

Marriage Timing and Forward Contracts in Marriage Markets

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Abstract

We study how contractual incompleteness affects marriage contracts, including pre-marital investments in human capital, age of marriage, and the timing of payments. We formalise different solutions to the contractual problem and document their use across societies and at different points in history. The most common form of marriage arrangement today is one where human capital investments precede the marriage agreement. However, two other forms of contractual arrangements have also been prevalent in the past: (i) transfer of the bride to the groom's family prior to human capital investments (e.g. pre-pubescent marriages); (ii) a forward contract specifies investments to be made in the bride before her transfer to the groom's family (e.g. cradle betrothal). Each alternative suffers from a form of inefficiency (due, respectively, to search costs, agency problems in childrearing, and underinvestment due to the classical hold-up problem). The model generates predictions regarding the contractual form adopted as a function of the prevailing production technology, population density, and credit constraints. We argue that a theory of marriages that allows contractual form to be endogenous provide insights about the impact of development policies that are missed when the contractual form is taken as given.

Keywords: Marriage Markets, Child Marriage, Dowry, Human Capital Investments, Brideprice, Forward Contracts, Incomplete Contracts, Hold-up Problem.

JEL Classification Codes: D02, D86, J12, J16, J24, O12.

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1 Introduction

The economic analysis of institutions, including their genesis, functions and consequences, has received a great deal of interest in the recent past and continues to be an active area of research. Among these institutions, those relating to marriage and the family play an important role in shaping economic decisions and social outcomes, particularly in traditional societies. There has been substantial work by economists in understanding one important element of marriage institutions, namely, the determinants and consequences of marriage payments (i.e. dowry, bride-price, etc.).¹ Other terms of the marriage contract – such as the timing and conditionality of various transfers – have been relatively understudied by economists, although well-documented by sociologists, anthropologists and demographers.

The existing literature provides a variety of examples where the marriage contract is shaped by various types of contractual incompleteness. For example, Botticini and Siow (2003) argue that, historically, dowry transfers have played the role of a pre-mortem bequest from parents to a marrying daughter, to incentivise their son's effort – which cannot be contracted upon – on the parental estate. Anderson and Bidner (2015) argue that the inability of the bride and groom to commit to post-marital transfers has led a part of dowry payments (in contemporary South Asia) to be directed to the groom (as opposed to the traditional practice of giving it to the bride), to ensure that he finds the marriage contract sufficiently attractive. Do, Iyer and Joshi (2013) argue that consanguinity is a response to the problem that post-marital investments by the families of the bride and groom cannot be contracted upon; because if the wedded families have blood ties, their mutual trust and altruism will incentivise investments in the marrying couple.

In this paper, we focus on a different type of contractual incompleteness that has received little attention in the literature thus far, namely contractual incompleteness in pre-marital investments in the human capital of the bride and groom by the families. These investments would include the health and education of the marriage partners and, more generally, any skills and training that would increase their productivity in the marital household. We

¹See Anderson (2007) for a review.

develop a theoretical model in which we formalise different solutions to this contractual problem and document their use across societies and at different points in history.

The most common type of marriage arrangement in practice today is one where human capital investments in the bride and groom are made before they (or their families) enter into any marriage contract. Then, if these investments are appropriately priced on the marriage market, then this would ensure that the two parties have incentives to make the efficient levels of investment. However, there may be no mechanism to price these investments, as recent work by Ashraf et al. (2016) shows.

An alternative solution would be for the bride to be transferred to the groom's family prior to any human capital investments in her. This would ensure that the groom's family reaps full returns from investments in the bride and, therefore, has the incentives to make the efficient level of investment. The practice of child marriage (more precisely, pre-pubescent marriage) would be an example of such a solution. Although the practice is rare today, demographic data and accounts from sociologists and ethnographers show that it was prevalent in the past across a range of societies, evidence that we present in subsequent sections.

A third solution to the problem of ensuring efficient pre-marital investments is for the families of the bride and groom to enter into a forward contract before these investments take place. Under this arrangement, the bride's family would make the necessary investments, with the bride moving to the groom's household only after the investments are complete. Marriage payments may be contingent on the level of investments made. The advantage of this solution over the alternatives discussed above is that obviates the need to separate the bride from her family at an early age, and it allows sufficient time for finding a suitable match. However, the forward contract also has disadvantages as either party may walk away from the contract or attempt to renegotiate the contract. In particular, a hold-up problem (Williamson 1975; Grossman and Hart 1986) may lead to inefficient investments. Although marriage forward contracts are rare today, the ethnographic and historic evidence shows that they were practised in a range of societies and social groups in the past.

