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by

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Abstract
We examine the consequences of parental control over choice of wives for sons, for parental incentives to educate daughters, in a dualistic transitional economy, where preferences conflict across generations and the marriage market exhibits competitive dowry payments. Parental control generates persistence of low levels of female literacy, despite economic growth. In steady state equilibrium, the female literacy rate is uniquely determined by the magnitude of male employment in the high wage sector. Income gains for men or women, larger returns to female literacy, lower returns from child labour and tax-subsidy interventions all fail to raise female literacy. Universal female literacy would result, despite dowry, if grooms themselves chose their brides.

Outline

1. INTRODUCTION

This paper examines the role played by social norms which legitimize parental control over choice of brides for sons, in determining parental incentives to educate daughters, in a transitional economy, where preferences conflict across generations, the labour market is dualistic, and the marriage market exhibits competitive dowry payments. Parental control leads to persistence of low levels of female literacy, despite economic growth and large returns from female literacy. In steady state equilibrium, the proportion of educated women is uniquely determined by the magnitude of male employment in the high wage sector. Income gains for men or women, larger returns to female literacy, lower returns from child labour and tax-subsidy interventions all turn out to be ineffective in raising female literacy levels. If, however, grooms themselves determined their wives, then universal female literacy would be the only possible steady state outcome, despite dowry payments.

Evidence from school attendance and literacy figures indicates that, in south Asia, girls are much more likely to be put to work (typically inside the household or in the informal sector), rather than sent to school, than boys. In light of the widespread presence of the institution of *dowry*, i.e., payments from the bride's family to that of the groom, this reluctance appears puzzling.[1] Patrilocal marriage practices and cultural norms prevalent in most parts of south Asia would seem to imply that it is her husband's family which stands to retain the major part of any additional income an educated woman would generate. Thus parents themselves may have little *direct* incentive to invest in daughters. However, for precisely the same reason, parents would seem to have a strong incentive to prefer educated women as brides for their sons. This seems particularly likely if returns to women's schooling are significant, whether directly, from the labour market, or indirectly, within the household sector, where the schooling of women may

1 Dowry rates have steadily risen over the last fifty years in south Asia. See, for example, Deolalikar and Rao (1998), Rao (1993a, 1993b) and Dixit (1991) for India and Lindenbaum (1981) for Bangladesh. Rao (1993b) finds that the average dowry received by a son amounted to 68% of his household's assets. Sharma (1980) finds the dowry rate in north-western India to be no less than the annual income of the bride's father. We shall interpret dowry as 'groom-price'. In practice, some part of the payment made by the bride's parents may have the character of a pre-mortem bequest, or a ritual gift exchange. These aspects are not relevant to our analysis.

have important positive effects on the human capital of future generations.[2] Then, intuition suggests that, ceteris paribus, parents of educated women should face lower dowry demands. Thus, adjustments in dowry rates should provide an *indirect* incentive to parents to educate their daughters. Yet, in light of the persistence of a large gender gap in literacy and education levels in south Asia, this indirect incentive appears to be neither generalized, nor very strong in the aggregate.[3] Analyzing data from six villages in south-central India, covering 1923-1978, neither Rao (1993a, 1993b), nor Deolalikar and Rao (1998), nor, indeed, Edlund (2001) could find any evidence that greater schooling of brides is associated with a significant reduction in dowry. What explains this phenomenon?

A large literature exists on the institution of dowry. Yet, a formal investigation of the implications of this institution for parental incentives to invest in the education of daughters does not appear to be available.[4] Given the pervasive conjunction of dowry in south Asia with low levels of female literacy, and a large and persistent gender gap in literacy and schooling levels, such an exercise is of considerable importance, from both theoretical and policy perspectives.

One of the central features of a marriage contract in south Asia, especially in the rural areas, is that it is typically 'arranged', i.e., a contract negotiated between *parents* of the individuals who actually marry. Social norms make it accepted cultural practice for parents to have a major, effective say in the choice of marital partners for their offspring. New couples are generally expected to live with the groom's parents. This suggests that parental objectives in choosing wives for sons may conflict with the interests of their sons. This possibility seems particularly likely in a *transitional* society, i.e. a society

2 That such gains are significant is a view widely held. See, for example, UNDP (1996). Behrman *et al.* (1999) find evidence that part of the significant, positive relationship between maternal literacy and child schooling in Green Revolution areas of India is due to the productivity effect of home teaching.

3 According to Census data, the gender gap in literacy rates in India was 28.84 percentage points in 1991, and 21.70 percentage points ten years later.

4 Becker (1981), Chen (1985), Zhang and Chan (1999), Edlund (2001), and Botticini and Siow (2002) are primarily concerned with explaining the rationale for dowry. Rajaraman (1983) attempts to explain the transformation of endogamous groups from a system of negative dowry (i.e., bride price) to that of positive dowry in India. Caldwell, Reddy and Caldwell (1983), Rao (1993a, 1993b and 2000), Bhat and Halli (1999), Deolalikar and Rao (1998), and Edlund (2000) focus on 'marriage squeeze' in India, i.e., increased competition for grooms, and its implications for trends in dowry rates. Anderson (2003) explores the connection between caste and dowry inflation. Bloch and Rao (2002) analyze dowry-related violence against women in India.

undergoing rapid changes in its social framework, such as south Asia, where the values, objectives and lifestyles of the younger generation are often at sharp odds with those of their parents, and which is exhibiting a movement away from the traditional 'joint family' system, towards the nuclear family.[5] Yet, the ramifications of this system of arranged marriage with dowry payments, within a context of 'generational conflict', have not received attention in the economics literature. Our specific contribution lies in tracing its implications for parental incentives to educate daughters.

Caldwell *et al.* (1983, p.359), discussing the popular justification for a large age difference between husbands and wives in south India, put the perception thus. "Where brides are older and closer to the bridegrooms in age, they will probably fit less readily into the extended family, and their emotional bonds with their husbands will probably compete more with the bonds between husbands and their mothers." A similar apprehension would lead parents to prefer a large education gap between their sons and their daughters in law, as a method of reducing the possibility of domestic discord and household partition.[6] On the other hand, respondents in village surveys in south India almost universally affirmed: "(P)arents desire their daughters to marry educated men with urban jobs, … because the wives of such men … *will usually live apart from their parents-in-law*" (Caldwell *et al.* (1983 p.347), italics ours). Rural parents are "…giving their daughters more schooling, … even though such investments cannot be offset against the amount of dowry. Rather the schooling is explained as the minimum qualification for securing an educated husband…" (Caldwell *et al.* (1983, p.357)). This suggests rural parents value education in brides *if* they happen to have educated sons in the urban sector (or, more generally, in high wage occupations), but not otherwise. Thus, parental preferences regarding the educational status of brides seem to be shaped by labour market opportunities enjoyed by their sons. Such preferences, in turn, should

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5 For example, preliminary figures from the 2001 Census show that, in the state of West Bengal in India, while population increased by 17.84% over the last decade, the number of residential houses rose by 25.58%. Average household size declined significantly in both urban and rural areas (The Statesman, Kolkata, April 4, 2003).

