# An Economic Model of Early Marriage

Zaki Wahhaj*
University of Kent

March 2018

**Abstract**

To explain female adolescent marriage patterns around the world, we develop a marriage market model with asymmetric information about prospective marriage partners, and a noisy signal about the bride's quality during an engagement. In equilibrium, there is a negative relationship between the age and perceived quality of women on the marriage market and, consistent with available evidence, older brides make higher net marriage payments. The model also implies path dependence in the evolution of adolescent marriage practices over time and persistent effects on marriage practices from transitory shocks. Model simulations show interventions which increase the opportunity cost of early marriage attenuates the association between bride quality and age, triggering a virtuous cycle of marriage postponement.

Keywords: marriage market, gender, adolescent development, fertility, dowry

JEL codes: D83, J12, J16

*Email: z.wahhaj@kent.ac.uk. Address: School of Economics, Keynes College, University of Kent, Canterbury CT2 7NP, United Kingdom. I would like to thank Dilip Mookherjee, Jean-Philippe Platteau, Vijayendra Rao, Debraj Ray, Rajiv Sethi and participants at seminars at the University of Kent, Exeter, Manchester, Nottingham, the 2013 Royal Economic Society Conference at Royal Holloway College, the UNU-WIDER meeting on 'Gender and Development', and the Theoretical Research in Development Economics Workshop at Barcelona Graduate School of Economics for many useful comments and advice on earlier versions of this work. The paper has also benefitted from a large number of discussions with co-researchers and colleagues including Niaz Asadullah, Maria Garcia-Alonso, Anirban Mitra, Mathan Satchi, Katsuyuki Shibayama, Jose I. Silva, and Manuel Toledo. Any errors in the paper are my own. This research has been supported, in part, by funding through the Australian Government's Development Research Awards Scheme (Agreement #66396). The views expressed here are those of the author and not necessarily those of the Commonwealth of Australia.

# 1 Introduction

The marriage of young female adolescents (henceforth called 'early marriage') remains prevalent in many parts of the world despite repeated efforts by national governments and international development agencies to discourage and end the practice. According to the State of World Population Report 2005, 48 per cent of women in Southern Asia, and 42 per cent of women in Africa in the age group 15-24 years had married before reaching the age of 18 (UNFPA 2005). Across all developing regions, one-third of women aged 20-24 were married or in a union before the age of 18 during the period 2000-2011 (UNFPA 2012). A growing literature documents how the timing of marriage for women affects investments in their own education and fertility decisions (Field and Ambrus 2008), social networks and attitudes towards gender norms (Asadullah and Wahhaj 2017), as well as the human capital of the next generation (Sekhri and Debnath 2014, Chari et al. 2017).

In recent years, there has been renewed efforts from national governments and trans-national bodies to address the issue. In July 2015, the United Nations Human Rights Council unanimously adopted a resolution to "eliminate child, early and forced marriage" and the Sustainable Development Goals specifically includes the elimination of child marriage as one of its targets (5.3) within the broader goal of gender equality.[1] International organisations, and NGOs have invested in developing interventions that raise awareness about the negative consequences of early marriage, that provide parents incentives to postpone marriage for their children, and that provide adolescents new opportunities to acquire skills and alternatives to a traditional path of early marriage and early motherhood.[2]

Despite these recent efforts (and examples of success stories), the overall prevalence of marriage among female adolescents around the world has yet to show a significant downward trend. For example, using data from 48 countries with at least two DHS/MICS surveys in the period 1986-2010, a UNFPA study finds little overall change in the practice in either rural or urban areas (UNFPA 2012). Two other stylised facts about female early marriage practices are noteworthy. Historically, the practice has been widely prevalent in China, the Middle-East and the Indian sub-continent (Dixon 1971) while being absent from Europe from at least the beginning of the 18th century, the period in which reliable records begin (Hajnal 1965). Second, the practice finds its highest prevalence today in the least developed countries (UNICEF 2016).

In this paper, we develop a theoretical model of female early marriage to address two related questions: (i) What accounts for the variation in female adolescent marriage across population groups and the persistence of the practice in developing countries today? (ii) What are the likely effects of ongoing policy interventions aimed at eradicating early marriage among young adolescents? The theoretical model has two key elements: (a) asymmetric information regarding the 'quality' of women on the marriage market; (b) an imprecise technology for detecting the quality of prospective brides during an 'engagement'. Marriages go ahead when

[1] http://www.reuters.com/article/2015/07/02/us-womensrights-un-resolution-idUSKCN0PC25O20150702
http://www.un.org/sustainabledevelopment/gender-equality/

[2] Notable examples include Brac's Adolescent Development Programme in Bangladesh, which provides livelihood training courses, education to raise awareness on social and health issues, and clubs to foster socialisation and discussion among peers; and the Berhane Hewan project in Amhara, Ethiopia, a joint initiative between the New York based Population Council and the Amhara regional government, which uses community dialogue, and simple incentives involving school supplies to encourage delayed marriage and longer stay in school for girls. The World Bank, the UK Department for International Development, and the Nike Foundation are providing support to a number of similar projects around the world.

a prospective bride is detected to be of high quality, or their quality remains undetected, but not when they are detected to be of low quality. Consequently, the longer a woman has been on the marriage market, the higher the conditional probability that she was previously found to be of low quality during an aborted engagement.

Because of the negative (equilibrium) relationship between the age and perceived quality of women on the marriage market, men prefer to marry young brides and women are inclined to accept marriage proposals while they are young rather than wait. The higher the proportion of women who accept early marriage offers, the stronger is the negative relationship between age and perceived quality, which induces the next cohort to make similar life choices. This leads to a persistence of early marriage practices. The model includes marriage transfers (bride-price or dowry) determined at the time of marriage by Nash bargaining, where the outside options of the prospective bride and groom serve as threat points. In equilibrium, older brides pay higher net marriage transfers than young brides because of their weaker outside option and worse reputation, which reinforces the inclination of women to marry at a young age.

Large-scale interventions of the kind discussed above provide adolescent girls with opportunities other than marriage. By improving their outside options, these interventions may induce some fraction of adolescent girls – who may otherwise have accepted offers of early marriage – to pursue these opportunities. As more girls postpone marriage for reasons unrelated to their quality on the marriage market, the negative relation between the quality and age of prospective brides declines, causing more men to seek older brides, and more girls to reject offers of early marriage in the next period. Consequently, the reputation of older women on the marriage market improves further and the cycle continues. Thus, expanding non-marriage related opportunities for adolescents can trigger a virtuous cycle of marriage postponement. The fact that an intervention targeted at adolescent girls can make it more and more attractive for future cohorts to postpone marriage means that the long-term impact of such interventions on marriage and subsequent life choices may well exceed the impact on the first cohort which is exposed to it.

The theoretical model thus draws attention to the opportunities for adolescent girls outside of marriage as a determinant of age of marriage. Poor access to education, training and employment for girls – often characteristic of developing countries and regions – can severely limit these opportunities. But the model also highlights that interventions aimed at addressing these constraints have dynamic effects on the marriage market, which needs to be taken into account in policy considerations.

We illustrate this argument and provide a measure of the relevant magnitudes using the case of Bangladesh, which has one of the highest rates of female early marriage today. We solve for key parameters of the model using a number of moment-matching conditions derived from the demographic situation in the country during the 1970's (before the country experienced dramatic changes in fertility and the education and labour force participation of women).

We show that an initiative that increased the opportunity cost of early marriage for women in Bangladesh would trigger a continuous decline in its incidence as per the reasoning above. An increase by half a standard deviation causes the incidence of early marriage to decline by a total of 11 percentage points. But the first cohort exposed to the initiative would experience only between one-third and two-third of this decline.

Second, we show that a small-scale randomised control trial of the same initiative would fail to achieve the marriage market equilibrium changes of the full-scale intervention and, therefore, significantly under-estimate its potential for lowering the incidence of early marriage.

Our modelling assumption that the quality of women on the marriage market is imperfectly detected is motivated by the sociological theory that, in patriarchal societies, the honour and status of families are dependent on the 'purity' of their female members and that there is uncertainty regarding the 'purity' of unmarried adolescent girls (Ortner 1978, Kandiyoti 1988). The concern with 'purity' extends to brides who will marry into a family which, it has been argued, creates marriage pressures from the age of menarche (Dube, 1997). There is growing empirical evidence within the economics literature of such pressures leading to early marriage (Field and Ambrus 2008; Sekhri and Debnath 2014; Chari et al. 2017; Hicks and Hicks 2015; Sunder 2015; Asadullah and Wahhaj 2017) documented for Bangladesh, India, Uganda and Kenya. The assumption that the quality of women on the marriage market is imperfectly detected provides a formal explanation for this phenomenon but, as we show, it also has dynamic implications for the marriage market, which have hitherto received little attention in the literature.

This paper belongs to a long literature that applies the concept of matching to investigate marriage-patterns, following Gale and Shapley (1962) and Becker (1973, 1974). More specifically, it is related to a growing body of literature that applies models of dynamic search and matching (Diamond and Maskin, 1979) for understanding phenomena related to marriage markets. For example, Anderson (2007) investigates the relationship between population growth and dowry prices; Edlund (1999) argues that sex selection driven by son preference can cause women to be born consistently in low-status families; Bhaskar (2011) shows how the same phenomenon can lead to a congestion externality on the marriage market; Sautmann (2017) provides a characterisation of the marriage payoff functions which would lead to commonly observed marriage age patterns around the world including positive assortative matching in age; and Bhasker (2015) looks at the implications of demographic transitions for the marriage market.

In the next section, we discuss how the model of female early marriage developed in this paper relate to existing theories in the sociological, economic and demographic literature. The model of the marriage market is introduced and analysed in Section 3. Section 4 extends the model to incorporate heterogeneous agents. The model is used to conduct numerical analysis and derive implications for the case of early marriage in Bangladesh in Section 5. Conclusions are provided in Section 7.

## 2 Alternative Theories on Marriage Age

Within the field of economics, there is a rich literature explaining the phenomenon that in most societies, husbands are typically older than their wives. For example, Bergstrom and Bagnoli (1993) argue that the age gap in marriage is due, at least in part, to the fact that the individual characteristics which traditionally determine one's desirability as a marriage partner are revealed or realised at a later age for men than for women. Coles and Francesconi (2007) postulate that economic success (which increases with age) and physical health (which declines with age) are complementary for the gains realised from a marriage. This would lead to a pattern of age gap between marriage partners and – given that labour market opportunities have traditionally been more restricted for women – the tendency for older men to marry younger women.

A large literature also emphasizes the natural link between fertility preferences and a demand for young brides. For example, in his study of marriage patterns across the world, Goody (1990) argues that, in traditional societies, young brides are preferred because they have a longer period of fertility before them; and they are more likely to be obedient and docile, necessary qualities to learn and accept the rules and ways of her new household. Dixon (1971) attributed the historic practice of early marriage in China, India, Japan and Arabia to the prevalence of 'clans and lineages' which gave economic and social support to newly married couples, as well as pressures to produce children for strengthening and sustaining the clan. By contrast, the traditional emphasis on individual responsibility in 'Western family systems' meant that newly married couples were expected to be able to provide for themselves and their children, which 'necessarily causes marital delays while the potential bride and groom acquire the needed skills, resources and maturity to manage an independent household'.

Becker's theory of fertility would further imply a link between income levels and the marriage age of women. Becker hypothesized that parents care about both the quantity and 'quality' of children which can lead to a negative income elasticity of fertility as richer parents substitute away from quantity towards fewer children of higher 'quality' (Becker 1960; Becker and Lewis 1973).[3] This would lower the demand for young brides and, potentially, increase the demand for educated brides on the marriage market who can better look after their offspring.[4] Thus, the theory implies a decline in female early marriage and increase in female schooling as income levels rise within the population.

Another explanation for female early marriage stems from notions of family 'honour' and female 'purity'. According to Ortner (1978), across a wide range of societies the honour and status of families are held to be dependent on the 'purity' of their women; and their reputation for 'purity' is ensured through strict control over their social and sexual behaviour. Kandiyoti (1988) describes this honour system as a feature of societies which are both patrilocal and patrilineal, encompassing social groups in North Africa, the Muslim Middle East, and South and East Asia. And Moghadam (2004) notes that, in these societies, the honour of women 'and, by extension, the honour of their family depends in great measure on their virginity and good conduct'. A large literature documents this phenomenon for specific societies, for example, Schneider (1971) for regions on both sides of the Mediterranean sea, Dyson and Moore (1983) for northern India, Baron (2006) for Egypt. In this context, the early marriage of women – at an age when they would have a higher expectation of being 'pure' – would help protect the honour of both the bride's family and the family receiving the bride.

We argue that these theories are inadequate in explaining the phenomenon of female early marriage on empirical grounds. First, if female early marriage is due to the economic drivers of the marriage age gap, this explanation raises the question as to why the marriage age gap occurs in most societies while the phenomenon of female early marriage is, and historically has been, specific to certain societies and regions; absent, for example, from Western Europe, as far back as records can reveal, as noted in the introduction.

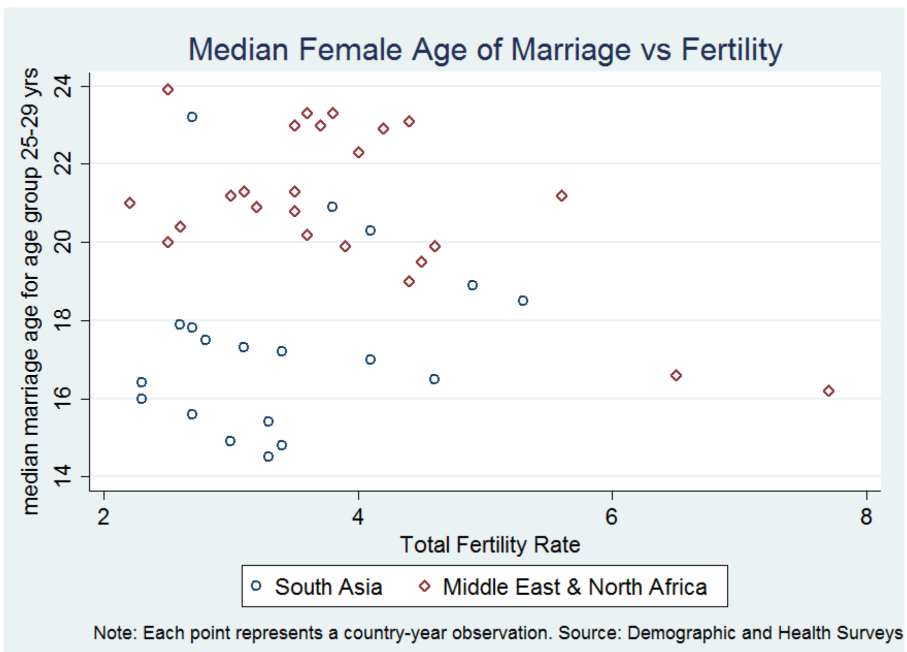
Sociological theories which emphasize the role of the extended family or clan and economic theories

[3] See also Doepke (2015) for a discussion on this literature.

[4] I would like to thank an anonymous referee for pointing out this last link.

based on the quantity-quality trade-off in fertility choice can explain variations in the practice of female early marriage over time and across populations. But they would predict a close relationship between fertility and marriage patterns, which is not consistent with recent data. For example, between the early 1970's and early 1990's, Bangladesh experienced one of the most rapid fertility transitions in recent history (the total fertility rate declined from 6.3 to 3.4 children) but the median age of marriage increased by just 1.7 years over the same period.[5][6] Figure 1, which shows a scatterplot of the total fertility rate (TFR) against the median age of marriage for women aged 25-29 years based on every available DHS survey for countries in South Asia, the Middle East and North Africa, suggests only a weak correlation between the two variables. On the other hand, there is wide variation in marriage age for any given TFR range, even in surveys where the total fertility rate was close to the replacement rate of 2.

Figure 1: Country-Year Observations for Median Marriage Age and Total Fertility Rate




Sociological theories based on the concepts of family 'honour' and female 'purity' can account for regional variation and the persistence of early marriage practices but they raise another question. The literature, discussed above, implies that the concepts of family 'honour' and female 'purity' are important for the regions represented in Figure 1. Yet, as the figure shows, there is substantial variation in female early marriage across these populations.

The theoretical model in this paper explains female early marriage based on the assumption of asymmetric information about the quality of potential brides. The exercise shows that it can lead to history dependence

[5] According to the 2014 Bangladesh DHS Report, the total fertility rate declined from 6.3 in the period 1971-1975 to 3.4 in the period 1991-1993. The same survey reports the median age of first marriage as 15.3 years among women aged 20-24 in the 1993-94 DHS, as compared to 13.6 years among women aged 40-44.

[6] The total fertility rate (TFR) refers to "the total number of births a woman would have by the end of her childbearing period if she were to pass through those years bearing children at currently observed age-specific fertility rates" (NIPORT 2013). We use the TFR in this discussion as it captures fertility preferences at a point in time more accurately than completed fertility rates by cohort.

and dynamic changes to transitory shocks. Thus, the model can explain changes in early marriage practices over time independently of changes in fertility, and the co-existence of different marriage practices across societies which are otherwise identical. Our modelling approach is a formalisation of the role of female 'purity' on the marriage market in patriarchal societies but the dynamic effects we highlight are absent from the sociological literature.

The model has the prediction that a practice of early marriage prevails when adolescent girls have limited economic opportunities and female 'purity' is deemed important on the marriage market; but past shocks and policies can also have persistent effects on current marriage practices. We argue that this set of predictions can account for historical and current patterns of early marriage better than the alternative explanations for the phenomenon provided above.

# 3 A Model of Marriage Timing

## 3.1 Description of the Marriage Market

We describe a basic marriage market model in this section and discuss our choice of assumptions and potential extensions in more detail in the next. The marriage market is set within a dynamic population where individuals born in each period $t$ live for a finite number of periods $T$. Each individual has two traits: gender ('male' or 'female') and character ('good' or 'bad'). In each cohort, there are equal numbers of males and females and a fraction $\varepsilon \in (0,1)$ has bad character. An individual's own character is private information.

Individuals born in period $t$ attain puberty at the beginning of period $(t+T_p)$. Females born in period $t$ can be in the marriage market in periods $(t+T_p)$ and $(t+T_p+1)$. Males born in period $t$ enter the marriage market in period $t+T_p+1$ only. We describe individuals as being 'young' and 'older' at age $T_p$ and $T_p+1$ respectively. We denote by $n_m(t)$, $n_{f1}(t)$ and $n_{f2}(t)$ the number of men, young women and older women, respectively, who are on the marriage market in period $t$. Married couples bear children when the husband is aged $T_p+2$. Single men aged $T_p+2$ can potentially bear children too, out-of-wedlock (with single women or women married to other men). Each newborn child has equal probability of being male or female. We denote by $\kappa$ the per-period growth rate in average fertility. In the model $T$, $\varepsilon$ and $\kappa$ are exogenously given.[7]

The marriage market is segmented into two parts. In the first, men are matched with young women, and in the second, men are matched with older women. At the start of each period, each man on the marriage market decides which marriage market segment he will enter. We denote by $\theta_t$ the fraction of men who opt for the marriage market segment for young women in period $t$, a variable which will be determined endogenously.

The probability that a man seeking a young bride in period $t$ (i.e. who opts for the marriage market segment for young brides) finds a match is $\mu\left(\frac{n_{f1}(t)}{\theta_t n_m(t)}\right)$ and the corresponding probability for an older bride is $\mu\left(\frac{n_{f2}(t)}{(1-\theta_t)n_m(t)}\right)$ where $\mu(.) : [0,\infty) \longrightarrow [0,1]$ is an increasing function.

When a match has been made successfully, a 'background check' is performed to determine the character

[7]While a two-period overlapping generations model would suffice for our main theoretical results, the $T$ period life-cycle presented here provides more clarity regarding the demographic structure of the model and links more easily to the numerical analysis in Section 5.

of the prospective bride. The background check can have two possible outcomes. It may be uninformative or it may reveal – in a private signal to the prospective groom and/or his family – that the prospective bride has 'bad' character. For a woman of 'good' character, the background check is always uninformative. In the case of a woman of 'bad' character, her character is revealed with probability $\pi \in (0,1)$ and with probability $(1-\pi)$ it is uninformative.

Following the background check, the two parties decide whether the marriage should go ahead. If either party declines, then the man and woman remain single during that period. We denote by $\underline{u}_m$ and $\underline{u}_f$ the per-period utilities obtained, respectively, by single men and women.