More generally, the available evidence on different types of marriage arrangements across societies and over time show (i) a diversity of contractual forms in use; (ii) a secular decline,

over time, in the use of forward contracts and pre-pubescent marriages and emergence of a post-pubescent (spot-market) marriages as the dominant contractual arrangement. We use the theoretical model to account for these changes, based on the reasoning that changes in production technology and population density would affect the pros and cons of different types of marriage contracts.

Next, we show that our theoretical model has implications for a number of development policies related to poverty alleviation and gender equality, including cash transfers, improved access to female schooling and legal minimum age of marriage. We argue that a theory of marriages that takes the contractual form as given would provide one answer regarding the impact of development policies, while a framework that allows contractual form to be endogenous may provide a different answer.

The remainder of this paper is organised as follows. In Section 2, we present the demographic and ethnographic evidence on different marriage contractual forms across societies and through history, and present a set of stylised facts based on this evidence. We develop our theoretical model on marriage contracts and characterise the marriage market equilibrium for different parameter values in Section 3. In Section 4, we extend the model to incorporate credit constraints, risk of adverse shocks and delayed realisation of productivity and discuss their implications for marriage contractual forms. In Section 5, we assess the potential side effects of various policies of gender and development when we take into account endogenous responses of marriage contractual forms to these policies. We provide conclusions in Section 6.

2 Evidence on Alternative Marriage Contractual Forms

In this section, we discuss the available evidence on alternative marriage contractual forms – across different parts of the world, and through history – documented in the literature. Next, we summarise the available evidence into a number of stylised facts that a theory that takes marriage contractual forms to be endogenous should explain.

An immediate challenge to this exercise is the absence of systematic data collection

on marriage contractual forms. While economic and demographic surveys often include questions on marriage transfers – e.g. brideprice and dowry – they do not, typically, attempt to document the timing of these transfers and other steps in the marriage process. For example, Meekers (1992) observes that "African marriage ... is a process composed of several stages between the preliminary rites and the full acceptance of the couple as a social unit" including, potentially, the transfer of bridewealth to the bride's family in stages. As such, demographic accounts that picture marriage as a single event would miss important aspects of the marriage contractual form. Using data from the 1980-81 Côte d'Ivoire Fertility Survey, Meekers (1992) shows that the timing of three events related to marriage – consummation, first cohabitation, and the marriage ceremony – usually do not coincide: for the Baoulé ethnic group, the average time between consummation and first cohabitation is 12 months, with the marriage ceremony occurring, on average, 11 months after consummation. We argue that these time differences mask details of the contract that are often not being captured in demographic surveys. (An exception to this characterisation are demographic surveys for India, which we discuss below). For this reason, we give attention to both quantitative and qualitative evidence on alternative marriage contractual forms, the latter being based on ethnographic accounts of marriage arrangements for a wide range of societies.

Marriage Forward Contracts: In the case of India, it has been noted that marriages often involve a two-stage process. The first stage involves a formal marriage ceremony, following which the bride continues to live with her parents. The consummation of the marriage, and the start of cohabitation between the bride and groom begins only after a second ceremony is performed, called 'gauna' in northern India and 'sobana' in southern India. There may be a difference of several years between the two events, with the first ceremony occurring before the bride has attained puberty, while the second ceremony occurs following the onset of menarche (Leeson and Suarez 2017; Caldwell, Reddy and Caldwell 1983; Chari et al. 2017). We argue that an extended period between the marriage ceremony and the start of cohabitation corresponds to a forward contract, whereby the bride's family promises to 'deliver' their daughter over to the groom's family at a later date. The 1992-93 National Family Health Survey recorded information on both the date of the marriage

ceremony and the date of the start of cohabitation for a nationally representative sample of women in India. We use this information to measure the prevalence of marriage forward contracts in India. As Table 1 shows, more than 1 in 5 married women had a marriage which involved a forward contract with at least a year difference between the marriage ceremony and the start of cohabitation.

