The Hidden Cost of Migration: Effect of Brother's Migration on Sister's Marriage Outcomes in Rural Bangladesh*

Ali Protik
Department of Economics
Brown University

Randall Kuhn
Graduate School of International Studies
University of Denver

November, 2006

Abstract

This paper examines the effect of brother's migration on the marriage patterns of sisters in a rural area of Bangladesh. It has been proposed that when sons are migrants, especially when accompanied by their spouses, parents become more willing to marry their daughters nearby to secure care support for their old-age. Such willingness arises because of a missing market for care. We use a rich dataset from the Demographic Surveillance System in Matlab, Bangladesh, which contains 20 years of marriage and migration records from 1974 to 1996, supplemented by a 1974 baseline census. We compare women who face similar marriage prospects but differ by their brother's migration status. Consistent with the theoretical predictions of a general equilibrium model, we find strong evidence that women with migrant brothers are more likely to marry someone from the same village and are also more likely to marry someone with lower human capital. While marrying someone from the same village is a rational response for providing increased care support to parents, marrying someone with lower human capital ensures that a woman with migrant brothers marries a man who is less likely to migrate himself. Our findings suggest that migration can have important distributional consequences in a society with a growing share of elderly population and a missing formal market for care. Introduction of formal markets for care and/or generation of productive off-farm employment opportunities are thus important for mitigating adverse impacts on both the elderly and the young generations.

JEL Classification: J12, J14, O12, O15

---

*Corresponding author: Ali E. Protik, Department of Economics, Brown University, Providence, RI 02906; E-mail: ali_protik@brown.edu. We are extremely grateful to Andrew Foster for his guidance and support throughout the whole course of this paper. This paper has also benefitted from helpful discussions with Quamrul Ashraf, Afra Chowdhury, Oded Galor, Alaka Holla, Isaac Mbiti, Kaivan Munshi, Mark Pitt, Yona Rubinstein and David Weil. We thank participants of Brown applied micro lunch seminar for their comments and suggestions. We are, however, responsible for all remaining errors.

1 INTRODUCTION

High rates of rural to urban migration have contributed to changing old-age living arrangements in recent years. With rapid demographic transition and a growing share of the elderly in the population, this has raised concerns over old-age support for the elderly. Although new economic models of migration postulate migration as a household strategy, in which risk-averse households diversify their income risks (Stark and Bloom 1985, Stark 1991), and some recent researches have shown that changing living arrangements need not diminish provision of care for the elderly,[1] some concerns persist. An increasing trend of migration of adult sons accompanied by their spouses may limit the abilities of adult sons to provide personal care to their parents. Moreover, limited public and/or private markets for care may limit the substitutability of financial support for personal care. These are issues that may not only result in an adverse effect on elderly well-being but can also alter household decisions in ways detrimental to adult children.

There is some evidence of negative impacts of migration and the missing market for elderly care on the young generation. In a recent paper, Giles and Mu (2005) found that in rural China, younger adults are less likely to migrate to the cities when a parent is ill, constraining adult children's labor supply decisions. In the rural Bangladeshi context, Kuhn (2003) and Kuhn and Protik (2006) suggest that parents may try to arrange for their daughters to marry in closer proximity, i.e. someone inside the village, if married sons and daughters-in-law are not available to provide personal care. Although daughters typically leave their natal residence after marriage to live with their husbands and provide care to the parents-in-law if they co-reside, it is not unlikely that they pay visits to their natal residence if extensive health care is needed. Such arrangements, however, may have profound effects on the marriage outcomes of daughters, the quality of grooms they marry and the amount of dowries paid, for example.

[1] For example, Asis, Domingo, Knodel, and Mehta (1995), Knodel, Chayovan, and Siriboon (1992), Mason (1992) and Zimmer and Kwong (2003) find that living arrangements tend to alter in ways necessary in the face of demographic transition and that a breakdown of the family-based elderly support system is unlikely. Frankenberg, Lilliard, and Willis (2002), Frankenberg and Kuhn (2003), Lee, Parish, and Willis (1994) and Lilliard and Willis (1994) find that adult migrant children in countries experiencing rapid urbanization may replace personal care with financial support as a compensation for their prolonged absence.

In this paper, we examine the impacts of male migration on the marriage outcomes of women with migrant brothers in Matlab, a rural area in Bangladesh. Matlab is an ideal setting for our analysis as it has been experiencing high rates of out-migration since the early 1980s. This migration has been fueled by rapid urban employment generation and has been facilitated by Matlab's close proximity to Dhaka city, the capital. Matlab has also experienced a dramatic decline in fertility and now faces the prospect of an aging population.

In particular, we use a general equilibrium model of the marriage market to show that a greater willingness on the part of a woman to stay in close proximity to her natal residence would increase surplus in the marriage market, *ceteris paribus*, if she marries the lower quality groom. Our results are driven by the fact that, while deciding on their daughters' marriage location, households with migrant sons must recognize that potential grooms are also likely to migrate. This is more so for high human capital men than for the low human capital ones, which we will show later. Hence, marrying a daughter to a closer location within or around the village does not necessarily mean that she would be around in future. The implication is that, although an attractive candidate, a high human capital man is also more likely to migrate.

We use the model to motivate and structure the empirical analysis. We use 20 years of marriage and migration data between 1974 and 1996 from the Matlab Health and Demographic Surveillance System (HDSS), which has been recording vital demographic events of individuals residing in the surveillance area since the late 1960s. These records are supplemented by a 1974 baseline census of the population residing in Matlab in 1974. This rich data-set allows us to follow each unmarried woman who lived in the surveillance area in 1974 and married in the next 20 years. We match women who resided in the same village and married in the same year on observable characteristics under the assumption that women from the same village marrying in the same year face the same marriage prospects. We then use a fixed-effect logistic regression to estimate the effect of migrant brothers on the marriage outcomes of these women. Given the structure of the matching process, our regressions are also robust to village, year and village-year fixed-effects. We find broad support for our theoretical predictions that women with migrant brothers are

more likely to marry someone inside the village and that they are more likely to marry a lower human capital groom.

The findings in this paper have important implications for welfare. Studies on migration in general and on the effect of urban-to-rural remittances on the sending community in particular, find positive effects on the sending community on various grounds.[2] Given that risk-averse households in rural communities diversify income risks by strategically placing well-suited members in the urban sector, it should not come as a surprise that rural-to-urban migration results in a positive outcome for these households. Yet, we find that migration can have important distributional consequences in a society with a growing share of elderly population and missing formal markets for care. The main contribution of this paper is to incorporate the demand for old-age personal care into the decision making processes of migrant households. While existing theories based on the intention for inter-temporal smoothing of consumption (of a numeraire good) can explain why people migrate in the first place, failure to take personal care into account, in societies where remittances cannot be readily substituted to care, may lead us to overestimate the benefits of migration.

In addition, we find that the cost of migration is disproportionately borne by women with migrant brothers as they are matched with lower human capital men in equilibrium. The resulting implication could be profound as various child outcomes (e.g. child human capital, child health) are positive functions of parental human capitals (Strauss and Thomas 1995). Consequently, our results indicate the importance of introducing markets for elderly care in rural communities. Such public policies will not only benefit the elderly but will also mitigate adverse effects on women and possibly the subsequent generation.[3] In areas of high out-migration, non-farm productive employment creation in rural areas can be effective complements to introducing markets for care.

The rest of the paper is organized in the following way. Section 2 gives a short background on the Bangladesh contexts. Section 3 outlines the theory and spells out the main predictions of the paper. We explain the empirical strategy and identification in section 4.

[2] See Taylor (1999) for an excellent summary.

[3] As we mentioned earlier, Giles and Mu (2005) has independently reached a similar conclusion in terms of policy, although in a different cultural context and for a different outcome.

Sources of data are revealed in section 5 along with some descriptive statistics. Empirical findings are discussed in section 6, while section 7 concludes.

2 BACKGROUND

The goal of this section is to describe the events that led to population aging and potential loss of personal care for parents in Matlab, Bangladesh. We will also discuss the traditional role of daughters in providing care to old-age parents and plausible changes in response to recent circumstances that provide the motivation for our study.

The Matlab study area consists of 149 spatially contiguous villages in the Matlab subdistrict of Bangladesh. It is located in the flood plains of the Meghna river system about 40 miles southeast of Dhaka city, the capital. Travel time from Matlab to Dhaka using conventional bus and boat transport is about six hours. Matlab is a desirable setting for this research because it is characterized by population aging, high out-migration of young adult men, and a missing market for elderly care. It also happens to be the site of a longstanding Demographic Surveillance System (henceforth DSS) providing us with 20 years of marriage and migration records suited particularly for our study.

