THE MARRIAGE MARKET: HOW DO YOU COMPARE?

by

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SELECTED SONS AND DEJECTED DAUGHTERS:

SEX AND STATUS[1]

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Abstract

Preference for sons is widespread in India and China. Modern technology allowing prenatal sex determination considerably lowers the cost of choosing the sex of offspring. This paper models endogenous sex-choice and shows that unbalanced sex ratios is but one of several possible consequences of a preference for sons. In particular, we point to the possibility of women consistently being born into low status families and thus relegated to a permanent under class. Also we show that a preference for sons could result in spousal age gaps, caste endogamy and cousin marriages. Finally we argue that social mobility rather than a quantity restrictions on number of offspring such as the Chinese one-child policy, could be a driving factor behind the recent increase in sex ratios observed in both China and India.

Key words: Son preference; sex-choice; caste endogamy; one-child policy.
JEL Classification: J12; J16; O33.

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1. INTRODUCTION

The biologically normal sex ratio (sons to daughters) at birth range from 1.03 to 1.06. In 1986 the Chinese figure was 1.11 (Hull 1990); four years later it had risen to 1.14 (Tuljapurkar et al. 1995), which could imply that for every one hundred girls born, at least nine are missing. In India and Pakistan, the sex ratio at birth is still higher. Traditional methods for sex targeting, e.g. infanticide or neglect and abuse of daughters, are costly. Modern technology offers a more convenient solution - prenatal sex determination. The need to curb population growth and to control the "quality" of the population, prompts China and India to promote increasing usage of ultrasound examination of foetuses. Today, one of its main uses is to ensure male offspring; banning of the practise has proven ineffectual (e.g. Banister 1987; Das Gupta 1987; Royston and Armstrong 1989; Yong-Ping 1990; Johansson and Nygren 1991; WHO 19912; Yi et al 1993). The increase in the sex ratio has, in China, been attributed to the so called one-child policy (e.g. Wen 1993). However, we will argue that such a policy could actually balance the sex ratio.

Yet, the real danger with increasing spread of prenatal sex determination might not lie in a deterioration of the sex ratio, but in who will have sons and who will have daughters. Female infanticide is known to be a high caste phenomenon (Tambiah 1973), and it is high castes in the north-west of India that exhibit extremely male sex ratios at birth (Miller 1981; Oldenburg 1982). Also, discrimination of girls has been found to increase with prosperity (Sen 1985) and education level of mothers in India (Miller 1981). In this paper, we will argue that pre-natal sex determination might exacerbate this trend.[2]

2 Positive correlation between social status and maleness of offspring is a more general phenomenon. For further references see Cronk (1989).

It is socially more acceptable, and thus presumably more common, for men to marry women of inferior status, a phenomenon also known as hypergamy, than *vice versa*.[3] Other well known marriage patterns are those of caste endogamy as practised in e.g. India, and the - historically well documented but somewhat odd - practise of cousin marriages, still common throughout the Middle East and parts of Asia and Africa (e.g. Murphy and Kasdan 1959).

Spousal gaps are not restricted to status. Throughout the world, men tend to marry younger women. The age gap is narrowing in developed countries, but remains high in many developing ones. Looking at Asia and the Middle East, the largest (average) age gap for first marriages is found for Bangladesh, 7.2 years, followed by Egypt, 5.5, Pakistan, 5.1, Morocco, 4.9, and India, 4.7 years (Bergstrom and Bagnoli 1993, Table B1). These are also countries in which the preference for sons is well documented (e.g. Das Gupta 1987; Royston and Armstrong 1989).

While most previous research has sought to explain son preference as a result of poor female relative male income earning potential, marriage market terms of trade or legal status (e.g. Rosenzweig and Schultz 1982; Dasgupta 1993), we take son preference as given and seek to analyse its consequences. Male sex ratios is the most conspicuous but not the only effect. We will see that a preference for sons could result in marriage patterns such as spousal age or status gaps, caste endogamy and cousin marriages.[4]

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3 In polygynous societies, most females would be married as opposed to only the high ranking men. Consequently, assuming equally many males as females at each level of the social hierarchy, polygyny would lead to hypergamy. However, hypergamy is also the socially accepted form of mixed-class unions in monogamous societies.

4 Sociological studies of endogamy (or exogamy) typically focus on documenting the incidence or the social functions of such a rule (e.g. Dumont 1970; Khury 1970). Economic models readily predict endogamy from the assumption of positive assortative mating, e.g. Laitner (1991). Hypergamy, however, does not follow from marriage market sorting.

Son preference need not result in uniform discrimination of girls. Because if people want not only sons, but sons who marry, there must be daughters somewhere. For instance, Confucianism pivots around the father-son relationship. Clearly, daughters are required to keep this chain going. This paper is concerned with the issue of from where these women would be delivered. We argue that son preference might result in high status people favouring sons and low status people favouring daughters. The argument is that a woman faced with two marriage proposals will choose the most attractive of the two men. Attractiveness is a function of many factors, of which social position and wealth are prominent examples. Thus the risk of celibacy could be greater for sons from low status families. Provided that parents care about marital status of offspring, low status parents might opt for daughters despite a preference for sons. Still, not all women need to end up at the bottom half of the social spectrum if parents prefer a daughter who could marry up to a son who would marry down. The rationale for such concerns could be presence of public goods in marriage.

Parents calculating the marriage market prospects of a son might not only consider his prospects with women his age, but also younger females. It is of course crucial that an older man can out-compete a younger man. We will study how a preference for sons, coupled with e.g. poverty and inability to borrow against future income, might drive spousal age gaps.

Social mobility is probably higher today than hundred or fifty years ago. There are two aspects to social mobility that are of particular interest to the current inquiry: we will arguen that it could both explain unbalanced sex ratios and the break down of caste endogamy. Presumably, social mobility weakens the link between parents' status and that of marriageability of child and could induce low status people to opt for sons. Hence, unbalanced sex ratios could stem from social mobility. The optimism and turbulence that followed the de-regulation of the Chinese economy, and the marked rise in sex ratios at birth, could thus be more than coincidental.

The paper is organised as follows. In Section 2 we formulate the basic model for endogenous sex-choice under son preference. In Section 3, we discuss the link between spousal age gaps and son preference, and in Section 4 we study unbalanced sex ratios. Section 5 concludes the paper.

2. THE MODEL

We consider a two sex population, $s \in \{m, f\}$ with *m* for male and *f* for female. In generation *t* there are M_t males and F_t females, who live for one generation. Hence, population size is $N_t = M_t + F_t$. Men and women marry in order to reproduce, and we assume monogamy and no re-marriage. Each couple have two children.[5] It follows that the population evolves according to $N_{t+1} = 2\min\{M_t, F_t\}$.

People prefer sons, provided that the sons marry.[6] Let (superscript) $g \in \{0,1\}$ indicate marital status of offspring, with 1 for married. Preferences over sex and marital status of offspring are ordered as follows: a married son is better than a married daughter, who beats an unmarried child of either sex. We write the utility of a child as $U(s^g)$, where

5 Allowing for population growth would not significantly change the results.

6 Otherwise, the decision problem would be trivial. Everybody would go ahead and have sons, from a biological perspective, hardly a successful strategy. Also note that parents want both of their children to marry, so that two married daughters are preferred to one married daughter and one unmarried son. Parents being content with only one child marrying would not be consistent with the assumption about the demand for children. We will return to this issue in Section 4.

(2.1) $U(m^1) > U(f^1) > U(s^0)$.

The central issue is that of sex-choice, which we assume is costless. Couples decide on sex of offspring, where (s_1, s_2) is a couple's reproduction strategy for the first and second born respectively. An equilibrium is a set of strategies, one for each couple, such that no couple would obtain higher utility from another sex-choice, given the other couples' strategies.

We assume individuals to be unambiguously ranked within a generation. The rank index $r_t \in \{1,2,\ldots,N_t\}$ denotes status, where person 1 has the highest status. Male ranking is indicated by superscript *m*, $r_t^m \in \{1,2,\ldots,M_t\}$ and analogously for females, $r_t^f \in \{1,2,\ldots,F_t\}$. Ranking determines marriage market attractiveness, and it is a well known result that the only stable matching is positive assortative (Becker 1981), i.e. it has the highest ranking man marrying the highest ranking woman, and so on.

We denote rank at birth by subscript *b*, $r_{b,t} \in \{1,2,\ldots,N_t\}$. The father's rank r_{t-1}^m and the individual's birth order $\omega \in \{0,1\}$, with 1 for the first born, determine rank at birth as follows,

(2.2) $r_{b,t}(r_{t-1}^m, \omega) = 2r_{t-1}^m - \omega$.

Note that the first born has higher status (lower rank index) than the second born, and that children to a high ranking father outrank children to a lower ranking father irrespective of birth order.

