Assortative Mating, Family Characteristics and Marital Transactions in India

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This paper examines how equilibrium sorting takes place in marriage markets in India where matches are often arranged and are accompanied by a monetary transfer from the bride's household to the groom's household. It constructs an empirical model of spouse selection based on Becker's (1973) efficient marriage market hypothesis. By specifying a marital production function and introducing the influence of multiple individual characteristics simultaneously in the matching technology, this paper creates a matching algorithm and uses the estimated parameters to isolate the characteristics that drive the matching process and to examine positive assortative mating with respect to nonmarket characteristics.

INTRODUCTION

How individuals (or their parents) sort themselves through marriage into households is an interesting and important economic issue. For example, it has major implications for distribution of income, individual investment in self-improvement and fertility. It also influences subsequent marital stability (Becker, Landes and Michael 1977), labor market performance of women, parent's efficient allocation of resources (Zhang 1994), and genetical natural selection of different characteristics over time. This paper uses micro data from India to examine how equilibrium sorting takes place in marriages that are often arranged and accompanied by monetary transfers from the bride's household to the groom's household. In doing so, it employs Becker's (1973) efficient marriage market hypothesis to construct an empirical model of spouse selection in which stable assignments of marriage partners are derived from a utility maximization problem. Individuals, in this model, derive utility from consuming commodities which are produced jointly by them according to a household production function. Marriage markets are efficient if men and women are matched in such a way that maximizes aggregate household commodity output over all marriages. While marriage assignments are stable if no married individual would prefer being single and if no unmatched pair would prefer each other to their assigned partners. By specifying a marital production function and introducing the influence of individual characteristics in the mate-selection process, this paper creates a matching algorithm and uses the estimated parameters to examine assortative mating with respect to nonmarket characteristics and to isolate the factors that affect matching behavior. It also compares the optimal pairing of men and women, predicted by the matching model it develops, to their actual pairing to assess the efficiency of marriage markets in India.

The economic theory of mate-selection treats marriage as a voluntary and mutual arrangement between men and women. It is natural, then, for economists to use the market analogy to model the matching process (Gale and Shaply 1962, Becker 1991). In Becker's model, marriage occurs only if the gains from marriage are positive and partners expect to raise their utility level above what it would be were they to remain single. A marriage market forms from competition among single men and women seeking mates. Marital matches are responsive to the personal traits of individuals that define their marriageability, which influence their market and nonmarket productivity and serve as inputs to the household production function. The marriage market functions by choosing the optimal sorting of men and women that maximizes the average gain over all marriages. This maximization process yields two possible outcomes: positive assortative mating--“likes” marry “likes”--for traits that are complementary (age, race, education) and negative assortative mating--opposites attract--for traits that are substitutable (wages and hours worked).

There is a long history of research on patterns of marital matching. An extended survey by Epstein and Guttman (1984) documents the widely observed positive assortative mating for many traits as indicated by the conventional measure of simple correlations. Positive correlations are reported for age, education, race, nonmarket income, religion, ethnic origin, and height of spouses. Becker’s prediction of negative assortative mating on spouse’s wages and hours worked on the other hand, has received little empirical support (Lam 1988, Nakostein and Zimmer 2001, Zhang and Lui 2003). While the patterns of marital sorting have been studied by many, this paper makes several contributions to extend scholarship on the topic. First, although Becker predicts positive and negative assortative mating for a variety of personal characteristics, he does not specify a particular model to test his predictions. Hence a significant contribution of this paper is that it develops an estimation methodology to study how equilibrium sorting takes place in the marriage market based on Becker’s pioneering work on the economics of marriage.

Second**,** individual endowments play a prominent role in economic models that describe the sorting of individuals in the marriage market. However, almost all studies, theoretical or empirical, on the subject analyze matching in one trait only (Boulier and Rosenzweig 1984; Behrman, Rosenzweig and Taubman 1994; Burdett and Coles 1997). Moreover, most of these studies have been descriptive and have not served to separate the co-varying factors in mate selection. It is not clear how the presence of other traits affects sorting of a particular trait or any two traits. For instance, controlling for other traits what is the tradeoff between dowry and bride’s education? Both males and females offer a number of desired characteristics on the marriage market; such as simplification would therefore, not be practical. This paper improves upon the existing literature by considering multivariate dimensions of selecting a mate. A potential mate's "attractiveness" is not captured by a single trait but rather as a vector of traits. Consequently, the multivariate technique is employed to not only assess patterns of assortative mating with respect to any particular trait, but also to isolate characteristics that are important and valued in selecting mates in India.