Although there is an absence of comparable demographic data for marriages in Africa, the ethnographic literature provides rich evidence on the prevalence of marriage forward contracts. Quoting again from Meekers (1992): "In traditional societies, girls frequently were promised in marriage while they were infants, or even before they were born (see Himmelheber and Himmelheber, 1958 for the Dan; Murdock, 1959 for the Volta tribes; Schwartz, 1971 for the Guere)." The phenomenon of early betrothal is also noted in the encyclopedia *Marriage Customs of the World* (Monger 2004), as a practice observed across a wide range of societies: "... child betrothal was widely practiced among many African tribes ... In some African communities, the husband-to-be would live with the girl's parents until she was old enough for marriage. Anthropologists have found many cases and societies in which children were betrothed at birth or soon after." We argue that these marriage promises were, essentially, forward contracts: where the bride's family promised their offspring to the family of the groom at some future date in exchange of transfers, potentially at different points in time, over the duration of the contract.

Examples of other African tribes that made use of similar marriage contractual forms are provided by Rosenblatt (1967): "[Among the] Aranda, Buka, Callinago ... Ifugao ... Lepcha, Murngin and Tupinamba ... child betrothal is customary or common. During the long period of betrothal, the two betrothed individuals of their consanguineal families do a great deal for their affinals-to-be. These exchanges of gifts or services build ties between families." On the Kagoro in Nigeria, Smith (1960) wrote "Infant betrothal was followed by a long series of minor exchanges which continued until the woman's husband had paid *drangwan* to her father in order to ratify his claim to the child she had borne." Other instances of infant betrothal in Africa are documented by Brydon (1979) for the Amedzofe-Avatime in Ghana, Anyanwu (1973) for the Mbaise Igbo of Nigeria, Meekers (1995) for the Ewe in

Togo. Bocharov (2001) writes that, in polygynous societies in Africa, a family may arrange a betrothal for a minor girl to obtain the funds necessary to pay the brideprice for the eldest son.

It is important to note that the available evidence of early betrothal is not limited to Africa alone. We find evidence of infant betrothal among Australian Aboriginals (Keen 2002), Eskimo tribes (Monger 2004), in the Melanesian islands (Bell 1935), and in eastern Turkey (Ertem and Kocturk 2017). Russian ethnographers have documented the practice of infant betrothal in the Caucasus. Smirnova (2006) notes that, among the peoples of the Caucasus, marriage through betrothal displays several forms that range from archaic compulsion to free choice. The earliest form is an agreement between the parents of the future groom and bride, which was made when the "fiancées" are still infants or sometimes even before they were born. According to Bayramukova (2005), "cradle betrothal" was a common phenomenon among the Nogais in the North Caucasus: the father of a newborn girl would promise her in marriage in exchange of a brideprice paid, potentially, in several instalments. Bayramukova (2005) also note that the practice was prevalent among the Karachays in the North Caucasus, albeit the rules were more lax, and the agreement of the bride and the groom was considered necessary for the marriage to take place. Murzakhanov (2016) provides another example of "cradle betrothal" in the Caucasus, namely among the Nalchik Mountain Jews. The tradition required that both cradles – corresponding to the bride and groom – be marked with the same type of sign, to indicate the engagement. The promised bride has to respect certain rules before marriage (avoid meeting the future groom or his relatives, attend weddings or feasts only accompanied by a relative, etc.). The refusal by one of the two parties to honor the agreement was considered by the other side as a punishable offense.

We also find historical evidence of early betrothal in the Indian subcontinent. In describing early betrothal in Punjab in the 19th century, Rose (1908) writes "... the general feeling is that the girl is a valuable piece of property, and that betrothal is a contract to transfer her ownership to the boy's family, when she reaches a marriageable age, but the boy's death cancels the contract." The marriage betrothal is a binding promise and breaking it involves severe social penalties, even to the extent that "a betrothed girl whose fiancé died could not

be married, and if such a marriage occurred it brought social discredit on the family".

There is also evidence of forward marriage contracts among the English nobility in the 16th and 17th centuries. For example, Stone (1961) writes of marriage arrangements whereby "the marriage was allowed to take place early but consummation was postponed, sometimes until several years later, the girl continuing to live with her parents ... [or] marriage was accompanied by a unique or even token consummation followed by a prolonged separation' (p. 199).

