transfers, marriage markets, and efficiency

Given the inefficient nature of the equilibrium, it is natural to consider the conditions under which spousal matching in the marriage markets and/or Coasian transfers from the husbands to the wives could restore Pareto efficiency. The process of matching in the marriage and remarriage markets could restore efficiency by improving the wives' divorce threat points and enforcing intra-marital sharing rules that encourage the wives to invest efficiently in education. In contrast, by providing a mechanism through which the wives internalize the gains associated with moving to the efficient level of education, Coasian transfers provide a different channel through which efficiency could be restored.

In other related work, such as Iyigun and Walsh (2003) and Iyigun (2004), we show that the process of spousal matching in the marriage markets can induce Pareto efficient outcomes even in the presence of pre-marital investments prior to spousal matching. These results would hold here too under the following conditions: (a) it is possible for divorced women with children to match with new husbands frictionlessly; (b) for single men available in the remarriage markets, the potential stepchildren acquired through the new marriage and the biological children they could have in the new marriage are perfect substitutes; and (c) there are sufficient numbers of childless single men in the remarriage market. While we are agnostic about the potential husbands' preferences toward biological and stepchildren and the availability of single childless men in the remarriage markets, there is considerable empirical evidence which suggests that the likelihood of remarriage is significantly lower for divorced women with children in general and those with young children in particular.[13] In the words of Becker et al. (1977), the presence of children "...hinder(s) the search for another mate and reduce(s) the gain from remarriage" (p. 1157). The bottom line is that, within this framework, matching in the marriage market is not a viable mechanism for achieving Pareto outcomes. For this reason, in what follows we abstract from the process of spousal matching and assume that the couple stays married.

Coasian transfers present another potential channel through which the Pareto inefficiency could be eliminated. As constructed, the model does not allow for the use of dowries as Coasian

[13] See, for instance, Wu (1994) and Sweeney (1997).

transfers by the husbands to the wives to induce efficient levels of education. However, if incorporated into the model, such transfers could restore efficiency under the following assumptions: (a) spouses are identified before individuals make their educational choices; (b) the wives can credibly commit not to over-accumulate education in return for the transfer; and (c) both spouses can credibly commit to the arranged marriage. While we rule out such transfers, they would be Pareto improving as long as there exists a commitment mechanism which ensures that the conditions listed above are met.[14] In fact, some authors argue that the practice of consanguinity–the marriage of biologically close relatives–persists in developing countries today despite its inherent risks for the children of such marriages precisely because they act as one such mechanism.[15] One potential difficulty is that, if a dowry payment is made, the future wife has an incentive to subsequently renege on her promise and educate more than the efficient level. And if instead of receiving a dowry when young she is provided only with a commitment that entitles her to a given level of consumption in the second period, her future husband has an incentive to renege on his promise and take advantage of her low education level. The key issue is that, if the time costs of childrearing are higher for women, then Pareto efficient outcomes will generally involve her obtaining low levels of education. The presence of these time costs of childrearing reduces the likelihood that the potential for remarriage will serve to enforce a high level of utility for women in marriage. Thus, without the payment of a dowry and a commitment mechanism which ensures that conditions (a) through (c) hold, a woman's decision to achieve a lower education level would be based on the assumption of time inconsistent behavior either on her part or her husband.[16]

6. Numerical example

As we already noted, our model does not yield analytical solutions. However, the formulation we present here lends itself nicely to numerical analysis, and in what follows, we present some computational exercises to fully characterize the equilibrium.[17] In particular, we first

[14] This mechanism would specifically involve a dowry payment from the future husband to the future wife before she commits to an education level. The upfront, lump-sum dowry payment would compensate the wife for the loss in her utility due to her lower education level in marriage. Since in our model individuals derive utility from only leisure in the first period and consumption in the second period, there will have to be a storage technology or an appropriate financial market for her to transfer the upfront dowry payment from the first period to the second one when she will use it to augment her consumption.

[15] See, for example, Hussain (1999) who finds that divorce can cause an entire family across generations (and possibly a family business) to break apart and, that in such unions, there can be greater external pressures to avoid this outcome.