Jepsen and Jepsen’s (2002) analysis of matching behaviors of four types of couples: same-sex male couples, same-sex female couples, opposite-sex unmarried couples and married couples is one exception to the research outlined above. Using the 1990 US census data they employ a conditional logit model to test Becker’s predictions of positive and negative assortative mating for a variety of economic traits and find evidence of positive assortative mating on labor market as well as non-labor market traits across all types of couples. Suen and Lui’s (1999) multivariate analysis on matching of recently married couples from the 1976 Hong Kong census is another exception. They find strong evidence that male and female attributes of age, schooling, place of birth, and wage are complementary in the production of marital output, suggesting positive assortative mating on these traits. Third, despite the repeated usage of Becker’s theory of marriage, strong tests of his predictions have not been made. As Suen and Lui (1999) point out, the literature on marriage and matching has completely ignored Becker’s hypothesis that marriage markets maximize aggregate marital output, i.e., marriage markets are efficient. To correct for this oversight, Suen and Lui utilize Becker’s framework of optimal sorting to develop and estimate a model of spouse selection in which some of the parameters of the production function for marital output are recovered. Using the estimated parameters, they find the optimal male-female pairing that maximizes the sum of marital output. They then use the distance between the actual pairing of husbands and wives in their sample and the optimal pairing to provide the first goodness-of-fit test of Becker’s efficient marriage market hypothesis. Like Suen and Lui (1999), this paper also estimates a household production function to examine if the observed patterns of matching are efficient in India. However, it uses a different set of individual traits (inputs) and a different functional form for the household production function compared to Suen and Lui. More specifically, while this paper develops desirability indices for each individual and builds match matrices based on them, Suen and Lui use the efficiency conditions from the linear programming assignment problem to develop their estimating equation.

Fourth, studies on marriages in India have often concluded that hypergamy, the dominant urge to contract a desirable marriage, one in which the status of bride's and groom's families are comparable and one in which the groom's income, education and occupation is higher than that of the bride, is widespread and socially more acceptable compared to hypogamy, in which a man marries up (Billig 1991, Caldwell, Reddy and Caldwell 1983, Edlund 1999). Consequently, it is argued that in a large majority of marriages, the bride's household pay's a dowry to the groom's household as a means of cementing a good alliance and to compensate for bride-groom quality differences within a hypergamous and arranged marriage system. While, the nearly universal hypergamy norm suggests that men ranked low and women ranked high in terms of their individual and family traits should be unable to find marriage partners, Rao (1993) reports that 99% of the women and men are married in India by the ages of 20 and 25 respectively. To address this contradiction, this paper constructs a "marriage index" for each male and female in the marriage market on the basis of his or her observed characteristics. The marriage index, which is a measure of an individual's desirability as a mate, is then utilized to form a match matrix to examine the extent of hypergamous and hypogamous marriages in India on a multivariate dimension.

Finally, women have traditionally brought wealth to their marriages in the form of a dowry in India. Whatever other functions the dowry serves, it could enhance the marriageability of a female in the marriage market as well as serve as a reasonable proxy for her unobserved traits in the matching process. Thus, to examine the role of dowry in sorting individuals, this paper extends the matching model it employs by including the size of monetary transfers in calculating the marriageability index of a female in the marriage market.

Results support Becker's predictions of positive assortative mating with respect to age, education, height and parental wealth suggesting that these traits are complements in the household production function. Results also reveal that while the outcome of the process of mate selection is driven by the education of the groom followed by his age, it is the age of the bride followed by her height that has the largest affect on matching behavior in India. Furthermore, the equilibrium sorting indicates that low type females are less likely than low type males to marry a higher type spouse. Therefore, the available evidence does not justify the assumption in the literature that women marry up more frequently than men. Most importantly, results show that dowry increases the likelihood of women marrying men of similar type and therefore improves the efficiency of marriage markets in India. This is an important result, as it lends support to the equalizing differences role of marital arrangements in India (Dalmia 2004). Moreover, it has important policy implications for the institution of dowry in India.