Social status is simply a ranking of individuals according to an endowment that is a monotone function of rank at birth $e(r_{b,t})$.[7] Higher status implies higher endowment. In Section 4 we will allow for social mobility, which we model by the addition of a normally distributed random variable ε with mean zero and standard deviation σ. The endowment and the random term gives consumption as

$$(2.3) \quad c = e(r_{b,t}) + \varepsilon, \qquad \varepsilon \sim n(0,\sigma).$$

People care about the sex of offspring, whether their children marry, consumption c and, possibly, the social standing of children-in-law. With abuse of notation, for a parent generation t - 1, we indicate the rank index of a child-in-law by $r_{s,t}$, where the subscript $s \in \{m, f\}$ refers to the sex of the proper child, i.e. a daughter-in-law's rank index is $r_{m,t}$. We assume utility to be additively separable in sex of offspring, consumption and status of children-in-law, as well as the first and the second child. To simplify the notation we will discuss parental utility as if parents had only one child. Formally, we write utility as

$$(2.4) \quad W(s^g, c, r_{s,t}) = \begin{cases} U(s^1) + V(c) + \kappa(N_t - r_{s,t}) & \text{if} \quad g = 1, \\ U(s^0) + V(c) & \text{if} \quad g = 0, \end{cases}$$

where κ is a non-negative constant.

Utility is increasing and concave in consumption, $V'(c) > 0$ and $V''(c) < 0$. Furthermore, we assume that utility from marrying children well is proportional to rank index. Since a high rank

7 There are no bequests or gifts in the model. We may think of the endowment as inherited social capital.

index corresponds to low social status, $r_{s,t}$ enters negatively in (2.4). N_t is there just to ensure that married children give higher parental utility than unmarried children.

2.1 *Narrow Gender Considerations*

In this sub-section we make the simplifying assumption that rank as adult is solely determined by status at birth and that parents do not consider rank of children-in-law, i.e. $\kappa = 0$, and $\sigma = 0$. Utility and consumption are hence $W(s^g, c) = U(s^g) + V(c)$ and $c = e(r_{b,t}) + p$ respectively.

Consequences of free sex-choice under preference for sons is the issue we wish to address. Given the above assumptions about narrow minded parents, we have the following results.

Lemma 1. Sex ratios balance in equilibrium.

Proof: Assume the contrary, an equilibrium in which a generation *t* - 1 does not balance the sex ratio of offspring, i.e. $M_t \neq F_t$. This implies that not all children would marry. From (2.1) we know that this cannot be an equilibrium for the parent generation as there would be couples who had unmarried sons (daughters) who could have been married daughters (sons).□

Hence in equilibrium, $N_t = N_{t-1}$, and $M_t = F_t$. Henceforth, we will look at steady state and drop the subscript *t*. To ease notation, let $A = N/2$.

Definition: i) $r \in \{1,2,\ldots,A\}$ makes up an *upperclass* and $r \in \{A+1, A+2,\ldots,2A\}$ an *underclass*; ii) under *complete segregation*, one sex constitutes an upperclass and the other an underclass.

Proposition 1. i) There is a Nash equilibrium in which women constitute an underclass. ii) There is no Nash equilibrium in which men constitute an underclass.

Proof: We start by noting that given that $r \in \{1,2,\ldots,A\}$ is male, $r \in \{A+1, A+2,\ldots,2A\}$ would only marry if female. Next, we require that given that $r \in \{A+1, A+2,\ldots,2A\}$ is female, no $r \in \{1,2,\ldots,A\}$ would give higher parental utility if female. This is true since $r \in \{1,2,\ldots,A\}$, if male, would all find wives, and a married son yields higher parental utility than a married daughter.

By a similar argument it can be verified that men constituting an underclass cannot be a Nash equilibrium. Assume that $r \in \{A+1, A+2,\ldots,2A\}$ is male. Then we need that all $r \in \{1,2,\ldots,A\}$ are female, otherwise the males would not marry. But if $r \in \{1,2,\ldots,A\}$ are female, anyone of them could give higher parental utility as a son, since a son would be the highest ranking male in a population with at least one female, and we know that he would marry.□

Complete segregation with females constituting an underclass is not the only Nash equilibrium, $r \in \{1,2,\ldots,A-1,A+1\}$ being male and $r \in \{A, A+2, A+3,\ldots,2A\}$ female, is also one. We note, however, that women invariably marry up.[8]

8 While this paper focusses on how a universal preference for sons could result in social stratification by sex, the predictions coincides with that of Trivers and Willard (1973). Assuming that male relative to female

What if, given a (Nash) allocation of sons and daughters, parents could trade sons and daughters? We could think of this as parents trading the right to a married son, consumption is in this case $c = e(r_b) + p$, where p denotes the transfer payment. Would trade take place, and what would be the ensuing allocation of sons and daughters? We call an equilibrium stable if no further trade can take place. This amounts to asking whether there exists a payment p which would be high enough to induce some parents of a son to trade him for a daughter, and at the same time be low enough for some parents of a daughter to consider paying p and switching to a son. For simplicity, we will assume that the issue of side payments can be discussed in terms of father's rank. The relevant comparison is between a married daughter and a married son, therefore we suppress the superscript indicating marital status.

Proposition 2. Women constituting an underclass is the only stable Nash equilibrium.

Proof: Consider that for someone of rank r to be willing to give up a son for a daughter, the payment $p > 0$ must be such that $V(e(r) + p) - V(e(r)) > U(m) - U(f)$. At the same time, someone of rank r' must be willing to pay p to buy a son, in other words we need that $U(m) - U(f) > V(e(r')) - V(e(r') - p)$. By concavity of $V(\cdot)$ we know that these two conditions can only be satisfied for $e(r) < e(r')$, which corresponds to $r > r'$. □

In other words, if a payment, from one parent couple to another, such that they would agree to trade sons and daughters, exists, it must be between a father of rank r trading a son for a

reproductive success is greater at the upper end of the social hierarchy and that female relative male reproductive success is greater at the lower end, natural selection would favour species that adjust the sex ratio of offspring accordingly. This paper suggests an alternative interpretation of the observed phenomenon of maleness of offspring to be positively correlated with social status among humans.

daughter, and a father of rank r' trading a daughter for a son, where $r > r'$. From which it follows that if the rank indices of fathers to sons are lower than those of fathers to daughters, no voluntary trade can take place.

Would the results still hold if our short lived parents were imaginative enough to also care about the sex of grand children? Assume that preferences over grand-children are ordered according to the same principle as those over children. Under complete segregation, the highest ranking quartile of the population (provided that N is a multiple of four) would have sons and grand-sons. The second highest quartile would have sons and grand-daughters. Grand-sons can only be obtained had they chosen daughters instead. Under positive time preference, the second quartile cannot do better than under complete segregation. Having established that the first two quartiles opt for sons, the last two quartiles cannot do better than to choose daughters. Hence we conclude that if grand children carry less weight in the utility function than own children, e.g. from impatience or lower degree of genetic closeness, the complete segregation result would hold.

2.2 *General Status Considerations*

Even though positive correlation between maleness of offspring and social status has been observed (e.g. Cronk 1989), the complete segregation result is at odds with everyday observation. One reason could be the rather restrictive assumption of parents being indifferent to social status of their children's partners. In this section we will see that a relaxation of that assumption modifies the complete segregation result. No longer are women exclusively born into the lowliest households. As in the previous section, there are several equilibria. We will focus on one that has a caste like structure. We model parental concern for status of in-laws by assuming $\kappa > 0$. Everything else is as in Section 2.1.

We know from Proposition 2 that in the equilibrium robust to side payments, no money will change hands as those with daughters invariably are poorer than those they would need to buy off. Consequently, consumption is given by initial endowment. Let us denote the difference between how well a daughter would marry compared to a son by

$$(2.5) \quad \Delta = r_m - r_f ,$$

and let *relative* son preference be

$$(2.6) \quad \Delta^* = \frac{1}{\kappa}\left(U(m^1) - U(f^1)\right).$$

Sons are preferred to daughters if $W(m^1, c, r_m) \geq W(f^1, c, r_f)$, which rearranged yields the condition

$$(2.7) \quad \Delta \leq \Delta^* .$$

For the purpose of this section we define a *group* to be a set of individuals of consecutive rank (individuals 1, 2, 3 make up a group while 1, 3, 4 do not), and a one-sex group is a *layer*. Lastly, a *caste* is a two-layer, endogamous, group. We can now state our next result.

Proposition 3. Consider a relative son preference $\Delta^* \in [2k-1, 2k+2)$, where k is a positive integer. Then there is a steady state population size $N = 2bk$, which has a social structure with b castes such that for $i = 0,2,\ldots,2(b-1)$, $r \in \{ik+1, ik+2, \ldots, ik+k\}$ is male and $r \in \{(i+1)k+1, (i+1)k+2, \ldots, (i+1)k+k\}$ is female.

Proof: Assume that for $i = 0,2,\ldots,2(b-1)$, $r \in \{(i+1)k+1, (i+1)k+2, \ldots, (i+1)k+k\}$, is female, and that all but one, say *j*, $r \in \{ik+1, ik+2, \ldots, ik+k\}$ are male. We need that the *j*:th person would give parents higher parental utility if male than if female. From (2.8) we know that this is true if $r_m - r_f \leq \Delta^*$. The left hand side is greatest for $j = ik+k$. If a son, *j* would marry woman $(i+1)k+k$, hence $r_m = (i+1)k+k$. If *j* were a daughter instead, she would marry man $ik+1$, hence $r_f = ik+1$, which yields $r_m - r_f = 2k-1 \leq \Delta^*$.

Next we need that no parents to daughters would regret their sex-choice, given the other parents' actions. Assume that for $i = 0,2,\ldots,2(b-1)$, $r \in \{ik+1, ik+2, \ldots, ik+k\}$ is male and that all but one, say *j*, $r \in \{(i+1)k+1, (i+1)k+2, \ldots, (i+1)k+k\}$ are female. Again, we require that a person *j* would give higher parental utility as a daughter than as a son. We start by looking at the lowest ranking layer of females, $i = 2(b-1)$. Were one of them a son, he would not marry at all. From (2.1) and (2.4) we know that their parents prefer them to be daughters.