If they both decide to proceed with the marriage, they negotiate a marriage contract that specifies a level of transfer $\tau$ from the bride to the groom ($\tau$ may be positive, negative or zero). The per-period utility to the bride and the groom from marriage are given by $\tilde{u}_f(\tau, c_m)$ and $\tilde{u}_m(\tau, c_f)$ respectively where $c_m, c_f \in \{\text{'good'}, \text{'bad'}\}$. They bargain over the level of marital transfers $\tau$. The outcome of bargaining corresponds to the Nash Bargaining Solution with equal bargaining power for the two parties and the threat point is given by their future prospects on the marriage market. During the bargaining process, the two parties do not have knowledge of the character of the potential partners except for what has been revealed by the background check. Upon marriage, the bride and the groom leave the marriage market with no possibility of divorce or re-entry into the marriage market in a future period.

In summary, the sequence of events within each period $t$ is as follows:

1. A new cohort is born, consisting of an equal number of males and females, a fraction $\varepsilon$ of bad character, and a fraction $1-\varepsilon$ of good character. Individuals born in period $(t-T)$ pass away.
2. All females born in period $(t-T_p)$ (labelled 'young'), and all unmarried males and females born in period $(t-T_p-1)$ (labelled 'older') enter the marriage market. The men choose a marriage market segment in which to search a bride.
3. Men in the marriage market segment for young and older brides are matched with potential brides with the probabilities given above.
4. In case of a match, a background check is performed on the prospective bride and its outcome is revealed to the prospective groom and/or his family.
5. The two parties decide whether the marriage should go ahead. If both parties are willing, they negotiate a marriage transfer.
6. Unmatched individuals and matched individuals who decline the opportunity or fail to agree on marriage terms remain single during that period. Pairs who marry learn about their partners' true character and obtain the marriage-specific utility.
7. Men born in period $t-T_p-2$ bear children.

Future utility is discounted by a factor $\beta \in (0,1)$ per period. For ease of notation, we introduce the functions $u_s(\tau, \varepsilon) = (1-\varepsilon)\tilde{u}_s(\tau, \text{'good'}) + \varepsilon \tilde{u}_s(\tau, \text{'bad'})$ for $s = m, f$. Thus, $u_m(\tau, \varepsilon)$ ( $u_f(\tau, \varepsilon)$ ) is the expected per-period utility to a man (woman) from a marriage to a woman (man) who has a probability $\varepsilon$ of bad character when the marriage contract specifies a transfer of $\tau$ towards the groom. We make the following assumptions about the functions $\tilde{u}_m(.)$, $\tilde{u}_f(.)$ and $\mu(.)$.

**Assumption 1** $\tilde{u}_m(\tau, c_f)$ *is strictly increasing in* $\tau$ *and* $\tilde{u}_m(\tau, \text{'good'}) > \tilde{u}_m(\tau, \text{'bad'})$ *for every* $\tau$.

**Assumption 2** $\tilde{u}_f(\tau, c_m)$ *is strictly decreasing in* $\tau$ *and* $\tilde{u}_f(\tau, \text{'good'}) > \tilde{u}_f(\tau, \text{'bad'})$ *for every* $\tau$.

**Assumption 3** $\tilde{u}_s(\tau, c_{-s})$ *is additively separable in* $\tau$ *and* $c_{-s}$ *and weakly concave in* $\tau$ *for* $s \in \{m, f\}$.

**Assumption 4** $\mu(.)$ *is strictly increasing with a range of* $[0, 1]$ *and* $\mu(0) = 0$.

**Assumption 5** $\theta\mu\left(\frac{x}{\theta}\right)$ *is increasing in* $\theta$ *for all* $x$.

**Assumption 6** $\underline{u}_m + \underline{u}_f > u_m(\tau, 1) + u_f(\tau, \varepsilon)$ *for all* $\tau$.

**Assumption 7** $\underline{u}_m < u_m(\tau, \varepsilon)$ *and* $\underline{u}_f < u_f(\tau, \varepsilon)$ *for some* $\tau$.

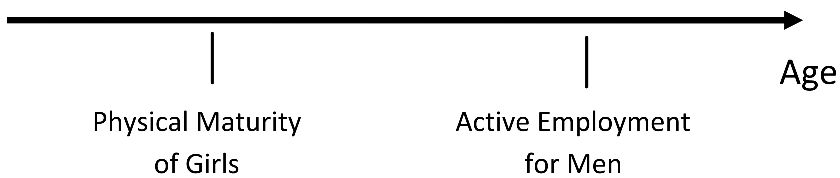
Assumption 6 implies that if the prospective bride is found to have 'bad character', then there is no level of pre-marital transfers such that both parties would prefer marriage to singlehood. By contrast, Assumption 7 implies that if no new information is obtained regarding the prospective bride or groom, then there exists a level of pre-marital transfers such that both parties would prefer marriage to singlehood (this is relaxed in Section 4). Assumption 5 is a restriction imposed on the function $\mu(.)$ which ensures that as the proportion of men in a particular segment of the marriage market (either for 'young' or 'older' women) increases, so does the *number* of men who are matched with that type of bride. We use Assumption 3 to ensure that utility from marriage is increasing in the 'reputation' (i.e. probability of good character) of the marriage partner, even though marriage partners with better reputation are more expensive in terms of net marriage transfers (see Lemma 4 in Appendix A).

## 3.2 Discussion on Modelling Choices and Assumptions

To provide support for the assumptions made about the marriage market and demographics above, we rely on the ethnographic and demographic literature regarding marriage customs and practices. As there is considerable variation in marriage customs and current practices in different parts of the world, we draw on the literature for a particular region, South Asia, for the sake of consistency. In section 6, we discuss what aspects of the model would need to be adapted for other regions and argue that the main insights from the model regions do not depend on the specific restrictions we impose in the main analysis.

In reality, each 'period' in the model would correspond to a time length of about 4.5 years and, for the social contexts under study, we would choose $T_p = 3$. Thus, as per the assumptions above, females are considered suitable for marriage from the age of 13.5 and males are considered suitable for marriage from 18.

We choose 13.5 years as an approximate the age of entry into the marriage market for girls as a majority would reach puberty around this age which, as noted in the literature, serves as a constraint on the minimum age of marriage in a range of developing countries. On the other hand, 18 years is the approximate age at which men would enter the marriage market as it marks the start of the period of active employment, which furnishes them with the resources to support a family.[8] Thus, being ‘young’ corresponds to the period between the onset of physical maturity for girls and active employment for men, roughly between the ages of 14 and 18.




By assumption, we have ruled out polygynous marriages and the possibility of divorce and remarriage. These assumptions are reasonable approximations in the South Asian context where the incidence of separation and divorce remains very low (Dommaraju and Jones, 2011) and only a small fraction of men and women are in polygamous marriages (Westoff 2003). Furthermore, most women and men are married by their late twenties (Mensch, Singh and Casterline, 2005), which forms the basis of our assumption that they remain on the marriage market – i.e. are considered eligible for marriage – during a limited number of years.

The assumption that the marriage market is segmented by age and that men pick a segment of the marriage market is a formal representation of a matching process where matchmakers have traditionally played an important role. In *Arguing with the Crocodile*, Sarah White’s detailed ethnographic account of marriage practices in rural Bangladesh, she notes that it is customary for the groom’s family to initiate contact with the bride’s family, and that this contact is made through a matchmaker who provides a communication line, and facilitates negotiations, between the two parties (White 1992). White also notes that "the different parties manoeuvre and fight their own corners, aiming to achieve the best bargain they can" which gives support to our assumption that bargaining is a key element of the negotiation process. Moreover "the many interests involved in the making of a marriage undoubtedly color the evidence given. Mismatches occur not only through lack of information, but also through deliberate deception", which suggests that each party has limited information about the potential match, and that they may choose not to disclose information about their daughter or son that may be regarded as a defect on the marriage market. Therefore, "... attention ... is often focused primarily on the wealth of the household, and the amount of dowry which is demanded or offered" (White 1992).

Next we turn to the question what is meant by the ‘character’ of potential brides and grooms. As noted in Section 2, across a wide range of societies the honour and status of families are held to be dependent on the ‘purity’ of their women; and their reputation for ‘purity’ depends on their propriety in social and sexual behaviour. What behaviour is considered appropriate may vary across societies and over time. Examples include abstinence from sexual relationships prior to marriage and extra-marital relationships following marriage and, in the strictest cases, avoidance of excessive intimacy with unrelated males. In terms of the

[8] In the context of Bangladesh, there is strong evidence that men rarely marry before the age of 18 unless they are engaged in an income-generating activity. For example, we find from the Bangladesh Adolescent Survey (2005) that, for those below the age of 18, 27% of never-married boys and 100% of ever-married boys are engaged in an income-generating activity.

model, a woman of 'good' character does not have the propensity to engage in such behaviour while a woman of 'bad' character does. This information is not readily available to the groom's party when they hail from a different village or community which is typically the case in societies that practise some degree of marriage exogamy. But they can make inquiries about a prospective bride through their social network that can potentially reveal information about past behaviour that is indicative of bad character. The background check described in the model is intended to capture this mechanism.

The ethnographic literature provides no indication that 'purity' – in the sense described above – is a relevant attribute for grooms in patriarchal societies. But men of good and bad character may differ in other ways that affect the bride's utility from marriage, such as a propensity towards domestic violence. We have implicitly assumed in the model that there is no mechanism to perform a background check on men, based on the idea that their pre-marital behaviour provides no indication of how they will behave within a marriage. Allowing a background check on men would have no implications for the reputation of older unmarried men because young men, in any case, are not on the marriage market. Similarly, male 'character' is not essential to the model but it facilitates the numerical analysis in Section 5.

We have assumed that the utility derived from a match on the marriage market depends on the character of the spouse but not on one's own character. A more general formulation would allow the utility function to depend on both. But as character refers to different behavioural traits for men and women, there is no obvious assumption to make between, for example, a groom's character and his relative preferences for a 'good' versus a 'bad' bride. Even with some differences in preferences of 'good' and 'bad' grooms, 'bad' grooms would adopt the same strategy as the 'good' ones to avoid revealing their type on the marriage market; and likewise for brides. Therefore, for ease of exposition, we have assumed homogeneity of preferences across different types of character in Section 3.1.

The use of the Nash bargaining solution for marriage transfers requires some justification given that there is asymmetric information between the two parties. Binmore, Rubinstein and Wolinsky (1986) show that, under *symmetric* information, a bargaining game of alternating offers yields the Nash bargaining solution as the outcome when the time lapse between offers is very small. In the context of traditional marriages, the bargaining over marriage transfers is likely to be conducted, not by the bride and groom, but by members of the extended family from whom any clear evidence of bad character is likely to be withheld for reputational reasons. Thus, we argue that bargaining under symmetric information about character is a reasonable approximation. Then Binmore, Rubinstein and Wolinsky (1986) implies a Nash bargaining solution with a threat point given by the expected value of the outside options of the bride and groom.[9]

While we assume that $\varepsilon$ and $\pi$ are the same for young and older women, it is straightforward to adapt the model such that the probability of 'bad character' or its probability of detection increases with age (higher $\varepsilon$ or higher $\pi$ for older women). Such a formulation would capture the idea that as they grow older, adolescent

[9]For this result, we use Binmore, Rubinstein and Wolinsky's analysis of the bargaining game with a constant, exogenous probability of breakdown. Even if bargainers have private information, we can argue that brides/grooms of bad character will adopt the same strategy as one with good character in the bargaining game to avoid their types being revealed through their behaviour. Then, Binmore, Rubinstein and Wolinsky's result still applies, albeit with the threat point corresponding to the outside options of individuals of *good* character. If the probability of bad character is small, this would make only a small difference in the equilibrium marriage transfers and do not change our qualitative results.

girls have more contact and experiences that can affect their character[10] or they leave behind more evidence regarding their character. These assumptions would make it easier to obtain an early marriage equilibrium but the key insights of the model and, in particular, the reputational effects of early marriage, would remain.

Note that, in the model, the fertility rate is assumed to be independent of the mother's age of marriage. We make this assumption as birth control practices became widely prevalent in South Asia before these populations experienced significant shifts towards late marriage among women. Therefore, female marriage age should not act as a constraint on fertility. While fertility preferences may be affected by other factors concurrently with changes in the marriage market, there is no mechanism within the model that can explain these preference changes and, therefore, we take the fertility rate to be exogenous. For ease of exposition, we assume in the theoretical model that the growth rate in fertility is constant and the sex ratio is equal to 1 but, for the numerical analysis, these parameters are based on the existing population data.

## 3.3 Equilibrium in the Marriage Market

For the subsequent analysis, we define a marriage market equilibrium as follows.

**Definition 1** *A Marriage Market Equilibrium is a strategy profile for men and women born in each period and beliefs regarding the character of young and older women in the marriage market such that (i) no individual on the marriage market can improve their expected utility by deviating to an alternative strategy; and beliefs satisfy (ii) Bayes' rule for the given strategy profile for each positive probability event; and (iii) the Consistency Criterion (Kreps and Wilson 1982) for each zero probabilty event.*

In the following discussion, we use the terms 'marriage market equilibrium' and 'equilibrium path' interchangeably. A given strategy profile would generate a sequence $\{\theta_t\}_{t=0}^{\infty}$ where $\theta_t$, as above, is the proportion of men who seek young brides in period $t$ (step 2 within each period of the game described in Section 3.1). Given such a sequence, we can derive the beliefs regarding the character of older women on the marriage market as follows:

Let $\lambda_1(t)$ and $\lambda_2(t)$ be, respectively, the period $t$ probability of finding a match for young women and older women on the marriage market. Let $\varepsilon_{f1}(t)$ and $\varepsilon_{f2}(t)$ be, respectively, the probability of bad character among period $t$ young and older women respectively *before* any background check has been performed; and $\hat{\varepsilon}_{f1}(t)$ and $\hat{\varepsilon}_{f2}(t)$ the corresponding probabilities *after* an uninformative background check. By construction, we must have (henceforth we drop the period indicator $t$ for ease of exposition if this does not create ambiguity):

$$\lambda_1 n_{f1} = \mu\left(\frac{n_{f1}}{\theta n_m}\right)\theta n_m \tag{1}$$

$$\lambda_2 n_{f2} = \mu\left(\frac{n_{f2}}{(1-\theta)\, n_m}\right)(1-\theta)\, n_m \tag{2}$$

**Reputation:** As there is no information available on the character of young women when they first enter the marriage market, we must have $\varepsilon_{f1} = \varepsilon$. For older women, the probability of bad character (before a

[10] However, in Section 5.1, we provide descriptive evidence, for women in Bangladesh, which suggests that the relevant behaviour is driven by a fixed character trait rather than one which is time-varying.

background check has been performed) depends on the likelihood that they were matched with a man when young. Specifically, using Bayes' rule, we obtain

$$\begin{aligned} \varepsilon_{f2}(t+1) &= \Pr(\text{bad}|\text{older}) \\ &= \frac{\Pr(\text{older}|\text{bad})\Pr(\text{bad})}{\Pr(\text{older})} \\ &= \frac{[(1-\lambda_1(t))+\lambda_1(t)\pi]\varepsilon}{(1-\lambda_1(t))+\lambda_1(t)\pi\varepsilon} \end{aligned} \tag{3}$$

From (3), it is evident that if $\lambda_1(t) > 0$ and $\varepsilon > 0$, then $\varepsilon_{f2}(t+1) > \frac{[(1-\lambda_1(t))+\lambda_1(t)\pi]\varepsilon}{(1-\lambda_1(t))+\lambda_1(t)\pi} = \varepsilon$. Therefore, if there are some women who are getting married when young, the probability of bad character is higher among older women than among young women.

Given that a background check detects 'bad character' only with some probability $\pi < 1$, a woman for whom such a check has been informative will still be assigned a positive probability of having a 'bad character'. We can determine this probability for young and older women using Bayes' rule as follows:

$$\begin{aligned} \hat{\varepsilon}_{f1} &= \Pr(\text{bad}|\text{young+uninformative}) \\ &= \frac{\Pr(\text{young+uninformative}|\text{bad})\Pr(\text{bad})}{\Pr(\text{young+uninformative})} \\ &= \frac{(1-\pi)\varepsilon_{f1}}{(1-\varepsilon_{f1})+(1-\pi)\varepsilon_{f1}} \\ &< \frac{(1-\pi)\varepsilon_{f1}}{(1-\pi)(1-\varepsilon_{f1})+(1-\pi)\varepsilon_{f1}} \\ &< \varepsilon_{f1} \end{aligned} \tag{4}$$

$$\begin{aligned} \hat{\varepsilon}_{f2} &= \Pr(\text{bad}|\text{older+uninformative}) \\ &= \frac{\Pr(\text{older+nothing}|\text{bad})\Pr(\text{bad})}{\Pr(\text{older+uninformative})} \\ &= \frac{(1-\pi)\varepsilon_{f2}}{(1-\varepsilon_{f2})+(1-\pi)\varepsilon_{f2}} \\ &< \frac{(1-\pi)\varepsilon_{f2}}{(1-\pi)(1-\varepsilon_{f2})+(1-\pi)\varepsilon_{f2}} \\ &< \varepsilon_{f2} \end{aligned} \tag{5}$$

So, when a background check on a woman has been uninformative, the probability that she has 'bad character' declines but remains positive, in case of both young women and older women. In summary, we have established the following results.

**Summary 1** $\varepsilon_{f1} = \varepsilon_f$ *and* $\varepsilon_{f2} > \varepsilon_f$*;*

$\varepsilon_{f2} > \varepsilon_{f1}$ *and* $\hat{\varepsilon}_{f2} > \hat{\varepsilon}_{f1}$*;*

$\hat{\varepsilon}_{f1} < \varepsilon_{f1}$ *and* $\hat{\varepsilon}_{f2} < \varepsilon_{f2}$ *if the background check has been uninformative;*

$\hat{\varepsilon}_{f1} = \hat{\varepsilon}_{f2} = 1$ *if the background check has revealed bad character.*

Next, let us consider whether a matched man and woman would be willing to proceed with a marriage after a background check has been performed (step 5 within each period of the game described in Section 3.1). This decision depends on their outside options, which we can derive as follows.

**Composition of Marriage Market Segments**: Given a sequence $\{\theta_t\}_{t=0}^{\infty}$, we can also determine the number of men and women in each marriage market segment in each period $t$ (which, in turn, determine the match probabilities). In period $t$, by assumption, all females born in period $t - T_p$ enter the marriage market segment for young brides. Similarly, in period $t$, all males born in period $t - T_p - 1$ enter the marriage market. Thus, $n_{f1}(t)$ and $n_m(t)$ depend simply on the initial population and the fertility growth rate $\kappa$. To fix ideas, let us denote by $y$ the size of the male cohort on the marriage market in period 0; i.e. $n_m(0) = y$. Given a fertility growth rate of $\kappa$, the size of the young female cohort on the marriage market is given by $n_{f1}(0) = \kappa y$. The number of older women on the marriage market in period $t$ depends on the number of young women who failed to marry in period $t - 1$. In particular, we have

$$n_{f2}(t+1) = [1 - \lambda_1(t) + \lambda_1(t)\varepsilon\pi]\, n_{f1}(t) \text{ for } t = 0, 1, 2, .. \tag{6}$$

The logic behind (6) is as follows: if a fraction $\lambda_1(t)$ of young women are matched with men in period $t$, then a fraction $\lambda_1(t)\varepsilon\pi$ will be discovered to have 'bad character'. Therefore, those who remain on the marriage market in the next period would include those who were not matched, numbering $(1 - \lambda_1(t))\, n_{f1}(t)$ and those who were found to have 'bad character', numbering $\lambda_1(t)\varepsilon\pi y$.

**Outside Options:** Let us denote by $v_{f2}$ the outside option of older women on the marriage market. An older woman who does not marry in the current period will remain single hereafter. Therefore, her outside option is given by

$$v_{f2} = \zeta \underline{u}_f$$

where $\zeta = \frac{1-\beta^{(T-T_p)}}{1-\beta}$. A young woman who does not marry in the current period will re-enter the marriage market as an older woman. If her probability of marrying as an older bride equals $\hat{\lambda}_2$, then her outside option is given by

$$\begin{aligned} v_{f1}\left(\hat{\lambda}_2\right) &= \underline{u}_f + \beta\zeta\left\{\hat{\lambda}_2 u_f(\tau_2, \varepsilon_m) + \left(1-\hat{\lambda}_2\right)\underline{u}_f\right\} \\ &= \left\{1 + \beta\zeta\left(1-\hat{\lambda}_2\right)\right\}\underline{u}_f + \beta\zeta\hat{\lambda}_2 u_f(\tau_2, \varepsilon_m) \end{aligned} \tag{7}$$

For young women of good character, $\hat{\lambda}_2 = \lambda_2$ (i.e. her probability of finding a match on the marriage market when she is older) but for young women of bad character, we have $\hat{\lambda}_2 = \lambda_2(1-\pi)$ because they face a risk of having their bad character revealed if they remain in the marriage market till they are older, make another match, and undergo another background check.