[16] We know of two other related papers in which a similar result holds. Chiappori and Weiss (2004) construct a model of marriage–divorce–remarriage in which childrearing time cost asymmetries exist between men and women. Due to this asymmetry, investment in children could fall below the Pareto optimal level when parents divorce. They show that there are two equilibria in their model: one with a low level of divorce and remarriage and another with a high level of divorce and remarriage. In the latter case, fathers are willing to commit to make child support payments that helps to restore Pareto efficiency, but in the former case, they are not. As a result, the level of investment in children falls short of the Pareto optimal level in the low-divorce equilibrium. Rasul (2004) argues that intra-household allocations may be inefficient when spouses cannot commit to their future actions related to fertility. If couples bargain with commitment, fertility outcomes take equal account of both spouses' fertility preferences. In contrast, if couples bargain without commitment, they may not take into account their spouse's fertility preferences. Using household data from Malaysia, and exploiting differences in threat points in marital bargaining across ethnic groups to help identify the underlying bargaining model, he finds evidence that couples bargain without commitment.

[17] The GAMS code underlying our numerical exercises is available upon request.

demonstrate that endogenous bargaining power leads to spousal competition for intra-marital decision-making power and thus to education levels that exceed the Pareto optimal levels. We then carry out some comparative static analyses that show how external changes that empower women directly or indirectly (such as a closing of the gender wage gap) would prompt women to raise their education levels even further.

Let us begin by noting that the analog of Eq. (16) can be derived for the husbands. That is, we can solve for the endogenous bargaining power parameter θ_m that is consistent with the husband receiving $\bar{U}_m$ in the second period:

$$\overline{\theta}_m = 1 - \frac{(2+\alpha)w_m\bar{e}^m}{2\left(w_f\bar{e}^f + w_m\bar{e}^m\right)}\sqrt{\exp(-k)\left(\frac{(2+\alpha)\tau w_f\bar{e}^f}{\alpha\left(w_f\bar{e}^f + w_m\bar{e}^m\right)}\right)^{\alpha}}. \tag{22}$$

In what follows, we assume that the relative bargaining power of the husband is equal to γ, $0<\gamma<1$. Hence, we let the endogenous spousal bargaining weight equal

$$\theta = \gamma\overline{\theta}_f + (1-\gamma)\overline{\theta}_m. \tag{23}$$

According to Eq. (23), the wife gets her reservation utility level in marriage when γ equals one, and the husband gets his reservation utility when γ equals zero. With $\gamma \in (0,1)$, both spouses get some share of the marital surplus. In this case, both spouses choose different education levels in youth compared to the cases in which they expect to either remain single or get married but one of them gets his or her reservation utility in marriage. One interpretation of γ is that it captures the impact of divorce legislation and property laws on intra-marital allocations; the closer is γ to one, the higher is the degree of cultural and institutional biases against women, and as a consequence, the lower is the share they extract from marital surplus.

The top panel of Table 2 presents the parameter values for our main set of computations. In column (a) of Table 2, we show our baseline equilibrium under the parameter restrictions we have chosen. As can be seen, women get educated significantly less than men and work less than them in this case. There are three reasons for this: in our base-line case, the gender wage gap, $(w_m - w_f)/w_m$, is 25%; the time cost of education, ψ, is 25% higher for women than it is for men; and the time cost of childrearing, τ, is 0.1 for women and is zero for men. As a consequence, women choose to allocate less time to education than men before the marriage. This, in turn, lowers their labor supply and marital bargaining threat point, $\bar{\theta}_f$. Hence, after they get married, they consume less than their husbands as well.

Column (b) of Table 2 demonstrates the importance of bargaining in increasing the level of the wives' education. This column presents the Pareto efficient values of spousal education, consumption, leisure, and fertility.[18] The comparison of the values in this column with those in the first column highlights our main conclusion: when bargaining power is endogenous and the time cost of childrearing is relatively higher for women, then women get educated more than is Pareto optimal. This is the mechanism through which the wives maintain their marital bargaining power, but it is also the reason why their families end up having fewer children in marriage.

[18] Pareto efficiency describes not a unique allocation, but rather, a continuum of allocations. In order to facilitate comparison to the baseline Nash equilibrium, we present here the allocation that maximizes the husband's welfare holding the wife's utility constant at her baseline Nash equilibrium level.