Matlab has experienced a remarkable decline in fertility in the last three decades like the rest of Bangladesh and many other developing countries. Total fertility rate (TFR) has declined from as high as 6.2 children per women in 1976 to 3 per women in 2004. The corresponding number for the country as a whole is similar, 6.3 in 1975 and 3 in 2004. Declining fertility coupled with improved life expectancy contributes to rapid population aging. The percentage of population who were 60 years and above in Matlab rose from 5.6 in 1974 to 7.8 in 2000. For 65 years and above, the percentage rose from 3.6 to 5. These numbers are much higher than the Bangladeshi average of 4.9% and 3.1% for 60^+ and 65^+ years respectively, because of better life expectancy of elders and an earlier onset of fertility decline in Matlab. However, the numbers are comparable to 8.8% and 5.9% for Asia as a whole in 2000 (United Nations 2002).

While fertility and mortality decline create greater proportions of elder dependents within households, migration of young adults driven by rapid urbanization is contributing to changing living arrangements. Urbanization in Bangladesh is quite striking – the

percentage of the urban population has increased from a mere 9.9 in 1975 to 25.1 in 2005 and is projected to be almost 30% by 2015. Any of these changes are and will continue to be fueled by migration of dependents of current migrants leading to declining co-residence between the elderly living in rural areas and their adult sons and daughters-in-law (Kuhn 2003). There remains a strong norm of financial support and personal care in Bangladesh, based largely on historic patrilineal preferences. Sons are the preferred source of financial support, daughters-in-law are the preferred source of personal care. Daughters are the less preferred source in both (Kuhn 2003). Family migration on the part of an adult married son may not be associated with a loss of financial support as migrants continue to send remittances, but is clearly associated with a loss of the preferred source of personal care.

Despite these recent changes in living arrangements, studies have found almost no evidence in favor of a breakdown of the family-based old-age support system (Amin 1998, Kabir, Szebehely, and Tishelman 2002). It is, however, not surprising since a formal market for care is completely absent in the rural areas of Bangladesh. In such a situation, adult sons often leave their spouses and children back in the rural areas when they migrate. Less well known is the fact that daughters are also pivotal in providing care to parents in spite of the norm of patrilocal exogamy and the traditional expectation that they will primarily care for their in-laws after marriage. To be specific, while sons are still the primary source of financial care, daughters play an important role in providing personal care and emotional support to the parents (Rahman, Menken, and Kuhn 2004, Kabir, Szebehely, and Tishelman 2002). In this event, it seems reasonable to think that daughters who live closer to their natal residences will be more able to visit their parents if necessary.

The abovementioned facts provide significant motivation for this paper – parents may try to marry their daughters in closer proximity to secure personal care for old-age when sons are migrants, especially when both sons and daughters-in-law are migants. We set aside the question of whether daughters want to be married nearby or not because arranged marriage is the norm and daughters have little say in the matter of choice re-

garding potential grooms.[4] Moreover, with sufficient altruism on the part of parents preferences of the bride's household and that of the bride's in the process of choosing a partner in the marriage market will most likely be identical.

3 THEORETICAL FRAMEWORK

3.1 Theoretical Considerations

To investigate who marries whom in equilibrium when proximity of the potential groom is a concern, both marriage location and match quality must enter the preference function. One way to address the issue is to view the problem as one for the bride's household.[5] Let the utility of the bride be an increasing function of the potential groom's quality and a decreasing function of distance. Then an increased willingness on the part of a woman to marry geographically close when her brother is a migrant will lead her to search within a smaller radius. This may lead to an increased probability for her to marry a lower quality groom.

There are two problems with this partial equilibrium approach. First, we will need to make certain distributional assumption regarding groom quality for the above result to be true. Such assumptions are difficult to test empirically. Moreover, marrying close in the rural area in reality may not guarantee living close to the natal household for the bride in a high out-migration area, since potential grooms may also migrate in the future. Hence, it is probably more logical to not only marry someone who lives close but also someone who is less likely to migrate, namely a lower human capital man. As shown below, migration probability increases with the level of human capital. Thus, the above partial equilibrium model will be conceptually wrong. The second problem with the above model is one of estimation. The model as such will not lend itself to a clean estimation strategy since location and groom quality are simultaneously determined and there is no obvious instrument available in this case.

[4] The 2007 World Development Report of the World Bank reports that only 3% of the interviewed Bangladeshi women between age 15-24 think that they have the most influence in their marriage decisions. The corresponding numbers for Ethiopia is 55%, for Iraq is 65% and for Malaysia is as high as 82%.

[5] This will be equivalent to the bride's choice problem given our discussion in the previous section. We will therefore use bride's preference and bride's household's preference interchangeably.

We take a different route in this paper. We use a general equilibrium model of marriage to determine the optimal assignment in the marriage market and examine the possible effects of an increased willingness on the part of some brides to marry close, on their marital outcomes. Our model will lend itself to a reasonable estimation strategy with a minimal set of (plausible) assumptions.

Becker's (1973, 1974) seminal work on marriage provides the basis for analyzing general equilibrium outcomes of the marriage market assuming optimal allocation to be efficient. Gains from marriage in the Becker model result from specialization in producing a composite private good by each household using market goods and time of household members as inputs. The assumption of a composite private good guarantees transferable utility among the spouses (Lam 1988), an important ingredient for characterizing marriage market equilibria.[6] Given the *household production functions* and transferable utility, any pair in the marriage market faces a utility possibility frontier if they were to marry each other and the efficient and stable assignment of marriage partners in a competitive marriage market is the one that maximizes aggregate output over all marriages (Becker 1991).

Lam (1988) extends Becker's model to include gains from joint consumption within marriages through *household public goods*. One problem that arises in such a model is that without transferable utility it may not be possible to assign payoffs to each partners in a marriage independent of the distribution of utility within the marriage (Lam 1988). In such a case, characterization of the efficient marriage market assignment as in Becker (1991) is difficult. However, there is a class of utility functions proposed by Bergstrom and Cornes (1981, 1983) which is both necessary and sufficient for transferable utility in the presence of one private good and n public goods.[7] The Bergstrom-Cornes class of utility functions has been successfully used by Lam (1988) to show assortative mating, by Bergstrom and Lam (1994) to show the effect of cohort size on marriage markets in

[6] For an analysis of the marriage market with non-transferable utility see Gale and Shapley (1962).

[7] The class of utility function in question is of the form: $f(x_i, y) = g(y)x_i + h_i(y)$, where y is the level of public good consumed jointly and x_i is the level of private good consumed by person i. One special case is when utility is quasilinear: $f(x_i, y) = x_i + g_i(y)$, which we are going to use in our model. By construction, there is no income effect when utility is quasilinear. We make this assumption for mathematical simplicity. For an excellent and detail survey of transferable utility and public goods in the context of marriage market, see Bergstrom (1997).

Sweden, and by Foster (1996) to show the effect of marriage market selection on human capital allocations in rural Bangladesh, to cite a few.

3.2 A Model with Spouse Quality and Distance

A central insight of this paper is that marital distance is a public good. The distance from a couple's residence to the wife's natal household is a matter of a joint consumption decision that a couple makes if they are to marry each other. We will also assume that the couple care about another public good, child human capital. In particular, we assume that the utility of a married person i of sex s, $s = \{m, f\}$ is linear and increasing in private consumption of good x, and quadratic and decreasing in child human capital, h, and marital distance summarized by l and d:

$$U_i^s(x_i, h, d, l) = x_i - (h - h_i^s)^2 - \theta_i^s(d^2 + (l - l_i^s)^2) \tag{1}$$

where h_i^s can be thought of as aspirations for child human capital of person i and we will additionally assume that it is an increasing function of one's own human capital; l_i^s is the location of parental residence for person i of sex s, and l is the location of the couple in the rural area after the marriage if they are not migrants. The distance from the groom's household to the destination of migration (city) is denoted by d.[8] Finally, θ^s is the weight individual i of sex s puts on distance. For the females, θ^f is the measure of willingness to marry close and will respond to brother's migration status. Our main interest is to determine how the marriage market responds to changes in θ^f on the part of some brides. For the rest of the analysis θ^m is normalized to 1 without loss of generality.[9]

[8] Note that if a couple is not a migrant then $d = 0$ and utility is only decreasing in the distance between the couple's residence and the bride's natal residence. However, when the couple is a migrant ($d > 0$), marital distance written as $d^2 + (l - l^s)^2$ technically requires that the destination of migration be perpendicular to the couple's location, l, in the rural area. Although this is a highly simplified assumption, using an appropriate trigonometric function will unnecessarily complicate the model without changing much of the basic results. Also, d is assumed to be continuous for mathematical convenience. We explain in detail how we conceptualize distance in Appendix A.

[9] One could argue against making θ^f – a preference parameter – a function of other variables. If we abstract from using a preference parameter as a function of brother's migration status and use cost of distance as an increasing function of brother's migration status in the budget constraint instead, we will get the exact same results. So, while a philosophical argument regarding which way to model is important and interesting, it can be left aside in the current context.