A HOUSEHOLD PRODUCTION FUNCTION OF THE MARRIAGE MARKET

Following Becker's model of marriage markets, let N denote the number of women in the marriage market (which also equals the number of men). Individuals are heterogeneous with respect to their observed and unobserved traits such as education, age and health. These attributes, which are inputs to the individual's production function, are collectively represented by a marriage index indicating an individual's type. It is assumed that a higher type individual is always preferred to a lower type individual. Let M_i be the index of male i, and F_j be the index of female j. The index of an individual's type is a measure of marriageability in terms of qualities that make him or her a desirable spouse. Based on the individual traits observed in the sample employed in the paper the measure of quality for men and women is given by

$$M_i = e^{\alpha_1 A_i^m + \alpha_2 E_i^m + \alpha_3 H_i^m + (1-\alpha_1-\alpha_2-\alpha_3) W_i^m} \tag{1}$$

$$F_j = e^{\beta_1 A_j^f + \beta_2 E_j^f + \beta_3 H_j^f + (1-\beta_1-\beta_2-\beta_3) W_j^f} \tag{2}$$

where superscripts m and f refer to male and female and A, E, H and W represent age, education, height and parental wealth of the individuals participating in the marriage market respectively.

Each individual tries to find a partner who maximizes his or her well being, with well being measured by the consumption of household produced commodities (Z). Examples of goods produced in the household include love, companionship, quality and quantity of children. The match quality is measured by a household production, with the couple's types as inputs to match production. To allow for increasing returns to scale as well as complementarity between the partners type, the match production is assumed to be the product of partner's type:

$$Z_{ij} = M_i F_j + \varepsilon_{ij} \tag{3}$$

Single observed characteristics such as height, age and education do not offer a perfect measure on marriageability of an individual in the marriage market. Clearly, other characteristics of marriage partners such as beauty, personality, intelligence etc. are important to the choice of a mate. Men and women consider potential mates on many different traits simultaneously and give varying weights to each in considering a potential spouse. However, not all the characteristics of participants in the marriage market may be observable by the researcher; hence the measurement error, ε_{ij}. Using equations (1) and (2), the match quality can then be written as

$$Z_{ij} = e^{\alpha_1 A_i^m + \alpha_2 E_i^m + \alpha_3 H_i^m + (1-\alpha_1-\alpha_2-\alpha_3) W_i^m + \beta_1 A_j^f + \beta_2 E_j^f + \beta_3 H_j^f + (1-\beta_1-\beta_2-\beta_3) W_j^f} + \varepsilon_{ij} \tag{4}$$

Individuals with equivalent resources need not be similar with respect to all characteristics relevant to marriage choice. Their overall equivalence could result from a balance of pluses and minuses in different areas. Such exchanges between characteristics are to be expected because males and females have traditionally filled different roles and thus are likely to focus on different attributes. For instance, when a woman marries a man with more education, her personal trait, such as dowry, that increases her "attractiveness" or marriageability may be accentuated in the marriage market. The presence of such resources is likely to reduce the measurement error on the match quality. Thus, to test this hypothesis and examine the role of dowries in match formation in India the marriageability index of a female is also calculated with dowry (D):

$$F_j = e^{\beta_1 A_j^f + \beta_2 E_j^f + \beta_3 H_j^f + \beta_4 W_j^f + (1-\beta_1-\beta_2-\beta_3-\beta_4) D_j^f} \tag{5}$$

The household commodity output produced by all possible monogamous matches can be represented by the following payoff matrix:

$$\begin{array}{c|ccccc}
 & F_1 & F_2 & \cdot & \cdot & F_N \\
\hline
M_1 & Z_{11} & Z_{12} & \cdot & \cdot & Z_{1N} \\
M_2 & Z_{21} & Z_{22} & \cdot & \cdot & Z_{2N} \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
M_N & Z_{N1} & Z_{N2} & \cdot & \cdot & Z_{NN}
\end{array}$$

where $M_1, M_2, ..., M_N$ and $F_1, F_2, ..., F_N$ refer to males and females of different qualities. With the quality measures of males and females given, the optimal assignment can be derived from maximizing the marital output over all marriages:

$$Z^* = Max \sum_{i,j} \delta_{ij} Z_{ij} \tag{6}$$

where δ_{ij} is the permutation matrix representing the number of matches of each type. If males and females are ranked in the same order, the higher their type the better, that is $M_1 < M_2 < .... < M_N$ and $F_1 < F_2 < .... < F_N$, the only optimal solution to the maximization problem is to match males and females along the main "core" diagonal. In other words, δ_{ij}, must be a diagonal matrix.