For $j \leq 2(b-1)k$, we need that $r_m - r_f > \Delta^*$. The minimum for the left hand side is obtained for $j = (i+1)k+k, i = 0,2,\ldots,2(b-2)$. If a daughter, she would marry man $ik+k$. If a son, he would marry woman $(i+3)k+2$ (provided that $k>1$, it is left to the reader to verify that the results would go through for $k=1$), hence we have the condition that $2k+2>\Delta^*$.□

Proposition 3 says that alternating, equal sized, male-female layers is an equilibrium. The first layer has k males, the second layer has k females, and by the assumption of positive assortative mating we know that they marry each other. As before, women marry up. We note that this equilibrium has the characteristics of a hypergamous caste-system.

Inspection of (2.6) gives at hand that the number of castes in a society depends positively on κ, the extent to which marrying children well matters. We see that as κ decreases, we approach the complete segregation case, since $\lim_{\kappa\to 0}\Delta^*=\infty$.

κ might be interpreted as a measurement of the degree of social stratification, where under high κ daughters are more attractive by virtue of the fact that they would marry up. Note that there is an upper limit to the importance of rank consideration relative to the preference for sons; if very high, the logical thing for a couple would be to let the first born be male, the second born female, and marry the two. Sibling incest is, however, rare.[9] The second closest thing would be that of siblings' children marrying each other. Cousin marriages are known to have been common in many societies and are still widely practised in the Middle East, and parts of South Asia. While previous studies of cousin marriages typically have focused on documenting the incidence or the social functions - such as strengthening of kinship loyalty - of such a rule,[10] Proposition 3 suggests that cousin marriage and caste endogamy could be related

9 See e.g. Pastner (1986).
10 For further references see e.g. Khury (1970).

phenomena, and that a general concern with status of in-laws rather than kinship loyalty might be the source of this practise.

3. Son Preference Driving Spousal Age Gaps

The pattern of women marrying up is not restricted to status. Typically, grooms are older than their brides, and the age gap is particularly pronounced in some of the less developed countries where the preference for sons is strong. In this section we will explore how a preference for sons could be one of the factors driving spousal, groom minus bride, age gaps. Besides the academic interest in explaining age gaps, they merit attention as it has been suggested that large age gaps could contribute to female marginalisation in marriage. For example, one of the reasons given for deliberately wanting the groom to be older than his bride in India is to ensure him sufficient superiority (Caldwell, Reddy and Caldwell 1983). Moreover, in an empirical study of dowry inflation in India, the age gap was used as one of the indicators of groom - bride quality difference (Rao 1993). Presumably, authority stems not only from proximity to death; age might be an advantage if, for instance, capital markets are poorly developed.

The main modification in this section is that in order to model age gaps, we let people live until age H. They can marry at any age $\eta \in [0, \mathrm{H}]$. People of the same age form a cohort. There are equally many people in each cohort. Within each cohort, people are unambiguously ranked by the rank index *r*. Throughout this section, *r* refers to ranking within a cohort. It will prove convenient to let *r* be continuous and uniformly distributed on an interval $r \in [0,2]$. Again, $r = 0$ denotes the highest ranking person in a cohort. The age and birth rank of single people are known to everybody. From the assumptions of constant cohort size and life span, it follows that steady state sex ratios balance, and from Proposition 2 we know that $r \in [0,1]$ is male.

There is no uncertainty as to status as adult or marriage market position, i.e. $\sigma = 0$, and we abstract from relative son preference, $\kappa = 0$. From (2.1) we know that all children marry. The issue in this section is not if but when. Therefore we suppress the superscript indicating marital status.

Several cohorts co-exist at each point in time. To simplify the exposition, we assume a continuous inflow of new borns, and outflow of age H cohorts. We wish to model spousal age gaps and we do so by assuming that ageing improves social standing for men at the rate λ in the following fashion: a man of age η' and rank r', is as attractive as a man of age η and rank

(3.1) $r = r' - \lambda(\eta' - \eta)$.[11]

As there is a latent deficit of females, women will always marry at age zero. Consequently, to establish spousal age gaps it suffices to concentrate on the male age of marriage. Let $x(\eta)$ be the (cohort) fraction of men who have married by age η and let $\eta(r)$ be marriage age as a function of rank index.

We start by determining maximum age gap, γ. It is constrained by life span H (for obvious reasons), and impatience. The latter matters because for parents to prefer a son who marries at age η to a daughter who would marry at age zero, it must be that $e^{-\rho\eta}U(m) \geq U(f)$, where $\rho > 0$ is the continuous discount rate, which implies that

11 No longer are individuals unambiguously ranked. We assume that people of different cohorts with the same overall rank also share marital status at each point in time, and that the γ men who are identically ranked and marry γ women of differing rank, throw a dice to determine who marries which girl.

$$(3.2) \qquad \gamma = \min\{\mathrm{H}, \max \eta : \eta \leq Q\}, \qquad \text{where } Q = \frac{\ln\left(\frac{U(f)}{U(m)}\right)}{\rho}.$$

We note that the maximum age gap increases with son preference and decreases with time preference.

To establish marriage age as a function of rank, we note that the lowest ranking man in each cohort, man $r = 1$, marries at age γ. From (3.1) we know that if he marries, so do all men of age η and rank index

$$(3.3) \qquad r \leq 1 - \lambda(\gamma - \eta).$$

Let η^* denote the youngest age at which any man marries, formally $\eta^* = \min\{\eta : x(\eta) > 0\}$. From (3.3) we obtain

$$\eta^* = \begin{cases} 0, & \text{if } \gamma - \frac{1}{\lambda} \leq 0, \\ \gamma - \frac{1}{\lambda} & \text{otherwise.} \end{cases}$$

In other words, η^* depends on the rate at which ageing promotes social standing. If ageing does little to advance status, here $\lambda \leq 1/\gamma$, there will be age zero men who marry, i.e. $\eta^* = 0$. If, on the other hand, ageing promotes marriage market attractiveness substantially, i.e. $\lambda > 1/\gamma$, men younger than $\eta^* > 0$ are outcompeted by older men for wives.

The fraction of men who have married by age η is

$$(3.4) \qquad x(\eta)=\begin{cases} 1-\lambda(\gamma-\eta) & \text{if} \quad \eta^{*}=0, \text{ and } \eta\in[0,\gamma], \\ 0 & \text{if} \quad \eta^{*}\geq\eta>0, \\ \lambda(\eta-\eta^{*}) & \text{if} \quad \gamma\geq\eta>\eta^{*}>0. \end{cases}$$

Average male marriage age/spousal age gap is $\bar{x}=\int_{\eta^{*}}^{\gamma}x'(\eta)\eta d\eta$, from which it follows that $\partial\bar{x}/\partial\gamma>0$, and $\partial\bar{x}/\partial\lambda>0$, i.e. average age gap increases with maximum age gap (which in turn increases weakly in son preference), and the rate at which ageing improves marriageability. Poorly functioning capital market could make accumulated savings a factor boosting eligibility, which suggests a link between underdeveloped financial markets and large spousal age gaps, both prominent features of some developing countries.

We are also interested in determining the relationship between status and age at marriage. The fraction of men who have married by age η, $x(\eta)$, can be interpreted as the rank index of the men who marry at age η. Hence, the inverse function of $x(\eta)$ gives age at marriage,

$$(3.5) \qquad \eta(r)=\begin{cases} x^{-1}(\eta) & \text{if} \quad \eta\in[\eta^{*},\gamma], \\ 0 & \text{if} \quad \eta<\eta^{*}. \end{cases}$$

From (3.4) and (3.5) it follows that $\eta'(r)\geq 0$, i.e. higher status men marry at a younger age. The implication that the lowest ranking men wait the longest to marry seems to square well with empirical findings for poor countries (e.g. Parish and Whyte 1978).[12]

12 Bergstrom and Bagnoli (1993) arrive at the opposite result. They show how uncertainty as to male income earning capacity and asymmetric information could induce high human capital men to postpone marriage.

This section's results can be summarised as follows.

Proposition 4. Spousal age gaps increase with son preference, and low ranking couples exhibit the highest age gaps.

4 Uncertainty and Unbalanced Sex Ratios

So far, sex ratios have balanced in equilibrium. However, in India, and China, men outnumber women and increasingly so. For China, the rise in the sex ratio has been linked to the implementation of the so called one-child policy. However, if allowed only a limited number of children, would parents not be even more anxious to see all of them married? We will argue that the rise in the sex ratio could stem from a rise in social mobility rather than a quantity restriction on the number of offspring.

The literature on the demand for children typically distinguishes between the consumption and the investment motive. So far we have only been concerned with the former. Undoubtedly, the investment motive could explain unbalanced sex ratios were one sex considered the better investment. It seems, however, reasonable to assume that the consumption demand for children is satisfied at a modest family size and that the investment motive assumes a less prominent role with higher levels of economic development.[13] Hence, we argue that economic growth *per se* would result in a reduction in the need for children as investment objects and, consequently,

However, the situation they model is more readily interpreted as being that of industrialised, developed countries.