We assume further that the income earned by a man if he is a migrant is increasing in the distance of the destination, d, and h^m, which is an increasing function of his human capital by assumption. The wage rate is assumed to be w.[10] Thus the household budget constraint when male i marries female j is:

$$x_i^m + x_j^f + ph = y_i^m + y_j^f + wh_i^m d \tag{2}$$

where x_i^m and x_j^f are private good consumptions of male i and female j respectively, p is the price of child human capital, h, and y_i^m and y_j^f are the levels of wealth of male i and female j respectively at the time of marriage.

As discussed earlier, modeling preference as in (1) when there is a private good and two public goods ensures transferable utility. Thus couples always choose the efficient levels of public goods that yield the highest utility frontier, and then choose any point on the frontier through the distribution of the private good — utility function (1) renders these two steps to be independent (Bergstrom 1997). In other words, any distribution of private consumption corresponding to the utility possibility frontier will result in the same level of public goods. This convenient property is the trade-off for using a restrictive utility function like (1). Nevertheless, as Lam (1988) points out, it is a fairly general one that does not restrict preferences to be identical or homothetic. In fact, since taste, θ^s, varies by individual it is possible for marital distance to be a public "good" for one and a public "bad" for the other as in this case.

Given preferences and the household budget constraint, the optimal amount of public goods that will be chosen if male i marries female j is found by maximizing the sum of their respective utilities:

$$U_{ij} = x_i^m + x_j^f - (h - h_i^m)^2 - d^2 - (l - l_i^m)^2 - (h - h_j^f)^2 - \theta_j^f (d^2 + (l - l_j^f)^2) \tag{3}$$

[10] See appendix A for more on this.

subject to the household budget constraint (2). The optimal level of marital distance, d_{ij}^* and l_{ij}^* and child human capital, h_{ij}^* that will be chosen is then:

$$l_{ij}^* = \frac{\theta_j^f l_j^f + l_i^m}{\theta_j^f + 1} \tag{4}$$

$$d_{ij}^* = \frac{w h_i^m}{2(\theta_j^f + 1)} \tag{5}$$

$$h_{ij}^* = \frac{1}{2}h_j^f + \frac{1}{2}h_i^m - \frac{1}{4}p \tag{6}$$

Notice that when $\theta_j^f = 0$ the couple will end up living at the pre-marital location of the husband and his household, l_i^m, which is common in the rural areas of Bangladesh and to be expected in the baseline case. However, optimal location moves somewhere between the couple's respective premarital locations as the willingness of the women j to marry close, θ_j^f, increases.[11] The optimal distance of migration is increasing in skill prices, w, and decreasing in wife's willingness to stay close to her natal residence which is to be expected. The optimal level of child human capital is the one for which the marginal utility from child human capital equals the marginal cost.

The total indirect marital utility of couple ij, i.e. when male i marries female j, is found by substituting (4)–(6) in (3):

$$V_{ij} = v_i^m(h_i^m, l_i^m, y_i^m) - \frac{1}{4}w^2\phi_j(h_i^m)^2 + v_j^f(h_j^f, l_j^f, y_j^f) + h_i^m h_j^f + \phi_j l_i^m l_j^f + \frac{1}{8}p^2 \tag{7}$$

where $\phi_j = \frac{\theta_j^f}{\theta_j^f + 1}$ and $\phi_j > 0$ as long as $\theta_j^f > 0$. $v_i^m(h_i^m, l_i^m, y_i^m)$ and $v_j^f(h_j^f, l_j^f, y_j^f)$ are functions of male i and female j 's own characteristics.

The next step is to find the optimal assignment in the marriage market. For simplicity, let us assume that there are two males i and j and two females i and j in the marriage market and that the market is sorted in a way that male i marries female i and male j marries female j. Stability of this sorting will require two things. One is that all four of these individuals are better off married than single, which we will assume to be the

[11] Obviously, by modelling location in this way, we fail to recognize the important fact that it will generally be convenient for a couple to live right next to the husband's family or even right next to the wife's family after marriage rather than living somewhere in between. However, recognizing this fact in the model will come at the cost of convexity and continuity in location choice. Also, the model will generate approximately the right results as long as θ^f is substantially smaller than θ^m which is likely to be the case here.

case and will maintain throughout the paper. The other is that no two persons can be made better off by switching partners, which, given current assignments (where male i marries female i and male j marries female j), is achieved when total marital surplus, S, is maximized over all possible assignments (Becker 1991):

$$S = V_{ii} + V_{jj} - V_{ij} - V_{ji} \geq 0 \tag{8}$$

Given transferable utility, equation (8) is both necessary and sufficient for stability in the marriage market if it actually contains two males and two females. Substituting (7) in (8) for each of the four combinations we have,

$$\begin{aligned} S &= \frac{1}{4}w^2(\phi_j - \phi_i)((h_i^m)^2 - (h_j^m)^2) + (h_i^m - h_j^m)(h_i^f - h_j^f) \\ &\quad +(l_i^m - l_j^m)(\phi_i l_i^f - \phi_j l_j^f) \geq 0 \end{aligned} \tag{9}$$

Notice that the functions containing individual characteristics only, $v^m()$s and $v^f()$s, fall out of this equation leaving only the interaction terms. The second term in equation (9) indicates that the marriage market will be characterized by positive assortative matching on aspirations for child human capital, h^s, $s = \{m, f\}$, which is a positive function of own human capital. This result is similar to that in Foster (1996). Additionally, the third term denotes that there will be positive assortative matching on distance. The first term is the one most interesting. It indicates that there will be negative assortative matching between willingness to marry close on the part of females and aspirations for child human capital, on the part of the males. This is the main proposition of this paper which we put forward more formally below.

3.3 Effect of Willingness to Marry Close on the Quality of Groom

Equation (8) and (9) enable us to evaluate the effect of a change in the willingness on the part of some females to marry in closer proximity on changes in the marital outcomes. Such changes in willingness will stem from brother's migration in the current context. For a meaningful comparison, which will also be convenient empirically, we will assume that the two brides i and j are similar in every other respect but their willingness to marry close. Specifically, we will assume that bride i has a higher willingness to marry closer,

$\theta_i^f > \theta_j^f$, but that the two brides have the same levels of human capital, $h_i^f = h_j^f$ and that their pre-marital residence is in the same place, $l_i^f = l_j^f$. To fix ideas, let us assume for the rest of the analysis that pre-marital residence, l^s, $s = \{m, f\}$, is the village these individuals live in.

With the above assumptions, the key to finding changes in marital outcomes is condition (9), which must hold for it to be an optimal assignment. Our main finding is that an increased willingness on the part of one female to marry close will lead her to marry the lower human capital groom:

Proposition 1. *With an optimal assignment in the marriage market where male i marries female i and male j marries female j, an increased willingness to marry close on the part of female i will increase surplus in the marriage market if male i has the lower human capital.*

Proof. See Appendix B.

Intuitively, if female i wants to marry close then it makes sense for her to marry the lower human capital male who lives in the same village since he lives closer and is less likely to migrate. The lower human capital male will be indifferent between the two females since they are otherwise similar in characteristics. Thus, the assignment will be stable and surplus in the marriage market will increases. However, as we show in the proof of proposition (1) in Appendix A, whether surplus increases or not is indeterminate in the case where male i has the higher human capital and resides in the same village while male j lives far. This happens since the higher human capital male, i, is more likely to migrate even though his pre-marital residence is in closer proximity. The following results are naturally implied by proposition (1):

Corollary 1. *If the two males are homogenous in quality and both males and females live in the same village, an increased willingness to marry close on the part of female i will not change surplus in the marriage market. If, however, one of the grooms live outside the village then surplus will increase if male i is the one living inside the village.*

Corollary 2. *If willingness to marry close increases equally for both the females, i and j, then surplus in the marriage market does not change with any reassignment.*

Both of these results follow directly from proposition (1) and our discussion above. For homogenous males living in the same village as the females, both females should be indifferent between the two males irrespective of their taste for marital distance since the two males are similar with respect to distance and human capital and hence, have the same probability to migrate. Surplus in the marriage market thus will not increase as a result of an increase in willingness to marry close on the part of female i. However, if one of the males live outside the village and female i's willingness to marry close increases then surplus increases if male i is the one living in the village since female i will be strictly worse-off otherwise. The assignment will be stable since no male or female can be made better-off with a reassignment. Corollary (2) is also a direct extension to proposition (1). Because the two females are similar in every characteristic, if their willingness to marry close increases by the same amount it is not possible to increase surplus in the marriage market with a reassignment.

4 ESTIMATION STRATEGY

The model of the previous section is used to structure the empirical analysis in this section. Our main interest is to find out whether females with a higher willingness to marry closer, as a result of their brother(s) being migrant(s), are married closer and to lower human capital grooms compared to females with non-migrant brothers. The corresponding regression function for estimating the effect of brother's migration on the education of the groom is the following:

$$E_{ivt} = \beta' X_{ivt} + \gamma M_{ivt} + u_{ivt} \tag{10}$$

where E_{ivt} is the years of schooling of the groom of female i residing in village v at the time of marriage marrying in year t, X_{ivt} contains observable (to the econometrician) characteristics of the female and her household. The willingness of female i to marry closer which is denoted by ϕ_{ivt} in the model will be proxied by brother's migration status M_{ivt}. Finally, u_{ivt} is the corresponding error term. We expect γ to be negative.