Premarital Transfer of Bride: We distinguish between the examples of marriage promises or forward contracts discussed above from agreements where the groom's family takes responsibility for the bride-to-be immediately upon agreement. Omokhodion (2003) identifies a number of tribes in Nigeria where marriage contracts take this form: "Some tribes practice the custom of placing young women under the care of their betrothed before they reach marriageable age; this is common among the Kona, Margi, Mumuye, and Mumbake, as well as the Mosi tribe. First, the responsibility for the girl's upbringing and chastity is thrown on the fiancé's family, and second, the appropriation of the girl by her betrothed is clearly signified." Unlike the case of marriage forward contracts, investments in the bride-to-be – in her health, education and skills – are made by the groom's family which have both advantages and disadvantages vis-a-vis forward contracts, which we highlight in the formal theoretical exposition below.

The available evidence indicates that pre-pubescent marriages have also been common in the Indian subcontinent at least until recently. Leeson and Suarez (2017) estimate that, among married women in India, an estimated 10.6 million had married by age 12, while their average age of puberty was above 14. Using the 1961-92 demographic survey of East Pakistan (presently Bangladesh), Schultz and DaVanzo (1970) report a median age of marriage of 13.66 years, with 35 percent of women married by age 12.²

Caldwell, Reddy and Caldwell (1983) argue that pre-pubescent marriages were common

²Although Schultz and DaVanzo (1970) do not report on the age of onset of puberty for this sample of women, more recent surveys show that women in Bangladesh rarely attain menarche before age 11 and there has been little variation in mean age of menarche over time (Field and Ambrus 2008, Asadullah and Wahhaj 2018).

in Karnataka, in southern India, until the first part of the twentieth century, a major reason being the fact that "many families feel deep disquiet and guilt over the presence of an unmarried menstruating daughter in the household". The Mysore Population Study (UN 1961; cited in Caldwell, Reddy and Caldwell 1983) estimated that 42 per cent of rural women in the region born between 1893 and 1902 had married before age 13. However, Caldwell, Reddy and Caldwell (1983) also noted a sharp shift in norms towards post-pubescent marriages during the second half of the twentieth century: in their study area in Karnataka, in 1980, only one per cent of girls in the age group 10-14 years were married.

Historians have also documented numerous cases of pre-pubescent marriages in Western societies. One example is the ancient Roman aristocracy (Hopkins 1965). By contrast, during the same period, Italian peasant girls were more likely to experience post-pubescent marriages.

3 Theoretical Model

3.1 Setup

3.1.1 Actors

Consider an economy with two types of families: those having daughters and those having sons. Families are atomistic, and the measures of each of the two groups is equal to 1. For simplicity, we will talk about bride's family (b) and groom's family (g). Children play no active role. Other than the gender of the child, families on both sides of the market are homogeneous.³

3.1.2 Objectives

The groom's family cares about the value of the bride, denoted by $v(I)$. where I represents investments in the girl's health, education, etc. and $v(\cdot)$ is an increasing and (strictly) concave function. Depending on the contract (to be specified below), the investment can be

³Our analysis and results extend to a setting where families are heterogenous in terms of location, language, religion, caste, tribe, the type of productive activity they undertake, and the marriage market is segmented according to these characteristics. We make the assumption of homogeneity for ease of notation.

made either by b or g . Matching with a bride or groom involves search which may be time-consuming. The reason is that although the potential marriage partners are homogeneous, not every household has an unmarried girl/boy of the appropriate age. The time involved in search is costless if it is undertaken while the son/daughter (for whom a partner is sought) is still a child, but it involves a cost in case either family is looking for a suitable partner on the spot market following the onset of puberty. We denote by σ_b for b and by σ_g for g the level of the cost when everyone else is on the spot market. Below, we provide an interpretation of these search costs and the reason for their absence in the pre-pubescent marriage market. The search costs are non-decreasing in the share of families that quit the spot market. The families also care about transfers (τ) which will be specified in the contract and can be in either direction (therefore, both brideprices and dowries are feasible). Besides the above, the bride's family also incurs a psychological cost (ψ) in case the marriage occurs before puberty. In case the daughter remains unmarried, b obtains a utility equal to u_b . Similarly, if the son remains unmarried, g obtains a utility of u_g .