13 Presumably, better functioning financial markets and less poverty reduce the need for children as e.g. old age support.

a balancing of sex ratios. In view of this, the rise in the sex ratios seen in India and China appears all the more puzzling.

We propose that the apparent paradox can be resolved by the introduction of social mobility. In its absence, parents know with certainty the social status of their offspring and thus whether a son would marry. Social mobility weakens the link between parents' status and that of child's marriageability and could induce low status parents to opt for sons. Thus, we argue, social mobility might contribute to unbalanced sex ratios.

Again, people live and marry in one period only and show no regard for status of children-in-law, i.e. $\kappa = 0$. We maintain the assumption from the previous section of continuous $r \in [0,2]$; $r = 0$ for the highest ranking person. Recall that status as adult (the one that matters for ability to marry) is simply a ranking of individuals according to $e(r_b) + \varepsilon$, $\varepsilon \sim n(0,\sigma)$. We model social mobility by setting $\sigma > 0$. The probability of a son marrying, q, depends on father's rank r, and social mobility as measured by σ. We express utility from a son as:

$$q(r,\sigma)U(m^1), \qquad \text{for } q(r,\sigma) \in (0,1),$$

to be compared with the utility of a daughter, who marries with certainty, $U(f^1)$.[14]

For the marginal parent the following must hold,

$$(4.1) \quad q(r^*,\sigma)U(m^1) \equiv U(f^1).$$

14 Utility of an unmarried son is normalised to zero.

We are interested in how the sex ratio responds to an increase in social mobility. Totally differentiate (4.1) and by the envelope theorem we obtain:

$$\text{(4.2)}\quad \frac{dr^*}{d\sigma} = -\frac{\frac{\partial q(r^*,\sigma)}{\partial r^*}\frac{\partial r^*}{\partial \sigma} + \frac{\partial q(r^*,\sigma)}{\partial \sigma}}{\frac{\partial q(r^*,\sigma)}{\partial r}} = -\frac{\frac{\partial q(r^*,\sigma)}{\partial \sigma}}{\frac{\partial q(r^*,\sigma)}{\partial r}}, \qquad \text{for } q(r^*,\sigma) < 1.$$

By assumption, the denominator $\partial q / \partial r$ is negative and from $\varepsilon \sim n(0,\sigma)$, the numerator $\partial q(r^*,\sigma) / \partial \sigma$ is positive.[15] We can now state our last result.

Proposition 5. An increase in social mobility raises the number of men to women.

Proposition 5 also implies that social mobility would result in the break down of caste endogamy. As sex ratios no longer balance within each caste, it follows that there will be high caste males who do not marry within their caste. As they are preferred to lower caste males, they would marry outside their caste. Hence, social mobility could undermine caste endogamy, which suggests that the latter might be a result of a static socio-economic context in combination with a preference for sons and concern for status of in-laws. We also note that the rise in the sex ratio in China has coincided with economic reforms that promoted not only economic growth but also a jump in social mobility (e.g. Byrd and Lin 1991). Moreover, social mobility could be one reason why cousin marriages have been rare in North America, have virtually disappeared from the European and Latin American scene, but are common in the Middle East, parts of Asia and Africa.

[15] For the more liberal distributional assumption of zero mean and finite standard deviation, we can use Chebyshev's inequality to establish that $q(\cdot)$ is at least $\overline{q}$. Then the following is true, $\partial \overline{q} / \partial \sigma \geq 0$.

5. CONCLUSIONS

We have modelled endogenous sex-choice under preference for sons and shown that the notion of male superiority could become a self-fulfilling prophecy with the spread of sex specific abortions. An improved sex-choice technology might not only lead to temporary discrimination of females, but also to a situation of permanent marginalisation.

We show that a preference for sons could be a factor behind men marrying younger women, and the pattern of hypergamy, i.e. women marrying socially superior men. In addition, we argue that hierarchically ordered endogamous groups, in which women consistently marrying up, could be a result of relative son preference, i.e. parents preferring sons unless daughters marry sufficiently well. Also, we show that caste endogamy and cousin marriage could be affine phenomena; and that, barring sibling incest, the latter is the limit case of low relative son preference.

Furthermore, the analysis suggests that increasing social mobility, following from e.g. industrialisation, could be one of the factors causing the break down of caste endogamy.

Lastly, we challenge the widespread view that the rise in the sex ratio at birth in China is due to the one-child policy. Instead, we argue, increasingly male sex ratios could stem from a rise in social mobility, and not a quantity restriction on the number of children.

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DEAR SON - EXPENSIVE DAUGHTER: WHY DO SCARCE WOMEN PAY TO MARRY?[1]

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Abstract

This century, female marriage market terms of trade in India, as measured by dowry payments, have deteriorated despite a worsening shortage of brides. We argue that this development can be explained by male *vis à vis* female heterogeneity, and that dowry inflation could be a result of an increase in male heterogeneity. Contrary to the conventional wisdom that increasing scarcity would raise prices, we explore the possibility of a reverse causality, increasing shortage of women driving dowry inflation. The argument is that scarcity *per se* might turn the marriage market terms of trade against women by increasing the return on male human capital investments.

Keywords: Dowry inflation; human capital investment; son preference.
JEL Classification: J12; J24.

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1. INTRODUCTION

The number of women to men has fallen steadily in India during this century (Sen 1985). Applying the model for dowry determination proposed by Becker (1981:92-94), scarcity of women would result in women being paid to marry. However, several scholars have pointed to a secular increase in dowries, a phenomenon often referred to as dowry inflation (Epstein 1973; Lindenbaum 1981; Caldwell, Reddy and Caldwell 1983).

Dowry in a society with an overall deficit of brides is a special case of a more general issue, why transfers between bride and groom families fail to reflect the true valuation of men and women as spouses. A related matter is that of under-investments in daughters. Dasgupta (1993), among others, points to patrilocal marriages as one source of positive externalities to human capital investments in daughters. However, patrilocal marriages do not suffice to explain why investments in daughters are recoupable to a lesser extent than investments in sons. The mere fact that the daughter who leaves her family to live with her in-laws is viewed as a loss, and the addition of a daughter-in-law is seen as a contribution (e.g. Dixit 1991; Dasgupta 1993), net of dowry, bears witness of marriage market imperfections.

Both dowries and bride prices (negative dowries) co-exist in India. Dowries originated as a means for financially strong low caste families to buy status through marriage of a daughter into a high caste family (Sarkar 1993). For long, the practise of paying dowry was a high caste phenomenon, while brideprices prevailed at the lower end of the social ladder. Today, the popular view in India is that dowries compensate for bride-groom quality differences (e.g. Lindenbaum 1973; Dixit 1991; Billig 1991).[2] The steady rise in dowries has not only brought financial hardship on the bride family, but also been taken as degrading, partly due to the

[2]The same logic prompts Rao (1993) to regress dowries on differences in bride-groom traits.

notion of payments reflecting inter-sex quality differences. Dowry inflation has been linked to a rise in domestic violence and a deterioration of women's status (e.g. Kishwar 1989, Saroja and Chandrika 1991, Sarkar 1993).

In order to examine the mechanisms driving dowries and to explain how scarce women can end up paying to marry, we present a simple model for dowry determination under male *vis-à-vis* female heterogeneity. The intuition is that men compete with men for women as spouses and *vice versa*. If women are interchangeable to a greater extent than men, female competition for men will be more fierce than male competition for women. Thus, a man might get paid, not as a result of him being better than his wife, but because he is better than the runner up. That intra-sex heterogeneity favours the heterogeneous side, the main result of Section 2, is also shown in the model developed by Stapleton (1988) for implicit marriage markets.

The central assumption of our argument is hence that men, as partners, are more heterogeneous than women.[3] This heterogeneity could result from the sexual division of tasks. If women concentrate on parenting, and assuming that the ability to parent is more evenly distributed in the population than other talents, women's output will be of more even quality than that of men. Consequently, the sexual division of tasks might result in men's performance being more heterogeneous than women's. Male *vis à vis* female heterogeneity could be further aggravated by the increasingly important role of education for income earning potential and social status. To the extent that human capital investments increase wage earning more than child bearing and rearing capacity, intra family resource allocation might favour male human capital investments, which in turn is likely to increase male *vis à vis* female heterogeneity.

[3]The discussion of dowries is not limited to societies where marriages are arranged. However, "love marriages" (re)introduces personal traits in the matching decision, a modification that is likely to reduce the gender gap in terms of heterogeneity.

Furthermore, one may speculate that the social norm of men dictating the family's status and the fact that some goods are not market allocated but assigned on the merit of status, could result in men being more heterogeneous than women. For instance, under a preference for sons and shortage of women, marriage to a high status man might be key to ensuring reproductive success of male offspring.

Also, the paper seeks to explain how shortage of women can go hand in hand with deteriorating female terms of trade on the marriage market, as indeed has been the case in India this century. The established view is that causality runs from poor female economic prospects to shortage of women (e.g. Rosenzweig and Schultz 1982). We consider the possibility of the reverse causality, scarcity of females aggravating the gender gap both in terms of income earning potential and marriage market terms of trade. In India, several scholars have pointed to the rise in importance of education as a determinant of groom attractiveness. Also, it has been noted that when calculating the return on educating a son, the fact that his education will have a bearing on his marriage market prospects is factored in (Lindenbaum 1973, Kapadia 1993). This suggests that the mere fact that men need to compete for women could result in men investing more in human capital, education in particular, than women. The argument is that the effect of education is to both increase productivity and marriage market prospects. As long as women marry with certainty, the return on education would be invariant to the sex ratio.