There are two major problems with estimating equation (10). First, it is plausible that high aspiration for child human capital is correlated within a girl's household resulting in

higher average education for each member of the household. Men from these households would then be more likely to migrate because of their higher human capital. If women with high aspiration for child human capital match with men with high aspiration for child human capital, as our model above implies, then unobserved household aspiration, which is likely to be included in u_{ivt}, will be correlated with both M_{ivt} and E_{ivt}. This will bias γ upward. Second, since females in our sample reside in different villages and marry in different years, it is likely that they face different marriage prospects. If villages with high out-migration rates are clustered together then high human capital males, on average, are also likely to be clustered in these villages. If marriages does not occur within these cluster of villages then it should be the case that a female from one of these villages is more likely to have a migrant brother and she is also less likely to be matched with a high human capital male. This will bias γ downward.

One way to deal with the first problem is to use an instrument for M_{ivt}. Unfortunately, an appropriate instrument is not available in the current context. One strategy to get around the second problem is to randomly match females who face similar marriage prospects but differ by their brothers' migration status and estimate the effect of the difference in their brother's migration status on the differences in their husband's human capital:

$$E_{ivt} - E_{jvt} = \beta'(X_{ivt} - X_{jvt}) + \gamma(M_{ivt} - M_{jvt}) + (u_{ivt} - u_{jvt}) \tag{11}$$

Although we get rid of the unobserved marriage market effects in (11), without an appropriate instrument for M, γ will still be biased. Differences in unobserved individual or household characteristics, $u_{ivt} - u_{jvt}$, will still be correlated with $M_{ivt} - M_{jvt}$ and $E_{ivt} - E_{jvt}$.

To get around both the problems stated above we use a technique in this paper which is similar to a dyadic regression.[12] In a dyadic regression, each observation corresponds to a pair of individuals instead of corresponding to only one individual. A regression of this form is a natural choice in this case given the structure of the problems discussed above and as it will closely follow our theoretical model. We elaborate on this below.

[12] For detailed discussions on dyadic regressions see Fafchamps and Gubert (2006) and Archand and Fafchamps (2006) where dyadic regressions are used to study risk sharing network formations in the rural Philippines and determinants of memberships in rural producer organizations in West Africa respectively.

4.1 Matching and Identification

We start by matching females who face similar marriage prospects. Females residing in the same village and marrying in the same year face similar marriage prospects given their characteristics. Our goal is to compare females who face similar marriage prospects given their (observable) characteristics but differ by the migration status of their brothers. Within each village-year we create two groups of females. Group one consists of females who have no brothers or have one brother but the brother is a migrant. Group two consists of all the other females. Each group one female is then randomly matched with a group two female.[13] The number of females in group one in the data is always lower than the number of females in group two. We replicate females in group one randomly to match the number of group two females within each village-year cluster. This certainly raises concerns about standard errors, which we address below. For each pair of matched females, female i and female j and their respective grooms, male i and male j, we proceed as follows.

Let $y_{ii,jj} = 1$ when male i marries female i and male j marries female j and zero otherwise, i.e. when male i marries female j and male j marries female i. Let us assume that aspirations for child human capital of the two partners are linear functions of observable individual characteristics, $h_i^s = \alpha' X_i^s$, where $s = \{m, f\}$ and X_i^s is a vector of individual characteristics like human capital and wealth for example. Then surplus equation (9) from the previous section can be written in the following empirical form:

$$\begin{aligned} Prob(y_{ii,jj} = 1) \quad = \quad & \lambda\{\beta_1'(X_i^m - X_j^m)(M_i^f - M_j^f)) + \beta_2'(X_i^m - X_j^m)(X_i^f - X_j^f)) \\ & + \beta_3(l_i^m - l_j^m)(M_i^f - M_j^f) + (\xi_1 - \xi_2)\} \end{aligned} \tag{12}$$

where $\beta_1' = \delta_1\alpha'$, $\beta_2' = \delta_2\alpha'$, with δ_1 and δ_2 being constants; M_k^f, $k = \{i, j\}$, is the migration status of female k's brother which we use as a proxy for willingness to marry close, ϕ_k, from surplus equation (9); and l_k^m is the residential location (village) of male $k = \{i, j\}$. $\xi_1 = \epsilon_{ii} + \epsilon_{jj}$ and $\xi_2 = \epsilon_{ij} + \epsilon_{ji}$, where ϵ_{ii} is the match specific unobservable when

[13] Since females in both groups within each village-year cluster face similar marriage prospects, the only difference remaining between them after controlling for observable characteristics is the migration status of their brother(s). It is possible that some females in group two will have all of their brothers as migrants. This is not a problem for our estimation as we show below.

male i marries female j and so on.[14] Assuming that both $\epsilon_{ii} + \epsilon_{jj}$ and $\epsilon_{ij} + \epsilon_{ji}$ follow type-I extreme value distribution will guarantee that $\lambda(.)$ is a logit function. In that case, equation (12) is equivalent to a conditional fixed-effect logit procedure (Chamberlain 1980).

Several things are worth noticing in equation (12). First, a pair of matched females appear in each observation as opposed to the more common one individual per observation. Second, any observed or unobserved individual and household characteristics that influence the choice of partners are differenced out. Recall that this was shown more formally in the previous section. Third, since females who reside in the same village and marry in the same year are matched with each other, equation (12) is robust to village, year and village-year fixed effects. Fourth, the effect of brother's migration on both distance of marriage and quality of groom can be simultaneously estimated in this regression.

The interpretation of the coefficients of equation (12) is straightforward. Let us start with β_2, which has the most intuitive interpretation. If there is positive assortative matching on one observable characteristic in X, say human capital E, then β_2 should be positive. Similarly, if females with migrant brothers are sorted to marry lower human capital grooms then β_1 should be negative. This is easier to see when brothers' migration status, M^f takes only two values, 1 when migrant and 0 when not migrant. Then if female i has migrant brothers and female j does not, we have, $M_i^f - M_j^f > 0$. Now, if female i is married to the lower human capital groom so that $E_i^m - E_j^m < 0$, we would expect β_1 to be negative. Interpretation of β_3 is trickier since l^m denotes husband's location in the rural area which we have assumed to be the village of his premarital residence. If we define $l_k^m = 1$, $k = \{i, j\}$, when male k is from the same village as the two females and 0 otherwise then a positive β_3 would imply that females with migrant brothers have a higher propensity to marry inside the village. Given our theoretical model, we would expect $\beta_1 < 0$, $\beta_2 > 0$ and $\beta_3 > 0$.

[14] The match specific error term, ϵ_{ii}, includes unobserved characteristics that specify how good a match male i is for female i. Conceptually, it can be thought of as the unobserved social distance between male i and female i.

4.2 Standard Error Correction

There are two reasons for the standard errors in the proposed analysis to be inconsistent. First, because same individuals appear in the two observations we use for fixed effect, $E[\xi_1, \xi_2] \neq 0$ leading to incorrect inference. Second, because we replicate females in group one to match the number of females in group two within each cluster of village-year, standard errors will also be correlated within each village-year cluster. Fortunately, since we do not pair up females across clusters, correcting for clustering within each village-year will also produce robust standard errors correcting for the first case above. We correct for clustering at the village-year level by using the *jackknife* procedure. In this case the jackknife procedure will calculate the standard errors N number of times, where $N = \{n_{(1)}, \ldots, n_{(N)}\}$ is the total number of clusters, deleting one cluster at a time with replacement. Let the standard error calculated when cluster i was deleted be $\eta_{(i)}$ and let $\eta_{(.)} = \frac{1}{N}\sum_{i=1}^{N} \eta_{(i)}$. Then the jackknife standard error will be calculated as follows:

$$s.e_{jack} = \sqrt{\frac{N-1}{N}\sum_{i=1}^{N}(\eta_{(.)} - \eta_{(i)})^2} \tag{13}$$

5 DATA AND DESCRIPTIVES

We combine vital registration data files for birth, marriage and migration records from the Health and Demographic Surveillance System (HDSS) in Matlab, Bangladesh, with a 1974 census of the population living in the DSS area at the time of the census. The population of the DSS according to the 1974 census was approximately 166,500 and the recorded number of households was 28,576. The census provides baseline economic and social characteristics of individuals including age, sex, relationship to the head, marital status, religion, occupation and education. Each census record has a unique identifier number and can be linked to any marriage, in- and out-migration record. Individuals are also assigned unique IDs upon birth or upon arrival into the surveillance area for the first time through marriage or in-migration. Birth and migration records between 1974 and 1996, and marriage records from 1975 to 1996 are available for analysis.