Let us denote by $v_m$ the outside option of older men on the marriage market (since young men do not marry by assumption, we need not consider their outside options for the analysis). An older man who does not marry in the current period will remain single hereafter. Therefore, his outside option is given by

$$v_m = \zeta \underline{u}_m$$

By Assumption 6, if the background check reveals bad character, there is no marriage contract such that both parties will prefer marriage with the currently matched partner to remaining single the rest of their lives. Therefore, they would not be willing to proceed with the marriage negotiations. By Assumption 7, if the background check has been uninformative, both parties will anticipate that a negotiated marriage contract in the current period (based on the Nash Bargaining Solution) will generate a higher expected continuation utility than refusing the current marriage prospect. Therefore, they will choose to proceed with the marriage negotiations.

**Marriage Transfers:** Next, we consider the terms of the negotiated marriage contract. The marriage transfers are given by the Nash Bargaining Solution which, in turn, depends on the outside options of the potential bride and groom. Note that all men on the marriage market have identical outside options and all older women on the marriage market have identical outside options. Therefore, all marriages involving older women will have identical transfers which we denote by $\tau_2$. Using the Nash Bargaining Solution, we obtain

$$\tau_2 = \arg\max_{\tau} \{\zeta u_m(\tau, \hat{\varepsilon}_{f2}) - v_m\} \{\zeta u_f(\tau, \varepsilon) - v_{f2}\} \tag{8}$$

In the case of young women, the outside option depends on their quality as discussed above. But their true quality is not known to the groom's party during the bargaining process beyond what is revealed through the background check. As discussed in the preceding section, brides of good and bad character have the same outcome from the bargaining process and the bargaining solution depends on the *expected* value of the outside option of young women, $\mathbf{E}v_{f1}\left(\hat{\lambda}_2\right)$. Then, all young women will have identical transfers which we denote by $\tau_1$. Using the Nash Bargaining Solution, we obtain

$$\tau_1 = \arg\max_{\tau} \{\zeta u_m(\tau, \hat{\varepsilon}_{f1}) - v_m\} \left\{\zeta u_f(\tau, \varepsilon) - \mathbf{E}v_{f1}\left(\hat{\lambda}_2\right)\right\} \tag{9}$$

**Choice of Marriage Market Segment:** Given the expressions for the outside options and marriage transfers derived above, we can analyse the choice of marriage market segment (step 2 within each period of the game) for men on the marriage market.

For a man who opts for the marriage market segment for young brides, a match occurs with probability $\mu\left(\frac{n_{f1}}{\theta n_m}\right)$, and the potential bride is found to have bad character with probability $\pi\varepsilon_{f1}$. Therefore, the man contracts a marriage with probability $\mu\left(\frac{n_{f1}}{\theta n_m}\right)(1-\pi\varepsilon_{f1})$. From this outcome, he receives a continuation utility of $\zeta u_m(\tau_1, \hat{\varepsilon}_{f1})$. Therefore, the expected utility from choosing the marriage market segment for young brides is given by

$$U_1 = \mu\left(\frac{n_{f1}}{\theta n_m}\right)(1-\pi\varepsilon_{f1})\,\zeta u_m(\tau_1, \hat{\varepsilon}_{f1}) + \left[1 - \mu\left(\frac{n_{f1}}{\theta n_m}\right)(1-\pi\varepsilon_{f1})\right] v_m \tag{10}$$

Similarly, a man who opts for the marriage market segment for older brides contracts a marriage with probability $\mu\left(\frac{n_{f2}}{\theta n_m}\right)(1-\pi\varepsilon_{f2})$. From this outcome, he receives a continuation utility of $\zeta u_m(\tau_2, \hat{\varepsilon}_{f2})$. Therefore, the expected utility from seeking an older bride is given by

$$U_2 = \mu\left(\frac{n_{f2}}{\theta n_m}\right)(1-\pi\varepsilon_{f2})\,\zeta u_m(\tau_2, \hat{\varepsilon}_{f2}) + \left[1 - \mu\left(\frac{n_{f2}}{\theta n_m}\right)(1-\pi\varepsilon_{f2})\right] v_m \tag{11}$$

From equation (10), we can see that the expected utility to men from the choice of marriage market segment for young brides, $U_1$, depends on $\theta_t$. The outside option of young brides, and therefore the equilibrium marriage payments, depend on the marriage prospects of older women in the *next* period. Thus, the value of $U_1$ in period $t$ also depends on $\theta_{t+1}$. All other terms on the right-hand side of (10) are exogenously given. Therefore, we can write the expected utility from stating a preference for a young bride as a function $U_1(\theta_t, \theta_{t+1})$.

Similarly, from equation (11), we see that the expected utility to men on the marriage market in period $t$ from the choice of marriage market segment for older brides, $U_2$, also depends on $\theta_t$. The reputation of older brides, and therefore the utility from marrying older brides depends on the proportion of young women who were married in the *previous* period. Thus, the value of $U_2$ in period $t$ also depends on $\theta_{t-1}$. All other terms on the right-hand side of (11) are exogenously determined. Therefore, we can write the expected utility from seeking an older bride as a function $U_2(\theta_t, \theta_{t-1})$.

It is straightforward to establish the following results.

**Lemma 1** *(i) Under Assumption 4,* $U_1(\theta_t, \theta_{t+1})$ *is strictly decreasing in* $\theta_t$ *and* $U_2(\theta_t, \theta_{t-1})$ *is strictly increasing in* $\theta_t$.

*(ii) Under Assumptions 1,* $U_1(\theta_t, \theta_{t+1})$ *is strictly increasing in* $\theta_{t+1}$.

*(iii) Under Assumption 3,* $U_2(\theta_t, \theta_{t-1})$ *is strictly decreasing in* $\theta_{t-1}$.

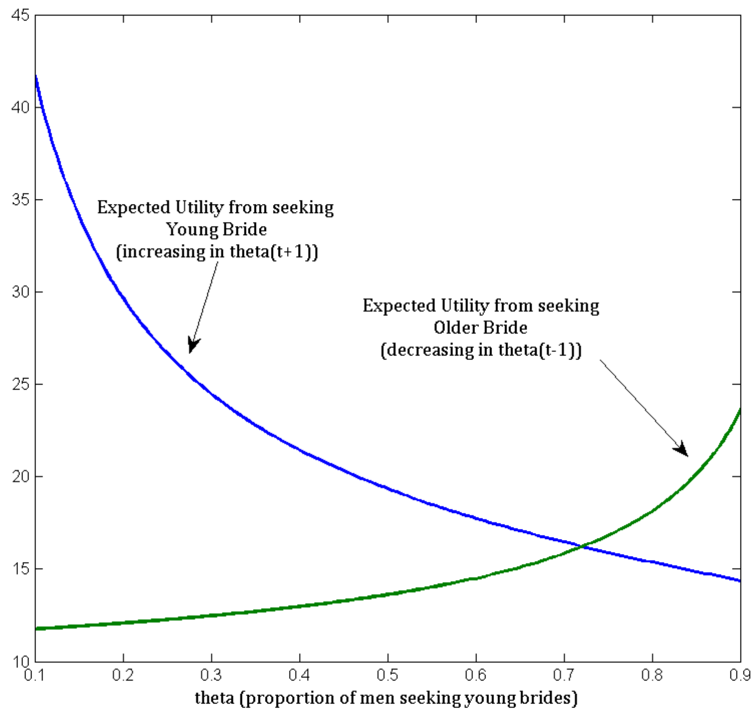
***Proof.*** *See Appendix A.* ■

The first part of Lemma 1 follows directly from the properties of the functions $u_m(.,.)$ and $\mu(.)$. The second part of Lemma 1 has the following intuition: as the future marriage prospects of young women improve, they will require higher net marriage payments for marrying as young brides. Therefore, the expected utility to men from seeking young brides will decline. The third part of Lemma 1 has the following intuition: if a large fraction of men sought young brides in the preceding period, then the reputation of older women, and therefore the expected utility from seeking an older bride, is low in the current period.

If, in equilibrium, $\theta_t \in (0,1)$, then we must have $U_1(\theta_t, \theta_{t+1}) = U_2(\theta_t, \theta_{t-1})$. If not, some men would be able to improve their expected utility by searching in a different segment of the marriage market.[11] From Lemma 1(i), we see that $U_1(.)$ is monotonically decreasing, and $U_2(.)$ is monotonically increasing, in $\theta_t$. Therefore there is, at most, one value of $\theta_t \in [0,1]$ which satisfies the preceding equation, as in Figure 2.

[11] In equilibrium, men of good and bad character will, on average, pursue the same strategy; i.e. a fraction $\theta$ of each type seek young brides, or each type plays a mixed strategy, opting for the marriage market segment for young brides with probability $\theta$. If not, then potential grooms would be able to improve their perceived character simply by moving from one segment of the marriage market to another.

Figure 2: Expected Utility to Men from Seeking Different Types of Brides




Similarly, we can reason that if $\theta_t = 0$, we must have $U_1(0, \theta_{t+1}) \leq U_2(0, \theta_{t-1})$ and if $\theta_t = 1$, then $U_1(1, \theta_{t+1}) \geq U_2(1, \theta_{t-1})$. These arguments enable us to compute the equilibrium value of $\theta_t$ whenever $\theta_{t-1}$ and $\theta_{t+1}$ are known. For this purpose, let us define function $I : [0,1] \times [0,1] \longrightarrow [0,1]$ as follows:

**Definition 2**

$$I(\theta_{t-1}, \theta_{t+1}) = \begin{cases} \theta \text{ if } U_1(\theta, \theta_{t+1}) = U_2(\theta, \theta_{t-1}) \text{ for some } \theta \in [0,1] \\ 0 \text{ if } U_1(\theta, \theta_{t+1}) < U_2(\theta, \theta_{t-1}) \text{ for each } \theta \in [0,1] \\ 1 \text{ if } U_1(\theta, \theta_{t+1}) > U_2(\theta, \theta_{t-1}) \text{ for each } \theta \in [0,1] \end{cases}$$

In words, the function $I(\theta_{t-1}, \theta_{t+1})$ returns the fraction of men on the marriage market who seek young brides in period $t$ in equilibrium, if the corresponding proportions in periods $t-1$ and $t+1$ are given by $\theta_{t-1}$ and $\theta_{t+1}$ respectively. Using this definition, we can establish the following result.

**Proposition 1** *Given an initial value $\theta_0$, the sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$ together with beliefs given by (3), (4) and (5) constitutes an equilibrium if and only if $\theta_t = I(\theta_{t-1}, \theta_{t+1})$ for $t = 1, 2, ...$*

Proposition 1 provides a convenient characterisation of all possible equilibria in the marriage market and the different ways in which the marriage age for women may evolve over time when all individuals in the marriage market are choosing their best response. The proposition takes the initial value of $\theta$ as given because, by construction, the reputation and number of older women on the marriage market depends on the marriage decisions of men in the preceding period. Alternatively, we can take the initial reputation and number of older women on the marriage market as given but the two approaches are isomorphic.

The sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$ described in Proposition 1, together with the initial value $\theta_0$, is sufficient to provide a complete description of the marriage market from period 1 onwards including the number of men and women in each segment of the marriage market (using an initial cohort size $y$ as described above, the fertility growth rate parameter $\kappa$ and equation (6)) and their respective match probabilities (using (1) and (2)), beliefs regarding the character of older women on the marriage market (given by (3) and (5)), the outside option of young women on the marriage market (equation (7)), and the equilibrium marriage transfers (equations (9) and (8)).

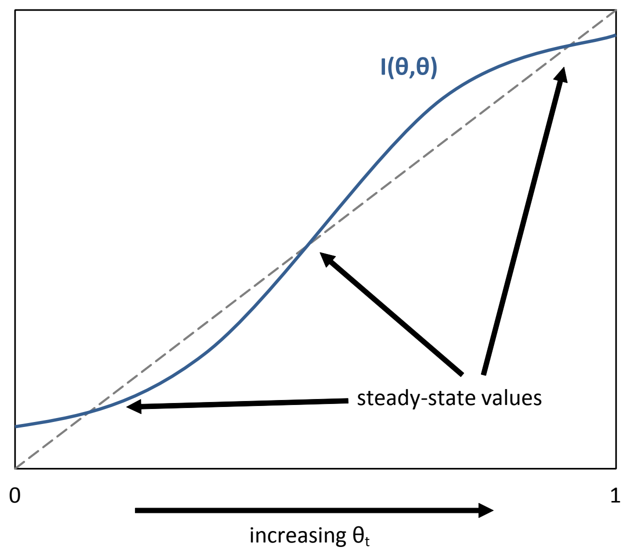
However, an assumption about the initial value of $\theta$ is not sufficient to generate a unique equilibrium path. For the same initial value $\theta_0$, there are potentially multiple sequences $\{\theta_\tau\}_{\tau=1}^{\infty}$ satisfying the condition in Proposition 1, i.e. multiple equilibrium paths. For example, a marriage market where there is an expectation of wide prevalence of early marriage in the future would have a different trajectory from another marriage market where there is an expectation of a wide prevalence of late marriage even if they start from the same initial conditions. For this reason, in the subsequent analysis, we focus on a particular kind of equilibrium which, we argue, has an intuitive appeal. This is the marriage market equilibrium path with "iterated expectations" presented in Section 3.4.

Before introducing this equilibrium refinement, we introduce the concept of a steady-state in the marriage market which is important for the subsequent analysis. We say that the marriage market is in steady-state if the proportion of men seeking young brides is the same in every period. If some $\theta \in [0,1]$ satisfies the equation $\theta = I(\theta, \theta)$, then there exists an equilibrium where the proportion of men seeking young brides is equal to $\theta$ in every period. We can establish that for any set of preferences, matching function, outside options, and parameters $\varepsilon$ and $\pi$, there is at least one steady-state:

**Lemma 2** *There exists at least one steady-state value $\theta \in [0,1]$; i.e. $I(\theta, \theta) = \theta$.*
***Proof.*** *See Appendix A.* ■

Figure 3 shows a possible plot of $I(\theta, \theta)$ against $\theta$. It follows from Lemma 1(i) that the curve is upward-sloping. At $\theta = 0$, it must lie on or above the 45-degree line and at $\theta = 1$, it must lie on or below the 45-degree line. From Lemma 2, we know that it must cross the 45-degree line at least once. Each value of $\theta$ where the curve crosses the 45-degree line constitutes a steady-state equilibrium. Thus, the marriage market has at least one and potentially, multiple, steady-state equilibria.

Figure 3: Steady-State Equilibria




## 3.4 Marriage Market Equilibria with Iterated Expectations

We noted above that an assumption about the initial value of $\theta$ is not sufficient to generate a unique equilibrium path in the marriage market with forward-looking beliefs. Therefore, in this section, we introduce an equilibrium refinement as follows. First, we compute, given an initial value of $\theta$, the evolution of the marriage market if people had 'naive' expectations; more precisely if, when making decisions in period $t$, they expect that the proportion of men seeking young brides in the next period will be the same as it was in the last: $\theta_{t+1} = \theta_{t-1}$. Next, we derive a second marriage market path where expectations about the future corresponded to the marriage market path obtained with 'naive' expectations; i.e. $E_t(\theta_{t+1}) = I(\theta_t, I(\theta_t, \theta_t))$. We iterate this process, in each step assuming that expectations about $\theta$ in future periods correspond to the $\theta$ values in the sequence derived in the preceding step.. We can show that the sequence of marriage market paths generated using this algorithm corresponds to a unique forward-looking equilibrium path. This is formally shown below. First, we introduce a formal definition for, and establish some key properties of, the Naive Expectations equilibrium.

**Definition 3** *Given an initial value $\theta_0$, the sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$ constitutes a Naive Expectations Equilibrium if, $\theta_t = I(\theta_{t-1}, \theta_{t-1})$ for $t = 1, 2, ...$*

**Proposition 2** *Given an initial value $\theta_0$, there is a unique sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$ that satisfies the criteria of a 'Naive Expectations' equilibrium. Furthermore,*

*(i) if $I(\theta_0, \theta_0) > \theta_0$, then $\{\theta_\tau\}_{\tau=1}^{\infty}$ is an increasing sequence which converges to the smallest steady-state in the interval $(\theta_0, 1]$;*

*(ii) if $I(\theta_0, \theta_0) < \theta_0$, then $\{\theta_\tau\}_{\tau=1}^{\infty}$ is a decreasing sequence which converges to the largest steady-state in the interval $[0, \theta_0)$;*

*(iii) if $\theta_0 = I(\theta_0, \theta_0)$, then $\theta_\tau = \theta_0$ for $\tau = 1, 2, ....$*

***Proof.*** *See Appendix A.* ■

Next, we show that the sequence of marriage market paths generated using the algorithm described above converges to a unique marriage market equilibrium path with forward-looking expectations.

**Proposition 3** *Suppose that the initial value $\theta_0$, together with the sequence $\left\{\theta_\tau^0\right\}_{\tau=1}^{\infty}$ constitutes a Naive Expectations Equilibrium. Let $\theta_1^\alpha = I\left(\theta_0, \theta_2^{\alpha-1}\right)$ and $\theta_\tau^\alpha = I\left(\theta_{\tau-1}^\alpha, \theta_{\tau+1}^{\alpha-1}\right)$ for $\alpha \in \{1, 2, ..\}$, $\tau \in \{2, 3, ..\}$. Let $\Theta = \{\lim_{\alpha\to\infty} \theta_\tau^\alpha\}_{\tau=1}^{\infty}$. The sequence $\Theta$ exists, is unique, and, together with initial value $\theta_0$, constitutes a marriage market equilibrium path. Furthermore, $\Theta$ is a monotonic sequence that converges to a steady-state.*
***Proof.*** *See Appendix A.* ■

We call the marriage market path generated by the iterative process described in Proposition 3 an equilibrium with 'iterated expectations'. The proposition establishes existence and uniqueness of the equilibrium. Also, the path is monotonic and it converges to a steady-state value. While it is only one of potentially many marriage market equilibria, we argue that it has an intuitive appeal because, if we iteratively make the individuals on the marriage market more sophisticated in forming their future beliefs, the corresponding sequences will converge to the marriage market equilibrium described in Proposition 3. For the subsequent analysis, this is our preferred equilibrium.

## 3.5 Path Dependence and Diverse Marriage Customs

As stated in Proposition 3, for a given initial value $\theta_0$, there is a unique equilibrium with 'iterated expectations'. Nevertheless, it suggests an explanation as to why different populations with the same characteristics – i.e. same preferences, outside options, matching process, and parameters $\varepsilon$ and $\pi$ – may have different rates of prevalence in early marriage at a point in time. The incidence of early marriage in two populations at some point in the past may have been different because of policies or shocks, even if these were transitory. In the model, we would represent such a scenario using different initial values $\theta_0$ for the two populations. Each value of $\theta_0$ generates a unique marriage market path (Proposition 3), and we can further show that distinct values of $\theta_0$ generate distinct paths in the marriage market (see Corollary to Proposition 3 in Appendix A).

Thus, the prevalence of early marriage can differ across populations because of historical differences in policies or shocks even if these populations are otherwise identical. In other words, there is path dependence in the marriage market. Furthermore, if the marriage market has multiple steady-state equilibria (as in Figure 3), then two populations that are otherwise identical may have very different marriage customs in permanence; for example (i) a steady-state equilibrium where most men seek young brides and most women marry early, older women on the marriage market have substantially worse reputations, and young women have a weak outside option (because they would have a low probability of marrying at an older age if they turn down a current marriage offer); (ii) a steady-state equilibrium where most men seek older brides and most women marry late, older women on the marriage market have reputations similar to that of young women, and young women have a strong outside option (because they would have a high probability of marrying at an older age if they turn down a current marriage offer).

## 3.6 Additional Properties of the Marriage Market Equilibrium

**Relationship between the Bride's Age and Net Marriage Transfers**: Although the model can generate dynamics in the marriage market as well as a multiplicity of equilibria, older brides always make higher net marriage transfers than young brides with one exception. Formally, we have the following result.