The paper is organised as follows. Section 2 discusses the mechanisms behind dowry determination under male *vis à vis* female heterogeneity and shows how male heterogeneity might result in dowry inflation. Section 3 studies possible effects on dowries of an increase in the shortage of females. We argue that scarcity of females might increase the difference between men and women's investments in education and - via increased male heterogeneity - raise dowries. Section 4 concludes the paper.

2. Why Scarce Women Pay to Marry

Consider a world populated by two sexes, men and women. There are N women and L men. For the purpose of discussing the Indian case of rising dowries in the face of a shortage of women, we assume women to be the scarce sex, $N < L$.[4] Further, let us assume that both men and women value marriage, and are willing to reduce consumption in order to marry. Let $W = \{w_1, w_2, \ldots, w_N\}$ denote the set of women, and $M = \{m_1, m_2, \ldots, m_L\}$ the set of men.

As we are interested in male relative to female heterogeneity, it is convenient to assume the females to be of the same quality, while allowing the males to differ in quality.[5] Let z be a variable capturing the quality of the females in the eyes of the men, and z_i denotes the quality of woman i. Women are homogeneous as far as the men are concerned, hence $z_i = z$, for all i in W. Let the variable x capture the quality of the men, and x_j denotes the quality of man j. Moreover, the set of males is ordered so that $x_1 \geq x_2 \geq \ldots \geq x_L$. We assume quality and utility to be measured in money.

We are interested in whom of the men will marry, and at what prices marriage will be traded. It is useful to think of this in terms of men selling and women buying marriage. As women are identical, men value marriage to a woman at a constant z. Let d_j, which may be positive or

[4]Throughout the paper, the assumption of monogamy is maintained. Monogamy is a central assumption when discussing dowry determination as in Section 2. For the discussion in Section 3, it is a convenient assumption, but not central to the results.
[5]Allowing the women to differ in quality would complicate the exposition but not add substantially to the analysis.

negative, denote the price of man j. The utility of remaining single is normalised to zero. If married, man j's utility (or profit) is given by the value of marriage plus the payment, formally

(2.1) $v_j = \mu_j(d_j + z)$, where $\mu_j = 1$ if man j is married, and zero otherwise.

Because of male heterogeneity, women care about whom they marry. In particular, man j is valued at x_j. Hence, woman i's utility from marriage to man j is the quality of man j, x_j, minus the price of him, d_j, formally

(2.2) $u_{ij} = x_j - d_j$.

A matching is a set of two-sex pairs. A matching is said to be stable if it is individually voluntary, and non-improvable. Voluntariness states that no individual would do better by remaining single, formally

(2.3) $u_i, v_j \geq 0$, for $\forall i \in W$ and $\forall j \in M$.

Non-improvability, i.e. no man and woman would do better married to each rather than to their assigned partners, requires that

(2.4) $u_i + v_j \geq \alpha_{ij}$,

where $\alpha_{ij} = x_j + z$ is the value of the marriage of woman i to man j. The total value of the market is the sum of the values of pairs. A property of a stable matching is that it maximises this sum (Shapley and Shubik 1972), which implies that the N best men marry.

To start with, dowry must be such that only the top N men prefer to be married at the going prices. In particular, this means that the price of marriage required of man N+1 must leave him better off single (if he is priced out of the market, so are all the other men of lower quality), formally

(2.5) $d_{N+1} < -z$.

We also know that dowry must leave all married men with non-negative utility as they can always opt for bacherlorhood and earn zero utility, which gives a lower bound on dowry

(2.6) $d_N \geq -z$.

We now proceed to establish prices associated with the men who do marry. The non-improvability condition (2.4) implies that the quality difference between man j and j+1 is matched by an equally large difference in dowry. [6] Formally,

(2.7) $d_j = d_{j+1} + \left(x_j - x_{j+1}\right)$, for $j < N$.

From (2.5) to (2.7) we obtain

[6] To see this, consider a lower price $d_j' = d_j - \varepsilon$, with $\varepsilon > 0$. At this price, all women would be better off married to man j. In particular, the woman previously married to j+1, achieving $u_{ij+1} = x_{j+1} - d_{j+1}$, would at this new price prefer to be married to man j and obtain $u_{ij} = x_j - d_j + \varepsilon = x_{j+} - d_{j+} + \varepsilon$. Hence, such a price would be inconsistent with stability.

(2.8) $d_N \in [-z, -z + (x_N - x_{N+1})]$.

To sum up, stability requires that price differences exactly match quality differences. There is, however, an interval of prices compatible with stability.[7] We are now able to express dowry as a function of d_N, and the quality difference between a man j and the last married man N. Formally,

(2.9) $d_j = d_N + (x_j - x_N)$.

Were all men the same, the last term would of course be zero. The intuition is that if all men are identical, they must also achieve identical utility. The fact that there are bachelors waiting in the wings ensures that dowry is bid down to that of men's valuation of married life.

From (2.9) we see that it is female quality and male quality differences rather than male - female ditto that drive dowries. It is also clear that positive dowries in the face of shortage of brides could result were men sufficiently differentiated.[8]

The issue this paper set out to study is that of dowry inflation, i.e. a general increase in dowry payments. Our first result follows directly from (2.9).

[7]In the case of a "wide band", the scope for bargaining would be larger. Then changes in observed dowry payments might be attributable to changes in male relative female bargaining strength.
[8]Gaulin and Boster (1990) claim that dowries will be observed in monogamous, stratified societies. However, for the stratification story to work, men must be more stratified than women. Otherwise, stratification *per se* would not have any particular bearing on dowry determination.

Proposition 1: Average dowry is

$$\bar{d} = \bar{d}_N + \frac{1}{N}\sum_{j=1}^{N} x_j, \quad \text{where } \bar{d}_N \in [-z - x_N, -z - x_{N+1}].$$

Assuming that $\bar{d}_N = -z - x_N$, we can rewrite the expression for average dowry as

$\bar{d} = \frac{1}{N}\left((1-N)x_N + \sum_{j=1}^{N-1} x_j\right)$ and it is readily seen that average dowry increases with the sum of qualities of (married) men $j < N$, and decreases in the quality of man N, as he represent the women's outside option.[9] We also see that adding or subtracting a constant to male quality does not change dowries, i.e. $\bar{d}(x') = \bar{d}(x)$, for $x_j' = x_j + a, \forall j \in M$.[10] To further illustrate the implications of Proposition 1, suppose that $x_j, j \in \{1,2,\ldots,N\}$ is uniformly distributed on the interval $[x_N, x_1]$, and that $d_N = -z$. Let us consider the effect of an increase in dispersion on dowries. An increase in $x_1 - x_N$, corresponds to an increase in $x_j - x_N, j < N$, from (2.9) we know that dowries increase.

Proposition 1 suggests that dowry inflation in India can be better understood if socio-economic developments are interpreted in terms of changes in male *vis à vis* female heterogeneity. This century has seen a drastic reduction in segregation based on caste and increased social mobility. Presumably, a reduction in the importance of caste affects both men and women, and is thus unlikely to be the only factor behind increased competition for males and the consequent dowry increases. I argue that the dissolution of the caste system, the sexual division of labour, and the rise in importance of education as a determinant of wage earning

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[9] Strictly speaking it is man $N+1$ who is the outside option, but we have assumed that man N and $N+1$ are of the same quality.
[10] Unless a change in the mean quality of the males affects the men's valuation of married life, cf. (2.9).

capacity (e.g. Lindenbaum 1981), have deprived females of their main differentiating factor, caste, while allowing males to substitute wage earning potential for caste differentiation.[11] Also, the move away from child marriages could have contributed to this general trend of a reduction in the importance of inherited status for dowry determination.[12]

3. Scarcity of Women Driving Dowry Inflation?

It is commonly believed that female scarcity is a direct result of poor economic prospects for women or high costs associated with marrying off a daughter (e.g. Miller 1981). The issue this paper set out to explore is not only why dowries are positive, but also why they have increased in the face of an increasing shortage of women. Nothing in the previous analysis suggests that shortage *per se* is bad; shortage of females would still give women an edge on the marriage market. This section explores the possibility of scarcity of females increasing the gender gap in terms of income earning potential and turning the marriage market terms of trade against brides.

Consider the introduction of education. Education serves many non-rival purposes. For men, investment in education is likely to affect income earning potential, heterogeneity, and marriage market opportunities.[13] So far in this paper, there has not been any uncertainty as to whom of the men get to marry. However, merit based competition for jobs and improved access to

[11]For a discussion of the dissolution of the caste system see e.g. Epstein 1973; Beteille 1991; Mayoux 1993.

[12] If marriage is negotiated when the parties are young, caste might be the most reliable indicator of spousal quality. Child marriages were banned in The Child Marriage Act of 1929 (Lindenbaum 1973).

[13]Women might want to invest in education too. If, for instance, educated women carried a premium on the marriage market they might have an incentive to do so, which could affect dowries either from a level change in z or through the introduction of female heterogeneity. However, the expected return to education for females will be invariant to the sex ratio. Hence, we can concentrate on the male side of the story.

education is likely to increase social mobility, and thus entail greater uncertainty as to adult status. In this section we introduce a lottery model, where women are prizes and men participate by buying tickets in the form of education. To see that investment in education resembles taking part in a lottery consider that expected payoff depends on how much is invested in education, and the actual outcome for each man depends on how well he can capitalize on his investment.