Table 2
Parameter specifications and simulation results

	(a)	(b)	(c)	(d)	(e)
Parameters					
α	0.2	0.2	0.2	0.2	0.2
γ	0.6	0.6	0.6	0.6	0.6
ψ	1.25	1.25	1.25	1	1.25
τ	0.1	0.1	0.1	0.1	0.075
k	0.25	0.25	0.25	0.25	0.25
w_{f}	0.75	0.75	1	0.75	0.75
w_{m}	1	1	1	1	1
Eq. outcomes					
e^{f}	0.298	0	0.345	0.423	0.267
e^{m}	0.513	0.552	0.509	0.509	0.511
l_1^{f}	0.627	0.677	0.569	0.577	0.667
l_1^{m}	0.487	0.487	0.491	0.491	0.489
l_2^{f}	0.473	0.487	0.454	0.457	0.191
l_2^{m}	0.446	0.448	0.455	0.453	0.558
c^{f}	0.106	0.058	0.157	0.145	0.097
c^{m}	0.229	0.247	0.231	0.231	0.226
n	2.99	5.13	2.25	2.37	4.31
$1-l_2^{\mathrm{f}}-\tau n$	0.228	0	0.321	0.306	0.226
$1-l_2^{\mathrm{m}}$	0.554	0.552	0.545	0.547	0.191
$\overline{\theta}_{\mathrm{f}}$	0.264	n.a.	0.362	0.342	0.236
$\overline{\theta}_{\mathrm{m}}$	0.394	n.a.	0.467	0.451	0.397
U_{f}	−2.99	−2.99	−2.80	−2.84	−2.92
U_{m}	−2.53	−2.43	−2.55	−2.55	−2.48

This finding is strengthened by the possibility of corner solutions under which the wives' second period time constraint, presented in Eq. (6), binds. While not exposited here, there are parameterizations of the model under which this constraint binds and the wives do not work in the second period. This case is interesting because, unlike the Pareto efficient solution presented in Table 2 under which the wives do not work and get no education, in this Nash equilibrium, the wives choose positive levels of education to increase their marital bargaining power—even though this education leads to a reduction in first period leisure and provides no material benefit to the married couple.

In column (c) of Table 2, we present the effects of a lower gender wage gap on household choices. As shown, equal pay empowers women because it raises their optimal education level. With a higher education level, women work harder during the marriage and wield higher marital bargaining power. But a more educated wife also has higher childrearing opportunity cost so household fertility drops. And since both household fertility and women's leisure during the marriage are lower, a higher spousal leverage manifests itself in a significantly higher level of consumption for the wives. In Fig. 1, we depict how the spousal education response functions shift in response to a smaller gender wage gap. As shown, the new equilibrium entails a significantly higher education level for the wives and slightly less education level for the husbands.

In column (d) of Table 2, we show the effects of a lower time cost of education for women. The results are roughly in line with those of column (c): more educated women have higher threat points in marriage which generate for them higher marital bargaining power. They cannot

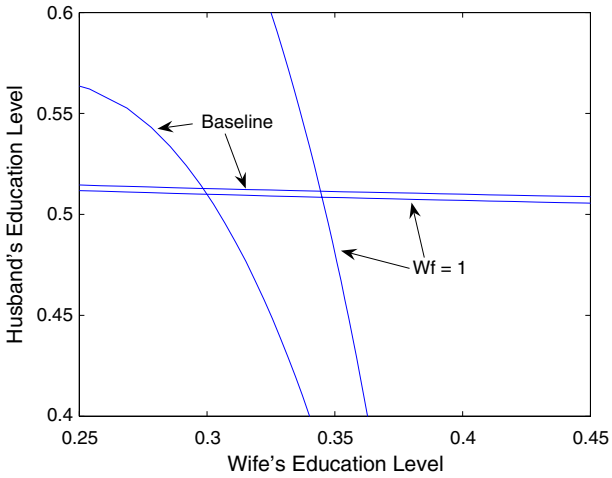

Fig. 1. Impact of closing the wage gap on reaction functions.

exercise this power by having more children because their childrearing opportunity cost has gone up. A higher labor supply by the wives also lowers their leisure time during their marriage. Hence, the only way through which women exercise their increased marital power is via a higher level of consumption. In Fig. 2, we show how the spousal education response functions shift in response to a lower education time cost for women. Because lowering the wives' cost of education affects the Nash Equilibrium only through induced changes in the wives' choice of education level, the husbands' reaction function remains unchanged. As in the above case, the new equilibrium entails a significantly higher education level for the wives and a roughly similar education level for the husbands.