6 Discord among females is a major proximate cause of household partition in south Asia (Barkat-e-Khuda (1985), Caldwell *et al.* (1984)). Analyzing a data set from Bangladesh, Foster (1993) estimated that marriage increased the probability of household partition by 26.1%. Foster also finds evidence that sons who separate enjoy at least some autonomy, in that, unpartitioned households behave differently from partitioned households.

have important consequences for the determination of relative dowry rates, and, thereby, parental incentives to educate daughters.

We model an economy with overlapping generations and male heterogeneity, where the labour market for male workers is segmented into high income and low income occupations. Ceteris paribus, parents prefer to marry daughters to men employed in the high income sector, and are willing to pay a higher price (dowry) for such grooms. After marriage, couples wish to form their own households in order to consume in accordance with their own preferences, once their income reaches a critical level. Parents wish to prevent such household partition. Parents of men employed in the high income sector prefer literate (or, more generally, educated) brides, and are willing to accept lower payments for them. However, parents of men employed in the low income sector prefer uneducated brides. This is so because, by choosing (only) such brides, they can prevent their own sons from separating. In steady state equilibrium, the proportion of women who are educated is uniquely determined by the magnitude of male employment in the high earnings sector. An expansion in male high wage employment provides incentives to parents, through relative movements in dowry rates, to educate daughters. This reduces the extent of female child labour.

However, parental control over the marital contract makes the level of female literacy 'sticky': relatively unresponsive to both income growth and state policy. Increases in male incomes, if not associated with a rise in the proportion of the male labour force employed in the high wage sector, fail to improve the female literacy rate. Better income opportunities for literate women have no effect either. Reductions in returns from female child labour are similarly ineffective, as are relatively small tax/subsidy interventions. This happens because such changes do not provide incentives to parents of low income grooms to accept lower dowries from parents of educated brides. For all parents to have incentives to educate daughters, it is not enough to eliminate their direct monetary gains from child labour. The state needs to compensate parents for the higher dowry they'll have to pay for low income grooms. Thus, suppression of female child labour does not, by itself, ensure education for girls. If, however, grooms themselves were to determine their marital partners, then universal female literacy would be the only steady state outcome, *despite dowry payments*.

Section 2 sets up the model. Section 3 examines the steady-state equilibrium. Section 4 discusses tax/subsidy interventions. Section 5 concludes. Proofs are relegated to the Appendix.

2. THE MODEL

Individuals live for two periods. At the beginning of period 1, each individual is born into a household consisting of parents and one sibling of the opposite sex.[7] The individual reaches adulthood sometime during that period. On reaching adulthood, individuals enter the adult labour market, and get married soon thereafter (before the end of the period). After getting married, sons may continue to live with their wives in the parental household, or form separate households of their own. Individuals lose their parents at the end of the first period of their lives, and become parents themselves at the beginning of the second period, by acquiring two children each, one of either sex.

The adult labour market is segmented into a high wage sector (H), and a low wage sector (L), which includes domestic labour. Workers may be skilled or unskilled. Skills are acquired through schooling when young. Unskilled workers in sector L receive w per period. Skilled workers in this sector receive an amount s more than their unskilled counterparts in the first period. Thus, education provides an additional income s in the L sector, which, for convenience, is assumed to be received entirely in the first period of one's life. Education is also the necessary, but not sufficient, condition for entering the H sector. This sector can absorb, *at the most*, some proportion, h, of adult male workers in each generation when they enter the labour market, $h \in (0,1)$. Thus, if all male workers in a generation are educated, then h proportion of them will be absorbed in H jobs. An H worker earns $(w + r)$ in the first period, and w thereafter, $r > s$. Thus, $(r\text{-}s)$ represents the positive rent that accrues to an individual merely by virtue of his being able to acquire a place in the H sector; for convenience, this rent, like the return to education, is assumed to be received entirely early on. All female and child workers are employed in the L sector. The proportion of male workers in each generation who are initially absorbed in the L sector is thus at least $(1-h)$. Once adult workers enter a

7 We can allow households to have any number of boys and girls without altering the analysis qualitatively, so long as the aggregate boy-girl ratio for the economy is unity.

particular sector, they stay on in that sector till the end of the period. Each child can earn w_c. All earnings, adult as well as juvenile, are received at the end of the period.[8]

During childhood, each individual may either be sent to school or sent to work by parents. Any child, if sent to work, adds w_c to household income. However, when child workers reach adulthood, they can only find unskilled L jobs. Skills that children acquire through schooling improve their future (adult) earnings by more than the foregone income: $s > w_c$. Schools are free.[9]

The set of all couples belonging to generation $t \in \{0,1,...\}$ will be denoted by $[0,1]\times\{t\}$. By p_E^t, p_N^t, respectively, we denote the proportion of girls in generation t who are sent to school, or put to work. Thus, p_E^t also denotes the proportion of educated brides in generation t, and p_N^t, that of brides who are not. The corresponding values for boys will be denoted, respectively, by q_E^t, q_N^t.

Agents are married off, to individuals chosen by parents, once they enter the labour market. Employment and educational status are common knowledge at the time of marriage. At that time, parents of sons receive the promise of some amount of money, d, as dowry from parents of daughters, to be paid at the end of the period. The dowry contract is costlessly enforceable. All consumption in each period takes place at the end of the period, immediately after all incomes, including dowry incomes, are received. Agents cannot borrow across periods.[10] Parents pay, and retain, all dowry.

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8 One can interpret labour market dualism in terms of 'formal' and 'informal' sectors of the economy, whereby the formal sector is characterized, because of institutional, transactions cost and efficiency wage considerations, by high and relatively rigid wage levels with employment rationing, whereas the informal sector is the residual sector marked by market clearing wage levels. Formal sector jobs are likely to be largely urban, but employment in government and quasi-government institutions constitute an important source of such jobs in rural areas. Informal sector jobs are found largely in agriculture, petty trade, services and small-scale manufacturing. Alternatively, we can assume that h proportion of male workers are innately more productive than others, and that it is this inherent ability which is reflected in their higher earnings. Yet a third interpretation is that h proportion of households are endowed with income-augmenting assets, in particular, land, which adult sons inherit from their parents. Allowing some, or even all women, to have H jobs will not alter our conclusions. (See Remark 3.8 below.) We include self-employment as a possibility in either sector.