**Proposition 4** *In any marriage market equilibrium, in each period $t$, older brides make higher net marriage transfers than young brides, i.e. $\tau_1(t) < \tau_2(t)$ if $\theta_{t-1} > 0$ or $\theta_{t+1} < 1$; $\tau_1(t) = \tau_2(t)$ if $\theta_{t-1} = 0$ and $\theta_{t+1} = 1$.*

***Proof.*** *See Appendix A.* ■

The intuition behind Proposition 4 is as follows. If a positive fraction of men sought young brides in period $t-1$, then older women on the marriage market will have worse reputation than young women in period $t$. If a positive fraction of men are expected to seek older brides in period $t+1$, then young women have a better outside option than older women in period $t$. Both these effects will drive up the price of young brides relative to that of older brides. Conversely, older women on the marriage market have the same reputation and outside option as young women in period $t$ if all men sought older brides in period $t-1$ *and* all men are expected to seek young brides in period $t+1$, leading to the exception case indicated in the proposition. But this is unlikely to occur in any marriage market equilibrium. Proposition 4 is consistent with the stylised fact that, for women, delaying marriage requires a higher dowry payment (Field and Ambrus 2008; Amin and Bhajracharya 2011).

**Negative Externalities from Early Marriage:** We can use the steady-state equilibrium to illustrate the inefficiency that is inherent in the marriage market. Consider a woman who accepts an offer of marriage when young. By doing so, she adversely affects the reputation of – and therefore the net marriage transfer required from – those who marry late (either because they declined offers of early marriage, or because they were not matched while young). Thus, accepting an offer of early marriage imposes a negative externality on women who marry later, which is not internalised in the marriage market equilibrium.

A hypothetical way of internalising this cost would be to impose a fee for accepting offers of early marriage equal to the resulting increase in net marriage payments required from older brides (the collected fees subsequently being used to subsidise the cost of marrying late). It is evident that such a policy would discourage young women from accepting offers of early marriage and cause those at the margin to decline such offers. In order words, a policy which leads to an internalisation of the negative externality would tend to lower the proportion of early marriages.

**The Role of Reputational Effects in Early Marriage:** The key feature of the model that creates a pressure for early marriage is the reputational effects associated with older women on the marriage market. The probability with which a background check can detect 'bad character' among potential brides, $\pi$, determines the importance of these reputational effects.

Intuitively, we can reason that a change in $\pi$ would have the following effects. Decreasing $\pi$ improves the reputation of older women on the marriage market in period $t$ for any given $\theta_{t-1}$ and $x_{t-1}$. Furthermore, it improves the outside option of young women in period $t$ for any given $\theta_{t+1}$ and $x_t$, as it improves their next period reputation were they to re-enter the marriage market. Therefore, they are more inclined to decline offers of early marriage and they can bargain for more favourable marriage transfers. From the perspective of potential grooms, this lowers the expected utility of seeking young brides and raises the expected utility of seeking older brides in period $t$ for any given $\theta_{t-1}$, $x_{t-1}$ and $\theta_{t+1}$. These changes creates a shift towards later marriage in equilibrium. Proposition 5 provides a formalisation of this reasoning by comparing the set of steady-state equilibria for different values of $\pi$.

**Proposition 5** *Suppose* $\pi_1, \pi_2 \in [0, 1)$ *and* $\pi_1 < \pi_2$*. For every steady-state in the marriage market under* $\pi = \pi_2$ *where the proportion of men seeking young brides is above 0, there exists a steady-state under* $\pi = \pi_1$ *where a smaller proportion of men seek young brides. For every steady-state in the marriage market under* $\pi = \pi_1$ *where the proportion of men seeking young brides is below 1, there exists a steady-state under* $\pi = \pi_2$ *where a higher proportion of men seek young brides.*

***Proof.*** *See Appendix A.* ■

If $\pi = 0$, then age does not provide any signal about the 'quality' of potential brides in the marriage market, and there are no reputational effects from delaying marriage. Then, according to Proposition 5, we obtain a steady-state equilibrium with a lower incidence of early marriage than for any $\pi \in (0, 1)$. This illustrates the role of the reputational effects discussed earlier in sustaining the practice of early marriage. In the Section 5, we conduct a moment-matching exercise for the marriage market in Bangladesh to obtain values for key parameters of the model including $\pi$ and can thus assess the importance of these reputational effects.

# 4 Turning Down Marriage Offers and Agent Heterogeneity

The possibility of path dependence and multiple steady-states highlighted above raises the question whether and how the marriage market can be moved from a situation where there is a wide prevalence of early marriage to one where it is rare (or the transition process is accelerated). The type of policies discussed in the introduction can affect the marriage market by expanding the opportunities for adolescent girls outside of marriage (e.g. in education or employment). In particular, these policies may induce adolescent girls with marriage offers to turn them down to pursue these opportunities which, as we will show, has dynamic effects on the marriage market.

To explore the effects of such policies within the model, in this section we relax Assumption 7, which would mean that for some matches on the marriage market, there may be no possible contract that satisfies both parties. To capture situations where some, but not all, young women may find it in their interest to turn down marriage offers, we allow utility from remaining single while young to vary across individuals. This may be due to differences in opportunities or prospects. Specifically, let $\underline{u}_{f1} = \overline{x} + \psi$ where $\overline{x}$ is a constant common to all individuals and $\psi$ is distributed across individuals according to the cumulative distribution function $F(.)$.[12] We assume that $\psi$ is observed by the groom's party when a match is made. Then, we can

[12] In a similar fashion, we could extend the model to introduce heterogeneity in the wealth or preferences of men. This can lead to men with different characteristics opting for different types of brides but not impact upon the main dynamics related to early marriage. Therefore, for ease of exposition, we abstract away from groom heterogeneity in this paper.

establish the following result.

**Lemma 3** *Suppose that a young woman with utility from singlehood equal to $\underline{u}_{f1}$ is matched with a potential groom. Then, there exists a threshold value $x$ such that a marriage contract acceptable to both parties is negotiated if and only if $\underline{u}_{f1} \geq x$. The same threshold applies whether the young woman has good or bad character.*

**Proof.** See Appendix A. ■

If there are some young women above the threshold $\overline{x}$ (i.e. $F(x - \overline{x}) < 1$), this has two implications for the marriage market. First, a potential groom is less likely to be matched with a young bride with whom a marriage contract can be negotiated. The probability of marriage for men in the marriage market segment for young brides will be given by

$$\mu\left(\frac{n_{f1}}{\theta n_m}\right)(1 - \pi\varepsilon_{f1}) F(x - \overline{x})$$

where $\theta$, as before, is the proportion of men who seek young brides. Second, if some women are postponing marriage when they are young, it provides an alternative reason why older women may be single (other than the two reasons discussed above: not being matched with a potential groom and being found to have 'bad character'); and, consequently, the reputation of older women on the marriage market would improve. Specifically, it is given as follows:

$$\begin{aligned} \varepsilon_{f2} &= \Pr(\text{bad}|\text{older}) \\ &= \frac{\Pr(\text{older}|\text{bad})\Pr(\text{bad})}{\Pr(\text{older})} \end{aligned}$$

$$\Longrightarrow \varepsilon_{f2} = \frac{\varepsilon_f[(1-\lambda_1) + \lambda_1\pi + \eta\lambda_1(1-\pi)]}{(1-\varepsilon_f)[(1-\lambda_1) + \eta\lambda_1] + \varepsilon_f[(1-\lambda_1) + \lambda_1\pi + \eta\lambda_1(1-\pi)]} \tag{12}$$

where $\eta = 1 - F(x - \overline{x})$ denotes the proportion of young women who turned down offers of marriage in the preceding period. If $\eta = 0$, the expression in (12) is identical to that in (3). As $\eta$ increases, $\varepsilon_{f2}$ declines; i.e. there is a fall in the probability of 'bad character' among older women on the marriage market. In addition, the number of older women in the marriage market will go up with the proportion of young women who declined offers of marriage in the *preceding* period (represented by $\eta'$ below):

$$n_{f2} = [1 - \lambda_1 + \lambda_1\varepsilon_f\pi + \eta'\lambda_1(1 - \varepsilon_f\pi)]\, y \tag{13}$$

Equations (18) and (12) together yield, for given $\theta_t$ and $\theta_{t+1}$, the threshold value $x_t = \hat{x}(\overline{x}, \theta_t, \theta_{t+1})$ above which young women turn down offers of marriage and the proportion of women who do so, $\eta_t = 1 - F(x_t - \overline{x})$. (We suppress the parameter $\overline{x}$ in the function $\hat{x}(.)$ hereafter in this section for ease of notation).

As per the reasoning above, the expected utility to potential grooms from seeking a young bride, in a given period $t$, will depend on $x_t$ while the expected utility from seeking an older bride will depend on $x_{t-1}$ since it determines, as per (12), the reputation of older women in the current period. We can therefore represent the expected utilities by $\hat{U}_1(\theta_t, \theta_{t+1}, x_t)$ and $\hat{U}_2(\theta_t, \theta_{t-1}, x_{t-1})$ respectively. Using these expected utility functions, we can define a function $\hat{I}(.)$ akin to the function $I(.)$ introduced in Section 3.3:

**Definition 4**

$$\hat{I}\left(\theta_{t-1}, x_{t-1}, \theta_{t+1}\right) = \begin{cases} \theta \text{ if } \hat{U}_1\left(\theta, \theta_{t+1}, x_t\right) = \hat{U}_2\left(\theta, \theta_{t-1}, x_{t-1}\right) \text{ for some } \theta \in [0,1] \\ 0 \text{ if } \hat{U}_1\left(\theta, \theta_{t+1}, x_t\right) < \hat{U}_2\left(\theta, \theta_{t-1}, x_{t-1}\right) \text{ for each } \theta \in [0,1] \\ 1 \text{ if } \hat{U}_1\left(\theta, \theta_{t+1}, x_t\right) > \hat{U}_2\left(\theta, \theta_{t-1}, x_{t-1}\right) \text{ for each } \theta \in [0,1] \end{cases}$$

*where* $x_t = \hat{x}\left(\theta, \theta_{t+1}\right)$.

Using the definition of $\hat{I}\left(\theta_{t-1}, x_{t-1}, \theta_{t+1}\right)$, we can provide a characterisation of equilibria as follows.

**Proposition 6** *Given initial values* $\theta_0$ *and* $x_0$*, a sequence* $\{\theta_\tau, x_\tau\}_{\tau=1}^{\infty}$ *constitutes a marriage market equilibrium if and only if, we have* $\theta_t = \hat{I}\left(\theta_{t-1}, x_{t-1}, \theta_{t+1}\right)$*, and* $x_t = x\left(\theta_t, \theta_{t+1}\right)$*, for* $t = 1, 2, ....$

There exists a steady-state equilibrium at $\theta \in [0,1]$ if and only if $\theta = \hat{I}(\theta, x, \theta)$ where $x = \hat{x}(\theta, \theta)$. In other words, if the proportion of men seeking young brides, and the threshold value above which women decline offers of marriage, are equal to $\theta$ and $\hat{x}(\theta, \theta)$ respectively in some period, and $\theta = \hat{I}(\theta, \hat{x}(\theta, \theta), \theta)$, then there exists an equilibrium where these values remain the same in all future periods.

## 4.1 The Effects of Policy Changes and Shocks on the Marriage Market

In this section, we address the question how policy changes or shocks that change the outside options of young brides affect the marriage market. The result we highlight is that even policies and shocks that have transitory effects – i.e. affect some cohorts on the marriage market only – can have a long-term effect on the marriage market equilibrium path. To make the result stark, we consider the case where there is a change in the outside option for one cohort only as described in the following proposition.

**Proposition 7** *Suppose that* $\{(\theta_t, x_t)\}_{t=0}^{\infty}$ *is a marriage market equilibrium path with iterated expectations. A transitory shock which improves (worsens) the outside option for young women entering the marriage market in period* $\tau$ *would induce an alternative marriage market equilibrium path with iterated expectations* $\left\{\left(\tilde{\theta}_t, \tilde{x}_t\right)\right\}_{t=\tau}^{\infty}$ *where* $\tilde{\theta}_t \leq \theta_t$ *and* $\tilde{x}_t \leq x_t$ *(*$\tilde{\theta}_t \geq \theta_t$ *and* $\tilde{x}_t \geq x_t$*) for* $t \geq \tau$ *and strict inequality from period* $\tau + 2$ *onwards.*

***Proof.*** *See Appendix A.* ■

The intuition behind Proposition 7 is as follows. A shock which improves the outside option for young women in period $\tau$ would induce some fraction of them to refuse marriage offers that they would have otherwise accepted. Their refusals improve the reputation of older women on the marriage market in the next period. Therefore, in period $\tau + 1$, a higher fraction of men seek younger brides than in the initial equilibrium path which, in turn, improves the reputation of older women in the following period and the cycle continues. Thus, a policy targeted at – or a shock experienced by – one cohort of adolescent girls only affects the marriage market prospects of future cohorts as well.

These effects apply whether, when the shock occurs, the marriage market is in steady-state or on a dynamic path towards a steady-state. If the initial shock is large enough – and there are multiple steady-states – then it may lead the marriage market towards a new steady-state with a lower incidence of early marriage.

If the marriage market has only one steady-state then the effects of the shock depends on whether the current incidence of early marriage was above, at or below that implied by the steady-state. If it was below, then the shock accelerates the evolution towards the steady-state; while if it is below, the shock decelerates the evolution towards it. If the marriage market was in steady-state when the shock occurred, then it moves onto a dynamic path with a lower incidence of early marriage before eventually returning to the same steady-state.

Additionally, Proposition 7 implies that, in the case of a policy which applies to successive cohorts, the full effect of the policy will not be evident in the initial cohorts who are exposed to it.

# 5 An Application to Early Marriage in Bangladesh

In the preceding sections, we developed an overlapping-generations model of marriage timing and provided a theoretical characterisation of the marriage market equilibrium within this model. In this section, we explore how well such a model can explain phenomena related to early marriage, in particular changes in the incidence of early marriage over time. We also use the model to provide insights about how the incidence of early marriage would respond to government interventions and demographic shocks.

For the numerical analysis, we calibrate the model using the context of Bangladesh. The assumptions of the model are, arguably, a good approximation of the key marriage patterns in Bangladesh, which is characterised by low incidence of divorce and polygamy, and high rates of exogamy.[13] According to the figures available from the latest Demographic and Health Survey, about 65% of women aged 20-24 years were married by the age of 18 (NIPORT 2013) and Bangladesh has one of the highest rates of early marriage for women in the world today (UNFPA 2012). The 1929 Child Marriage Restraint Act imposed a minimum age of marriage, which is presently 18 for women and 21 for men. However, this law is frequently ignored and rarely enforced. For adolescent girls in Bangladesh, marriage brings about a sudden change in roles and responsibilities. It typically involves leaving school and withdrawing from the labour market to undertake household duties (Amin et al. 2014; Amin, Mahmud & Huq, 2002).

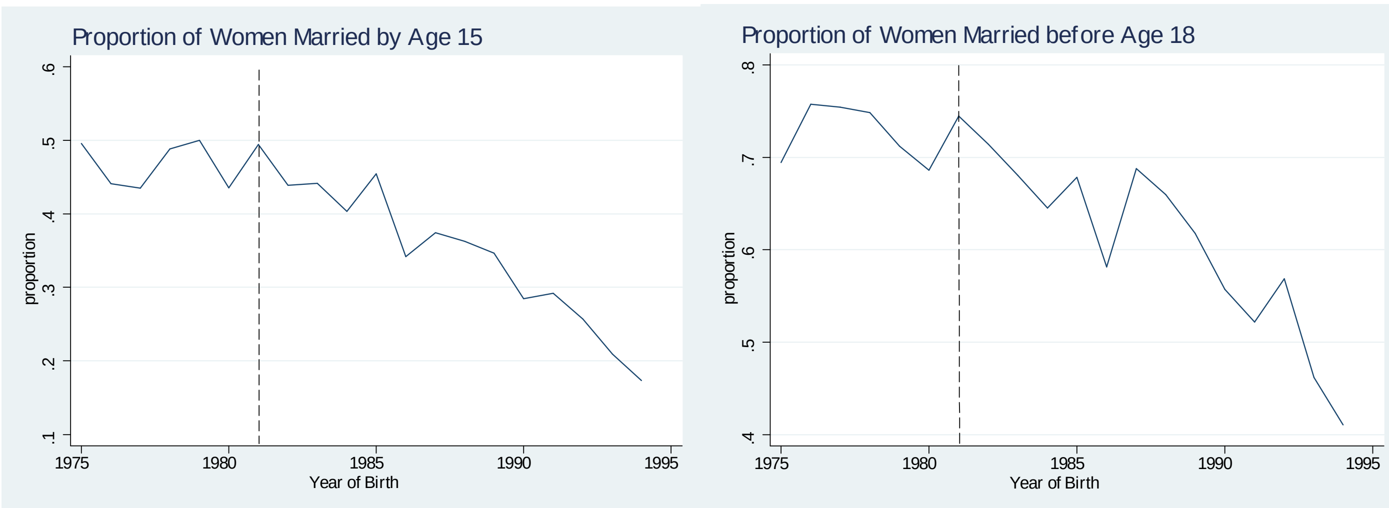
Despite the high incidence of early marriage among women in Bangladesh today, it is important to recognise that the average age of marriage has not been stationary. The following figures show how the incidence of early marriage among girls in Bangladesh has evolved over a twenty-year period, using data from the Bangladesh Women's Life Choices and Attitudes Survey (WiLCAS 2014).[14] We see that for cohorts born between 1975 and 1981, the proportions marrying early were more or less constant, but it has declined for each of the subsequent cohorts. This decline has been attributed to both decreased cost of schooling for girls as a result of government initiatives on tuition and stipend programmes (Schurmann 2009, Asadullah and Chaudhury 2009) as well as increased labour market opportunities for women, in particular

[13] In the 2011 Bangladesh Demographic and Health Survey, among women aged 15-49 years, 1% are divorced. Among married men in the same age group, less than 1% are in polygynous marriages (NIPORT 2013). As for exogamy, we find among married female respondents (aged 20-39 years) in the 2014 Bangladesh WiLCAS that 88% had no family connection with their husband prior to marriage.

[14] The Bangladesh WiLCAS 2014 is a nationally representative survey of women aged 20-39 years with information on education, employment, marriage, childbirth, and beliefs and attitudes funded by Australian Aid through the Australian Development Research Awards Scheme. Further information about the survey can be obtained from Asadullah and Wahhaj (2017).

in the ready-made garments sector (Heath and Mobarak 2015).

Figure 4: Incidence of Early Marriage across Birth Cohorts




Recent data shows that, except for a small fraction, most women in Bangladesh today marry after reaching menarche (Asadullah and Wahhaj 2017). But older demographic surveys indicate that pre-pubescent marriages were the norm at least until the first part of the mid-twentieth century (see, for example, Schultz and DaVanzo 1970). The literature suggests that there has been a gradual shift in the norm from pre-pubescent to post-pubescent marriage in South Asia, with social pressures to marry off girls before menarche giving away, initially, to an acceptance that the procedure could be postponed until menarche (Caldwell, Reddy, Caldwell 1983).