Complete demographic profiles of each household in the 1974 census are constructed by linking individuals born after 1974, from the birth surveillance files, to their respective households via mother ID.[15] All unmarried daughters of heads in 1974 who have a marriage record in the marriage surveillance files between 1975 and 1996 are included in the analysis leaving us with a group of 28,759 females. Information on the background characteristics of the husbands and their households are available only if they are from the DSS also. We thus exclude all females who married someone outside of the DSS which leaves us with a sample of 13,123 females. Because we compare females, all of whom marry within the DSS, this exclusion does not pose any particular threat to our estimation. Certain important characteristics of the girls like age and education at the time of marriage are also available from the marriage records allowing for cross validation of age and for using updated education information at the time of marriage.

All women in the sample are linked to their brothers using household ID and relationship to head in the 1974 census. Migration status of brothers is constructed by linking brothers to the out and in migration surveillance files. Although these files record the exact date of migration episodes, they are recorded after six months of absence from the household or after six months following a return. Thus the migration records do not include seasonal and circular migration episodes or vacation trips. Because individuals can be linked across files using their unique IDs, we could determine whether someone was a permanent migrant by combining records from the out-migration and the in-migration files. Brothers are also linked to the marriage surveillance files for determining their marital status before migration and at the time of their sisters' marriages. This also allows for identification of sisters-in-law and determination of the migration status of the sisters-in-law.

Table 1 reports the marriage market characteristics of females and their grooms in the sample. Average age of females at marriage is about 18 years compared to 25 years for males. Levels of education attainment are extremely low in the sample. Females have 1.9 years of schooling on average, of whom 65% are illiterate. Males have 2.8 years of

[15] Although children from the birth files are linkable to their mothers, there is no way to link children to their mothers (and thus to siblings) if there are more than one mother per household. Only 0.54% of the household heads in the 1974 census are polygynous and we exclude them from our analysis.

schooling on average and the proportion illiterate among them is 0.57. Given the relative proportions of illiterate males and females, some low educated females certainly *marry up*. Landholding among the households of the sampled females and their grooms is also very low (0.113 acres for females compared to 0.106 acres for males). Almost every individual (99%) in the sample come from households owning less than 1 acre of land. Finally, the proportion of females in the sample who married someone inside the village is about 24%. This percentage would be lower if we also included marriages to someone outside of the study area. This pattern is to be expected as village endogamy is not the typical practice. Table 2 reports the household characteristics of the females in the sample. About 58% of them come from an agricultural household and 87% of them are Muslim. They also have a large number of siblings, almost 3 brothers on average and about 2 sisters on average.

6 RESULTS

We begin this section by verifying two assumptions made while formulating the theory. One important assumption that was central in driving the theoretical results is that men with high aspirations for child human capital have a higher propensity to migrate. Because aspiration for child human capital is a positive function of own human capital, marrying a lower human capital groom is a safer bet if a woman wants to stay in closer proximity. We first show that this result holds for Matlab. Figure 3 presents non-parametric estimates of the relationship between human capital of males (measured in years of schooling) and the probability of being a migrant for males aged 15-64 who resided in the DSS in 1974.[16] Probability of migration increases sharply with years of schooling until 10 years of schooling. This relationship holds for permanent migration as well (Figure 4).

We also assume implicitly that men who migrate before marriage are not out of the marriage market. If the village stock of migration correlates highly with subsequent migration (because of a network effect) and if unmarried migrants do not marry back

[16] The Epanechnikov kernel is used to smooth data in Figure 2, Figure 3, Figure 5 and Figure 6. Almost identical patterns will be obtained without smoothing.

in the rural areas, then the available grooms in the rural marriage markets will be the ones with lower human capital given the evidence above. Consequently, women from high migrant-stock villages will have a higher probability of having a migrant brother and will also face worse marriage prospects in terms of potential grooms if she wants to marry closer. This result is similar to the one we predict with our theory but has a different interpretation. A woman with migrant brothers may marry a lower human capital groom not because he is a safer bet but because lower human capital grooms are the ones available for marrying. Table 3 compares the proportions of males who marry in the DSS by their migration status. The sample used for this table are the males who resided in the DSS during the 1974 census and have married in the next 20 years. The percentage of ever migrants who married someone in the DSS is almost similar to the percentage for males who never migrated (66% vs. 67%). Even permanent migrants have a similar percentage of marrying someone within the DSS when compared to the temporary migrants (65% compared to 67%).

Having verified the above two assumptions one other issue needs to be addressed. We match females within each cluster of village-year based on the number of brothers. As mentioned earlier, group one females consists of those who have no brother or have one brother but the brother is a migrant and group two females consists of everyone else. Figure 4 shows average education of grooms by their wives' number of brothers for four different education categories of females. For each of the four categories, no education, primary education (0-5 years), secondary education (6-10 years), and higher education (more that 10 years), it is evident from the figure that there is no correlation between number of brothers of the females and the education of their grooms implying that the criteria we use to group females for matching are not likely to bias the results in favor of our finding.

Finally, we describe the variables used as migration status of the brothers while estimating equation (12). In essence, migration status of brothers, measured at the time of sister's marriage, is used as a proxy for willingness to marry close. We use six different variables as proxies for this willingness as explained below. In terms of equation (12) these variables are different measures of M^f. Characteristics included in X in equation

(12) are human capital and landholding. Ideally, any characteristic that determines aspiration for child human capital should be included in X. However, the focus of this paper is the demonstration that females with migrant brothers marry lower quality grooms in equilibrium. Thus constructing aspiration for child human capital as a linear combination of human capital and landholding will be a reasonable approximation.

The results of the fixed-effect logistic regressions are reported in Table 4 and Table 5. We find strong positive assortative matching on education and landholding in all the six different regressions. These findings are merely a restatement of findings elsewhere using the same data (Foster 1996). The striking findings are all in terms of the effect of willingness to marry close, proxied by various variables denoting brother's migration status, on husband's quality and distance of marriage. The clearest case when parents would be willing to marry their daughters close, is the case in which they have no living sons at all. In our first specification (column 2 table 4) we use a dummy variable that is equal to 1 when the female has no living brother and zero otherwise as a proxy for willingness to marry close. Females with no brothers are significantly more likely to marry someone in the village (village endogamy) and are significantly more likely to marry someone with lower human capital. Although these females are also more likely to marry someone with lower landholding status, the result is not statistically significant.

Next we use proportion of brothers who have ever migrated as a proxy for willingness (table 4 column 3). This is probably the noisiest proxy for willingness because migrant brothers at the time of marriage can always return when the parents are old. However, the results found in the previous regression remain intact. A better proxy for willingness is probably the proportion of brothers who are permanent migrants, which we use in the third regression and get almost similar results (table 4 column 4).

One problem of using migration status of all brothers as a proxy for willingness could be the following. In the unlikely event that the brothers are in the marriage market in the same year as the sister, it will effect the marriage market as a whole and thus will have an impact on the marriage match of the sister via a general equilibrium effect. Moreover, given our story of old-age support and that daughters-in-law are the primary source of care, it is probably advisable that we use the migration status of married brothers. Using

proportions of ever migrant married brothers and proportions of permanent migrant married brothers (table 5 column 2 and 3) as proxies for willingness to marry close, we still find statistically significant results conforming to our predictions. Finally, we use proportions of sisters-in-law who are permanent migrants directly which should be the strongest of the proxies for willingness to marry the daughter closer given that the primary source of care is definitely lost. Our result remains robust to this specification too (table 5 column 4).

Although, interpretation of the signs of coefficients in the above regressions is straightforward, interpretation of the magnitudes are difficult. Nevertheless, some insights into these magnitudes may be obtained by calculating predicted probabilities from the regression coefficients. Let us take the first specification where we use whether a female has a brother or not as a proxy for willingness to marry close. Assume that the two matched females are equivalent in terms of their observable (to the econometrician) characteristics including whether they have a brother or not. Assume also that one of the males has mean education and the other has one standard deviation more education than the mean education. Under these circumstances, each female has a 50% probability of being matched to the higher human capital male. But if one of the females has no brothers ($M = 1$) while the other has at least one brother ($M = 0$), then probability of the female without a brother being matched to the higher human capital male drops to 44.68%.[17] Similarly, if one of the males resides outside of the village then the probability of the female without any brother being matched to him drops to 39.88%. Similar calculations can be done for all the specifications and the probabilities remain more or less similar (not shown here).

A key finding in all the regressions is that, although brother's migration status makes a woman more likely to marry a lower human capital groom, there is no significant evidence that it makes her more likely to marry a man with lower landholding. Figure 5 presents non-parametric estimates of the relationship between landholding of males

[17] Calculations based on coefficients from column 2 of table 4. Given the mean education (2.79 years of schooling) and its standard deviation (3.78) for males in the sample, this can be a comparison, for example, between the probabilities of marrying a male with incomplete primary education and one with more than primary education.

(in acres) and the probability of being a migrant for males aged 15-64 who resided in the DSS in 1974. Probability of migration shows no correlation with landholding for males with less than 2 acres of land, who constitute more that 99% of the sample. The same pattern also holds for the probability of permanent migration (Figure 6). Given this evidence, a woman who wants to ensure that her potential groom has a lower propensity to migrate cannot gain anything by marrying a man with lower (or higher) landholding status. Thus, our findings in terms of landholding serves as additional evidence in favor of our hypothesis.