9 This assumption is for notational simplicity. Otherwise, considering s to be net of school fees would suffice.

10 This can be relaxed, at the cost of notational complexity, without providing any additional insight.

The marriage market

Recall that grooms can be of three types: literate and high wage (*H*), literate and low wage (L_E) or illiterate and low wage (L_N); whereas brides can be literate (*E*) or illiterate (*N*). Marriage markets are competitive. A parent with a daughter of type $k \in \{E, N\}$ faces a triple of dowry rates $\langle d_{Hk}, d_{L_E k}, d_{L_N k} \rangle$, so that he has to pay parents of a, say, type H groom an amount d_{Hk} if he wishes to marry his daughter to that groom. Thus, there's a sextuple of dowry rates $\langle d_{HE}, d_{HN}, d_{L_E E}, d_{L_N E}, d_{L_E N}, d_{L_N N} \rangle$ which parents take as given. The parent of a daughter of type *k* decides whether to make a marriage offer to the parent of a groom. The offer includes the promise to pay the groom's parent d_{jk}, where $j \in \{H, L_E, L_N\}$ denotes the groom's type. The groom's parents can either accept the offer, or reject it and (costlessly) wait for another offer.

Given a vector of dowry rates, we say that parents of i weakly prefer a match with parents of *j* if the utility that parents of *i* get from marrying *i* off to *j* is at least as high as the utility they would get from marrying *i* off to somebody other than *j*. Strong preference is defined analogously. A *feasible groom profile* for generation *t* is defined as: $a_g^t = \left\{ \left\langle r, s^g(r) \right\rangle \middle| \, r \in [0,1] \times \{t-1\}, \text{ and } s^g : [0,1] \times \{t-1\} \to \{H, L_E, L_N\} \right\}$ such that

$$L\left\{ \left\langle r, s^g(r) \right\rangle \middle| \, r \in [0,1] \times \{t-1\}, \text{ and } s^g = H \right\} \leq h; \text{ and}$$

$$L\left\{ \left\langle r, s^g(r) \right\rangle \middle| \, r \in [0,1] \times \{t-1\}, \text{ and } s^g = L_E \right\} = 0 \text{ if}$$

$L\left\{ \left\langle r, s^g(r) \right\rangle \middle| \, r \in [0,1] \times \{t-1\}, \text{ and } s^g = H \right\} < h$, where $L(.)$ denotes the Lebesgue measure. Thus, an individual groom in generation *t* is characterized by: (a) the couple in the earlier generation he is born to, and (b) his own type. A groom profile is just one possible way in which the grooms could be assigned to different types. A groom profile is *feasible* if (a) the size of the type H groom population is not larger than the employment capacity of the H sector and (b) H jobs remain unfulfilled only when there is a lack of educated male applicants. The set of all feasible groom profiles in generation *t* is A_g^t. Analogously, a *feasible bride profile* for generation *t* is defined as:

$a_b^t = \left\{\left(r, s^b(r)\right) \mid r \in [0,1]\times\{t-1\},\ \text{and}\ s^b : [0,1]\times\{t-1\} \to \{E,N\}\right\}$. The set of all feasible bride profiles in generation t is A_b^t. A *feasible profile* in generation t is a pair $\left\langle a_g^t, a_b^t \right\rangle \in A_g^t \times A_b^t$. A *marriage allocation for a feasible profile* $\left\langle a_g^t, a_b^t \right\rangle$ *in generation t* is a one-to-one and onto mapping from a_g^t to a_b^t. Thus, given a specific feasible collection of grooms and brides, a marriage allocation is some way of matching every groom with a bride in that collection, and vice versa.

Preferences and Inter-generational conflict

Each adult couple is characterized by a single set of preferences. Given a family, we shall identify the constituent couples in the older and younger generations by P and S, respectively. Each couple consumes two goods, X and Y. Let x_P, y_P denote the amounts of the two commodities consumed by P, while x_S, y_S will denote the amounts of the two commodities consumed by S. The P couple's preferences over their own, and their son's, consumption bundles are given by:

$$u^P = x_P{}^{\alpha} y_P{}^{1-\alpha} + x_S{}^{\alpha} y_S{}^{1-\alpha} + G(n),$$

while the S couple's preferences are given by:

$$u^S = x_P{}^{\beta} y_P{}^{1-\beta} + x_S{}^{\beta} y_S{}^{1-\beta},$$

where $\alpha \in (0,1], \beta \in (0,1), \alpha \neq \beta$.

Note first that there exists a 'generation gap': preferences vary across generations. Second, parental preferences are 'paternalistic': they are better off if adult sons follow their lifestyle, i.e., consume according to the parents' preferences. [11] G is increasing, with $G(0) = 0$, while n measures the type of husband that P's daughter acquires. Ceteris paribus, parents consider men who earn more better matches. Formally: $n = n_H$ if the

11 The assumption that sons are better off if parents consume according to the sons' preferences is for simplicity. We can also generalize the utility functions, at the cost of algebraic detail. $\alpha = 1$ captures the introduction of a new type of consumption, say, watching television, which is valued only by the younger generation.

groom is employed in sector H, $n = n_{L_E}$ if he is educated and employed in sector L, and $n = n_{L_N}$ otherwise; $0 < n_{L_N} < n_{L_E} < n_H$.[12]

Consumption goods are produced inside the household using purchased inputs, including labour.[13] If the household wishes to consume some vector (x, y), in any period, then it has to spend $(x + y)$ to buy a composite divisible input, and a fixed amount, *a*, to buy a composite *indivisible* input. The composite indivisible input is a fixed cost that has to be incurred to set up a household. It is thus a capital asset, assumed, for simplicity, to depreciate fully at the end of the period. The capital asset can be of two different types, $\alpha, \beta \in (0,1]$. If the household purchases a capital asset of type $\eta \in \{\alpha, \beta\}$, then, given that it spends some amount $m > 0$ on variable inputs, it can produce (and consume) any consumption vector (x, y) within the set $\{(x, y) \in \Re_+^2 \mid x \leq \eta m, y \leq (1-\eta)m\}$.

At the beginning of the period, parents purchase the domestic capital asset of type α. Once their son gets married, the S couple has to decide whether to spend their earnings to produce within the available domestic technology set, or to form a separate household by paying the fixed price *a*. Evidently, should they form a separate household, S would acquire domestic technology of type β.

One can think of this formalization thus. Early on, the P couple set up a household, i.e., acquire a house to live in and organize their activities according to a particular set of rules. The parental household is thus organized according to the values and preferences of parents. For example, P may set apart space for religious activities, but not for entertaining guests or watching television. Or they may object to consumption of alcohol. S have different preferences. However, S find themselves constrained in consuming according to their own preferences if they live with parents. They cannot entertain friends, watch television, or drink alcoholic beverages, because of lack of

12 Desirable qualities in a bridegroom are "…defined to an astonishing degree by the extent of modern education and the access of the bridegroom to an urban occupation…, as well as the amount of property owned" (Caldwell *et al.* (1983, p. 357)). See also Ifeka (1989).