In the multivariate case, the parameters of the model α_i and β_j are of interest as they not only reveal which traits have the largest effect on match formation but also indicate whether there is positive or negative assortative mating with respect to the characteristics used in measuring each individual's attractiveness in the marriage market. In particular, if $\alpha_i \beta_j > 0$, positive assortative mating is optimal and the trait is categorized as a complement and if $\alpha_i \beta_j < 0$, negative assortative mating is optimal and the trait is categorized as a substitute. For instance, if potential spouses differ in their education, positive assortative mating will characterize optimal sorting of partners if:

$$\frac{\partial Z_{ij}(A_i^m, E_i^m, H_i^m, W_i^m, A_j^f, E_j^f, H_j^f, W_j^f)}{\partial E_i^m \partial E_i^f} = \alpha_2 \beta_2 Z_{ij} > 0 \tag{7}$$

EMPIRICAL PROCEDURE

To find the optimal pairing of men and women as defined by equation (6), the method of maximum likelihood is utilized to estimate the household production function. To do so, index values of each type of male and female are first determined by using initial guess values for the parameters. Values of the $\hat{M}$'s and the $\hat{F}$'s are then sorted in ascending order and for computational ease divided into five equal segments to create five different types of each individual in the marriage market; that is $N = 5$ .Next, matches between men and women of different types are noted and used to create a 5 x 5 match matrix. All individuals of a certain type are assigned the same value, which is equal to the mean of the index for his/her type. An indicator variable, representing the marriage type, is defined as $Y = 1$ if the match occurs along the main diagonal of the match matrix and $Y = 0$ if the match is off the main diagonal. The indicator variables are then used to estimate the following model:

$$\begin{aligned} &Y = 1 \text{ if } Z_{ii} \geq Z_{ij} \Rightarrow \varepsilon_{ij} \leq M_i F_i - M_i F_j = F(W) \\ &Y = 0 \text{ if } Z_{ii} < Z_{ij} \Rightarrow \varepsilon_{ij} > M_i F_i - M_i F_j = 1 - F(W) \end{aligned} \tag{8}$$

where $W = M_i F_i - M_i F_j$

The model is made operational by a particular choice of distribution for the disturbance. The disturbances are assumed to be independently and identically exponentially distributed. The log likelihood function is then given by

$$\ln L = \sum_{Y=0} \ln[e^{-\lambda W}] + \sum_{Y=1} \ln[1 - e^{-\lambda W}] \qquad (9)$$

where $\gamma^2 = \dfrac{1}{\lambda^2}$, variance of the exponential distribution, measures the dispersion in match production from the main diagonal.

Theory does not suggest preferred functional forms for the household production function and an individual's desirability index. To test the robustness of the model, therefore, alternative functional forms were employed. The log likelihood function was estimated, for example, using linear desirability indices for males and females and/or production functions similar to those chosen by Suen and Lui (1999) who are the only other researchers that model the household production function directly. While these alternative forms permit to test for positive and negative assortative matching, they do not allow identification of the production function parameters. Nonetheless, consistent results were found with all functional forms regarding positive and negative assortative matching on individual characteristics, suggesting conclusions of this paper are not dependent on the choice of functional forms for the individual indices or the production function.

HOW EFFICIENT ARE THE MARRIAGE MARKETS IN INDIA?