## 5.1 Evidence regarding Moral Behaviour

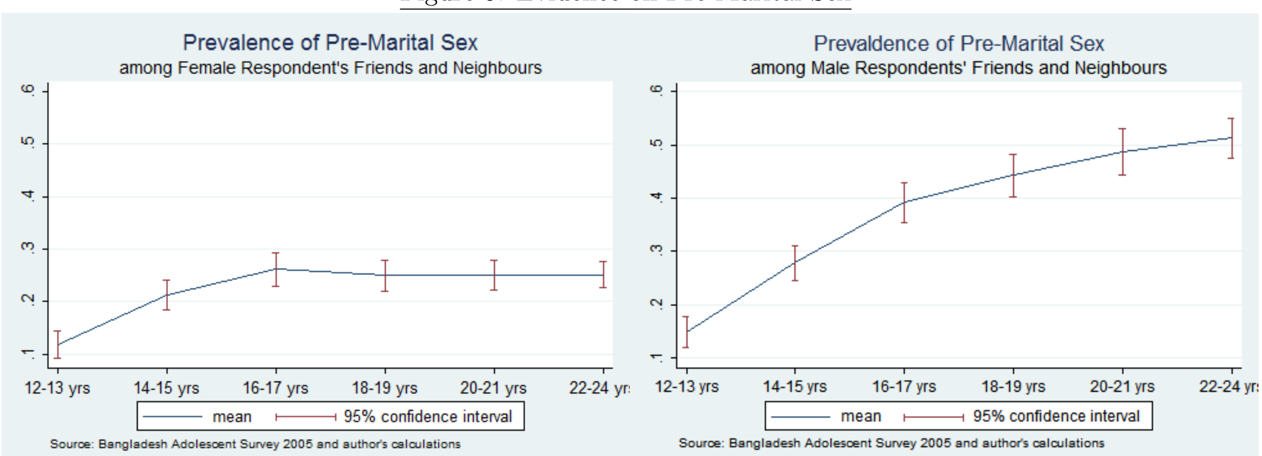
Before proceeding to the numerical analysis, we provide some empirical evidence on the significance of ‘purity’ or ‘moral character’ in the lives of rural Bangladeshi women. In Section 2, we referenced the sociological literature to argue that these concepts were closely related to the sexual behaviour of the women concerned. It is rare for a large-scale survey in Bangladesh to include questions on sexual behaviour outside of marriage. One survey which included such questions is the Bangladesh Adolescent Survey (BAS), a nationally representative survey of 10-24 year olds, conducted by the Population Council in 2005.[15] The BAS included the question "Do you know of anyone among your friends and neighbours who had sexual experiences prior to marriage?", to which 28% of boys/men (N = 5,119) and 17% of girls/women (N = 6,867) answered "yes". This is followed by the question "What are reasons/causes for pre-marital sex", to which 18% of male respondents and 36% of female respondents responded "one’s own bad behaviour" (up to three reasons could be provided). In the Bangladesh Demographic and Health Surveys (BDHS), (ever-married) male and female respondents are asked about their own sexual behaviour and, in particular, the age at which

[15] Gani (2007) provides a detailed description of the survey.

they initiated sexual activity. In contrast to the figures from the BAS, none of the women in the BDHS report engaging in premarital sex although some men do (NIPORT 2013, 2016). The combined evidence from the BAS and BDHS indicates that while some fraction of women engage in pre-marital sex, they are unwilling to admit to such behaviour in a formal survey, possibly to avoid judgement by the enumerator or the risk of this information becoming more widely known. Thus, pre-marital sex appears to be a social taboo for women.

Figure 5 shows the proportion of respondents in the BAS who answered yes to the question on the sexual experiences of friends and neighbours according to the respondents' age and gender. In the case of male respondents, the proportion increases steadily with age, from about 15% among 12-13 year-olds to 51% among 22-24 year-olds. By contrast, for female respondents, the proportion increases till the age group of 16-17 year-olds and remains on a plateau thereafter. If we assume that the respondents are reporting on the behaviour of friends of the same gender and of a similar age, these patterns are consistent with the idea that the women who experience pre-marital sex have already done so by the time they are 18, and the remaining women do not engage in sex till after marriage. In other words, a fixed proportion of women have the *propensity* to engage in pre-marital sex; i.e. the behaviour is driven by a fixed character trait. As described above, more than a third of female adolescent respondents to the BAS are willing to make a moral judgement regarding those who do, and it is reasonable to assume that this type of judgement will be at least as widespread on the marriage market. Furthermore, while the survey questions focus specifically on pre-marital sex, in practice these moral judgements are likely to apply to a wider set of behaviour as discussed in Section 3.2.

Figure 5: Evidence on Pre-Marital Sex




## 5.2 Model Calibration

We calibrate the model based on the marriage market conditions for women born between 1975 and 1982. Since the incidence of early marriage was relatively stable during this period (as noted above) we assume, for the purpose of this calibration, that the marriage market is in steady-state. Table 1 shows the functional forms used for the numerical analysis: the utility function is linear and the matching function takes a Cobb-

Douglas form. It is straightforward to verify that these functional forms satisfy Assumptions 1-5. The functional form for the matching function is motivated by the use of log-linear functions for the estimation of matching functions, and evidence found in favour of constant returns to scale, in a wide range of studies (see Mortensen and Pissarides 1999; and Petrongolo and Pissarides 2001).

We let $m_0 = 0.90$ which implies that when there are equal number of men and women in one segment of the marriage market, 90% of them find matches. The assumption of a high match probability is reasonable given that each search period in the model corresponds to 4.5 years. The qualitative findings from simulating the model, discussed below, is not sensitive to the precise value assumed for $m_0$.

The values of the functional parameters $\pi$, $\sigma$ and $\gamma$ are chosen to match the steady-state values to key moments in the data; specifically, the proportion of women who have early marriages, the ratio of equilibrium marriage transfers for older brides to that for younger brides, and the proportion of women who remain unmarried at the end of their second period in the marriage market. The full set of data moments that enter the numerical analysis, as well as the data sources, are shown in Table 2.

Table 1: Functional Form Assumptions for Numerical Analysis

| Function | Functional Form Used | Parameter Values |
|---|---|---|
| Utility | $\tilde{u}_m(\tau, c_f) = \tau + \sigma c_f$<br>$\tilde{u}_f(\tau, c_m) = -\tau + \sigma c_m$ | $\sigma$ estimated |
| Matching Function | $f(n_m, n_f) = m_0 (\theta n_m)^\gamma (n_f)^{1-\gamma}$<br>$\theta n_m \mu\left(\frac{n_f}{\theta n_m}\right) = f(n_m, n_f)$ | $m_0 = 0.9$, $\gamma$ estimated |

Table 2: Data-Moments

| Data Moment | Value | Source |
|---|---|---|
| % Married before 18, Females born 1975-82 | 72.05% | 2014 WiLCAS |
| Mean Dowry for Brides < 18, Females born 1975-82 | Tk 7,131 | 2014 WiLCAS |
| Mean Dowry for Brides >= 18, Females born 1975-82 | Tk 14,887 | 2014 WiLCAS |
| Std. dev. of Dowry, Brides < 18, born 1975-82 | Tk 36,713 | 2014 WiLCAS |
| Females 15-19 yrs, 1980 | 6.474m | UN Pop. Div.[16] |
| Females 20-24 yrs 1980 | 5.501m | UN Pop. Div. |
| Males 15-19 yrs, 1980 | 6.695m | UN Pop. Div. |
| Males 20-24 yrs, 1980 | 5.701m | UN Pop. Div. |
| % Never Married, Female 25-29 yrs | 2.2% | 1993/94 DHS |

Recall that the utility obtained from being single during one period, represented by $\underline{u}_m$, $\underline{u}_{f1}$ and $\underline{u}_{f2}$ in the model, are exogenously given. For older women, we set the utility from remaining single equal to that derived from marriage to a man of 'bad character' with zero transfers. This assumption is intended to capture the strong social pressures of marriage for women and can be backed by anecdotal evidence on women unwilling to leave husbands who are prone to abuse and violence.[17] For men, we set the utility from remaining single equal to that derived from marriage to a woman of 'bad character' and a positive transfer equal to 1 unit. This is intended to capture the asymmetry in social pressures and economic opportunities between men and women, as well as provide a precise meaning for a 1 unit transfer. Finally, given that educational and economic opportunities were limited for both young and older women during the period

[16] World Population Prospects: The 2012 Revision
[17] See, for example, Bloch and Rao (2002).

under consideration, we fix $\underline{u}_{f1} = \underline{u}_{f2}$: i.e. the utility from singlehood is the same for young women and older women (Note that, where there is a positive incidence of early marriage, young women on the marriage market will, nevertheless, have better outside options then older women because they have higher chances of being married). We also fix $\eta = 0$ for the moment-matching exercise – i.e. we assume that no marriage offers are refused in the initial steady-state but we allow $\eta$ to adjust for the subsequent simulations.

In addition, we set $\beta = 0.77$ and $\varepsilon = 0.05$. Given that each period in the model corresponds to 4.5 years, the value assumed for $\beta$ represents an annual discount factor of 0.94, which is broadly in line with assumptions made in the macroeconomics literature. The value chosen for $\varepsilon$ is guided by: (i) the fact that a lower value causes the estimated $\pi$ to hit its constraint at 1 and (ii) a significantly higher value seems improbable as it would translate into a significant pattern of marriage partners of bad character being 'found-out' following marriage, and there is limited evidence of this in the context of Bangladesh.[18]

For the moment-matching exercise, we solve a system of 11 equations in 11 unknowns listed in Appendix B. The values of the parameters $\gamma$, $\sigma$ and $\pi$, and the steady-state values for variables in the system thus obtained are reported in Table 2B.

Table 2B: Parameters and Steady-State Values from Moment-Matching Exercise

| variable | $\theta$ | $\lambda_1$ | $\varepsilon_{f2}$ | $\lambda_2$ | $n_{f2}$ | $\tau_2$ | $\tau_1$ | $v_{f1}$ |
|---|---|---|---|---|---|---|---|---|
| steady-state value | 0.705 | 0.751 | 0.152 | 0.935 | 0.243 | 0.491 | 0.235 | 1.978 |

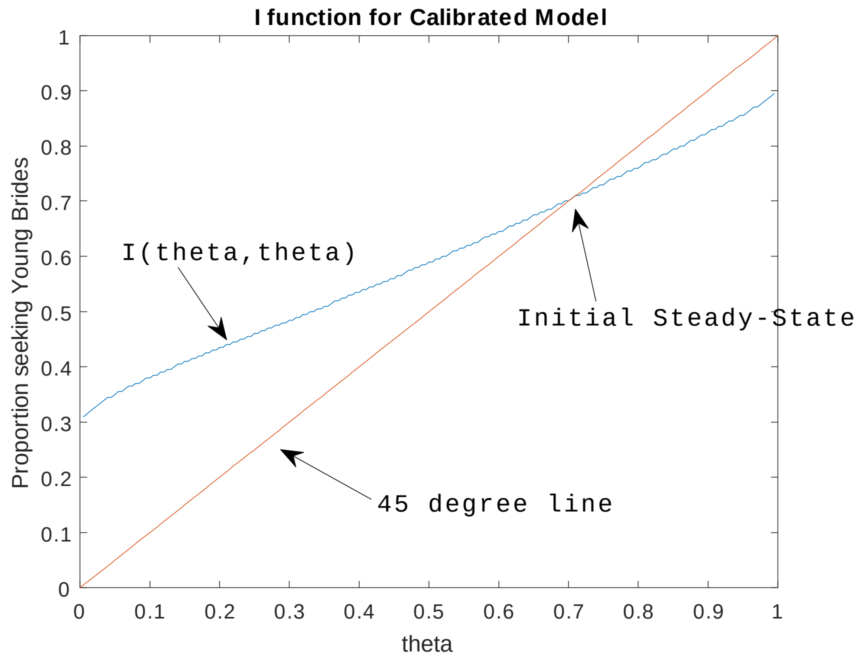
| parameter | $\gamma$ | $\sigma$ | $\pi$ |
|---|---|---|---|
| steady-state value | 0.5952 | 1.2212 | 0.8015 |

Note that the theory nests a model in which the age of potential brides is not associated with 'quality': this is obtained when $\pi = 0$: which would mean that there is, effectively, no mechanism to detect the quality of potential brides. The fact that we obtain a high value for $\pi$ in the moment-matching exercise, and consequently a significantly worse reputation for older women ($\varepsilon_{f2} = 0.1522$ while $\varepsilon_{f1} = 0.05$) suggests that the key marriage patterns in Bangladesh are consistent with strong reputational effects which results in an endogenous preference for young brides.

Figure 6 shows a plot of $I(\theta, \theta)$ against $\theta$ for the model calibrated to the marriage market in Bangladesh. The curve crosses the 45-degree line at just one point. This occurs at $\theta = 0.7160$ . Therefore, the model implies that given the sex ratios, population growth rate and outside options for men and women relative to marriage during the late 1980's in Bangladesh, there was only one feasible steady-state equilibrium, with a high proportion of men seeking young brides.

[18] Recall from the previous section that a quarter of female adolescents in the BAS aged 18 and over know of friends and neighbours who have engaged in pre-marital sex. Assuming that such behaviour would be equated with 'bad moral character' if it became known during marriage market negotiations, a value of $\varepsilon = 0.05$ would imply that when a girl engages in pre-marital, this information is shared, on average, with 5 friends and neighbours.

Figure 6: Steady-State in Calibrated Model




In the following sections, we use the calibrated model to explore how the marriage market would evolve in response to demographic shocks and policy changes and compare the model dynamics to that observed in the data. For the simulations, we assume that the outside options of young women are normally distributed and we choose the standard deviation of the distribution to equate the standard deviation of $\tau_1$ to that of dowries for young brides in the data.

## 5.3 Demographic Changes and the Incidence of Early Marriage

Bangladesh experienced a sharp decline in fertility between the 1970's and the 1990's, a phenomenon which is commonly attributed to family planning programmes launched in the late 1970's (see, for example, Joshi and Schultz 2007). The total fertility rate fell from 6.3 in 1975 to 3.4 in 1994 (NIPORT 2013). The rate of population growth can have important implications for the marriage market due to a phenomenon known as the 'marriage squeeze' (Rao 1993; Bhat and Halli 1999). Within the framework of the theory presented above, a growing population makes the cohort of young women larger than that of older men, which increases the chances of success of potential grooms seeking young brides. Conversely, a sudden decline in fertility will translate into increased difficulty in finding young brides 14-18 years later which could explain, in principle, why early marriage in Bangladesh began to decline for cohorts born after 1982. To explore this possibility, we introduce a demographic shock to the model, assuming it is initially in a steady-state, and examine how the incidence of early marriage evolves in subsequent years. Specifically, we reduce the cohort growth rate from 15% to 5% (recall that each cohort in the model corresponds to an age group of 4.5 years), keeping all other parameter values as discussed in the preceding section.

Table 3 below compares the proportion of women married before age 18 in the data, and according to the calibrated model following the demographic shock, for the cohorts born in 1975-82 and subsequent 5-year age groups.[19]

Table 3: % Married before Age 18, Data and Simulation of Demographic Shock

| Cohort (Year-of-Birth) | Data (2014 WiLCAS) | Naive Expec. | Forward-Looking |
|---|---|---|---|
| 1975-82 | 72.05 | 72.05 | 72.05 |
| 1983-87 | 65.12 | 73.45 | 73.43 |
| 1987-91 | 61.22 | 73.84 | 73.85 |
| 1992-96 | 48.58 | 73.85 | 73.85 |
| New Steady-State | - | 73.85 | 73.85 |

Table 4: Simulated Values for Demographic Shock (Naive Expectations)

| Cohort (Year-of-Birth) | $\theta$ | $\lambda_1$ | $\varepsilon_{f2}$ |
|---|---|---|---|
| Initial Steady-State | 0.705 | 0.7506 | 0.1522 |
| 1983-87 | 0.68 | 0.7674 | 0.1522 |
| 1987-91 | 0.69 | 0.7720 | 0.1597 |
| 1992-96 | 0.69 | 0.7720 | 0.1619 |
| New Steady-State | 0.69 | 0.7720 | 0.1620 |

We consider two scenarios for the model simulations: (i) agents have naive expectations (as defined in Section 3.4) and (ii) agents have forward-looking expectations. The proportion married before 18 for birth cohorts 1972-1982 is identical in the simulations and the data as the parameter values of $\gamma$, $\sigma$ and $\pi$ are chosen to match data-moments. For subsequent birth cohorts, the simulations show an *increase* in early marriage, contrary to the data which shows a sharp decline (Table 3).

The reason for the counter-intuitive increase in early marriage in the simulations is as follows. As per our intuition, the proportion of men who seek young brides ($\theta$) initially decline due to the demographic shock; but they have relatively fewer young women to choose from and this results in an *increase* in the proportion of women who receive offers of early marriage ($\lambda_1$) as shown in Table 4 (We provide only the calculated values for naive expectations as the case of forward-looking expectations path is very similar in this instance). The increase in early marriage causes the reputation of older women on the marriage market to worsen ($\varepsilon_{f2}$), and therefore, the proportion of men seeking young brides increase again in subsequent periods. Overall, a decline in population growth rate has little net effect on the incidence of early marriage.[20]

As discussed in Section 2, a decline in fertility can affect female marriage age by increasing the demand for older, more educated brides, effects which are not captured in these simulations. Nevertheless, the mechanism highlighted here offers an explanation as to why, in some developing countries, female age of marriage has evolved gradually in spite of rapid fertility transitions.[21]

It is meaningful to ask whether the previously high rates of fertility were an important driver behind early marriage in Bangladesh and whether the fertility decline mentioned above had a role in the subsequent shift

[19] Note that two of the age-cohorts reported in the table, (1983-1987) and (1987-1991), have an overlap of one year. This is to ensure that the data is roughly comparable to the model where each period is approximately 4.5 years.

[20] It is significant that when the market has reached a new steady-state, following the demographic shock, the reputation of older women in the marriage market is *worse* than what it had been in the initial equilibrium. This is because in the new demographic phase following the fertility decline, where there are more potential grooms for every potential young bride, the presence of an older woman in the marriage market is even *more* 'suspect' than it had previously been.

[21] For example, in Bangladesh, India and Nepal, fertility has declined and female schooling has increased significantly during the last three decades but the incidence of early marriage has evolved much more slowly (Raj, McDougal and Rusch 2012).

towards later marriage. As noted above, the incidence of early marriage among women show a downward trend beginning with cohorts born after 1981. These women would be expected to bear children starting in the mid-1990's. By this time, the total fertility rate had already fallen to 3.4, and it remained more or less stagnant till the 2000's.[22] Therefore, fertility demand on its own cannot explain the decline in early marriage for cohorts born during the 1980's. According to the fertility data in the 2014 WiLCAS, among women who had 3 or more children, 63% met this criteria based only on births at age 19 and later. Thus, it is unlikely that women marrying at 18 as compared to 15 were at a significant disadvantage for achieving a fertility target of 3 or 4 children.

### 5.4 Changes in the Opportunity Cost of Early Marriage

The opportunities available to adolescent girls in Bangladesh have expanded significantly since the 1980's. First, the Bangladesh government introduced a number of educational reforms and initiatives that lowered the cost – and improved access – to schooling for Bangladeshi women: in 1990, free tuition was introduced for all girls enrolled in classes VI-VIII, and in 1994, a female secondary school stipend programme was launched, extending to all non-metropolitan areas in the country by 2000 (Schurmann 2009). In 1993, a food-for-education programme – whereby households received grain for the government if they had one or more children enrolled in primary school – was introduced in rural areas (Ahmed and Nino 2002), and subsequently this initiative was converted to a cash-for-education programme. Second, the labour market opportunities improved significantly, most notably because of the dramatic growth of the ready-made garments sector which today employs more than three million women (Heath and Mobarak 2015).

Marriage for Bangladeshi women has traditionally meant the termination of schooling and withdrawal from the labour market, as this is the moment when they begin to live with their in-laws, take on new domestic responsibilities and practise a certain degree of social seclusion (Amin and Suran 2009). Therefore, the initiatives in education and the changes in the labour market highlighted above expanded the opportunities for single women to a much greater extent than they did for married women. Thus, arguably, these initiatives and changes increased the opportunity cost of early marriage for Bangladeshi women.

If so, it is reasonable to model these changes as an increase in the utility that young women derive from singlehood.[23] Such an increase would raise the probability that a young woman declines an offer of marriage, and decreases the net marriage transfer that can be obtained from her (because her outside option during the bargaining process is higher). Consequently, it will be less attractive for a potential groom to seek a young bride, and this could result in a decline in early marriage.

To explore this possibility, we introduce an increase in the utility from singlehood for young women, assuming it is initially in steady-state, and investigate how the marriage market evolves in subsequent periods. Specifically, we increase the utility from singlehood for all young women by half the standard

[22] According to the Bangladesh Demographic and Health Surveys, the total fertility rate was 3.4 in 1993/94, 3.3 in 1996/1997, 3.3 in 1999/2000 and 3.0 in 2004 (NIPORT 2013). See also footnote 6 for the choice of the total fertility rate for this discussion.

[23] We assume, implicitly, that the intervention does not impact upon the outside option of older women on the marriage market or their contributions to marriage. In the context of Bangladesh, these effects are likely to be small as there is a strong social stigma associated with spinsterhood (documented, for example, by Rozario 1992) and labour force participation among married women remains low (NIPORT 2013).

deviation of the utility distribution.