Consider a situation of initially homogeneous men and women. Shortage of women prompts men to compete for wives. Assume that education indicates income earning potential and that women look for men who can support them financially. Moreover, we allow men the possibility to invest in education. Education raises average quality but is also assumed to increase male heterogeneity.[14] This situation can readily be interpreted in terms of a rent-seeking model with multiple prizes where men invest in education in order to obtain a wife. As there are several women, there are several winners. We are interested in how a decrease in the number of prizes (women) relative to the number of contenders (men) would affect the level of male rent-seeking expenditures (in this case assumed to be human capital).

Following the previous notation, there are L rent-seekers, the vector of human capital investments is $\hat{h} = \{h_1, h_2, \dots, h_L\}$, and h denotes average human capital investment.[15] The men compete for wives, and each winner gets only one, valued at z.[16] There are N prizes.

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[14] For instance, the recent increase in wage inequality in North America and Western Europe seems to be linked to an increase in education level of the work force (see e.g. Juhn, Murphy and Pierce 1993).
[15] For simplicity, assume a unit price.
[16] Female heterogeneity would not change the qualitative results. Recall that women are assumed the scarce sex.

Clark and Riis (1996) propose the following contest success function. Let P_i, the probability of player i of winning one of the N prizes, be the sum of probabilities of winning the s:th prize conditional on not having won in the previous rounds. Man i's probability of marrying is then

$$(3.1) \qquad P_i = p_i^1 + \sum_{s=2}^{N} \prod_{k=1}^{s-1} (1-p_i^k) p_i^s \ .$$

Following Clark and Riis we assume the following version of independence of irrelevant alternatives,

$$p_i(h_1,h_2,\ldots,h_{j-1},0,h_{j+1},\ldots,h_L) = \frac{p_i(h_1,h_2,\ldots,h_{j-1},h_j,h_{j+1},\ldots,h_L)}{1-p_j(h_1,h_2,\ldots,h_{j-1},h_j,h_{j+1},\ldots,h_L)},$$

i.e. the probability of man i winning, when j is not participating, could be expressed as the probability of winning conditional on j not winning, which together with the assumption that $p_i^1 = \frac{h_i}{Lh}$ yields the following expression for the probability of winning in the s:th round,

$$p_i^s = \frac{p_i^1}{(1-(s-1)p_j^1)}, \qquad \text{for} \qquad s > 1.$$

The expected profit for player i is

$$(3.2) \qquad \Pi_i(\hat{h}) = P_i z - h_i \, .$$

Hence man i sets h_i to satisfy the first order condition

(3.3) $$\frac{\partial P_i}{\partial h_i} z - 1 = 0,$$

which evaluated at a symmetric equilibrium yields

(3.4) $$h_i = h = \frac{z}{L}\left(\frac{N(L-1)}{L} - \sum_{k=1}^{N-1} \frac{N-k}{L-k}\right).$$

In order to study how male human capital investments are affected by a change in the number of women to men we differentiate the expression for h in (3.4), which for large L[17] yields

(3.5) $$\frac{dh}{d\frac{N}{L}} < 0 \qquad \text{for} \qquad \frac{N}{L} > c,$$

$$\frac{dh}{d\frac{N}{L}} > 0 \qquad \text{for} \qquad \frac{N}{L} < c, \qquad \text{where } c \approx 1 - \frac{1}{e} \approx 0.632,$$

from which our second result follows.

[17] For smaller L the same qualitative results will hold. However, the particular value of the cut-off point may vary. Also, symmetry as to differentiation with respect to N or L is a limit result.

Proposition 2: For $\frac{N}{L} \in [c,1]$, increasing shortage of women raises male human capital investments.

As we argue that education is linked to male heterogeneity and dowry payments, Proposition 2 suggests that scarcity of females could actually reinforce a preference for sons.

The impact of a change in female shortage depends on the initial sex ratio. The intuition is that there are two effects to consider. A fall in the number of women to men results in more fierce competition for wives, but it also lowers the pay-off to the lottery. For a sufficiently low ratio of women to men, the latter effect dominates. The value of the cut-off point c merits some attention. A cut-off point close to one would imply that a slight shortage of women could set in train male disinvestment in education, and possibly dowries. However, the above result suggests that the number of women to men might drop considerably before the marriage market favours women by means of lower dowries.

To sum up, scarcity of females might work against women because it could increase the returns to male human capital investments. We argue that this is likely to increase gender gaps in terms of income earning potential and heterogeneity. The result also points to the possibility of scarcity of females being self-enforcing, as shortage might make daughters *less* attractive than sons, suggesting an explanation to co-existence of shortage and marginalisation of women as observed on the Indian sub-continent.

4. Conclusions

This paper has developed a model for dowry determination under scarcity of women and male heterogeneity to account for the phenomenon of a secular increase in dowries despite an increasing shortage of women as seen in India. We argue that increased male heterogeneity could stem from the reduction in the importance of inherited status (e.g. caste) and a more prominent role of education for earning potential.

We have shown that when the assumption of homogeneous men and women is relaxed, scarcity of one sex is not a sufficient condition for commanding a price on the marriage market. We question the idea of inter-sex differences driving dowries. Instead we propose that under scarcity, the dowries are determined by intra-sex differences.

We employ a multiple prize lottery model to show that under reasonable assumptions about the relationship between education and heterogeneity, *increasing* scarcity of females might actually raise the price of husbands, which points to the possibility of scarcity of women being self-enforcing.

APPENDIX

Derivation of (3.5).

(A.1) $$Lh = z\left[\frac{N(L-1)}{L} - \sum_{j=1}^{N-1}\frac{N-j}{L-j}\right], \qquad \text{for} \qquad N > 1.$$

(A.2) $$\lim_{L\to\infty}\frac{dLh}{dN} = z\left[\frac{L-1}{L} - \sum_{j=1}^{N-1}\frac{1}{L-j}\right] \qquad < 0 \quad \text{for} \quad \frac{N}{L} > c, \text{ and}$$

$$> 0 \quad \text{for} \quad \frac{N}{L} < c,$$

where $c \approx 1 - \dfrac{1}{e} \approx 0.63$.

As:

(A.3) $$\lim_{L\to\infty}\frac{L-1}{L} = 1,$$

and

(A.4) $$\sum_{1}^{N-1}\frac{1}{L-j} \approx \int_{N-1}^{1}\frac{1}{L-j}dj = \left[\ln(L-j)\right]_{N-1}^{1} = \ln\left(\frac{L-1}{L-N+1}\right),$$

(A.2) is negative if

$$\lim_{L\to\infty}\ln\left(\frac{L-1}{L-N+1}\right) = \ln\left(\frac{L}{L-N}\right) > 1,$$

which implies

$$\frac{L}{L-N} > e.$$

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MARRY THE MAID: EDUCATION, TAXES, AND JOB SATISFACTION[1]

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Abstract

This paper aims at explaining why education reduces female marriage market attractiveness, while the opposite is typically true for men. We assume that women are ranked according to their take home pay and time spent doing household work. We explicitly consider the role of job satisfaction for labour supply. The argument is that job satisfaction could induce women to work too much from the point of view of their partners. The result is that under low wage dispersion educated women are out-competed by less educated women for husbands, while under high wage dispersion, the marriage squeeze would affect poorly educated women. Heavy taxation and low returns to education are factors which compress the (net) wage distribution. We argue that the particularly low marriageability of better educated women in Sweden and the low propensity to marry among poorly educated women in the US could be a result of differences in the wage distribution in the two countries.

Keywords: Marriage sorting; wage dispersion; female labour supply; job satisfaction.
JEL Classification: J12; J22.

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1. INTRODUCTION

Typically, better educated men are more likely to marry and remain married. For women the relationship between education and family formation is less clear cut. Goldin (1992 and 1995), among others, documents the low propensity among career women to form families.[2] However, the marriage market penalty on female education has decreased steadily (Moorman, Gibson, and Fay 1987; Statistics Sweden 1993; Lichter et al 1992; Golding 1992). On the other hand, the decreasing rate of marriage among poorly educated women in the US has provoked a debate about declining family values in general and a degeneration of "black" family patterns in particular (e.g. Bennet, Bloom and Craig 1989).[3] A popular view is that this development could be due to declining relative wages for unskilled labour, the argument being that women with little education have a harder time finding men capable of assuming the role of the breadwinner (e.g. Mare and Winship). This logic assumes that lower marriageability of men with little education primarily affects women with similar qualifications. But as we will argue, this is by no means a given. Instead, the developments in the US might be read as an outcome of increasing wage dispersion in combination with low income taxation.

While the effect of marital status on female labour supply has been extensively studied (see e.g. Berndt 1991: Ch. 11 for references), the possibility of the reverse causality has received only scant attention in the economics literature.[4] This paper aims at providing an explanation to the ambiguous relationship between female education and marriage market attractiveness. We do

[2]Some of you might also recall the June 2,1986 cover of Newsweek picturing a graph claiming to illustrate that a 40 year old woman's probability of marrying was so low that she was "more likely to be killed by a terrorist". The "Harvard-Yale Study" as it came to be known provoked widespread public interest (for criticism of the same see Moorman, Gibson and Fay 1987; and Cherlin 1990).