13 We think of domestic labour as labour services of members, bought by the household at the market wage rate.

space, or because of the psychic cost from parental objections and consequent domestic friction. Social norms may also require that they turn over the major part of their own earnings to parents, who then decide how that money is going to be spent on the S couple's consumption goods. S can free themselves from 'parental interference', formalized as consumption restrictions, and spend their earnings in a way that best satisfies their own preferences, if they form a separate household organized according to their own goals. But, to do so, they must spend the amount *a* to purchase capital assets, such as a house and some consumer durables, necessary for setting up a household.

Let m_P, m_S be the total variable domestic expenditures incurred in the P and S households, respectively. Note that, if S live with parents, then $m_S = 0$, while m_P is simply the sum of the variable domestic expenditures of the P and S couples. If, however, S live separately, then m_P is the variable expenditure incurred by P, while m_S is that incurred by S. Then, we can write:

$$u^P = [m_P + m_S(1-k_P)] + g(n), \tag{2.1}$$

$$u^s = [m_S + m_P(1-k_S)]; \tag{2.2}$$

where $k_P, k_S \in (0,1)$, $g = G/\alpha^{\alpha}(1-\alpha)^{1-\alpha}$. Let P's own income in the period be I_P. We assume $\left[I_P - a - g(n_H) \geq \frac{a(1-k_P)}{k_P} \right]$. This ensures that P is able and willing to pay up to $g(n_H)$ for an H groom, whereas he is willing to pay at most $g(n_{L_E})$ for an L_E one, and $g(n_{L_N})$ for an L_N one. It also ensures that it is optimal for P to choose the domestic technology α. S's income is I_S.[14]

14 Given preferences (2.1) and (2.2), no couple has any incentive to transfer money to the other couple. Thus, we abstract from issues of bequests and transfers from sons, which are not relevant to our analysis. In our formulation, dowry payments are pure 'groom-price': they do not have any pre-mortem inheritance component.

Separation and bride preference:

It is rational for S to separate if, and only if: $I_S \geq a/k_S$. The term a/k_S may be thought of as a measure of the degree of parental control over adult sons. The lower the divergence in preferences across generations (i.e., the lower the value of k_S), the larger such control. A stable traditional society is characterized by low k_S, while a large value of k_S captures sharp differences across generations in a transitional society undergoing rapid change. P is always worse off in case the S couple separates: parents lose the equivalent of $[a + k_P(I_S - a)]$ amount of their own income.[15]

We first embed the idea that wealthier S couples are more likely to separate.

A1. 2s+2w > a/k_S > 2w + s.

A2. r+2w > a/k_S.

By A1, if both members of the S-couple are in the L sector, and at most one is literate, then they will not separate. However, if both are educated, then they will do so, even if both are in the L sector. By A2, if one member of the S-couple is in the H sector, then the couple will separate. By A1 and A2, if parents have a type H son, then that son will separate, subsequent to marriage, regardless of the type of bride they choose. However, if he is of type L_E, the son will find it rational to separate only if parents choose a type E bride. An uneducated L son will never separate.

The net gain to parents with H sons, from choosing a type E (rather than N) bride, is:

$$[(1-k_P)s + (d_{HE} - d_{HN})].$$

The net gain to parents with L_E sons, from choosing an E bride, is:

$$[s(1-2k_P) - a(1-k_P) - 2wk_P] + [d_{L_E E} - d_{L_E N}].$$

We assume the following.

A3. $s < a$.

15 The gains that parents make, if adult sons live with them, include those from being looked after in old age. It has been noted in other contexts that, as they grow older, parents' desire for children's visits usually exceeds the latter's desire to visit them (see Konrad *et al*. (2002) and the references therein).

A3 builds in the idea that returns to female education in a transitional economy are significant, but not extremely so, due to lack of complementary inputs such as capital, technology and infrastructure.

Given A1 and A3, we must have, for any arbitrary $k_P \in (0,1)$,

$$[a(1-k_P)+2wk_P - s(1-2k_P)] > 0 . \tag{2.3}$$

Summarizing our discussion, then, we have the following result.

Lemma 2.1. *Let d_{iE}, d_{iN} be the dowry amounts paid by parents of type E and type N brides, respectively, for grooms of type i, $i \in \{H, L_E\}$, and let A1-A3 be satisfied. Then:*

(i) *parents of H grooms strongly prefer N brides iff $[d_{HN} > d_{HE} + (1 - k_P)s]$, while they weakly prefer N brides iff the inequality holds weakly, and*

(ii) *parents of L_E grooms strongly prefer E brides iff $\lfloor d_{L_E E} > d_{L_E N} + \Phi \rfloor$, while they weakly prefer E brides iff the inequality holds weakly; where $\Phi = [a(1-k_P)+2wk_P - s(1-2k_P)] > 0$.*

Thus, due to parental altruism, H parents can strongly prefer E brides even when such brides bring in *lower* dowry. Parental self-interest dictates that L_E parents strongly prefer E brides *only* if they bring in higher dowry, and possibly prefer N brides *even if* E brides yield higher dowry.

Remark 2.2. Evidently, if sons were choosing brides themselves, then they would always be willing to accept lower dowry for an educated bride, regardless of their own type.

3. STEADY STATE EQUILIBRIUM

Given dowry rates and a feasible profile, a marriage allocation is stable if no parent strictly prefers a match different from that specified by the allocation. This implies no parent should strictly prefer marrying his son/daughter to a different person, *regardless of that person's type*. Neither should a parent strictly prefer the person his progeny is actually marrying to be of a *different type*.

Definition 3.1. Given a sextuple of dowry rates, $T = \left\langle d_{HE}, d_{HN}, d_{L_E E}, d_{L_E N}, d_{L_N E}, d_{L_N N} \right\rangle$, a marriage allocation for a feasible profile $\left\langle a_g^t, a_b^t \right\rangle$ in generation *t*, M, constitutes a *stable marriage allocation with respect to* $\left\langle T, \left\langle a_g^t, a_b^t \right\rangle \right\rangle$ if, and only if: (i) for every $\alpha \in a_g^t$, parents of α weakly prefer a match with parents of M(α) to any match $\beta \in [0,1] \times \{t-1\} \times \{E, N\}$, and (ii) for every $\beta \in A_b^t$, parents of β weakly prefer a match with parents of $M^{-1}(\beta)$ to any match $\alpha \in [0,1] \times \{t-1\} \times \{H, L_E, L_N\}$.