Table 5a: Simulated Values for Opportunity Cost Increase (Naive Expectations)

| Cohort (Year-of-Birth) | Marriage before 18 % | $\theta$ | $\lambda_1$ | $\varepsilon_{f2}$ | $\eta$ |
|---|---|---|---|---|---|
| Steady-State | 72.05 | 0.705 | 0.7506 | 0.1522 | 0.0026 |
| Period 1 | 68.67 | 0.64 | 0.7218 | 0.1522 | 0.0089 |
| Period 2 | 66.73 | 0.60 | 0.7031 | 0.1369 | 0.0114 |
| Period 3 | 64.26 | 0.57 | 0.6887 | 0.1295 | 0.0127 |
| Period 4 | 63.73 | 0.55 | 0.6738 | 0.1245 | 0.0138 |
| New Steady-State | 63.20 | 0.53 | 0.6687 | 0.1181 | 0.0154 |

Table 5b: Simulated Values for Opportunity Cost Increase (Forward-Looking Expectations)

| Cohort (Year-of-Birth) | Marriage before 18 % | $\theta$ | $\lambda_1$ | $\varepsilon_{f2}$ | $\eta$ |
|---|---|---|---|---|---|
| Steady-State | 72.05 | 0.705 | 0.7506 | 0.1522 | 0.0026 |
| Period 1 | 66.33 | 0.60 | 0.7031 | 0.1522 | 0.0173 |
| Period 2 | 64.10 | 0.55 | 0.6788 | 0.1281 | 0.0163 |
| Period 3 | 63.20 | 0.53 | 0.6687 | 0.1208 | 0.0154 |
| Period 4 | 63.20 | 0.53 | 0.6687 | 0.1181 | 0.0154 |
| New Steady-State | 63.20 | 0.53 | 0.6687 | 0.1181 | 0.0154 |

In Table 5a, we see that, in the case of naive expectations, the increase in the utility from singlehood results in a 6.5 percentage point decline in the % of men seeking young brides ($\theta$) for the first cohort exposed to the 'shock'. The value of $\theta$ declines further for subsequent cohorts, reaching a new steady-state value of 0.53 after 8 periods. We also see that the reputation of older women in the marriage market ($\varepsilon_{f2}$) improves over time after the shock and the proportion of young women declining offers of early marriage ($\eta$), albeit very small, is increasing over time. The co-evolution of $\theta$, $\varepsilon_{f2}$ and $\eta$ captures a virtuous cycle as follows. As a result of increased utility from singlehood from the intervention, young women have greater bargaining power and can negotiate a lower dowry. Therefore, fewer men make marriage offers to them, and this improves the reputation of older women on the marriage market the following period. This causes more men to seek older brides and more women to decline offers of early marriage which leads to a further increase in the reputation of older women next period. And thus the cycle continues. The evolution of the marriage market is similar in the case of forward-looking expectations (Table 5b) but the steady-state is reached more quickly.[24]

The incidence of early marriage declines by about 9 percentage points when the new steady-state is reached, which is roughly half the magnitude of the decline in $\theta$.[25] But the first cohort which exposed to the shock experiences a decline in the early marriage rate in the range of 3.4 to 5.7 percentage points (depending on whether expectations are naive or forward-looking). Therefore, the effect of the shock on the first cohort only captures about one-third to two-third of the total effect on early marriage by the time that the new steady-state is reached.

[24] One difference of note in the case of forward-looking expectations is that the marriage refusal rate initially jumps and then declines to the new steady-state value. This is because young women anticipate that they will have better reputation than their elders if they re-enter the marriage market next period and, therefore, are more willing to decline current marriage offers. However, as the marriage market evolves towards late marriage, their outside options improve, and they are able to negotiate better terms of marriage (lower dowry) in the current period and so the refusal rate starts to fall.

[25] The reason for the disparity between the change in $\theta$ and $\lambda_1$ is that as fewer men seek young brides, the chances of success *increase* for those who continue to do so; this is evident in the fact that, for a young woman, the probability of receiving a marriage offer ($\lambda_1$) falls at about half the rate of $\theta$ following the shock.

Next, we tackle the question how much the outside opportunities of young women would have to increase to obtain the decline in early marriage we observe in the data. We also incorporate the effects of the fertility decline which occurred in Bangladesh since the late 1970's as discussed above. Table 6 shows the evolution of early marriage when we allow the utility from singlehood to increase at a constant rate by 1 standard deviation of the utility distribution over three cohorts. We find that the equilibrium path for forward-looking expectations matches the data reasonably well while that for naive expectations lag behind.

Table 6: % Married before Age 18, Simulation of Increased Opportunities + Demographic Shock

| Cohort (Year-of-Birth) | Data (2014 WiLCAS) | Naive Expec. | Forward-Looking |
|---|---|---|---|
| 1975-82 | 72.05 | 72.05 | 72.05 |
| 1983-87 | 65.12 | 71.80 | 67.01 |
| 1987-91 | 61.22 | 68.00 | 59.34 |
| 1992-96 | 48.58 | 60.00 | 50.95 |
| New Steady-State | - | 49.19 | 49.19 |

## 5.5 Randomised Control Trials relating to Early Marriage

The current gold standard for testing the efficacy of development interventions, including those targeted at adolescents, is to run small-scale randomised control trials (RCTs). It is well-known that the potential effect that a scaled-up intervention may have on market equilibria or on social norms may be missed in a small scale RCT as the trial may be insufficient to achieve the hypothesized equilibrium shifts (see, for example, Duflo et al. 2007, Banerjee and Duflo 2009). In the case of programmes aimed at reducing early marriage, the equilibrium effects are likely to be important as discussed above, and therefore a small-scale trial may significantly under-estimate the efficacy of the intervention under consideration. The theory proposed in this paper – where the marriage market and social norms play important roles – provides a good setting to evaluate how significant this under-estimation is likely to be.

In the following, we simulate a number of scenarios where x% of young women in the population benefit from an intervention that increase their opportunity cost of early marriage by half a standard deviation of the utility distribution. The marriage market is initially in the steady-state computed above. We assume that the programme beneficiaries are identifiable if they re-enter the marriage market as older women and, therefore, they can potentially have a different reputation from non-beneficiaries (if, for example, they had a different marriage refusal rate). To abstract away from differences arising from the *speed* at which the market adjusts to the intervention, we focus on the new steady-state values following the intervention.

First, we consider the case where $x = 10\%$; i.e. where one in every ten young women in the marriage market, chosen at random, are exposed to the programme.[26] From Table 7, we see that the rate of early marriage – for programme beneficiaries – falls by about 1.4 percentage points. For $x = 20\%$, the corresponding figure is about 1.9 percentage points. By contrast, when all women in the population are beneficiaries of the intervention, the rate of early marriage declines by 9 percentage points.

[26] To have a sense of the scale of an RCT with $x = 10\%$ in the context of Bangladesh, we can proceed as follows. According to the 2005 Bangladesh Adolescent Survey, 63% of married adolescents have a marriage partner from the same sub-district and, therefore, we can take the sub-district to be a very rough approximation of the typical size of the marriage market. According to the 2011 Population Census of Bangladesh, the average size of a sub-district is about 250,000 and the number of female adolescents aged 15-19 within the sub-district about 13,000. Therefore, the intervention would have to target 1,300 adolescent girls in the sub-district.

The main channel through which these effects occur is by changing the expected utility to a potential groom from seeking young brides. A programme beneficiary is more likely to refuse a marriage offer or negotiate a more favourable marriage transfer for herself and this makes her less attractive from the perspective of the man. However, in the case of a small-scale intervention, the chances that the potential groom seeking a young bride is matched with a programme beneficiary remains low and therefore the impact on the equilibrium is small. In particular, the figures in Table 7 suggest that a trial targeting $x\%$ of adolescents in the marriage market will shift $\theta$ – the proportion of men seeking young brides – by roughly $x\%$ of that of the full-scale intervention. On the other hand, the small-scale trials are able to capture reasonably well the direct effect on early marriage refusals: $\eta = 0.0105$ for the 10% intervention as opposed to 0.0154 for the fully scaled-up programme.

Table 7: Simulated Steady-State Values (for Programme Beneficiaries) from an RCT

| Cohort (Year-of-Birth) | Marriage before 18 % | $\theta$ | $\lambda_1$ | $\varepsilon_{f2}$ | $\eta$ |
|---|---|---|---|---|---|
| Initial Steady-State | 72.05 | 0.705 | 0.7506 | 0.1456 | 0.0026 |
| 10% | 70.63 | 0.69 | 0.7441 | 0.1454 | 0.0105 |
| 20% | 70.19 | 0.68 | 0.7397 | 0.1434 | 0.0115 |
| 50% | 67.49 | 0.62 | 0.7125 | 0.1323 | 0.0133 |
| 100% | 63.20 | 0.53 | 0.6687 | 0.1181 | 0.0154 |

# 6 Implications of Polygamy, Divorce, Remarriage and Alternative Mating Rules

For the main analysis in this paper, we imposed a number of restrictions on the marriage market – regarding divorce and remarriage, and polygamy – arguing that, in the case of marriages in South Asia, they have a low enough incidence to justify the simplifying assumptions. However, there are other parts of the world with a high prevalence of female child marriage as well as divorce and polygamy, most notably in sub-Saharan Africa. Therefore, it is reasonable to ask whether and to what extent the main implications of the theoretical model are valid for other parts of the world.

If polygyny is socially permissible, it would mean that married men may re-enter the marriage market in a future period. This would increase competition on the groom's side of the market and affect the matching probabilities for both brides and grooms. If divorced men are able to remarry, this would have similar implications. However, older women on the marriage market would still have worse reputation, and, therefore, the driver behind early marriage, highlighted in the preceding sections, would still be relevant.

If divorced women are able to remarry, it would mean that some fraction of women who marry re-enter the marriage market in a future period. It is reasonable to assume that their previous marital history will be public knowledge and, therefore, they will be distinguishable from both young women (entering the marriage market for the first time) and older women who have not been married previously. Therefore, potential grooms would have the possibility of choosing between three types of potential brides rather than two. In any case, older never-married women on the marriage market would still have worse reputation than young women for the reasons highlighted in the previous sections. Once again, the driver behind early marriage obtained in the theoretical analysis will be relevant.

We assumed, for the theoretical model, that men are the first to act – choosing whether to seek young or older brides – while women can accept or decline offers of marriage, in line with traditional marriage customs in South Asia. If, instead, the theory allows women to initiate a search, men would accept or decline marriage offers based on their beliefs regarding the character of the potential bride and the reputational effects associated with the age of the bride would still be present.

In summary, remarriage and polygamy, where they are relevant, would need to be taken into account in the numerical analysis. But the main insights from the theoretical model do not depend on the assumptions made regarding their absence. On the other hand, the value placed on the 'purity' of the bride and rules regarding marriage exogamy – which would result in imperfect information regarding this characteristic on the marriage market – are key for the mechanism behind child marriage highlighted in this paper.

# 7 Discussion

In recent years, international donors and development agencies have designed and implemented a range of interventions aimed at expanding the economic and educational opportunities of adolescents, particularly girls, in developing countries; with the reduction of the incidence of early marriage and postponement of childbirth among their intended goals.

In this context, it is important to realise that decisions regarding the timing of marriage of a son or daughter, although they are made within a single household, may be influenced by the choices made by other households in the community or region. In this paper, we investigated a particular mechanism through which these individual choices can influence the costs and benefits of early marriage versus late marriage for everyone in a marriage market: if some qualities of prospective brides are not fully observable at the time of marriage, then the incidence of early marriage will influence the perceived quality of older women on the marriage market.

One of the key innovations in the theory proposed in this paper is the signalling and reputational effect associated with marriage timing for women: marriage delays signal 'bad quality' and this imposes a pressure on women to accept early offers of marriage and a preference among potential grooms to seek young brides. It is important to note that the theory also nests a model in which the age of potential brides is *not* associated with 'quality'. This is equivalent to the case where $\pi = 0$: which would mean that there is, effectively, no mechanism to detect the quality of potential brides and, therefore, if an older woman is still on the marriage market it is only because she did not find a match, or refused a marriage offer, in her youth.

In calibrating the model to the case of Bangladesh, we allowed $\pi$ to be computed so that the steady-state variables match the data-moments. We obtained $\pi = 0.8015$, which means that in about 4 out of 5 instances, a background check can reveal the quality of a potential bride with 'bad character'. Thus, the moment-matching exercise generates significant reputational concerns and an endogenous preference for young brides which can account for key marriage patterns in Bangladesh.

In this situation, expanding opportunities for some adolescent girls – to the extent that they or their parents choose to postpone their marriage – can trigger a virtuous cycle whereby the perceived quality of older brides improve, which in turn makes it more attractive for other girls to postpone marriage, and so on. In a study of the timing of marriage and childbearing in rural Bangladesh (Schuler et al., 2006), this idea is succinctly captured in a reported interview with an 18-year-old girl:

> '... when asked why her parents had delayed her marriage while her younger sisters had married at ages 12-15 ... [she replied] "My father thought it was unnecessary for girls to read and write but in my case he did not object ... None of my peers were sitting idle at home so I also went to school. Now it is better for girls. They don't have to pay school fees – the government finances it ... Everyone has had some schooling, at least up to the eighth or ninth grade. No one would want to marry an illiterate girl so they are sent to school." p. 2831

The fact that an intervention targeted at adolescent girls can make it more and more attractive for future cohorts to postpone marriage means that the long-term impact of such interventions on marriage and subsequent life choices may well exceed the impact on the first cohort which is exposed to it.

# 8 Appendix A

First, we state and prove Lemma 4, which is used in the proof of Lemma 1. Lemma 4 shows that an individual's utility from marriage declines as the probability of bad character of the marriage partner increases, even though marriage partners with worse reputation are 'cheaper' in terms of net marriage transfers.

**Lemma 4** *If* $\tau^* = \arg\max_\tau \{\zeta u_m(\tau, \varepsilon_f) - v_m\}\{\zeta u_f(\tau, \varepsilon_m) - v_f\}$ *then, under Assumptions 1, 2 and 3, the expression* $\{\zeta u_m(\tau, \varepsilon_f) - v_m\}$ *is decreasing in* $\varepsilon_f$ *and* $\{\zeta u_f(\tau, \varepsilon_m) - v_f\}$ *is decreasing in* $\varepsilon_m$*.*

**Proof.** of Lemma 4: From the first-order condition to the optimisation problem that defines $\tau^*$, we have

$$\frac{\partial u_m}{\partial \tau}\{\zeta u_f(\tau^*, \varepsilon_m) - v_f\} + \frac{\partial u_f}{\partial \tau}\{\zeta u_m(\tau^*, \varepsilon_f) - v_m\} = 0 \tag{14}$$

■

Differentiating throughout w.r.t. $\varepsilon_f$ and using Assumption 3, we obtain

$$\zeta\frac{\partial u_m}{\partial \tau}\frac{\partial u_f}{\partial \tau}\frac{\partial \tau^*}{\partial \varepsilon_f} + \frac{\partial u_f}{\partial \tau}\zeta\left(\frac{\partial u_m}{\partial \tau}\frac{\partial \tau}{\partial \varepsilon_f} + \frac{\partial u_m}{\partial \varepsilon_f}\right) = 0 \tag{15}$$

$$\implies \quad 2\zeta\frac{\partial u_m}{\partial \tau}\frac{\partial u_f}{\partial \tau}\frac{\partial \tau^*}{\partial \varepsilon_f} + \zeta\frac{\partial u_f}{\partial \tau}\frac{\partial u_m}{\partial \varepsilon_f} = 0$$
$$\implies \quad \frac{\partial \tau^*}{\partial \varepsilon_f} = -\frac{\partial u_m}{\partial \varepsilon_f}/2\frac{\partial u_m}{\partial \tau} > 0$$

We show by contradiction that $\{\zeta u_m(\tau^*, \varepsilon_f) - v_m\}$ is decreasing in $\varepsilon_f$. Suppose not. Then, when $\varepsilon_f$ is larger, $\{\zeta u_m(\tau^*, \varepsilon_f) - v_m\}$ remains the same or becomes larger, $\{\zeta u_f(\tau, \varepsilon_m) - v_f\}$ is smaller and, because $\frac{\partial \tau^*}{\partial \varepsilon_f} > 0$, by Assumption 3 $\frac{\partial u_f}{\partial \tau}$ is (weakly) more negative and $\frac{\partial u_m}{\partial \tau}$ is (weakly) smaller. Then equation (14) would be violated. Therefore, we must have $\{\zeta u_m(\tau^*, \varepsilon_f) - v_m\}$ decreasing in $\varepsilon_f$. Similarly, we can show that $\frac{\partial \tau^*}{\partial \varepsilon_m} < 0$ and $\{\zeta u_f(\tau, \varepsilon_m) - v_f\}$ is decreasing in $\varepsilon_m$.

**Proof.** of Lemma 1: (i) By Assumption 4, $\mu\left(\frac{n_{f1}}{\theta_t n_m}\right)$ is strictly decreasing in $\theta_t$. Therefore, using the definitions of $U_1(\theta_t, \theta_{t+1})$ and $U_2(\theta_t, \theta_{t-1})$ in (10) and (11), we have $U_1(\theta_t, \theta_{t+1})$ strictly decreasing in $\theta_t$ and $U_2(\theta_t, \theta_{t-1})$ is strictly increasing in $\theta_t$.

(ii) Using (7), we see that the outside option of young women in period $t$, $v_{f1}\left(\hat{\lambda}_2\right)$, is increasing in the value of $\hat{\lambda}_2$ in period $t+1$. Using (2), $\lambda_2$ is decreasing in $\theta_{t+1}$. Therefore, $v_{f1}\left(\hat{\lambda}_2\right)$ is decreasing in $\theta_{t+1}$.Then, using (9), $\tau_1$ is increasing in $v_{f1}\left(\hat{\lambda}_2\right)$. It follows from equation (10) and Assumption 1 that $U_1$ is increasing in $\theta_{t+1}$.

(iii) Using (3), $\varepsilon_{f2}$ in period $t$ is increasing in $\lambda_1$ in period $t-1$. Using (1), $\lambda_1$ is increasing in $\theta_{t-1}$. Therefore, $\varepsilon_{f2}$ is increasing in $\theta_{t-1}$. Then, using equations (11) and (8), Assumption 3 and Lemma 4 that $U_2$ is decreasing in $\theta_{t-1}$. ■

**Proof.** of Lemma 2: Define $J(\theta) = I(\theta, \theta) - \theta$. Given that $u_m(.)$, $\mu(.)$ and $\xi(.)$ are continuous functions, so is $J(.)$. By construction, $J(\theta) \geq 0$ at $\theta = 0$ and $J(\theta) \leq 0$ at $\theta = 1$. If $J(0) = 0$ or $J(1) = 0$, then the corresponding $\theta$ value would constitute a steady-state. If $J(0) > 0$ and $J(1) < 0$, then it follows from the Intermediate Value Theorem that there exists some $\theta \in [0, 1]$ such that $J(\theta) = 0$. Therefore, $I(\theta, \theta) = \theta$. ■

**Proof.** of Proposition 2: Given $\theta_0$, we can construct a sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$ as follows. Let $\theta_{t+1} = I(\theta_t, \theta_t)$ for $t = 1, 2, ...$ By construction, the sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$, together with the initial value $\theta_0$, satisfies the definition of a 'Naive Expectations' equilibrium (Definition 3). Furthermore, as $I(.,.)$ is increasing in both arguments by Lemma 1, given $\theta_0$, no other sequence $\left\{\theta'_\tau\right\}_{\tau=1}^{\infty}$ can satisfy Definition 3. Therefore, given the initial value $\theta_0$, there is a unique sequence that satisfies the criteria of the 'Naive Expectations' Equilibrium.

(i) Suppose $I(\theta_0, \theta_0) > \theta_0$. As $I(1, 1) \leq 1$, and $I(.,.)$ is a continuous function, it follows that there exists at least one steady-state value in the interval $(\theta_0, 1]$. Let us denote the first (i.e. smallest) of these steady-state values as $\theta_s$; i.e. $I(\theta_s, \theta_s) = \theta_s$. By continuity of $I(.,.)$, we have $\theta < I(\theta, \theta)$ for $\theta \in [\theta_0, \theta_s)$.

By construction, $\theta_1 = I(\theta_0, \theta_0)$. Since $\theta_0 < I(\theta_0, \theta_0)$, we have $\theta_1 > \theta_0$. We can show by contradiction that $\theta_1 < \theta_s$. Define $K(\theta) = I(\theta, \theta)$. By Lemma 1, $K(\theta)$ is increasing in $\theta$. Therefore, $K^{-1}(.)$ is an increasing function. Therefore, if $\theta_1 > \theta_s$, then $K^{-1}(\theta_1) > K^{-1}(\theta_s)$. By construction, $K(\theta_0) = I(\theta_0, \theta_0) = \theta_1$. Therefore $K^{-1}(\theta_0) = \theta_1$. Therefore $\theta_0 > \theta_s$, which is a contradiction of our initial premise.