[3] In 1992, single parent families made up 62 % of all black family groups with children under the age of 18, and while 90 % of white women are projected to marry, this is true for only 75 % of black women (Bureau of the Census 1993).

[4]An exception is Johnson and Skinner (1986).

so by explicitly considering the role of job satisfaction for the labour supply decision, and by linking female attractiveness to the wage distribution and taxation.

Stable marriage matchings are assortative (Becker 1981), i.e. attractive men match with attractive women.[5] Becker argues that negative assortative matching according to market productivity, allowing complete specialisation in the household, is efficient.[6] This result hinges on the assumption that household services must be home produced.[7] However, there are market alternatives to most domestic services. The extent to which these compare varies, but most would agree that there are substitutes for child care, tutoring, housekeeping, gardening, cooking, etc. The mere fact that high human capital men have remained the most attractive spouses in the face of a large rise in the number of career women suggests that market provision of domestic services could indeed be important.[8] Lam (1988) discusses marriage market sorting, when gains from marriage are in the form of a household public good which can be both home or market produced. We differ from Lam in that we model labour supply as an individual, and not an household, decision, and consider job satisfaction in order to explain why well educated women do not mimic poorly educated women.

Welfare concerns, in particular the situation of children, have motivate public policy interest in the distribution of household income. The recent rise in wage inequality in the US and Western Europe (e.g. Karoly 1992; Juhn, Murphy, and Pierce 1993; Edin and Holmlund 1995) has not only resulted in increasing inequality between individuals but also across households, which points to the possibility of the wage distribution affecting marriage market sortings.

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[5] Given that there is concensus as to the ranking.
[6] Becker notes that specialisation need not be along sexual lines, nor complete if one task, e.g. household work, is considered less worthwhile.
[7] As noted by Gronau (1977).
[8] Otherwise, one may speculate, the attractiveness of low human capital men (high willingness to supply household labour) would rise and the apparent mis-match between educated women and uneducated men might not appear so apparent.

One strand of explanations of the negative relationship between education and family formation has it that education results in financially, or otherwise, more independent women. While plausible, it begs the question why independence reduce marriage market attractiveness for women, but not for men. Another recurrent theme is that of ingrained gender roles stipulating educational hypergamy, i.e. men looking down and women up, educationwise, while searching for a spouse (e.g. Qian and Preston 1993; Hoem 1995). However, such an approach falls short of accounting for changes in marriage patterns, in particular why the marriage market penalty associated with female education has decreased.

Why would marriage market matchings be influenced by the wage distribution and taxes? Traditionally, the man is the provider and the woman the home maker.[9] Assuming that male spousal quality is measured by income earning ability, and that of females is based on income earning capacity in combination with household labour supplied, the income distribution could affect female ranking, while leaving that of men intact. Introspection and casual observation suggest that non-material rewards such as self esteem and job satisfaction increase with the skill level of the task.[10] If willingness to supply household labour is negatively related to education level, a compressed income distribution, either through high taxation or low returns to education, could turn the ranking on its head, making the least educated women the most desirable. Hence, the stable matching might change with the income distribution.

[9] Stafford (1980) finds for the US, when studying national time use surveys for 1965 and 1975, that married men allocate about 80 % of work time to market work and 20 % to household work, the corresponding figures for women were 55 % and 45 % respectively. For Sweden, a time-use survey carried out 1990/1991 showed that among co-habitating couples with toddlers, working, but women do twice as much household work as men, who on the other hand do twice as much market work (Statistics Sweden 1994). Perhaps more to the point, the price elasticity of male labour supply is typically found to be smaller than that for women, which suggests that for women household work is an alternative to wage work to a greater extent than for men (for references see e.g. Berndt 1991:Ch. 11).

[10] Incidentally, in Sweden, the number of registered days of sick leave is lowest for the highest income group (TCO-Tidningen, no. 21, 15-22 September 1995).

The remainder of the paper is organised as follows. The next section gives an empirical background, presenting data on the relationship between marriage and divorce patterns by education in the US and Sweden. In Section 3 we develop the model, and Section 4 concludes the paper.

2. Marriage and Education - Empirical Background

Historically, better educated women were less likely to marry in both the US and Sweden, the two countries that will serve as points of reference throughout this paper. The reason why we choose to focus on these two countries is that while similar in many respects, the wage distribution is markedly more compressed in Sweden. In Sweden, the fraction of never married increases with education for women and decreases for men, see Table 1. For the US, more education is linked to lower probability of ever marrying for both men and women. However, while slight for men, the effect is pronounced for women, see Table 2. Recent data suggest that the relationship could even be slightly positive (e.g. Qian and Preston 1993).[11] Still, for Sweden, the propensity to marry is lower for women than men beyond 15 years of education, and the gap is particularly high for individuals with post graduate education as demonstrated in Table 3. [12]

[11] Also, it might be too early to conclude whether highly educated women simply postpone marriage or still are considered poor marriage material.

[12] In 1992, the stock of graduate students in Sweden was 13379, of which one third were female. The same year, 1023 PhDs were accorded, of which 27% to women (Statistics Sweden 1992).

Table 1. Never Co-habitated[1], by Sex and Education, Sweden, 1984-85, Per Cent

By age:	25		30		35		40		45		50	
	M[3]	F[3]	M	F	M	F	M	F	M	F	M	F
Education[2]												
-9	56	25	27	11	19	7	16	5	15	5	14	4
9-12	43	24	18	11	9	7	6	6	6	6	6	6
12+	45	34	14	14	7	11	4	12	4	12	1	12

[1] Co-habitation denotes marital and marriage like unions. [2] Years. [3] M-Male, F-Female Source: Statistics Sweden (1994)

Table 2. Never Married, by Sex and Education, the US, 1980, Per Cent

Age group	25 -	34	35 -	44	55 -	64	75 -	84
Education	M[1]	F[1]	M	F	M	F	M	F
High school	20.1	11.8	6.4	4.4	4.7	4.3	5.3	7.9
College	28.7	24.1	7.8	7.3	4.4	7.3	4.5	16.0
College +	28.4	29.7	8.8	14.5	5.9	14.5	6.0	28.3

[1] M-Male, F-Female. Source: Moorman 1987.

Table 3. Propensity to Form Unions by Education for Swedish Men and Women, Index Numbers[1]

Years[2] of schooling	Women	Men	Difference: Women-Men
- 9	96	66	30
9-10	93	93	0
10-11	124	111	13
12-14	92	95	-3
14-15	123	112	11
15-17	109	123	-14
17-	66	135	-69

[1]Index numbers control for the age distribution of the population. High values are associated with high propensity to form unions (marital and co-habitational). [2]Based on an approximate conversion of the following categories: pre-high school 1-9 years or less, pre-high school 9-10 years, high school 2 years or less, high school 3 years or more, college 3 years or less, college more than 3 years, post-graduate studies. Source: Statistics Sweden (1994).

The argument could be made that traits that make individuals less likely to marry, would also make them more likely to divorce.[13] Hence, if education reduces a woman's marriage market attractiveness, female education and marital instability might also be positively related. The empirical findings paint a mixed picture. In a recent study of the US, education reduced divorce hazard for both men and women, see Table 4 below taken from Weiss and Willis (1995, table 6.1).[14] Education is commonly considered to subsidise search; it boosts market productivity and co-education reduces search cost. Moreover, it has been suggested that positive relationship between education and marital stability could be a result of educated

[13] For reasons of imperfect information as to the pay off to marriage, as well as search friction, individuals of poor spousal value might enter marriage.

[14] Weiss and Willis (1995) analyse the 1972 National Longitudinal Study of the High School Class of 1972 surveyed in 1986. It is worth noting that Becker, Landes and Michael (1977) find a negative simple correlation between male education and risk of divorce, but otherwise weak effects of education on divorce risk, when analysing the 1967 Survey of Economic Opportunity. Based on this, one may conjecture that, in 19 years, education has become a more important determinant of marital stability, possibly a reflection of its growing importance as a determinant of income.

people being more capable of making informed decisions (Hoem 1995). For Sweden, however, female education has been associated with higher marital instability, see Table 5 below. The shift towards a positive relationship between female education level and marital stability occurred in the early 1980s.

Table 4. Effect of Education on Probability of Divorce, the US, Probit Coefficients

	Wife's Education		
Husband's Education	High-School	Some College	College Graduate
High-School	n.a.	-0.124	-0.135
		(-1.985)	(-1.443)
Some College	-0.080	-0.221	-0.184
	(-1.385)	(-4.517)	(-1.709)
College Graduate	-0.257	-0.334	-0.499
	(-3.214)	(-4.761)	(-7.233)

Note: Data from the National Longitudinal Study of the High School Class of 1972, data pertain to 1986, regressions control for income; t-statistics in parentheses. Source: Weiss and Willis (1995, table 6,1).

Table 5. Relative Risks of First-marriage Disruption at Positive Parities,[3] by Education Level, Sweden

Schooling	All[1]	Cohorts born 1944[2]	Cohorts born 1964[2]
Pre-high school	1	1	2.37
High school	1.35	1.14	1.45
Post-high school	1.72	1.35	1

[1] Swedish Fertility Survey of 1981.[2] Swedish Fertility Survey of 1991.[3] Children born to the marriage. Source: Hoem (1995, table 1).