7 CONCLUSIONS

One of the cornerstones of the process of development is a reduction in barriers to exchange across space. This process of exchange facilitates productive growth through increasing allocation of factors towards areas of comparative advantage and through the capture of possible scale economies. There is little doubt that in many developing countries the process of migration of potential workers from rural to urban areas has played a major role in ensuring the productive use of young workers.

In principle, one might expect a similar process to operate in the context of marriage. Lower barriers to migration and increased information might allow individuals to search for an appropriate spouse over a wider area and thus increase the extent of sorting in the marriage markets across high quality grooms and brides. This process of sorting may have efficiency consequences if mother's and father's quality are complementary, for example, in the production of child human capital or if there is a substantial idiosyncratic component to the surplus generated when two individuals are matched. But it also is likely to have significant consequences for inequality and for economic mobility across generations.

In this paper, we argue that the process of increased integration of the marriage market is importantly constrained by an emergent force that operates in the reverse direction. Given patrilocal residence, limited migration, and enough sons, parents can be reasonably assured of having a daughter-in-law living nearby to provide for personal care needs. However, in the presence of substantial out-migration there may be an advantage in limit-

ing the scope of search for marriage partners for one's daughter. In particular, a daughter who marries a groom from the same village, and a low quality one who is less likely to migrate, will be more likely to settle near her parents and thus be able to provide personal care when needed.

One central factor driving the above pattern of marriage is of course the absence of formal markets for old age care. While informal institutions like the family-based system of care play an important role in the absence of formal markets, they can have negative consequences under conditions of development and change. More important is the fact that such consequences are disproportionately shared by a traditionally disadvantaged group (women). At the same time our results suggest that in a patrlineal society such as Bangladesh, daughters can be more valuable to parents under changing economic conditions than is traditionally believed. This can have implications for intra-household allocations, especially in societies undergoing fertility transitions. Although the data requirements for undertaking a complete investigation of changing intra-household resource allocations resulting from widespread migration are quite demanding, future research in this area would provide a more complete understanding of the implications of men's migration for women in the sending community and of the unintended consequences of development in general.

References

Amin, S. (1998): "Family Structure and Change in Rural Bangladesh," *Population Studies*, 52(2), 201–213.

Archand, J.-L., and M. Fafchamps (2006): "Matching in Rural Producer Organizations," manuscript.

Asis, M., L. Domingo, J. Knodel, and K. Mehta (1995): "Living Arrangements in Four Asian Countries: A Comparative Perspective," *Journal of Cross-Cultural Gerontology*, 10, 145–162.

Becker, G. (1973): "A Theory of Marriage, Part I," *Journal of Political Economy*, 81(4), 813–846.

——— (1974): "A Theory of Marriage, Part II," *Journal of Political Economy*, 82(2:2), S11–S26.

——— (1991): *A Treatise on the Family*. Cambridge: Harvard University Press.

Bergstrom, T. (1997): "A Survey of Theories of Family," in *Handbook of Population and Family Economics*, ed. by M. Rosenzweig, and O. Stark, vol. 1A, pp. 21–79. Amsterdam: Elsevier.

Bergstrom, T., and R. Cornes (1981): "Gorman and Musgrave are Dual: An Antipodean Theorem on Public Goods," *Economic Letters*, 7, 371–378.

——— (1983): "Independence of Allocative Efficiency from Distribution in the Theory of Public Goods," *Econometrica*, 51, 1753–1765.

Bergstrom, T., and D. Lam (1994): "The Effects of Cohort Size on Marriage-markets in Twentieth-century Sweden," in *The family, the market and the state of ageing societies*, ed. by J. Ermisch, and N. Ogawa. Oxford: Oxford University Press.

Chamberlain, G. (1980): "Analysis of Covariance with Qualitative Data," *Review of Economic Studies*, 47, 225–238.

Fafchamps, M., and F. Gubert (2006): "The Formation of Risk Sharing Netwroks," manuscript.

Foster, A. (1996): "Analysis of Household Behavior when Households Choose Their Members: Marriage-Market Selection and Human Capital Allocations in Rural Bangladesh," manuscript.

Frankenberg, E., and R. Kuhn (2003): "The Implications of Family Systems and Economics Context for Intergenerational transfers in Indonesia and Bangladesh," University of Colorado, Population Program Working Paper 2003-09.

Frankenberg, E., L. Lilliard, and R. Willis (2002): "Patterns of Intergenerational Transfers in Southeast Asia," *Journal of Marriage and Family*, 64, 624–641.

Gale, D., and L. Shapley (1962): "College Admissions and the Stability of Marriage," *American Mathematical Monthly*, 69, 9–15.

Giles, J., and R. Mu (2005): "Elder Parent Health and The Migration Decision of Adult Children: Evidence From Rural China," manuscript.

Kabir, Z. N., M. Szebehely, and C. Tishelman (2002): "Support in Old Age in the Changing Society of Bangladesh," *Ageing & Society*, 22, 615–636.

Knodel, J., N. Chayovan, and S. Siriboon (1992): "The Impact of Fertility Decline on Familial Support for the Elderly: An Illustration from Thailand," *Population and Development Review*, 18(1), 79–103.

Kuhn, R. (2003): "Changing Migration Pattern and Old-Age Support in Bangladesh," manuscript, Institute of Behavioral Science, University of Colorado at Boulder.

Kuhn, R., and A. Protik (2006): "Old-Age Support and Marriage Migration in Bangladesh," manuscript.

Lam, D. (1988): "Marriage Markets and Assortative Mating With Household Public Goods: Theoretical Results and Empirical Implications," *Journal of Human Resources*, 23(4), 462–87.

Lee, Y. J., W. Parish, and R. Willis (1994): "Sons, Daughters and Inter-Generational Support in Taiwan," *American Journal of Sociology*, 99(4), 1010–1041.

Lilliard, L., and R. Willis (1994): "Motives for Intergenerational Transfers: Evidence From Malaysia," *Demography*, 34(1), 115–134.

Mason, K. (1992): "Family Change and Support of the Elderly in Asia: What Do We Know?," *Asia-Pacific Population Journal*, 7(3), 13–32.

Rahman, O., J. Menken, and R. Kuhn (2004): "The Impact of Family Members on the Self-reported Health of Older Men and Women in a Rural Area of Bangladesh," *Ageing & Society*, 24, 903–920.

Rosenzweig, M. R., and O. Stark (1989): "Consumption Smoothing, Migration and Marriage: Evidence from Rural India," *Journal of Political Economy*, 97(4), 905–26.

Stark, O. (1991): *The Migration of Labor*. Massachusetts: Basil Blackwell.

Stark, O., and D. Bloom (1985): "The New Economics of labor Migration," *American Economic Review*, 75(2), 173–178.

Strauss, J., and D. Thomas (1995): "Human Resources: Empirical Modeling of Household and Family Decisions," in *Handbook of Development Economics*, ed. by J. Behrman, and T. Srinivasan, vol. III, pp. 1883–2023. Amsterdam: Elsevier.

Taylor, E. (1999): "The New Economics of Labour Migration and the Role of Remittances in the Migration Process," *International Migration*, 37(1), 63–88.

United Nations (2002): *World Population Ageing: 1950-2050*. New York: United Nations.

Zimmer, Z., and J. Kwong (2003): "Family Size and Support of the Older Adults in Urban and Rural China: Current Effects and Future Implications," *Demography*, 40(1), 23–44.

Appendix A

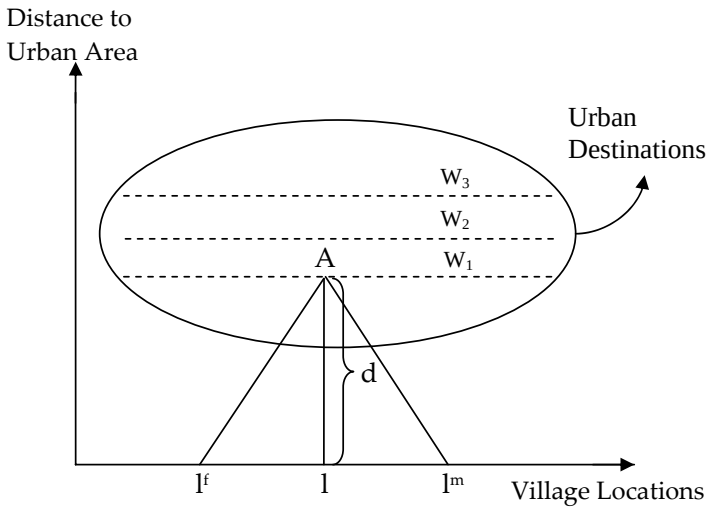

Figure 1: Conceptualizing Distance

Let locations of households in the rural areas be represented along the horizontal axis. Location of the female is represented by l^f and of the male by l^m. Distance to urban areas is measured in the vertical axis. Let the large oval denote urban destinations of migration. In the paper, we assumed that skill-price at the urban destinations is increasing in the distance of the urban destination from the rural area. This is represented in figure 1 by W_1, W_2 and W_3, which are equi-skill-price contours. If the couple migrates after marriage to live in urban destination A, then their distance from the bride's natal residence is Al^f. To apply Pythagorean Theorem, we project point A directly onto the horizontal axis. This gives us point l, which we assume to be the residence of the couple in the rural area after marriage had the couple not migrated. If the distance between l and A is d, then we can write the square of the distance of the couple from the bride's natal residence as: $d^2 + (l - l^f)^2$. Note that, in practice, couples will frequently reside at l^m, the husband's parental residence, if they are not migrants as opposed to residing at a different location like l. However, as long as the distance $(l^m - l)$ is significantly smaller than the distance to urban destination d, our approximation will do a reasonable job. By modeling distance in the way presented here we retain continuity in distance which is analytically convenient.