Following Suen and Lui the degree of efficiency of marriage markets in India can be measured using the ratio:

$$\text{Marriage market efficiency ratio}\,(ER) = \frac{Z^0}{Z^*} \qquad (10)$$

where $Z^0 = \sum \hat{\delta}_{ij} \hat{Z}_{ij}$ is the estimated total marital output and Z^* (see equation 6) is the maximal marital output obtained from the optimal assignment that matches men and women along the main core diagonal of the match matrix. Recall that according to Becker, if marriage markets are efficient and if males and females are ranked in the same order all matches will fall on the main diagonal. Assuming that the estimated coefficients of the matching model are the true production function parameters, Z^* can be easily computed. The distance between the estimated marital output and the optimal marital output can then be used to test Becker's efficient marriage market hypothesis. For instance, if the marriage market maximizes marital output, the efficiency ratio will be one. On the other hand, if the marriage market minimizes marital output, the efficiency ratio will be zero.

DESCRIPTION OF THE DATA

To empirically estimate the model of spouse selection outlined above, data from a survey of households in India for a study titled "Poverty, Gender Inequality and Reproductive Choice" is used. The fieldwork for this study was carried out by the National Council of Applied Economic Research (NCAER), New Delhi, between July 1995 and September 1995. A total of 1078 households spread over 5 districts in Uttar Pradesh (north India) and 800 households in 5 districts of Karnataka (south India) were surveyed on various aspects of household behavior, social and economic status, and issues related to marriage and old-age support. The focus of the survey, however, was on women in the reproductive age group of 15-49 years and men with wives in the same age group. The districts were chosen to represent cultural and geographic variations within each state. Seven villages from each district were randomly chosen and 20 households then randomly selected from each village. After eliminating the households with missing data 1037 observations were left spread more or less evenly across the five districts of Uttar Pradesh and Karnataka.

The term dowry has been employed in a number of ways in the literature. It is defined here to mean the net exchange of all cash and in-kind gifts made from the bride household to the groom household at the time of marriage and the expenses incurred in marriage ceremonies by the bride household net of those incurred by the groom household. Additionally monetary transfers were made at vastly different points in time, with the earliest marriage dating to 1956 and the most recent to 1994. To deal with this problem, all net dowry values were converted to constant 1994 prices.

Data on pre-marital income of the bride and groom households is not available. However, it is likely to be highly correlated with parental household wealth at the time of marriage. It is important that this wealth variable reflect the wealth position of the groom and bride's household at the time of or just before the marriage. The 1995 retrospective survey obtained information on the parental household wealth of both marriage partners, in terms of land owned, before their marriage. The use of this wealth variable ensures that the bride household's wealth is exogenous to the selection of grooms and decisions regarding the size of dowry (Rao 1993).

Descriptive statistics of the variables employed in the analysis are presented in Table 1. Numbers in the bottom row and last column refer to the means and standard deviations of the bride and groom characteristics respectively. For instance, while the grooms on average were older (by six years), more educated (by approximately three years) and taller (by 11.6 cms) than their brides, the bride's father owned half an acre more than the groom's father. The correlation coefficients between bride and groom traits are listed as the main elements of the cross table. Becker characterizes all the traits considered in the empirical analysis as complements; positive correlations are observed on all of them. The correlations suggest that individuals like to pair with those who are similar to them with respect to all nonmarket traits, although this preference is stronger for age, schooling and height.

TABLE 1
DESCRIPTIVE STATISTICS

Bride/ Groom	Age	Years of Schooling	Height (cms)	Father's Landholdings (acres)	Net Dowry (1994 rupees)	Mean (grooms)
Age	0.723*	0.191*	0.148*	0.024	-0.088*	22.21 (5.36)
Years of Schooling	0.112*	0.498*	0.03	0.121*	0.101*	4.75 (4.76)
Height	0.073*	0.095*	0.469*	0.105*	0.068*	163.69 (6.57)
Father's Landholdings	0.081*	0.144*	0.087*	0.103*	0.175*	3.10 (6.51)
Net Dowry	-0.128*	0.04	0.035	0.066*	1	144492.7 (166772.1)
Mean (brides)	16.22 (3.73)	2.06 (3.55)	152.1 (7.71)	3.64 (9.38)	144492.7 (166772.1)	

RESULTS

Parameter estimates of the household production function are reported in column 1 of Table 2. Results support Becker's prediction of positive assortative mating on nonmarket traits as coefficients of all observed spouse traits are positive. In other words, results suggest that spouse age, education, height and parental wealth are complements in the household production function. Of the four characteristics, education of the groom followed by his age and height have the largest effect on matching behavior, while it is the age of the bride followed by her height and parental wealth that affects mate selection and the organization of marriage markets in India.