By the same reasoning, $\theta_2, \theta_3 ... < \theta_s$. Since $I(\theta, \theta) > \theta$ for $\theta < \theta_s$, it follows that $\{\theta_\tau\}_{\tau=1}^{\infty}$ is an increasing sequence. Following the proof of Proposition 8, we can show that the sequence converges to $y = \sup\{\theta_\tau\}$ and that $y$ corresponds to a steady-state. As all elements of the sequence are smaller than $\theta_s$, it follows that the steady-state must be $\theta_s$.

(ii) Suppose $I(\theta_0, \theta_0) < \theta_0$, As $I(0, 0) \geq 1$ and $I(.,.)$ is a continuous function, it follows that there is at least one steady-state value in the interval $[0, \theta_0)$. Let us denote the largest of these steady-state values as $\theta'_s$; i.e. $I\left(\theta'_s, \theta'_s\right) = \theta'_s$. Following the reasoning in part (i) above, we can show that sequence$\{\theta_\tau\}_{\tau=1}^{\infty}$ is a decreasing sequence that converges to $\theta'_s$.

(iii) Suppose $I(\theta_0, \theta_0) = \theta_0$. Since $\theta_{t+1} = I(\theta_t, \theta_t)$ for $t = 1, 2, ..$, it follows that $\theta_1 = I(\theta_0, \theta_0) = \theta_0$, and $\theta_2 = I(\theta_1, \theta_1) = I(\theta_0, \theta_0) = \theta_0$, etc. Therefore, each element of the sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$ is equal to $\theta_0$. ■

Next, we introduce the concept of monotonic equilibria and characterise their properties. The results are used in the proof of Proposition 3.

**Definition 5** *Given an initial value $\theta_0$, the sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$ constitutes a* <u>*monotonic increasing*</u> <u>*equilibrium*</u> *if $\theta_t = I(\theta_{t-1}, \theta_{t+1})$ and $\theta_t \geq \theta_{t-1}$ for $t = 1, 2, \ldots$. Given an initial value $\theta_0$, the sequence $\{\theta_\tau\}_{\tau=1}^{\infty}$ constitutes a* <u>*monotonic decreasing*</u> <u>*equilibrium*</u> *if $\theta_t = I(\theta_{t-1}, \theta_{t+1})$ and $\theta_t \leq \theta_{t-1}$ for $t = 1, 2, \ldots$.*

**Proposition 8** *(i) Given an initial value $\theta_0$, there exists a monotonic increasing equilibrium if and only if there is a steady-state $\theta \in (\theta_0, 1]$. The equilibrium sequence $\{\theta_t\}_{t=1}^{\infty}$ converges to a steady-state $\theta \in (\theta_0, 1]$.*

*(ii) Given an initial value $\theta_0$, there exists a monotonic decreasing equilibrium if and only if there is a steady-state $\theta \in [0, \theta_0)$. The equilibrium sequence $\{\theta_t\}_{t=1}^{\infty}$ converges to a steady-state $\theta \in [0, \theta_0)$.*

**Proof.** of Proposition 8: (i) Consider a monotonic increasing sequence $\{\theta_t\}_{t=0}^{\infty}$ where $\theta_t \in [0, 1]$ for all $t$. First, we show that this sequence has a point of convergence in the interval $(\theta_0, 1]$. Let $y = \lim_{t \to \infty} \{\theta_t\}$. It follows that $y = \sup(\theta_t) = x$.

Next, we show that $y$ corresponds to a steady-state equilibrium, i.e. $I(y, y) = y$. We prove this by contradiction. Suppose $I(y, y) > y$. Then, as $I(.)$ is continuous in both arguments, we can find $\varepsilon$ sufficiently small such that

$$I(y - \varepsilon, y - \varepsilon) > y$$

Given the convergence property of $\{\theta_t\}_{t=0}^{\infty}$, there exists $T$ sufficiently large such that for $t \geq T$, we have $\theta_t > y - \varepsilon$. Therefore,

$$I(\theta_T, \theta_{T+2}) > y$$

$$\Longrightarrow \theta_{T+1} > y$$

This contradicts the earlier statement that $y$ is the supremum of the sequence.

Now suppose that $I(y, y) < y$ and let $z = y - I(y, y) > 0$. Consider some $\delta > 0$. By Lemma 1 and continuity of $I(.)$, we have, for each $\theta_1, \theta_2 \in (y - \delta, y)$

$$I(\theta_1, \theta_2) \leq y - z$$

Given the convergence property of $\{\theta_t\}_{t=0}^{\infty}$, there exists $T$ sufficiently large such that for $t \geq T$, we have $\theta_t \in (y - \delta, y)$. Therefore for each $r \geq T + 1$, we have

$$\theta_r = I(\theta_{r-1}, \theta_{r+1}) \leq y - z$$

Therefore,

$$\sup \{\theta_t\}_{t=T+1}^{\infty} \leq y - z$$

Given that the sequence $\{\theta_t\}_{t=0}^{\infty}$ is monotonic, we have

$$\sup \{\theta_t\}_{t=0}^{\infty} \leq y - z < y$$

which contradicts the earlier statement that $y$ is the supremum of the sequence. Therefore, it must be that $y$ corresponds to a steady-state equilibrium.

(ii) The proof for a monotonic decreasing sequence proceeds in the same manner as above, such that we let $x = \inf\{\theta_t\}$ and show that the sequence converges to $x$. Using the reasoning by contradiction used above, we then show that $x$ is a steady-state value, i.e. $I(x, x) = x$. ■

**Proof.** of Proposition 3: First, we show that $\lim_{\alpha\to\infty}\theta_\tau^\alpha$ indeed exists. By Proposition 2, $\left\{\theta_\tau^0\right\}_{\tau=1}^\infty$ is either an increasing sequence or a decreasing sequence. Without loss of generality, let us assume that it is an increasing sequence.

Then, by assumption, $\theta_2^0 > \theta_0$. It follows from the properties of function $I(.,.)$ that $\theta_1^1 = I\left(\theta_0, \theta_2^0\right) \geq I(\theta_0,\theta_0) = \theta_1^0$.

Similarly, $\theta_2^1 = I\left(\theta_1^1, \theta_3^0\right) \geq I\left(\theta_1^0, \theta_1^0\right) = \theta_2^0$. Following the same reasoning, $\theta_\tau^1 \geq \theta_\tau^0$ for all $\tau \in \{3,4,..\}$.

Similarly, $\theta_1^2 = I\left(\theta_0, \theta_2^1\right) \geq I\left(\theta_0, \theta_2^0\right) = \theta_1^1$. Following the same reasoning, $\theta_\tau^\alpha \geq \theta_\tau^{\alpha-1}$ for all $\alpha \in \{3,4,..\}$ and each $\tau$.

Therefore, $\{\theta_\tau^\alpha\}_{\alpha=1}^\infty$ is an increasing sequence for each $\tau$. Moreover, by construction, each $\theta_\tau^\alpha \in [0,1]$; i.e. the sequence is bounded. Let $x_\tau = \sup\{\theta_\tau^\alpha\}$. By definition, for each $\varepsilon > 0$, $\exists\bar{\alpha} \in \mathbb{N}$ such that $\left|\theta_\tau^{\bar{\alpha}} - x\right| < \varepsilon$ (if not, $x_\tau$ would not be the supremum of the sequence). Given that $\{\theta_\tau^\alpha\}_{\alpha=1}^\infty$ is a monotonic sequence, it follows that $|x_\tau - \theta_\tau^\alpha| < \varepsilon$ for $\alpha \geq \bar{\alpha}$. Therefore, for $r, s \geq \bar{\alpha}$, we obtain

$$\begin{aligned} |\theta_\tau^r - \theta_\tau^s| &\leq |x_\tau - \theta_\tau^r| + |x_\tau - \theta_\tau^s| \\ &\leq 2\varepsilon \end{aligned}$$

Therefore, $\{\theta_\tau^\alpha\}_{\alpha=1}^\infty$ constitutes a Cauchy sequence. Every Cauchy sequence of real numbers has a limit (see, for example, Lang, p.143). Therefore, $\{\theta_\tau^\alpha\}_{\alpha=1}^\infty$ has a limit. Similarly, we can show that if $\left\{\theta_\tau^0\right\}_{\tau=1}^\infty$ is a decreasing sequence, then so is $\{\theta_\tau^\alpha\}_{\alpha=1}^\infty$ and that it has a limit.

Let $\theta_\tau^\infty = \lim_{\alpha\to\infty}\{\theta_\tau^\alpha\}$. By construction,

$$\theta_\tau^\infty = \lim_{\alpha\longrightarrow\infty}\theta_\tau^\alpha = \lim_{\alpha\longrightarrow\infty} I\left(\theta_{\tau-1}^\alpha, \theta_{\tau+1}^{\alpha-1}\right) = I\left(\theta_{\tau-1}^\infty, \theta_{\tau+1}^\infty\right)$$

The last equality follows from the continuity of the function $I(.,.)$. Then, using Proposition 1, the initial value $\theta_0$, together with the sequence $\{\theta_\tau^\infty\}_{\tau=1}^\infty$, satisfies the criteria for an equilibrium in the marriage market.

If $\left\{\theta_\tau^0\right\}_{\tau=1}^\infty$ is an increasing sequence, by Proposition 2 $\theta_1^0 = I(\theta_0,\theta_0) > \theta_0$. Then, as the function $I(.,.)$ is increasing in both arguments, we have $\theta_1^1 = I\left(\theta_0, \theta_2^0\right) > I(\theta_0,\theta_0) > \theta_0$. Similarly, $\theta_2^1 = I\left(\theta_1^1, \theta_3^0\right) > I\left(\theta_0, \theta_2^0\right) > \theta_1^1$, and so on. Thus, $\left\{\theta_\tau^1\right\}_{\tau=1}^\infty$ is also an increasing sequence. By iteration, we can show that $\{\theta_\tau^\alpha\}_{\tau=1}^\infty$ is an increasing sequence for $\alpha = 2, 3, ...$ etc. Therefore, $\{\theta_\tau^\infty\}_{\tau=1}^\infty$ is an increasing sequence. Therefore $\theta_0$, together with the sequence $\{\theta_\tau^\infty\}_{\tau=1}^\infty$, constitutes a monotonic increasing equilibrium. Then, by Proposition 8, the equlibrium path converges to a steady-state in the interval $(\theta_0, 1]$.

Similarly, if $\left\{\theta_\tau^0\right\}_{\tau=1}^\infty$ is a decreasing sequence, we can show that $\{\theta_\tau^\infty\}_{\tau=1}^\infty$ is a decreasing sequence, and $\theta_0$, together with the sequence $\{\theta_\tau^\infty\}_{\tau=1}^\infty$, constitutes a monotonic decreasing equilibrium which converges to a steady-state in the interval $[0, \theta_0)$. ■

**Corollary 1** *of Proposition 3: Suppose that* $\{\theta_t\}_{t=0}^\infty$ *and* $\left\{\tilde{\theta}_t\right\}_{t=0}^\infty$ *are marriage market equilibrium paths with iterated expectations. If* $\theta_0 < \tilde{\theta}_0$*, then* $\theta_t < \tilde{\theta}_t$ *for* $t > 0$.

**Proof.** of Corollary: If $\theta_0 < \tilde{\theta}_0$, then, by construction, $\theta_t^0 < \tilde{\theta}_t^0$ for $t > 0$. Therefore, $\theta_t^\alpha < \tilde{\theta}_t^\alpha$ for $\alpha = 1, 2, ...,$ and $t > 0$. Therefore, $\theta_t = \lim_{\alpha\longrightarrow\infty}\theta_t^\alpha \leq \lim_{\alpha\longrightarrow\infty}\tilde{\theta}_t^\alpha = \tilde{\theta}_t$ for each $t > 0$. Therefore

$$\theta_1 = I(\theta_0, \theta_2) < I\left(\tilde{\theta}_0, \tilde{\theta}_2\right) = \tilde{\theta}_1 \text{ (since } \theta_0 < \tilde{\theta}_0 \text{ and } \theta_2 \leq \tilde{\theta}_2)$$

$$\Longrightarrow \theta_2 = I(\theta_1, \theta_3) < I\left(\tilde{\theta}_1, \tilde{\theta}_3\right) = \tilde{\theta}_2 \text{ (since } \theta_1 < \tilde{\theta}_1 \text{ and } \theta_3 \leq \tilde{\theta}_3)$$

Reasoning in the same manner, we obtain $\theta_t < \tilde{\theta}_t$ for $t = 3, 4, ...$ ■

**Proof.** of Proposition 4: Consider a sequence $\{\theta_t\}_{t=0}^{\infty}$ generated by a marriage market equilibrium. In some period $t \geq 1$, if $\theta_{t-1} > 0$, then $\lambda_1(t-1) > 0$. Then, using (3)-(5), we have $\hat{\varepsilon}_{f2}(t) > \hat{\varepsilon}_{f1}(t)$. If $\theta_{t+1} < 1$, then $\lambda_2(t+1) > 0$ and using (7), $v_{f1}(t) > v_{f2}(t)$. It follows from (9), (8) and Assumption **??** that $\tau_1(t) < \tau_2(t)$. Conversely, if $\theta_{t-1} = 0$ and $\theta_{t+1} = 1$, then $\lambda_1(t) = 0$ and $\lambda_2(t+1) = 0$. Then, $\hat{\varepsilon}_{f2}(t) = \hat{\varepsilon}_{f1}(t)$ and $v_{f1}(t) = v_{f2}(t)$. Therefore, we have $\tau_1(t) = \tau_2(t)$. ■

**Proof.** of Proposition 5: It follows from equation (12) that

$$\varepsilon_{f2}(\theta_{t-1}, x_{t-1}; \pi_1) < \varepsilon_{f2}(\theta_{t-1}, x_{t-1}; \pi_2) \tag{16}$$

That is, an older woman on the marriage market will have better reputation when the signal provided by the background check is noisier. Therefore

$$v_{f1}\left(\theta_{t+1}, x_t, \underline{u}_{f1}; \pi_1\right) > v_{f1}\left(\theta_{t+1}, x_t, \underline{u}_{f1}; \pi_2\right) \tag{17}$$

and $\tau_1\left(\theta_{t+1}, x_t, \underline{u}_{f1}; \pi_1\right) < \tau_1\left(\theta_{t+1}, x_t, \underline{u}_{f1}; \pi_2\right)$; i.e. younger women on the marriage market will have better outside options and make smaller net marriage transfers for smaller $\pi$.[27] Therefore, $\hat{U}_1(\theta, \theta_{t+1}, x_t; \pi_1) < \hat{U}_1(\theta, \theta_{t+1}, x_t; \pi_2)$ for each $\theta \in [0,1]$. On the other hand, it follows from (16) that $\hat{U}_2(\theta, \theta_{t-1}, x_{t-1}; \pi_1) > \hat{U}_2(\theta, \theta_{t-1}, x_{t-1}; \pi_2)$ for each $\theta \in [0,1]$. Furthermore, using (17) and (18), we have

$$x(\theta, \theta_{t+1}; \pi_1) < x(\theta, \theta_{t+1}; \pi_2) \text{ for each } \theta \in [0,1]$$

Therefore, if $\theta_t, \theta_{t+1}, x_{t-1}$ and $x_t$ are such that $\hat{U}_1(\theta_t, \theta_{t+1}, x_t; \pi_2) = \hat{U}_2(\theta_t, \theta_{t-1}, x_{t-1}; \pi_2)$ and $x_t = x(\theta_t, \theta_{t+1}; \pi_2)$, then

$$\begin{aligned} \hat{U}_1(\theta_t, \theta_{t+1}, x_t; \pi_1) &< \hat{U}_2(\theta_t, \theta_{t-1}, x_{t-1}; \pi_1) \\ x_t &> x(\theta_t, \theta_{t+1}; \pi_1) \end{aligned}$$

$$\Longrightarrow \hat{I}(\theta_{t-1}, x_{t-1}, \theta_{t+1}; \pi_1) < \hat{I}(\theta_{t-1}, x_{t-1}, \theta_{t+1}; \pi_2)$$
$$\text{and } x(\theta_t, \theta_{t+1}; \pi_1) < x(\theta_t, \theta_{t+1}; \pi_2)$$

Suppose that $(\theta_{ss}, x_{ss})$ constitutes a steady-state equilibrium under $\pi_2$. Therefore,

$$\theta_{ss} = \hat{I}(\theta_{ss}, \hat{x}(\theta_{ss}, \theta_{ss}; \pi_2), \theta_{ss}; \pi_2)$$
$$\Longrightarrow \theta_{ss} > \hat{I}(\theta_{ss}, \hat{x}(\theta_{ss}, \theta_{ss}; \pi_1), \theta_{ss}; \pi_1)$$

By construction, $\hat{I}(0, \hat{x}(0,0;\pi_1), 0; \pi_1) \geq 0$. Therefore, using the Intermediate Value Theorem, there exists a $\theta_{\pi 1} \in [0, \theta_{ss})$ such that $\theta_{\pi 1} = \hat{I}(\theta_{\pi 1}, \hat{x}(\theta_{\pi 1}, \theta_{\pi 1}; \pi_1), \theta_{\pi 1}; \pi_1)$. Let $x_{\pi 1} = \hat{x}(\theta_{\pi 1}, \theta_{\pi 1}; \pi_1)$.[28] Then, $(\theta_{\pi 1}, x_{\pi 1})$ consistutes steady-state under $\pi_1$ and $\theta_{\pi 1} < \theta_{ss}$.

[27] Recall that $v_{f1}$ and $\tau_1$ depend on the utility from singlehood $\underline{u}_{f1}$ which, given the assumption of heterogeneity in Section 4, can vary across women. We adjust the notation accordingly.

[28] To see this, let

$$H(\theta; \pi_1) = \hat{I}(\theta, \hat{x}(\theta, \theta; \pi_1), \theta; \pi_1) - \theta$$

At $\theta = \theta_{ss}$, we have $H(\theta; \pi_1) < 0$ and at $\theta = 0$, we have $H(\theta; \pi_1) \geq 0$. It can be shown that $H(\theta; \pi_1)$ is continuous in $\theta$. Therefore, the Intermediate Value Theorem applies and $\exists \theta_{\pi 1} \in [0, \theta_{ss})$ such that $H(\theta_{\pi 1}; \pi_1) = 0$.

Suppose that $\left(\theta'_{ss}, x'_{ss}\right)$ constitutes a steady-state equilibrium under $\pi_1$. Therefore,

$$\theta'_{ss} = \hat{I}\left(\theta'_{ss}, \hat{x}\left(\theta'_{ss}, \theta'_{ss}; \pi_1\right), \theta'_{ss}; \pi_1\right)$$

$$\Longrightarrow \theta'_{ss} < \hat{I}\left(\theta'_{ss}, \hat{x}\left(\theta'_{ss}, \theta'_{ss}; \pi_1\right), \theta'_{ss}; \pi_2\right)$$

By construction, $\hat{I}\left(1, \hat{x}\left(1,1;\pi_2\right), 1; \pi_2\right) \leq 1$. Therefore, using the Intermediate Value Theorem, there exists a $\theta_{\pi 2} \in \left(\theta_{ss}, 1\right]$ such that $\theta_{\pi 2} = \hat{I}\left(\theta_{\pi 2}, \hat{x}\left(\theta_{\pi 2}, \theta_{\pi 2}; \pi_2\right), \theta_{\pi 2}; \pi_2\right)$. Let $x_{\pi 2} = \hat{x}\left(\theta_{\pi 2}, \theta_{\pi 2}; \pi_2\right)$. Then, $\left(\theta_{\pi 2}, x_{\pi 2}\right)$ constitutes a steady-state under $\pi_2$ and $\theta_{\pi 2} > \theta'_{ss}$. ■

**Proof.** of Lemma 3: First we consider, for young women of good character, the decision whether to accept or refuse a marriage offer. Let $x$ be the value of the utility from singlehood at which such a women is indifferent between accepting and refusing a marriage offer. Then $x$ must satisfy the following equation:

$$\left(1 + \beta\zeta\right) u_f\left(\tau_1, \varepsilon_m\right) = x + \beta\zeta\left[\left(1 - \lambda_2\right)\underline{u}_{f2} + \lambda_2 u_f\left(\tau_2, \varepsilon_m\right)\right] \tag{18}$$

If $\tau_1$ solves $u_m\left(\tau_1, \hat{\varepsilon}_{f1}\right) = \underline{u}_m$ then, at $\underline{u}_{f1} = x$, both the bride and the groom will be left with zero surplus from the marriage. For $\underline{u}_{f1} > x$, there is no marriage contract that would satisfy both parties while, if $\underline{u}_{f1} < x$, then there is always some marriage contract that will satisfy both parties. Therefore, a marriage contract will be negotiated if and only if $\underline{u}_{f1} \geq x$.