Equilibrium dowry rates must be such that brides and grooms can be matched in some way that leaves all parents satisfied, at the price vector for alternative types that they are facing. Thus, a vector of dowry rates will constitute an equilibrium if, given those dowry rates, we can find at least one feasible profile of grooms and brides which has a stable marriage allocation corresponding to it.

Definition 3.2. A sextuple of dowry rates, $T^* = \left\langle d_{HE}^*, d_{HN}^*, d_{L_E E}^*, d_{L_E N}^*, d_{L_N E}^*, d_{L_N N}^* \right\rangle$, constitutes an *equilibrium* in the marriage market for generation *t* if, and only if, there exists a feasible profile $\left\langle \hat{a}_g^t, \hat{a}_b^t \right\rangle$ in generation *t* which has a marriage allocation, M^*, corresponding to it, such that M^* constitutes a stable marriage allocation with respect to $\left\langle T^*, \left\langle \hat{a}_g^t, \hat{a}_b^t \right\rangle \right\rangle$.

Lastly, we need to identify equilibrium properties of the marriage market that are *steady state*, i.e., inter-temporally stable. This is ensured only if no parent has reason to regret educating, or not educating, his son/daughter. One way of thinking about this restriction is in terms of *perfect foresight* on part of parents. Alternatively, if we assume that parents expect current dowry rates to persist, then, if the feasible profile today is such that parents regret their past choices, then parents in the next generation, observing current dowry rates, would make different decisions. This will lead to a different feasible profile and, thereby, a different vector of equilibrium dowry rates. Thus, neither

the initial feasible profile nor the initial vector of dowry rates would be inter-temporally consistent.

A steady state equilibrium vector of dowry rates therefore implies the existence of a marriage allocation whereby no parent could have done better by having a different type of daughter, whether with the same groom or a different groom. The analogous requirement must hold for parents vis-à-vis sons as well, with the additional consideration that parents can only choose the educational status of their sons, but not whether the latter will have H or L_E jobs, if literate.[16] Clearly, if an L_N parent would be better off by having an educated son instead, *both* when that son turned out to be H *and* when he turned out to be L_E, then that parent must necessarily regret the initial decision. Conversely, if this parent cannot be better off by having an educated son instead, *regardless* of whether that son then turned out to be H or L_E, then he cannot possibly regret the initial decision.

Characterization 3.3. A sextuple of dowry rates, $T^* = \left\langle d^*_{HE}, d^*_{HN}, d^*_{L_E E}, d^*_{L_E N}, d^*_{L_N E}, d^*_{L_N N} \right\rangle$, constitutes a *steady state* equilibrium in the marriage market *only if*,

(i) it constitutes an equilibrium in the marriage market for some feasible profile $\left\langle \hat{a}^t_g, \hat{a}^t_b \right\rangle$ in generation *t*, and

(ii) there exists a stable marriage allocation corresponding to $\left\langle T^*, \left\langle \hat{a}^t_g, \hat{a}^t_b \right\rangle \right\rangle$, M^*, which has the following properties:

(a) for every $\alpha \in \hat{a}^t_b$, there exists no $\beta \in [0,1] \times \{t-1\} \times \{H, L_E, L_N\}$ such that parents of α would be better off if [α was of a different type and α was married to β],

16 Except when we identify H status with inherited asset ownership, especially land. In that case, parents know whether their sons will be H or L_E, if educated. Characterization 3.3 covers this case as well.

(b) for every $\alpha \in \hat{a}_g^t$ such that α is of type H or L_E, there exists no $\beta \in [0,1] \times \{t-1\} \times \{E,N\}$ such that parents of α would be better off if [α was of type L_N and α was married to β], and

(c) for every $\alpha \in \hat{a}_g^t$ such that α is of type L_N, there exist no $\beta, \gamma \in [0,1] \times \{t-1\} \times \{E,N\}$ such that [[parents of α would be better off if α was of type L_E and α was married to β], and [parents of α would be better off if α was of type H and α was married to γ]].

T^* constitutes a *steady state* equilibrium in the marriage market *if* it satisfies conditions (i), , (ii(a)), (ii(b)) and the following:

(ii(c')) for every $\alpha \in \hat{a}_g^t$ such that α is of type L_N, there exists no $\beta \in [0,1] \times \{t-1\} \times \{E,N\}$ such that parents of α would be better off if [α was of type $\varsigma \in \{L_E, H\}$ and α was married to β].

Definition 3.4. **(i)** A feasible profile that corresponds to a steady state equilibrium vector of dowry rates will be called an *equilibrium feasible profile*.

(ii) A marriage allocation that is stable with respect to a steady state equilibrium vector of dowry rates and an equilibrium feasible profile corresponding to that vector of dowry rates will be called a *steady state equilibrium marriage allocation*.

If a steady state equilibrium vector of dowry rates exists, then we can find a pattern of educational choices and stable marriage allocation in every generation which will (a) allow these dowry rates to persist indefinitely as the equilibrium outcome in every generation, and (b) allow that pattern of educational choices to be reproduced indefinitely as the aggregate consequence of rational responses by individual parents to that equilibrium vector of dowry rates.

By educating daughters, parents lose w_c in foregone income. Hence, they will do so only if, for at least one type, j, of grooms, [$d_{jN} - d_{jE} \geq w_c$]. By Lemma 2.1(ii), if some parents find it worthwhile to educate daughters in a steady state equilibrium marriage allocation, it must be that they marry their daughters to type H or L_N grooms, i.e., [$d_{HN} - d_{HE} \geq w_c$] and/or $\lfloor d_{L_N N} - d_{L_N E} \geq w_C \rfloor$.

First suppose an E bride is matched with an H groom. By Lemma 2.1(i), parents of H grooms will find E brides acceptable only if $[d_{HN} - d_{HE} \leq (1 - k_P)s]$. We therefore assume the following.

A4. $(1 - k_P)s > w_c$.

If the inequality is reversed, then, when all grooms are literate, the only steady state equilibrium outcome possible is universal female *illiteracy*. With universal male literacy, universal female illiteracy will also constitute a steady state equilibrium outcome (though not the only one) if $[(1 - k_P)s = w_c]$. A4 is likely to be violated if *s*, i.e., gains from education, is small. This in turn would appear to be the case in technologically stagnant traditional societies, but not in transitional societies.

Lastly, we wish to abstract from male illiteracy in order to focus on female illiteracy. So, we ensure that the dowry premium that educated grooms would command in a steady state equilibrium is a sufficiently strong incentive for parents to educate sons. We also ensure that, for identical reasons, parents would prefer a literate son to have an H, rather than an L_E, job in a steady state equilibrium.

A5. $g(n_{L_E}) - g(n_{L_N}) > w_C + 2w + s$.

A6. $g(n_H) - g(n_{L_E}) \geq w_C + 2w + s$.