In the final column of Table 2, we report the impact of a lower childrearing time cost. As shown, a 25% lower childrearing time cost leads to almost 50% higher household

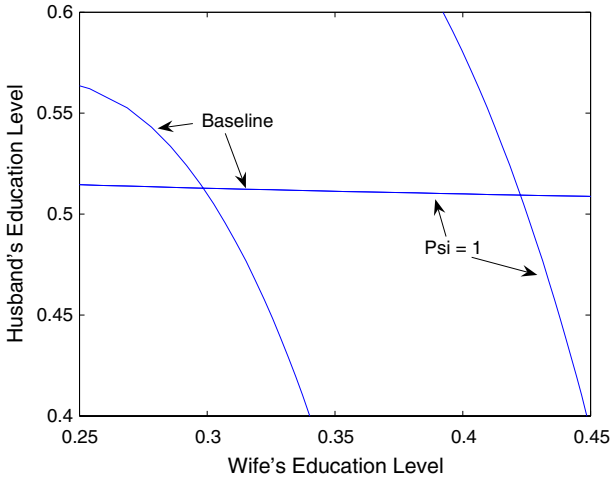

Fig. 2. Impact of reducing wife's education costs on reaction functions.

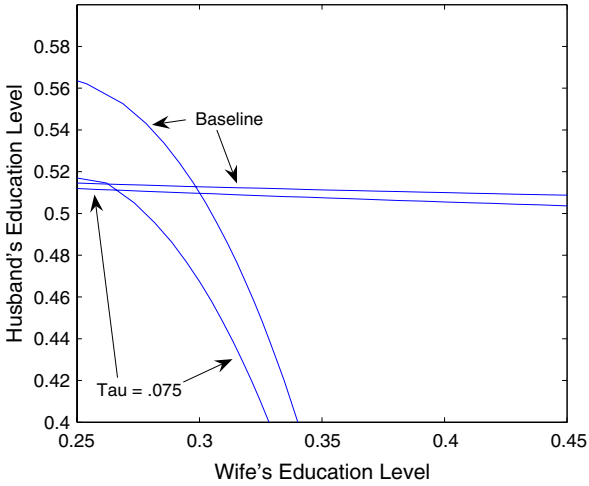

Fig. 3. Impact of reducing wife's timecost of childrearing on reaction functions.

fertility. As a result, women have lower threat points in marriage which generates for them significantly lower consumption in marriage. In Fig. 3, we illustrate the shift in the spousal education response functions in reaction to a lower childrearing time cost. In this case, both the husbands' and the wives' education levels drop but the decrease is much more dramatic in the case of the wives because the drop in the time cost of childrearing is associated with a marked increase in time devoted to childrearing and a smaller increase in time devoted to second period leisure. The significant reduction in the wives' labor supply associated with these changes in time allocation entails lower educational attainment for women.

7. Conclusion

During the last two decades, economists have recognized and examined the role of intra-household bargaining in various microeconomic phenomena pertinent to the process of development, including family and female labor supply, child labor and pecuniary and non-pecuniary intra-marital transfers. A departure from the unitary model of the household can be rewarding for studying the demographic transition as well because of the inherent biological differences between the two sexes in the requirements of parental time investment. These differences form the basis of a potential marital conflict over optimal fertility.

This paper identifies an important–but previously unreported–link between the evolution of marital gender power and demographic dynamics. What yields such a link is gender differences in the time cost of childrearing and the endogeneity of gender power in relative spousal earnings. As women invest more in their education, their marital bargaining power will rise and this will result in their families to subsequently have fewer children because the opportunity cost of having and rearing children will be higher for more educated women. Moreover, when bargaining power is endogenous and the time cost of childrearing is relatively higher for women, women get educated more than is Pareto optimal. This is the mechanism through which the wives maintain their marital bargaining power, but it is also the reason why their families end up having fewer children in marriage. As a consequence, shifts in gender power entail changes in fertility and the educational attainment of children.

Our approach shows that the biological differences between the sexes in the time requirement for childrearing in a bargaining framework makes the combinations of marriage, culture, and spousal bargaining integral to the process of economic development. We find that marriage is an important institution related to economic development because the extent to which wives' choices are reflected in couples' decisions affects population growth and educational attainment. Put differently, higher educational attainment empowers women not only because it raises the opportunity cost of childrearing but also because it serves as the basis of higher spousal bargaining power, which in turn yields lower fertility. On this basis, the degree to which an economy is culturally predisposed towards gender equality can be important.

Finally, our model also highlights why educational investment in daughters plays a special role in economic development: Education provides women with an unalienable asset in marriage, which in turn helps them to raise their bargaining power. Bequeathing physical and financial assets, especially in less-developed economies, may not empower women to the same extent because such assets can be sold in marriage and there is no connection between the return to these assets and the marital time commitment of the wives. Viewed from this perspective, educational investment in daughters provides a feasible mechanism through which women can effectively precommit to spending less time on childrearing during the marriage.

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