3. BUSINESS OR PLEASURE?

Consider a world populated by single men and women, who are interested in marriage. This is the modern world with no sex stereotyping, except that no men can do household work and all women are naturals.[15] Wage work is the alternative to household work, let l denote labour supply. Each individual has a given endowment of education, $e \in [0, \bar{e}]$. Better educated workers are more productive and paid accordingly. We assume the wage w to be a strictly increasing function of the education level, $w'(e) > 0$. Household labour is valued at wage rate $w(0)$, as all women can do household work.

Wage work is taxed proportionally at tax rate $t \in [0,1)$.[16] Household work, if performed by a household member, is not taxed.

Women receive utility from private consumption x, and home quality h. Moreover, we assume that they derive utility directly from working, and that job satisfaction is increasing in education. We write her utility as

(1) $U(x,h,l) = x^{\alpha} h^{\beta} l^{e}$, where $\alpha, \beta > 0$.

Home quality can be obtained either through household work or the market. We assume home quality to be a household public good,[17] and that the share of income spent on collective

[15] This is of course an extremely simplistic view of the world. Allowing for men to do household work would complicate the exposition but not add substantially to the analysis, as long as women are supposed to do more household work than men.

[16] We need that $t < 1$ because if wage work did not pay off in material terms, the women who spend most time doing household work would be the most attractive irrespective of $w(e)$.

[17] Chiappori (1988) points out that private goods might be treated as collective if spouses are sufficiently altruistic. Following in that vein, we argue that our specification includes the case of wives paying for husbands' private consumption.

consumption $\lambda \in (0,1]$ is exogenously given and constant across individuals.[18] Note that to allow for women working full time and still consume positive amounts of home quality we assume $\lambda > 0$. Formally,

$$(2) \qquad h = (1-l)w(0) + \lambda(1-t)lw(e).$$

Unlike home quality, private consumption x can only be obtained through market work.[19] Formally,

$$(3) \qquad x = (1-\lambda)(1-t)lw(e).$$

A woman needs to decide how much of her active time (normalised to 1) she should allocate to wage work, l, and household work, 1 - l, respectively. She maximises (1) subject to (2), (3) and $l \in [0,1]$.[20]

To simplify the exposition let $Q(e) = w(0) - \lambda(1-t)w(e)$.

A woman's labour supply is thus given by:

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[18] This is not to deny the importance of bargaining, but to allow us to concentrate on the impact of taxation. It is, however, crucial that λ does not vary "excessively" across individuals. The most straight forward way to see this is to consider large and unsystematic variations in λ. Then, the link between educational achievements and marriage market value could vanish.

[19] To anticipate events, as the model is set up, women with no education work in order to consume private goods. This is not realistic as housewives are typically given money by their husbands. This modification would result in a flat segment of $l = 0$ for $e \in [0, e']$, and a corresponding flat segment to the h function.

[20] In our model, marriage does not add utility other than indirectly via h. It is of course conceivable that marriage boosts utility, in which case, women might want to commit to work less in exchange for a marriage premium. Still, if the marriage effect amounted to a positive monotonic transformation of the utility function, the results would go through provided that we assumed away the possibility to contract on l.

(4) $$\hat{l} = \min\left\{\frac{[\alpha + e]w(0)}{[\alpha + \beta + e]Q(e)}, 1\right\}$$

We now ask how women will be ranked on the marriage market. In the model, men value women according to the household quality she provides, i.e. *h*. Whether education will move a woman up or down the female pecking order is determined by:

(5) $$\frac{\partial h}{\partial e} = -\frac{\beta w(0)}{(\alpha + \beta + e)^2} \qquad < 0 \qquad \text{for } e < e^*,$$

$$= \lambda(1-t)w'(e) \qquad > 0 \qquad \text{for } e \geq e^*,$$

where e^* is the education level beyond which women work full time, i.e.

(6) $$e^* = \min\{e : \hat{l} = 1\}.$$

This proves our first result:

Proposition 1. Female marriage market value decreases with education for $e < e^*$, and increases with education for $e \geq e^*$.

The reason why education reduces marriage market attractiveness for education levels below e^* is readily seen from (4). For $e < e^*$, $Q(e)$ is positive, i.e. household work produces more home quality than wage work. As labour supply is determined by both relative wages and job satisfaction, the latter creates a wedge between how the women wish to allocate their time and that preferred by their partners. Job satisfaction is assumed to increase with education and hence more educated women work "too much" which accounts for the decline in marriage market attractiveness up to e^*. Women with more education than e^* all work full time, Hence, beyond e^* the only differentiating factor is the wage rate, which we have assumed to be strictly increasing in education level.

We now turn to the issue of taxation. In particular, we are interested in saying something about why in Sweden it is well educated women who are least likely to marry, while a development in the US is that of poorly educated women facing particularly grim marriage market prospects.

From (4) and (6) we have that $\frac{[\alpha + e^*]w(0)}{[\alpha + \beta + e^*]Q(e^*)} = 1$. Differentiation yields,

(7) $$\frac{de^*}{dt} = \frac{[\alpha + \beta + e]w(e)}{(1-t)[w(e) + (\alpha + \beta + e)w'(e)]} > 0.$$

Proposition 2. e^* increases with the tax rate.

Combining Proposition 1 and 2 we find that for high tax rates, the model predicts an inverse relationship between education and family formation, and highly educated women would be least likely to marry. Conversely, for low tax rates better educated women would also be better wives, and the least attractive women would be the poorly educated.

The least attractive women are left with the prospect of marrying the least attractive men, who, in this set up, invariably are the least educated men.[21] Empirical evidence suggests that low human capital men remain single for reasons unrelated to the education level of the pool of single females.[22]

It is worth noting that the tax on labour is substantially higher in Sweden than in the US. In view of this, the increase in the number of poor single women (with or without children) in the US could be interpreted as a result of more intense competition from better educated women for marriageable men, compared with the situation in Sweden.

Generally speaking, there has been a secular decline in the negative relationship between female education and propensity to marry. Recent studies of the US have pointed to a positive link between education and marriage (e.g. Moorman 1987). While changing attitudes towards female education and labour force participation certainly have been part of the story, we will argue that a driving force could be that of an increase in the returns to education. As $w(e)$ and t enter symmetrically, but with opposite signs in (4) and (6) we readily see that the effect of an increase in $w(e)$ on e^* is similar to that of a tax reduction. Hence our third result is:

Proposition 3. e^* decreases with higher returns to education.

Proposition 3 implies that uneducated women are better wives if returns to education are low. Possibly because of positive externalities to knowledge (e.g. Romer 1986) and complementarities between physical and human capital, the argument could be made for

[21] Recall that no men do household work and hence are evaluated exclusively according to wage earning capacity.
[22] Whether the least attractive men are simply not worth marrying under any circumstance, or women prefer to wait for a more attractive offer is not the topic of this paper. To account for the empirical fact that some people stay single, a possible modification would be to include of a fixed cost to marriage.

returns to education being lower in less developed countries, countries in which, at least among the lower middle classes, an argument against educating daughters is the belief that it could ruin marriage market prospects. Also in the first world, not long ago, conventional wisdom held that education undermines female attractiveness.[23]

Even though high taxation or low returns to education might make better educated women refrain from marriage (in this model, choose a low h), they are better off than less educated women.[24]

4. CONCLUSIONS

Typically, higher educated women are less likely to marry and remain married, while the opposite is true for men. However, the marriage market penalty associated with higher education has decreased steadily. In this paper we discuss the impact of the income distribution on the relationship between female education and marriage market ranking. To account for the negative relationship between female education and marriage market attractiveness, we consider the role of job satisfaction. Departing from most of the literature on female labour supply, we look at the possibility of labour supply influencing marital status. We assume a traditional division of labour: women are in charge of household work. Furthermore, we assume that household work performed by household members is not taxed, while market work is subject to taxation. We find that if men value a woman according to the amount of

[23] When making comparisons across countries or over time it is important to keep in mind that the above results were derived under the assumption of no non-wage income. Wage dispersion is probably at least as high in some less developed countries as in some industrialised. However, wage income is probably swamped by other sources of income as a determinant of consumption for the upper class in say today's Indian sub-continent or 19th century Europe or North America.

[24] In this model, marriage market outcome would therefore not interfere with education choice, were education chosen by the individual (parents sometimes decide for their children and it is of course conceivable that they are more concerned with children reproducing than children's utility level *per se*).

household work she performs and her take home pay from market work, a possible explanation to the observed pattern of education reducing marriageability is that educated women allocate "too much" (from the point of view of their partners) time to market work. The reason is that under a compressed wage distribution, wage work, net of taxes, might not pay enough to compensate for time spent outside the home. Because of job satisfaction, educated women may insist on working despite poor pay and hence end up at the lower end of the female ranking. Conversely, under high wage dispersion, educated women would earn enough from market work to out-compete lesser educated women (who receive less job satisfaction and therefore volunteer more household work). Hence, under low taxation and high returns to education, education and marriage market ranking could be positively related, and it would be poorly educated women who would face a shortage of marriageable partners.

One of the limitations of the model is that women act in splendid isolation. We abstract from any interaction with a spouse - an extreme view that disregards possible cross-wage effects on labour supply.

We argue that the decrease in the propensity to marry among African-American women could be due to the particularly poor marriage market women with little education would face under high wage dispersion. Furthermore, the low propensity to form families for better educated Swedish women could be interpreted as a by-product of policies aimed at income levelling.

Also, the model suggests that higher returns to education for women could be a factor behind the steady reduction in the marriage market penalty associated with female higher education that we have seen the last century.

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