Given A1-A5, necessary conditions for a steady state equilibrium imply that one can only sustain, as a steady state equilibrium outcome, a scenario where (a) all men are literate, and (b) the proportion of literate women is identical to the proportion of men in the high wage sector.

Proposition 3.5. *Suppose* $T^* = \left\langle d^*_{HE}, d^*_{HN}, d^*_{L_E E}, d^*_{L_E N}, d^*_{L_N E}, d^*_{L_N N} \right\rangle$ *constitutes a steady state equilibrium in the marriage market, and suppose* $\left\langle \hat{a}^t_g, \hat{a}^t_b \right\rangle$ *constitutes an equilibrium feasible profile corresponding to T*. Let* q^*_E *be the proportion of literate grooms, and* p^*_E *that of literate brides, that are consistent with* $\left\langle \hat{a}^t_g, \hat{a}^t_b \right\rangle$. *Then, given A1-A5,* $q^*_E = 1 \text{ and } p^*_E = h$.

Proof: See the Appendix.

By Proposition 3.5, a steady state equilibrium vector of dowry rates generate parental incentives which make the proportion of E women equal to that of H men. In a steady state equilibrium marriage allocation, all E women marry H men. A1-A6 guarantee existence of steady state equilibria.

Corollary 3.6. *Given A1-A5, in any steady state equilibrium marriage allocation*, *all H grooms must marry E brides, while all* L_E *grooms must marry N brides.*

Proof: See the Appendix.

The steady state equilibrium vector of dowry rates must satisfy: $\left[d^*_{HE} - d^*_{L_E N} = \left[g(n_H) - g\left(n_{L_E}\right)\right] - w_c\right]$. Thus, the model uniquely determines the equilibrium *gap* between dowry payments received by H and L_E grooms. Notice however that the model generates multiple vectors of dowry rates that can be supported as steady state equilibrium.[17]

Implications:

Proposition 3.5 implies that an expansion in the size of male employment in the H sector will increase the female literacy rate. Thus, the transitional process, i.e., a process of technological innovation, capital formation and secular growth, *if* it progressively draws a larger proportion of the male workforce into the high wage economy over time (as in the classical two-sector model of Lewis (1954)), will also generate progressively higher levels of female literacy. A reduction in the size of the male workforce in the high wage sector will however reduce education levels among women.[18]

Remark 3.7. If 'jobless growth' in the H sector increases incomes in that sector without increasing its size, then the female literacy rate will not improve. Similarly, so long as A1-A5 continue to be met, increases in the informal sector wage rate, reductions in

17 One often observes sharp differences in dowry rates across economically similar, but traditionally exogamous, communities. Our model, with its multiple equilibria, is compatible with these observations. Cultural and historical factors may determine exactly which of the alternative equilibrium dowry vectors hold in practice. Furthermore, if different exogamous communities have different proportions of men in high wage occupations, then our model will predict corresponding differences in female literacy rates across these communities.

18 Thus, opening up of the manufacturing sector to import competition, down-sizing of public sector firms and labour-shedding in the bureaucracy may all have an adverse impact on the female literacy rate.

returns to child labour, increases in returns to education in the L sector, will all turn out to have no effect whatsoever on the steady state literacy rates. Thus, the gender gap in literacy turns out to be 'sticky', i.e., impervious to relatively small income gains in either sector.[19]

Remark 3.8. We have assumed that women can only find L jobs. We can allow some, or indeed all, E women to get H jobs, assuming, as in the case of men, that education is necessary for H employment. It can be checked, however, that, so long as we assume a stronger version of A3, namely, [r < a], our conclusions, as stated in Proposition 3.5 and Corollary 3.6, remain unchanged. Thus, state policies that increase returns to women's education, whether in the labour market or in the household sector, will be *completely ineffective* in altering the steady state equilibrium level of female literacy, unless they increase such returns drastically relative to the fixed cost of setting up a household, so that [r $>$ a]. Indeed, [r $>$ a] is a necessary, but not sufficient, condition for the effectiveness of such policies. Intuitively, this happens because moderate rises in returns to female education are not sufficient to make L parents accept lower dowry payments for E brides, while parents are willing to educate daughters only if, by doing so, they can reduce their dowry payments. Note further that, if r < a, then state policies which increase the proportion of women in the high wage sector by *displacing* men (through effective affirmative action programs or hiring quotas), will actually end up *reducing* the female literacy rate in the steady state equilibrium.

Remark 3.9. It is parental control over choice of brides, rather than dowry *per se*, which generates female illiteracy. To see this, suppose instead that sons chose their own brides, while parents passively received the market determined dowry payment. It is then easy to check, in light of Remark 2.2, that, given A1-A6, universal literacy, both male *and* female, can be the only steady state equilibrium outcome. If grooms chose their own brides, then universal female literacy would be the only possible steady state

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19 It also follows that a process of import liberalization, deregulation, privatization and downsizing of the government bureaucracy, by reducing the distortion in the labour market, may generate pro-poor income growth and reduce income inequality, but at the cost of greater gender disparity in education. See footnote 18.

equilibrium outcome even if grooms themselves received dowry payments. However, in this case, parents may not have an incentive to educate sons.

4. EXTENSION: DIRECT TAX-SUBSIDY INTERVENTIONS

Governments often offer direct incentives to parents for sending daughters to school. These can be low fees, free/subsidized school meals, provision of books, uniforms and health care facilities contingent on attendance, etc. A simple way of capturing such interventions is to assume the state provides a cash reward to parents, b, if they send daughters to school. The state can, also, in principle, penalize parents for non-attendance of daughters. We model such sanctions by means of a tax, τ, imposed on parents for failure to send daughters to school. Clearly; $b, \tau \geq 0$, $b + \tau > 0$.

Proposition 4.1. *Let* q_E^* *be some proportion of literate grooms, and* p_E^* *some proportion of literate brides, that can be sustained as a steady state equilibrium outcome, and let* $\Phi = \left[a(1-k_P) + 2wk_P - s(1-2k_P)\right]$. *Then, given A1-A5,* $q_E^* = 1$, *and: (i)* $\left[p_E^* > h\right]$ *only if* $\left[b \geq w_C - \tau + \Phi\right]$, *(ii)if* $\left[b > w_C - \tau + \Phi\right]$, *then* $\left[p_E^* = 1\right]$, *and (iii) if* $\left[b < w_C - \tau + \Phi\right]$, *then* $\left[p_E^* = h\right]$.

Proof: See the Appendix.