Appendix B

B.1 Proof of Proposition (1):

We need to show that when male i lives in the same village as the females and has the lower human capital, $\frac{\partial S}{\partial \beta_i^f} > 0$. Evaluating equation (7) for each possible match and substituting in equation (8) and then differentiating with respect to β_i^f we get the following:

$$\frac{\partial S}{\partial \beta_i^f} = -\frac{w^2 h_i^{m^2} - w^2 h_j^{m^2} - 8 l_i^m l_i^f + 8 l_j^m l_i^f + 4 l_i^{m^2} - 4 l_j^{m^2}}{4(\beta_i^f + 1)^2} \tag{B.1}$$

Since both of the females live in the same village we have $l_i^f = l_j^f$. Now let us assume that male i lives in the same village as the females while male j lives in a different village. This will be denoted by, $l_i^f = l_j^f = l_i^m$ and $l_j^m = l_i^m + \Delta_l$. Note that, δ_l is always positive. Let us also assume in addition that the two males are heterogenous with respect to their human capital, $h_j^m = h_j^m + \Delta_h$. Substituting these values in (A.1) we have:

$$\frac{\partial S}{\partial \beta_i^f} = \frac{(2 h_i^m \Delta_h + \Delta_h^2) w^2}{4(\beta_i^f + 1)^2} + \frac{\Delta_l^2}{(\beta_i^f + 1)^2} \tag{B.2}$$

The second term of (A.2) is always positive as long as $\Delta_l \neq 0$, meaning $l_i^m \neq l_j^m$, which we have assumed. The first term is positive if $\Delta_h > 0$, which given $h_j^m = h_j^m + \Delta_h$, is akin to saying if male i has the lower human capital. So, $\frac{\partial S}{\partial \beta_i^f} > 0$ if and only if $\Delta_l \neq 0$ and $\Delta_h > 0$. In words, given the current marital assignments where male i marries female i and male j marries female j, an increased willingness on part of female i increases marital surplus when male i is residing in the same village as the females and has the lower human capital. □

Note however that, when $\Delta_h < 0$ the first term of (A.2) is negative. To see this, let us rewrite the numerator of the first term as $w(2h_i^m + \Delta_h)\Delta_h = w\{h_i^m + (h_i^m + \Delta_h)\}\Delta_h = w(h_i^m + h_j^m)\Delta_h$. Since both $h_i^m \geq 0$ and $h_j^m \geq 0$ as they are levels of human capital, and since $\Delta_h < 0$ we have $h_i^m + h_j^m > 0$. With $w > 0$ the numerator then becomes negative. It is then not possible to sign $\frac{\partial S}{\partial \beta_i^f}$ given that the second term is positive. Consequently, it is not clear whether surplus in the marriage market will increase or not when β_i^f increases and male i has the higher human capital even though he lives in the same village.

B.2 Proof of Corollary (1):

If the two males are homogenous with respect to their human capital and location, then $\Delta_h = 0$ and $\Delta_l = 0$ in (A.2). We have, $\frac{\partial S}{\partial \beta_i^f} = 0$; marital surplus does not change. If, however, the two males reside in two different locations then we have $\Delta_h = 0$ and $\Delta_l > 0$ and so, $\frac{\partial S}{\partial \beta_i^f} > 0$. Since $l_i^f = l_j^f = l_i^m$ and $l_j^m = l_i^m + \Delta_l$, surplus will increase if male i resides in the village. □

B.3 Proof of Corollary (2):

We need to totally differentiate S with respect to β_i^f and β_j^f. Evaluating equation (7) for each possible match and substituting in equation (8) and then totally differentiating with respect to β_i^f and β_j^f we get the following:

$$\begin{aligned} \mathrm{d}S &= -\frac{(w^2 h_i^{m^2} - w^2 h_j^{m^2} - 8 l_i^m l_i^f + 8 l_j^m l_i^f + 4 l_i^{m^2} - 4 l_j^{m^2}) \partial \beta_i^f}{4(\beta_i^f + 1)^2} \\ &\quad + \frac{(w^2 h_i^{m^2} - w^2 h_j^{m^2} - 8 l_i^m l_j^f + 8 l_j^m l_j^f + 4 l_i^{m^2} - 4 l_j^{m^2}) \partial \beta_j^f}{4(\beta_j^f + 1)^2} \end{aligned} \tag{B.3}$$

Substituting $l_i^f = l_j^f = l_i^m$, $l_j^m = l_i^m + \Delta_l$ and $h_j^m = h_j^m + \Delta_h$ as in proposition (1) and additionally $\beta_i^f = \beta_j^f$ in (A.3) we have, $\mathrm{d}S = 0$. □

Figure 2: Probability of Migration for males 15-65 by Education

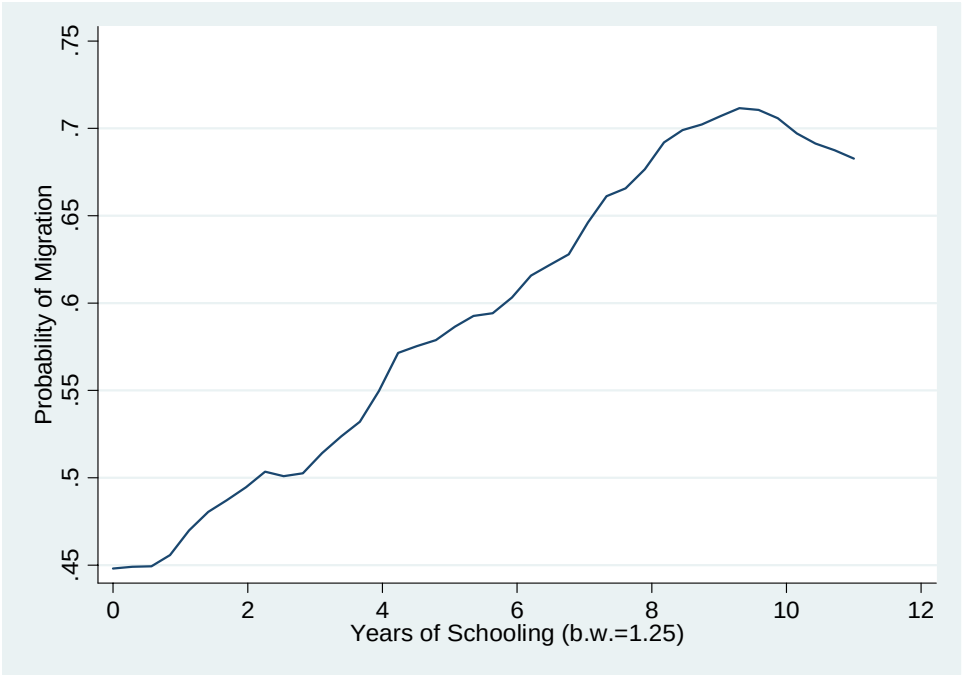

Figure 3: Probability of Permanent Migration for males 15-65 by Education

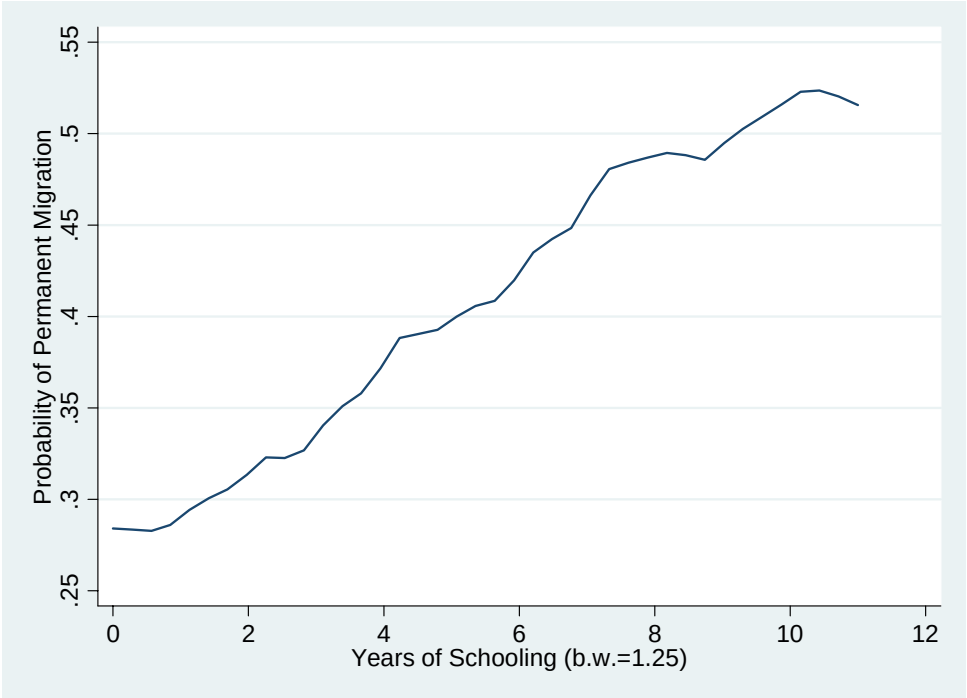

Table 1: Marriage Market Characteristics of the Females in the Sample and their Grooms: Descriptive Statistics