In equilibrium, young women of bad character will imitate the behaviour of those of good character in deciding whether to accept or refuse a marriage offer. In particular, accepting a marriage offer at some $\underline{u}_{f1} > x$ would imply that the bride has bad character (because, by construction, someone of good character with the same outside option would not accept a marriage offer in equilibrium); while a young woman would not find it in her interest to refuse the equilibrium marriage offer at $\underline{u}_{f1} < x$. Therefore, the same threshold $x$ applies to young women of bad character. ■

For the purpose of Proposition 7, we provide a formal definition of a Naive Expectations Equilibrium in the case where refusals occur. Given $\left(\theta_0, x_0\right)$, a Naive Expectations Equilibrium is constructed as follows. We let $\theta_t^0 = \hat{I}\left(\theta_{t-1}^0, x_{t-1}^0, \theta_{t-1}^0\right)$, $x_t^0 = x\left(\theta_{t-1}^0, \theta_{t-1}^0\right)$ for each $t \geq 1$. Then the algorithm for iterating expectations, introduced in Section 3.4, becomes $\theta_t^\alpha = \hat{I}\left(\theta_{t-1}^\alpha, x_{t-1}^\alpha, \theta_{t+1}^{\alpha-1}\right)$, $x_t^\alpha = x\left(\theta_t^{\alpha-1}, \theta_{t+1}^{\alpha-1}\right)$ for $\alpha = 1, 2, ...$ Following the reasoning of Proposition 3, we can show the sequence $\left\{\lim_{\alpha\to\infty}\left(\theta_\tau^\alpha, x_\tau^\alpha\right)\right\}_{\tau=1}^{\infty}$ exists and that it constitutes a marriage market equilibrium (with iterated expectations).

**Proof.** of Proposition 7: Suppose that the shock in question improves the common element of the outside option from $\overline{x}$ to $\tilde{x}$ for young women who enter the marriage market in period $\tau$ (leaving unchanged the outside option for other cohorts). Let us denote by $\left\{\tilde{\theta}_t^0, \tilde{x}_t^0\right\}_{t=\tau}^{\infty}$ the Naive Expectations Equilibrium in the case of the period $\tau$ shock and by $\left\{\theta_t^0, x_t^0\right\}_{t=\tau}^{\infty}$ the Naive Expectations Equilibrium when there is no such shock. By construction,

$$\begin{aligned}
\tilde{x}_\tau^0 &= \hat{x}\left(\tilde{x}, \theta_{\tau-1}, \theta_{\tau-1}\right) < \hat{x}\left(\overline{x}, \theta_{\tau-1}, \theta_{\tau-1}\right) = x_\tau^0 \\
\tilde{\theta}_\tau^0 &= \hat{I}\left(\theta_{\tau-1}, x_{\tau-1}, \theta_{\tau-1}\right) = \theta_\tau^0
\end{aligned}$$

Then, from the definition of the Naive Expectations Equilibrium, we can show that $\tilde{\theta}_t^0 < \theta_t^0$ and $\tilde{x}_t^0 < x_t^0$ for $t > \tau$. It follows that the same relationship holds for each iteration, i.e. $\tilde{\theta}_t^\alpha < \theta_t^\alpha$ and $\tilde{x}_t^\alpha < x_t^\alpha$ for $\alpha = 1, 2, ...$

Let $\tilde{\theta}_t = \lim_{\alpha \longrightarrow \infty} \tilde{\theta}_t^\alpha$, $\tilde{x}_t = \lim_{\alpha \longrightarrow \infty} \tilde{x}_t^\alpha$. Therefore, given that, for each $t \geq \tau$, $\left(\tilde{\theta}_t, \tilde{x}_t\right)$ is the limit of the sequence $\left\{\left(\tilde{\theta}_t^\alpha, \tilde{x}_t^\alpha\right)\right\}_{\alpha=0}^\infty$ and, by definition, $(\theta_t, x_t)$ is the limit of the sequence $\{(\theta_t^\alpha, x_t^\alpha)\}_{\alpha=0}^\infty$, we must have $\tilde{\theta}_t \leq \theta_t$ and $\tilde{x}_t \leq x_t$. Furthermore, note that

$$\begin{aligned} \tilde{x}_\tau &= \hat{x}\left(\tilde{x}, \theta_{\tau-1}, \tilde{\theta}_{\tau+1}\right) < \hat{x}\left(\overline{x}, \theta_{\tau-1}, \theta_{\tau+1}\right) = x_\tau \\ \tilde{\theta}_\tau &= \hat{I}\left(\theta_{\tau-1}, x_{\tau-1}, \tilde{\theta}_{\tau+1}\right) \leq \hat{I}\left(\theta_{\tau-1}, x_{\tau-1}, \theta_{\tau+1}\right) = \theta_\tau \end{aligned}$$

Therefore,

$$\begin{aligned} \tilde{x}_{\tau+1} &= \hat{x}\left(\overline{x}, \tilde{\theta}_\tau, \tilde{\theta}_{\tau+2}\right) \leq \hat{x}\left(\overline{x}, \theta_\tau, \theta_{\tau+2}\right) = x_\tau \\ \tilde{\theta}_{\tau+1} &= \hat{I}\left(\tilde{\theta}_\tau, \tilde{x}_\tau, \tilde{\theta}_{\tau+2}\right) < \hat{I}\left(\theta_\tau, x_\tau, \theta_{\tau+2}\right) = \theta_{\tau+1} \end{aligned}$$

Therefore,

$$\begin{aligned} \tilde{x}_{\tau+2} &= \hat{x}\left(\overline{x}, \tilde{\theta}_{\tau+1}, \tilde{\theta}_{\tau+3}\right) < \hat{x}\left(\overline{x}, \theta_{\tau+1}, \theta_{\tau+3}\right) = x_{\tau+2} \\ \tilde{\theta}_{\tau+2} &= \hat{I}\left(\tilde{\theta}_{\tau+1}, \tilde{x}_{\tau+1}, \tilde{\theta}_{\tau+3}\right) < \hat{I}\left(\theta_{\tau+1}, x_{\tau+1}, \theta_{\tau+3}\right) = \theta_{\tau+2} \end{aligned}$$

Therefore, in subsequent periods, $\tilde{x}_t$ and $\tilde{\theta}_t$ are strictly below $x_t$ and $\theta_t$ respectively. Following the same type of reasoning, we can show that $\tilde{\theta}_t \geq \theta_t$ and $\tilde{x}_t \geq x_t$ for $t \geq \tau$ and strict inequality from period $\tau + 2$ onwards if the transitory shock worsens the outside option of young women. ■

# 9 Appendix B

The following table lists the system of equations used to compute the steady-state values and parameters $\gamma$, $\sigma$ and $\pi$. For ease of notation, we let $\lambda_2' = (1 - \hat{\varepsilon}_{f1})\lambda_2 + \hat{\varepsilon}_{f1}\lambda_2(1 - \pi)$.

Table B1: System of Equations for Computing the Steady-State and Parameter Values

| # | Equation | Type |
|---|---|---|
| 1 | $\lambda_1 n_{f1} - \mu\left(\frac{n_{f1}}{\theta n_m}\right)\theta n_m = 0$ | equilibrium |
| 2 | $n_{f2} - \frac{n_{f1}}{cgr}\left[1 - \lambda_1(1 - \pi\varepsilon_f)\right] = 0$ | equilibrium |
| 3 | $\varepsilon_{f2} - \frac{[(1-\lambda_1)+\lambda_1\pi]\varepsilon_f}{(1-\lambda_1)+\lambda_1\pi\varepsilon_f} = 0$ | equilibrium |
| 4 | $\lambda_2 n_{f2} - \mu\left(\frac{n_{f2}}{(1-\theta)n_m}\right)(1-\theta)n_m = 0$ | equilibrium |
| 5 | $\mathbf{E}v_{f1} - \left\{1 + \beta\zeta\left(1 - \lambda_2'\right)\right\}\underline{u}_f + \beta\lambda_2'\left\{-\tau_2 + \sigma(1 - \varepsilon_m)\right\} = 0$ | equilibrium |
| 6 | $\tau_1 - \frac{1}{2}\left[\sigma(1-\varepsilon_m) - \sigma(1-\hat{\varepsilon}_{f1}) - \mathbf{E}v_{f1} + v_{m2}\right] = 0$ | equilibrium |
| 7 | $\tau_2 - \frac{1}{2}\left[\sigma(1-\varepsilon_m) - \sigma(1-\hat{\varepsilon}_{f2}) - v_{f2} + v_{m2}\right] = 0$ | equilibrium |
| 8 | $U_1(\theta, n_{f1}, n_m, \tau_1, \varepsilon_{f1}) - U_2(\theta, n_{f2}, n_m, \tau_2, \varepsilon_{f2}) = 0$ | equilibrium |
| 9 | $\tau_1/\tau_2 - 2.09 = 0$ | moment-matching |
| 10 | $\lambda_1(1 - \pi\varepsilon_f) - 0.7205 = 0$ | moment-matching |
| 11 | $(1 - \lambda_1 + \lambda_1\pi\varepsilon_f)(1 - \lambda_2 + \lambda_2\pi\varepsilon_{f2}) - 0.05 = 0$ | moment-matching |

Furthermore, $\lambda_2' = \lambda_2(1 - \pi\varepsilon_{f2})$, $\hat{\varepsilon}_{f1}$ is given by (4), and $\hat{\varepsilon}_{f2}$ by (5).

## References


[1] Ahmed, A.U., C.d. Ninno (2002). "The food for Education Program in Bangladesh: An Evaluation of its Impact on Educational Attainment and Food Security", *FCND Discussion Paper # 138*, International Food Policy Research Institute.

[2] Amin, S., S. Ainul, F. Akhter, M.M. Alam, M. I. Hossain, J. Ahmed, U. Rob (2014). *From Evidence to Action: Results from the 2013 Baseline Survey for the Balika Project*. Population Council.

[3] Amin, S. and A. Bajracharya. (2011). "Costs of Marriage - Marriage Transactions in the Developing World", *Promoting Healthy, Safe and Productive Transitions to Adulthood*, Population Council Brief no. 35, March 2011.

[4] Amin, S., S. Mahmud, and L. Huq (2002). *Kishori Abhijan: Baseline Survey Report on Rural Adolescents in Bangladesh*. Ministry of Women and Children Affairs, Dhaka, Government of the People's Republic of Bangladesh.

[5] Amin, S., & Suran, L. (2009). "Terms of Marriage and Time-Use Patterns of Young Wives – Evidence from Rural Bangladesh." *International Journal of Time Use Research*, vol. 6(1), pp. 92-108.

[6] Anderson, S. (2007). "Why the marriage squeeze cannot cause dowry inflation", *Journal of Economic Theory*, 2007, Vol. 137(1), pp. 140-152.

[7] Asadullah, M.N. and N. Chaudhury. (2009). "Reverse Gender Gap in Schooling in Bangladesh: Insights from Urban and Rural Households", *Journal of Development Studies*, Vol. 45(8), pp. 1360-1380.

[8] Asadullah, M.N. and Z. Wahhaj. (2017). "Early Marriage, Social Networks and the Transmission of Norms", *Global Development Institute Working Paper Series* 2017-016.

[9] Banerjee, A. V., & Duflo, E. (2009). "The Experimental Approach to Development Economics", Annual Review of Economics, vol. 1, pp. 151-78.

[10] Baron, B. (2006). "Women, honour, and the state: Evidence from Egypt". *Middle Eastern Studies*, vol. 42(1), pp. 1-20.

[11] Becker, G. S. (1960). "An Economic Analysis of Fertility." *Demographic and Economic Change in Developed Countries*. Princeton: Princeton University Press.

[12] Becker, G. S. (1973). "A Theory of Marriage: Part I". *Journal of Political Economy*, vol. 81(4), pp. 813-846.

[13] Becker, G. S. (1974). "A Theory of Marriage: Part II". *Journal of Political Economy*, vol. 82(2), pp. S11-S26.

[14] Becker, G. S., and H. G. Lewis. (1973). "On the Interaction between the Quantity and Quality of Children." *Journal of Political Economy*, vol. 81:S279–288.

[15] Bergstrom, T. and M. Bagnoli. (1993). "Courtship as a Waiting Game", *Journal of Political Economy*, Vol. (101), pp. 185-202.

[16] Bhaskar, V. (2011). "Sex Selection and Gender Balance". *American Economic Journal: Microeconomics*, pp. 214-244.

[17] Bhaskar, V. (2015). "The Demographic Transition and the Position of Women: A Marriage Market Perspective", Center for Economic Policy Research, Discussion Paper No. 10619.

[18] Bhat, P. M., & Halli, S. S. (1999). "Demography of Brideprice and Dowry: Causes and Consequences of the Indian Marriage Squeeze", *Population Studies*, Vol. 53(2), pp. 129-148.

[19] Binmore, K., A. Rubinstein, and A. Wolinsky (1986). "The Nash Bargaining Solution in Economic Modelling", *The RAND Journal of Economics*, Vol. 17(2), pp. 176-188.

[20] Bloch, F., & V. Rao, (2002). "Terror as a bargaining instrument: A Case Study of Dowry Violence in Rural India", *American Economic Review*, 92(4), 1029.

[21] Caldwell, J.C., P.H. Reddy, and P. Caldwell (1983). "The Causes of Marriage Change in South India", *Population Studies*, Vol. 37(3), pp. 343-361.

[22] Chari, A.V., R. Heath, A. Maertens, F. Fatima (2017). "The Causal Effect of Maternal Age at Marriage on Child Wellbeing: Evidence from Inda", *Journal of Development Economics*, Vol. 127, pp. 42-55.

[23] Coles and Francesconi. (2007). "On the Emergence of Toyboys: Equilibrium Matching with Ageing and Uncertan Careers", *IZA Discussion Paper No. 2612.*

[24] Doepke, M. (2015). "Gary Becker on the Quantity and Quality of Children", *Journal of Demographic Economics*, vol. 81(1), pp. 59-66.

[25] Diamond, P., and E. Maskin. (1979). "An Equilibrium Analysis of Search and Breach of Contract", *Bell Journal of Economics* Vol. (10), pp. 282-316.

[26] Dixon, R. (1971). "Cross-Cultural Variations in Age at Marriage and Proportions Never Marrying", *Population Studies,* Vol. 25(2), pp. 215-233.

[27] Dommaraju, P. and G. Jones. (2011). "Divorce Trends in Asia", *Asian Journal of Social Science*, Vol. 39(6), pp. 725-750.

[28] Duflo, E., Glennerster, R., & Kremer, M. (2007). "Using Randomization in Development Economics Research: A Toolkit", *Handbook of Development Economics*, vol. 4, pp. 3895-3962.

[29] Dyson, T. and M. Moore (1983). "On Kinship Structure, Female Autonomy, and Demographic Behavior in India", *Population and Development Review*, Vol. 9(1), pp. 35-60.

[30] Field, E. and A. Ambrus. (2008). "Early Marriage, Age of Menarche and Female Schooling Attainment in Bangladesh", *Journal of Political Economy,* Vol. 116(5), pp. 881-930.

[31] Edlund, L. (1999). "Son preference, sex ratios, and marriage patterns", *Journal of Political Economy*, Vol. 107(6), pp. 1275-1304.

[32] Gale, D., & Shapley, L. S. (1962). "College admissions and the stability of marriage". *American Mathematical Monthly*, 9-15.

[33] Goody, J. (1990). *The Oriental, the Ancient and the Primitive: Systems of Marriage and the Family in the Pre-Industrial Societies of Eurasia*. Cambridge University Press.

[34] Hajnal, J. (1965). "European Marriage Patterns in Perspective", *Population in History: Essays in Historical Demography*, Glass DV, Eversley DE, eds. Chicago, Illinois, Aldine Publishing Company, pp. 101-43.

[35] Heath, R., & Mobarak, A. M. (2015). "Manufacturing growth and the lives of Bangladeshi women", *Journal of Development Economics*, Vol. 115, pp. 1-15.

[36] Hicks, J. H., & Hicks, D. L. (2015). "Lucky Late Bloomers? The Consequences of Early Marriage for Women in Western Kenya. The Consequences of Early Marriage for Women in Western Kenya" (June 23, 2015), mimeo, University of Oklahoma.

[37] Jensen, R. and R. Thornton (2003). "Early Female Marriage in the Developing World", *Gender and Development*, Vol. 11(2), pp. 9-19.

[38] Joshi, S. & T.P. Schultz (2007). "Family Planning as an Investment in Development: Evaluation of a Program's Consequences in Matlab, Bangladesh", *Yale University Economic Growth Center*, Discussion Paper No. 951.

[39] Kandiyoti, D. (1988). "Bargaining with patriarchy", *Gender & Society*, Vol. 2(3), pp. 274-290.

[40] Kreps, D.M. and R. Wilson (1982). "Sequential Equilibria", *Econometrica*, Vol. 50(4), July 1982, pp. 863-894.

[41] Mensch, B., S. Singh, and J. Casterline (2005). "Trends in the Timing of First Marriage Among Men and Women in the Developing World", *Policy Research Division Working Paper*, Population Council, New York.

[42] Moghadam, V. M. (2004). "Patriarchy in transition: Women and the changing family in the Middle East", *Journal of Comparative Family Studies*, pp. 137-162.

[43] Mortensen, D. T., & Pissarides, C. A. (1999). "New Developments in Models of Search in the Labor Market", *Handbook of Labor Economics*, Vol. (3), pp. 2567-2627.

[44] NIPORT (2013). *Bangladesh Demographic and Health Survey 2011*. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International.

[45] Ortner, S.B. (1978). "The Virgin and the State", *Feminist Studies*, Vol. 4(3), pp. 19-35.

[46] Petrongolo, B., & Pissarides, C. A. (2001). "Looking into the Black Box: A Survey of the Matching Function", *Journal of Economic Literature*, pp. 390-431.

[47] Rao, V. (1993). "The Rising Price of Husbands: A Hedonic Analysis of Dowry Increases in Rural India", *Journal of Political Economy*, pp. 666-677.

[48] Rozario, S. (1992). *Purity and Communal Boundaries: Women and Social Change in a Bangladeshi Village*. Women in Asia Publication Series. Zed Books Ltd.

[49] Sautmann, Anja (2017). "Age-Dependent Payoffs and Assortative Matching by Age in a Market with Search", *American Economic Journal: Microeconomics*, vol. 5(3), pp. 124-156.

[50] Schneider, J. (1971). "Of vigilance and virgins: honor, shame and access to resources in Mediterranean societies", *Ethnology*, vol. 10(1), pp. 1-24.

[51] Schuler, S., L. Bates, F. Islam, and M. Islam (2006). "The Timing of Marriage and Childbearing among Rural Families in Bangladesh: Choosing between Competing Risks", *Social Science & Medicine*, Vol. 62, pp. 2826-2837.

[52] Schultz, P. and J. S. DaVanzo (1970). "Analysis of Demographic Change in East Pakistan: A Study of Retrospective Survey Data", Report prepared for Agency for International Development, R-564-AID. Rand Corporation.

[53] Sekhri, S. and Debnath, S. (2014): "Intergenerational Consequences of Early Age Marriages of Girls: Effect on Children's Human Capital," *Journal of Development Studies*, Vol 50, No 12, pp 1670-1686.

[54] Sunder, N. (2015). "Marriage Age, Social Status and Intergenerational Effects in Uganda. Social Status and Intergenerational Effects in Uganda", (November 29, 2015). Available at SSRN: http://ssrn.com/abstract=2655757

[55] UNFPA (2005). *State of World Population Report. The Promise of Equality: Gender Equity, Reproductive Health and the Milennium Development Goals.* United Nations Population Fund.

[56] UNFPA (2012). *Marrying Too Young: End Child Marriage.* United Nations Population Fund

[57] UNICEF (2016). *The State of the World's Children 2016. A Fair Chance for Every Child.*

[58] Westoff, C.F. (2003). *Trends in Marriage and Early Childbearing in Developing Countries*, DHS Comparative Reports No. 5. Calverton, Maryland: ORC Macro.

[59] White, S. (1992). *Arguing with the Crocodile: Gender and Class in Bangladesh*, Zed Books.