TABLE 2
MAXIMUM LIKELIHOOD ESTIMATES OF THE HOUSEHOLD PRODUCTION FUNCTION

	Estimates	
Parameters	Column 1	Column 2
Groom's Age	0.353	0.249
Groom's Education	0.387	0.327
Groom's Height	0.211	0.289
Groom's Father's Landholdings	0.049	0.135
Bride's Age	0.483	0.468
Bride's Education	0.060	0.066
Bride's Height	0.318	0.220
Bride's Father's Landholdings	0.139	0.098
Dowry		0.148
Variance	13.31	7.09
Log Likelihood	-718.3	-720.5

Such trade-offs between characteristics are expected, because husbands and wives have traditionally had different roles and each has emphasized different qualities in a marriage partner. Marriage has often been seen as the exchange of a man's income earning potential, proxied in the matching process by his education and age, for a woman's ability to bear children and manage a household, indicated by her age, which is a rough proxy for her beauty and reproductive potential (Bergstrom and Bagnoli 1993). It follows that the outcome of the process of mate selection is almost entirely driven by the economic assets of the male, his education, and the noneconomic assets of the female, her age.

Table 3, Panel A, presents the estimated match matrix. The matches reveal the expected, though not strong, diagonal pattern indicating that 37 percent of the marriages in India occur between similar types of males and females. On an absolute basis, however, the phenomenon of assortative mating is strongest at the extremes, suggesting a larger magnitude of marriages between young, illiterate, shorter and poorer males and females on one hand and older, more educated, taller and richer males and females on the other. When there is a departure from this "core diagonal" area, the magnitudes of equilibrium sorting reveal that males are more likely than females to marry a higher type spouse. In the 63 percent heterogamous marriages, 30.34 percent are hypergamous (i.e., women marrying up), while 32.66 percent are hypogamous (i.e., men marrying up).

Studies of mate selection provide extensive evidence supporting the generalization that hypergamy is almost universally more acceptable and more common than hypogamy (Edlund 1999). Since the male determines social rank of his family, it is suggested that he can afford to marry down without loss of status. The wealthy female on the other hand is not in a position to make such a trade (Bhat and Hali

1999). However, no justification for the assumption that women "marry up" more frequently than men is found. Differing measures of hypergamy and hypogamy have been employed in research, and these differences are likely to produce variations in the relative distribution of these two forms of marriage. For instance, some studies have compared the occupational status of the father's of the bride and the groom, while others have compared education of the spouses. Moreover, all studies have measured hypergamy on a single trait only and have failed to account for the fact that men and women bring multiple traits to a marriage, as a result it is not possible for women to always marry up on all measured dimensions. Therefore, it is not surprising that empirical studies have failed to find a consistent pattern of women marrying men of higher socioeconomic status.

TABLE 3
MATCH MATRICES

Panel A: Without Dowry (37% on Diagonal; 30.34% Hypergamy; 32.66% Hypogamy)						
	F_1	F_2	F_3	F_4	F_5	Total
M_1	115	53	26	10	3	207
M_2	42	61	44	46	14	207
M_3	23	50	52	49	33	207
M_4	17	28	44	58	60	207
M_5	10	15	41	44	97	207
Total	207	207	207	207	207	1035
Panel B: With Dowry (40.09% on Diagonal; 27.63% Hypergamy; 32.27% Hypogamy)						
	F_1	F_2	F_3	F_4	F_5	Total
M_1	123	56	19	4	5	207
M_2	33	63	61	37	13	207
M_3	30	42	59	54	22	207
M_4	11	36	31	66	63	207
M_5	10	10	37	46	104	207
Total	207	207	207	207	207	1035

Women have traditionally brought wealth to their marriages in the form of a dowry in India (Goody 1973). Whatever other functions the dowry serves, it could enhance the marriageability of a female in the marriage market. The estimates presented in column 2 of Table 2 include dowry along with age, education, height and parental wealth of a female in the construction of her marriageability index. The results suggest that positive assortative mating on all measured dimensions is the norm. Moreover, the results again imply that marriage markets in India operate to a large extent through the exchange of female' age, characteristic signaling her beauty and thus her ability to bear children, for male's economic traits, which are based largely on his education and thus income earning potential.