Recall that, from (2.3), $\Phi > 0$. First suppose the state cannot (for political or administrative reasons) tax parents for not sending daughters to school, i.e., $\tau = 0$. Then Proposition 4.1(i) implies that, to raise the female literacy rate above h, parents have to be given a subsidy *larger* than their earnings from work performed by daughters. Thus, simply compensating parents for foregone earnings from female child labour does not make it worth their while to send daughters to school. If the state cannot provide a subsidy, i.e., $b = 0$ (say, because of budgetary constraints), then it must tax parents who do not send their daughters to school by an amount *higher* than w_c. Thus, completely mopping up parents' earnings from the labour of their daughters, by an equivalent tax (or, alternatively, somehow suppressing child labour), does not suffice to improve the level of female education either. More generally, Proposition 4.1(parts ii and iii) implies that relatively small tax/subsidy intervention will be completely ineffective, leaving the degree of female education in the economy unchanged. This happens because, for

parents to have an incentive to educate daughters, it is not enough to compensate/eliminate their direct monetary gains from child labour. The state must compensate parents for the higher dowry they'll have to pay for L grooms as well.[20] Thus, parental authority in marriage decisions once again serves to make the level of female illiteracy sticky.

5. CONCLUSION

In this paper, we have explored the interconnection between employment opportunities for men and parental incentives for educating daughters in a transitional economy, where preferences vary across generations and dowry rates are flexible. We have shown that the proportion of men with access to relatively high income generating opportunities may be a critical determinant of the magnitude of female illiteracy, when parents control the choice of spouses for adult sons. Growth which increases incomes without increasing the relative size of the high wage sector may not improve female literacy rates, nor reduce the magnitude of female child labour. State interventions, whether in the form of increasing returns to women's schooling, subsidizing female education, or directly penalizing parents for failure to educate daughters, may all turn out to be ineffective as well. Thus, if the distribution of male workers between high and low income occupations remains relatively stable, then low levels of female literacy and high incidence of female child labour may persist, in spite of economic growth and state attempts to improve parental incentives for educating daughters. Our analysis generates a number of predictions regarding the behaviour of dowry rates and female educational levels, which need to be subjected to empirical verification in future work.

We have identified, as the primary culprit, social norms that allow parents to have a major say in the choice of wives for their sons, rather than dowry *per se*. It follows that state and/or civil society initiatives which challenge and contest these norms may have a positive impact on female educational levels. Initiatives to discourage early marriages are likely to be especially important in this regard. On the other hand, attacks on the institution of dowry itself, while perhaps important for other social objectives, may be beside the point in the context of parental incentives to invest in daughters.

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20 If $\left[b = w_C - \tau + \Phi\right]$, then every value of p_E^* in $\left[h,I\right]$ can be sustained as a steady state outcome.

APPENDIX

Proof of Proposition 3.5:

Step 1. We shall first show that, given A5, $q_E^* = 1$. Suppose there exists some P with an N son in a steady state equilibrium feasible profile. First suppose this N groom is matched with an N bride. Then, by Characterization 3.3 and A5, $\left[w_c + 2w + s < d^*_{L_E N} - d^*_{L_N N}\right]$ and $\left[w_c + 2w + s < d^*_{HN} - d^*_{L_N N}\right]$. However, in that case the N parent would be better off with an educated son, regardless of whether that son is L_E or H, a violation of Characterization 3.3. An exactly analogous reasoning rules out the other possibility that the N groom is matched with an E bride. Hence, there cannot be any N grooms in a steady state equilibrium feasible profile.

Step 2. We now establish that, given A1-A5, $p_E^* = h$. Recall that, from Step 1, grooms can only be either be H or L_E in a steady state equilibrium feasible profile.

Suppose first that $p_E^* > h$. Then $p_N^* < p_{L_E}$. For this to be sustained as an equilibrium outcome, dowry rates must be such that (i) E parents weakly prefer L_E grooms, and (ii) L_E parents weakly prefer E brides (both by Definition 3.1). These conditions imply, respectively, that:

$$g(n_H) - d^*_{HE} \leq g\left(n_{L_E}\right) - d^*_{L_E E}; \qquad \text{(N1)}$$

and

$$d^*_{L_E E} \geq d^*_{L_E N} + \Phi > d^*_{L_E N},$$

(N2)

(N2) following from Lemma 2.1(ii). However, (N1) and (N2) together imply that N parents with L_E matches would be strictly better off than E parents, which violates Characterization 3.3.

Now suppose $0 < p_E^* < h$. Then $1 > p_N^* > p_{L_E}$. For this to be sustained as an equilibrium outcome, dowry rates must be such that (i) H parents weakly prefer N

brides, and (ii) N parents weakly prefer H grooms (both by Definition 3.1). These conditions imply, respectively, that:

$$d^*_{HN} - d^*_{HE} > 0; \tag{N3}$$

(using Lemma 2.1(i)) and

$$g(n_H) - d^*_{HN} \geq g(n_{L_E}) - d^*_{L_E N}. \tag{N4}$$

Combining (N3) and (N4), we get:

$$g(n_H) - d^*_{HE} > g(n_{L_E}) - d^*_{L_E N}. \tag{N5}$$

Now, if L_E parents weakly prefer E brides, then, by Lemma 2.1(ii), $d^*_{L_E E} > d^*_{L_E N}$, which, by (N5), implies that E parents strongly prefer H grooms. But, in that case, by Definition 3.1, H parents must weakly prefer E brides; which in turn implies that all E brides must be matched to H grooms in an equilibrium marriage allocation. If, on the other hand, L_E parents strongly prefer N brides, then, by Definition 3.1, the equilibrium marriage allocation must involve all E brides getting matched to H grooms. Hence, all E brides must have H matches in either case. But, if all E brides are matched to H grooms, then, since $p^*_E < h$, Definition 3.1 implies that (i) H parents get identical payoffs from E and N matches, and (ii) N parents get identical payoffs from H and L_E matches, i.e.:

$$d^*_{HN} - d^*_{HE} > 0, \tag{N6}$$

(using Lemma 2.1(i)), and

$$g(n_H) - d^*_{HN} = g(n_{L_E}) - d^*_{L_E N}. \tag{N7}$$

(N6)-(N7) imply that E parents are better off than N parents, which violates Characterization 3.3.

Lastly, suppose $p^*_E = 0$. Then, by Definition 3.1, H parents must weakly prefer N brides. Hence, by Lemma 2.1(i) and (A4), we get: $d^*_{HN} - d^*_{HE} > w_C$. This however implies that N parents with H grooms would be better off with E daughters, a violation of Characterization 3.3. ◊

Proof of Corollary 3.6: In light of Proposition 3.5, it is evident that, in order to establish Corollary 3.6, it suffices to establish the following:

there cannot simultaneously exist an L_E E match *and* an HN match in any steady state equilibrium marriage allocation

Suppose there exists at least one L_E E match and at least one HN match in any steady state equilibrium marriage allocation. The HN match implies, in light of Lemma 2.1(i):

$$g(n_H) - d^*_{HE} > g(n_{L_E}) - d^*_{L_E N}. \tag{N8}$$

The L_E E match implies, by Lemma 2.1(ii), $d^*_{L_E E} > d^*_{L_E N}$, which, in light of (N8), yields:

$$g(n_H) - d^*_{HE} > g(n_{L_E}) - d^*_{L_E E}. \tag{N9}$$

By (N9), the E parent with the L_E match strongly prefers an H match, violating Definition 3.1. ◊

In order to prove Proposition 4.1, we first establish the following claims.