	Females (Brides)	Males (Grooms)
Age at Marriage	18.24	25.12
	(3.32)	(5.03)
Education (years of schooling)	1.90	2.79
	(2.93)	(3.78)
Proportion Illiterate	0.65	0.57
Proportion with Primary Education	0.23	0.21
Proportion with Secondary Education	0.12	0.22
Landholding (in acres)	0.113	0.106
	(0.169)	(0.166)
Proportion Landless	0.16	0.19
Proportion owning <1 Acre of Land	0.99	0.99
Proportion married someone in the village	0.24	-
	(0.43)	
No. of observation	13,123	13,123

Note: Standard deviations in parentheses

Table 2: Household Characteristics of the Females in the Sample: Descriptive Statistics

	Mean	Standard Deviation
Total no. of brothers	2.74	1.53
Total no. of sisters	2.13	1.56
Father's education	2.10	2.95
Proportion of fathers agricultural workers	0.58	0.49
Proportion Muslim	0.87	0.33
No. of observation	13,123	13,123

Table 3: Proportion of males marrying in the DSS by migrant status, 1975-1996

	Non-migrants	Ever Migrants
% marrying back in the DSS	67.23	66.17
	Temporary Migrants	**Permanent Migrants**
% marrying back in the DSS	67.24	65.43

Figure 4: Average Education of Grooms by No. of Brothers

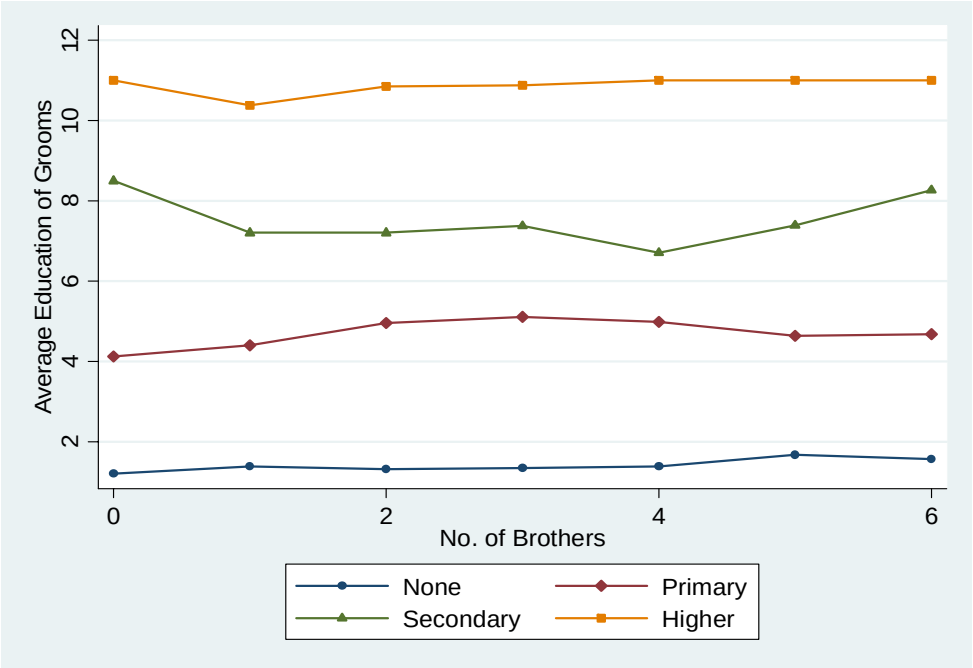

Table 4: Fixed-effect Logistic Regressions Results

	M = No brother	M = Proportion of brothers ever migrant	M = Proportion of brothers permanent migrant
M x husband's education	-0.0565 (0.0117)**	-0.0536 (0.0090)**	-0.0495 (0.0096)**
M x husband's landholding	-0.0053 (-0.0043)	-0.0056 (-0.0031)	-0.0027 (-0.0035)
husband's education x wife's education	0.0262 (0.0008)**	0.0271 (0.0009)**	0.0265 (0.0009)**
husband's landholding x wife's landholding	0.0005 (0.0002)*	0.0005 (0.0002)*	0.0005 (0.0002)*
M x village endogamy	0.4101 (0.0800)**	0.3278 (0.0649)**	0.3338 (0.0706)**
Observations	12154	12154	12154
Pseudo R-squared	0.11	0.11	0.1

Note: Jackknife standard errors in parentheses; * significant at 5%; ** significant at 1%

Table 5: Fixed-effect Logistic Regressions Results (continued)

	M = proportion of married brothers ever migrant	M = proportion of married brothers permanent migrant	M = proportion of sister-in-law permanent migrant
M x husband's education	-0.0544 (0.0111)**	-0.0523 (0.0112)**	-0.0894 (0.0055)**
M x husband's landholding	-0.0043 (-0.0039)	-0.0047 (-0.004)	-0.0035 (-0.0029)
husband's education x wife's education	0.0263 (0.0009)**	0.0262 (0.0008)**	0.0323 (0.0010)**
husband's landholding x wife's landholding	0.0005 (0.0002)*	0.0005 (0.0002)*	0.0006 (0.0003)*
M x village endogamy	0.3851 (0.0760)**	0.4087 (0.0785)**	0.1752 (0.0350)**
Observations	12154	12154	12154
Pseudo R-squared	0.11	0.11	0.12

Note: Jackknife standard errors in parentheses; * significant at 5%; ** significant at 1%

Figure 5: Probability of Migration for males 15-65 by Landholding

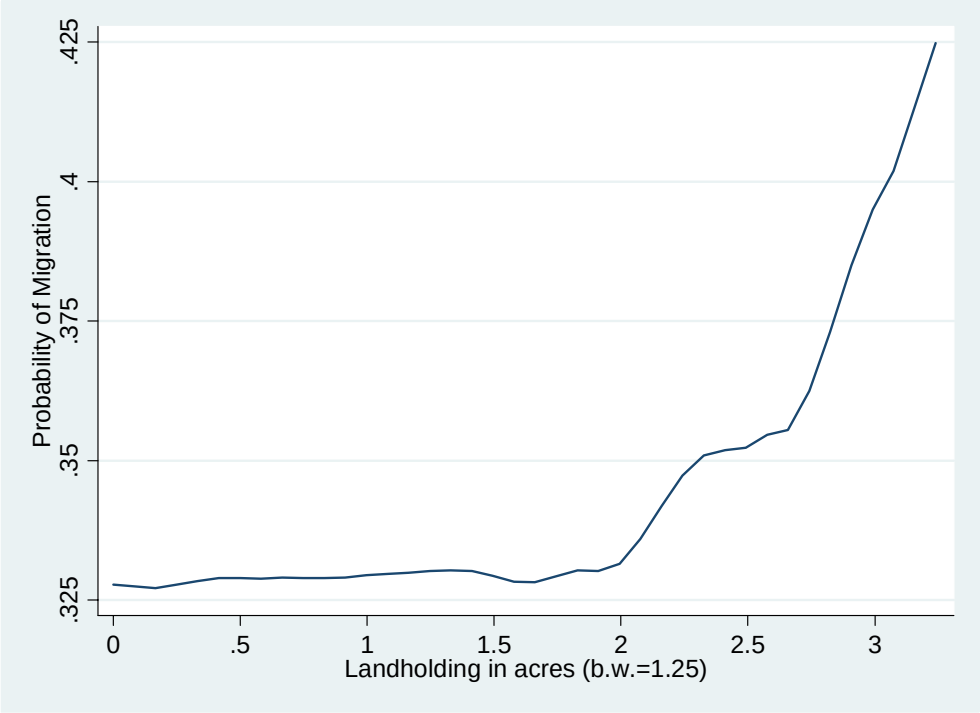

Figure 6: Probability of Permanent Migration for males 15-65 by Landholding