Table 3, Panel B presents the match matrix with dowry. The equilibrium sorting shows an increase in the number of matches along the diagonal from 37 percent in Panel A to 40 percent in Panel B. This variation in the degree of assortative mating is expected, because as more characteristics of those marrying are considered, the shocks to match production should decrease and hence the matches should become more and more symmetrical. This is also reflected in the degree of dispersion in the match production; a greater dispersion means more match heterogeneity. Results in Table 2 reveal that the shocks to match production decrease as dowry is introduced in the model.

The increase in the number of matches along the core diagonal with the introduction of dowry is a significant outcome. It lends support to the argument that dowries compensate for bride-groom quality differences. Prior research on dowries in India (Dalmia 2004) suggests that marriage transactions "equalize" the imbalances in the value of marriage between the households of the bride and groom. After controlling for the tendency of males (females) to marry females (males) of a similar type, the match matrix shows that hypergamy (27.63 percent) is less likely than hypogamy (32.27 percent). That is, females tend to marry males of a higher type less often than males tend to marry females of a higher type. Thus once again, no clear pattern of females marrying up more than males in India is found as generalized in the literature.

Finally, to evaluate how closely the actual solution to the assignment problem (Table 3) approximates the efficient solution (diagonal match matrix), the efficiency measure, ER, was computed (see equation 10). Using the spouse selection model based on the variables age, education, height and parental wealth the marriage market efficiency ratio was found to be 0.86 revealing that, compared to a full information and perfectly competitive market, the inefficiency loss in the Indian marriage market is 14 percent. After considering dowry in the calculation of a female's marriageability index, the inefficiency ratio drops to 11 percent suggesting that dowry increases the efficiency of marriage markets in India.

A possible explanation for the efficiency of marriage markets in India is the regulatory system of its society that enforces a variety of norms and sometimes-specific rules about who may marry whom. For example, marriages are arranged by the parents of the prospective bride and groom within endogamous groups. That is, men and women are only permitted to marry within a well-defined set of families who make up their subcaste, religion and often belong to the same geographic region. These social constraints make people more selective and enable them to choose partners similar to them in terms of their overall socioeconomic status.

However, couples with equivalent index values need not be similar with respect to all characteristics relevant to spouse selection. Their overall similarity may result from a balance of pluses and minuses in different traits. Therefore, when a woman marries a man with more education, monetary transfers from her household to the groom and his household may increase her attractiveness in the marriage market and hence accentuate her marriageability index. Thus, the prospect of such resources is likely to increase matches between men and women of similar type, when considered on multivariate dimensions, and improve the efficiency of marriage markets in India.

CONCLUSION

This paper examines how equilibrium sorting takes place in marriage markets in India. It constructs an empirical model of spouse selection based on Becker's (1973) efficient marriage market hypothesis, in which optimal assignments of marriage partners are derived from maximizing the household output function. By specifying a marital production function and introducing the influence of multiple individual characteristics simultaneously in the matching technology, this paper creates a matching algorithm and uses the estimated parameters to examine positive assortative mating with respect to nonmarket characteristics. To capture heterogeneity in personal characteristics and to measure how good a partner each individual will make, it constructs a marriage index for all males and females in the marriage market. It utilizes parametric techniques to universally rank men and women by their marital endowment and forms match matrices based on this information. Finally, to assess the efficiency of marriage markets in India the paper compares the optimal pairing of men and women predicted by the model to their actual pairing.

The maximum likelihood estimates of the structural model support Becker's predictions of positive assortative mating with respect to age, education, height and parental wealth suggesting that these traits are complements in the household production function. Results also reveal that while the outcome of the process of mate selection is driven by the education of the groom followed by his age, it is the age of the bride followed by her height that has the largest affect on matching behavior in India. Furthermore, the equilibrium sorting indicates that low type females are less likely than low type males to marry a higher type spouse. Therefore, the available evidence does not justify the assumption in the literature that women marry up more frequently than men. Most importantly, results show that dowry increases the likelihood of women marrying men of similar type and hence increase the efficiency of marriage markets in India. This is an important result, as it lends support to the equalizing differences role of marital arrangements in India (Dalmia 2004). Moreover, it has important policy implications for the institution of dowry in India.

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