Lemma N1. *Given A1-A4, there does not exist any steady state equilibrium marriage allocation which involves at least one HN match.*

Lemma N2. *Given A1-A4, if* $[b - (w_C - \tau) < \Phi]$*, then there does not exist any steady state equilibrium marriage allocation which involves at least one* L_E *E match.*

Proof of Lemma N1.

Suppose there exists a vector of steady state equilibrium dowry rates which generates a marriage allocation involving at least one HN match. Then, by Lemma 2.1(i) and (A4),

$$d^*_{HN} - d^*_{HE} \geq (1 - k_P)s > w_C - \tau;$$

which, in conjunction with the condition $b, \tau \geq 0$, $b + \tau > 0$, yields:

$$d^*_{HN} - (w_C - \tau) > d^*_{HE} - b.$$

This implies that the N parent with the H match would be strictly better off with an E daughter, a violation of Characterization 3.3.

◊

Proof of Lemma N2.

Suppose $[b - (w_C - \tau) < \Phi]$, and there exists a vector of steady state equilibrium dowry rates which generates a marriage allocation involving at least one L_E E match. Then,

using Lemma 2.1(ii), we have: $d^*_{L_E E} - b > d^*_{L_E N} - (w_C - \tau)$. This implies that the E parent with the L_E groom would be better off with an N daughter, which violates Characterization 3.3. ◊

Proof of Proposition 4.1.

Consider a sextuple of dowry rates which constitutes a steady state equilibrium in the marriage market, and suppose A1-A5 hold. That [$q^*_E = 1$] follows by an argument identical to that presented in Step 1 of Proposition 3.5.

(i) <u>*Step 1*</u>. First suppose that $p^*_E = 1$. Then (i) parents must be indifferent between H and L_E grooms (Definition 3.1), and (ii) parents cannot be better off by changing the educational status of their daughters (Characterization 3.3). We thus have, from requirement (i): $d^*_{HE} - d^*_{L_E E} = g(n_H) - g(n_{L_E})$. Now consider requirement (ii). By not educating his daughter, a parent can get either: $[g(n_H) - d^*_{HN} + (w_c - \tau)]$ or $[g(n_{L_E}) - d^*_{L_E N} + (w_c - \tau)]$. Suppose the higher payoff is with an L_E groom. Then requirement (ii) implies: $b - (w_C - \tau) \geq d^*_{L_E E} - d^*_{L_E N}$. Now, if $d^*_{L_E E} - d^*_{L_E N} < \Phi$, then L_E parents strongly prefer N brides (Lemma 2.1(ii)). Hence, for the dowry rates to constitute a steady state equilibrium which generates universal education of daughters, it must be that $d^*_{L_E E} - d^*_{L_E N} \geq \Phi$ (by Definition 3.1). We must therefore have: $b - (w_C - \tau) \geq \Phi$. If the higher payoff is with an H groom, then we have: $[g(n_H) - g(n_{L_E}) \geq d^*_{HN} - d^*_{L_E N}]$, which implies (since, from requirement (i), $d^*_{HE} - d^*_{L_E E} = g(n_H) - g(n_{L_E})$): $d^*_{HE} - d^*_{L_E E} \geq d^*_{HN} - d^*_{L_E N}$. We thus have:

$$d^*_{HE} - d^*_{HN} \geq d^*_{L_E E} - d^*_{L_E N}.$$

As before, in light of Lemma 2.1(ii) and Definition 3.1, for L_E parents not to have any incentive to strongly prefer N brides, we need:

$$d^*_{L_E E} - d^*_{L_E N} \geq \Phi.$$

Combining the two conditions, we get:

$$d^*_{HE} - d^*_{HN} \geq \Phi.$$

Now, if, by not educating their daughters, the best outcome that parents can have indeed involves choosing H grooms, then, in order to satisfy Characterization 3.3, it must be that:

$$b-(w_C-\tau)\geq d^*_{HE}-d^*_{HN},$$

i.e.,

$$b-(w_C-\tau)\geq \Phi.$$

Hence, if ($p^*_E=1$) is a steady state equilibrium outcome, we must have: $[b\geq w_C-\tau+\Phi]$.

Step 2:Now suppose $p^*_E\in(h,1)$. Then, by Definition 3.1, all E parents must weakly prefer L_E matches. Hence an E parent's payoff is: $\left[g\left(n_{L_E}\right)-d^*_{L_EE}+b\right]$. For E parents not to have an incentive to deviate (Characterization 3.3), it must be: $[b-(w_C-\tau)\geq d^*_{L_EE}-d^*_{L_EN}]$. Now, since, by assumption, $p^*_N<1-h$, from Definition 3.1 it follows that L_E parents weakly prefer E matches, which implies: $d^*_{L_EE}-d^*_{L_EN}\geq\Phi$. Thus, we need $[b-(w_C-\tau)\geq\Phi]$ in order to sustain, as an equilibrium outcome, $p^*_E\in(h,1)$. This completes the proof of part (i) of Proposition 4.1.

(ii) From Lemma N1, $p^*_E\geq h$. Suppose $[b-(w_C-\tau)>\Phi]$. First consider the possibility that $p^*_E\in(h,1)$. Then, by Lemma N1, the steady state equilibrium marriage allocation must be such that all N parents, and some E parents, have L_E matches. Then, Characterization 3.3 yields:

$$d^*_{L_EE}-b=d^*_{L_EN}-(w_C-\tau),$$

i.e. $\left[d^*_{L_EE}-d^*_{L_EN}>\Phi\right]$, which implies, by Lemma 2.1(ii), that all L_E parents strongly prefer E brides, a contradiction. Now consider the alternative possibility that $p^*_E=h$. Then, by Lemma N1, all L_E parents have N brides. We thus have, from Lemma 2.1(ii),

$$d^*_{L_EE}-d^*_{L_EN}\leq\Phi<b-(w_C-\tau),$$

which yields:

$$d^*_{L_EE}-b<d^*_{L_EN}-(w_C-\tau).$$

This implies that N parents would be better off with E daughters, which violates Characterization 3.3. So the only remaining possibility is $p_E^* = 1$. This completes the proof of part (ii) of Proposition 4.1.

(iii) Part (iii) of Proposition 4.1 follows immediately from Lemma N1 and Lemma N2.

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