3.1.3 Timing

There are three stages in the game ($t = 0, 1, 2$). At the beginning of $t = 0$, children are born, and families can arrange marriages (on the spot market) among all the population. This involves the bride's parents marrying off her daughter and sending her off to join the marital home even before she reaches puberty. Alternatively, they can arrange a forward contract, i.e. an arrangement between the families of the bride and the groom while they are still children, with a future date for the bride to join her marital home. The arrangement may also specify the investment in the girl that should occur in the intervening period, and any transfer of assets that should take place as part of the marriage contract. Any investment into girls is made at $t = 1$. At $t = 2$, fruits of the investment are realized and girls are ready to provide "marital services". Moreover, at this stage, forward contracts can be renegotiated (we provide details about the bargaining process that occurs in that case below).

3.1.4 Contracts

There are three contract types that we will consider:

1. **Spot marriage contracts for post-pubescent brides.** b decides on the investment before the match is made. Marriage and transfer (τ_s) occur simultaneously, after the onset of puberty.
2. **Forward marriage contracts for post-pubescent brides.** The match occurs at $t = 0$. The contract specifies the level of investment (to be made by b) and the transfer (τ_f) between g and b . A part of the transfer can be made at the time of the marriage, and thus conditional on the level of investment. Marriage occurs at $t = 2$.
3. **Spot marriage contracts for pre-pubescent brides.** The match occurs on the spot market at $t = 0$. The marriage (and the transfer τ_0) take place in the same period. Any investments into the bride are made by g at $t = 1$.
4. **Forward marriage contracts for pre-pubescent brides.** This type of contract, implying that parents arrange a forward marriage contract for their daughter but send her to join her marital household *before* she reaches puberty is theoretically possible. However, this will carry the same disadvantages as (3) and no obvious advantages, and therefore we will not consider it in our analysis.

The following table summarizes the payoffs of the two parties for each type of contract:

	post-pubescent	pre-pubescent
spot	$W_b = \tau_s(I) - I - \sigma_b$ $W_g = v(I) - \tau_s(I) - \sigma_g$	$W_b = \tau_0 - \psi$ $W_g = -\tau_0 + v(I) - I$
forward	$W_b = \tau_f(I) - I$ $W_g = -\tau_f(I) + v(I)$	

3.1.5 Interpretation of the Parameters

Before proceeding with the analysis of the model, we discuss what the parameters defined above are intended to capture in the context of marriage markets, and how they should be interpreted.

Search costs: The search costs σ_b and σ_g are intended to capture the time required to find a suitable partner for potential grooms and brides. This can be, for instance, in societies with low population density or (exogenous) restrictions on acceptable marriage groups (e.g. castes in India, religious or ethnic groups, exogamy norms, etc.). In the case of post-pubescent girls, these costs may be substantial in societies where brides are expected to be virgins (Ortner 1978; Dube 1997). A delay increases the (perceived) risk that the girl is no longer a virgin which can adversely affect her marriage prospects and the reputation of her family (Wahhaj 2018). While no similar pressure exists in the case of post-pubescent boys, unmarried adolescent males may (or may be believed to) engage in behaviour that carry serious risks for their health, economic prospects, etc.⁴ Additionally, marriage delays are costly for both the prospective bride and groom to the extent that it delays the formation of a production unit that generates greater value than the contributions of the unmarried boy and girl to their parental households. Based on this reasoning, we derive, in the Appendix, explicit expressions for the search costs σ_b and σ_g within a search and matching model based on Shimer and Smith (2000).

There are no equivalent costs for pre-pubescent girls and boys; as pre-pubescent girls are not at risk of loss of virginity, and pre-pubescent boys do not engage in risky behaviour. Furthermore, pre-pubescent brides and grooms do not to participate in household production and reproduction till they have reached puberty. A forward marriage contract (with marriage expected after the onset of puberty) means that a girl can join her marital household the moment she is deemed ready to play the part of a bride, given that the relevant searches have already been made prior to the onset of puberty.

Psychological costs: As noted above, we assume that parents face a psychological cost ψ when they opt for a pre-pubescent marriage for their daughter. We explain the source of this cost in the following manner. Parents have altruistic preferences towards their daughter, but not towards a daughter-in-law. As a result, the groom's parents do not internalise the

⁴An existing literature argues, based on evolutionary psychology theories and experimental evidence that adolescent males, and, more generally, males in the pre-mating stage, are prone to engage in risky and aggressive behaviour because of the evolutionary advantage such behaviour provides. See, for example, Wilson and Daly 1985; Baker and Maner 2008; Ainsworth and Maner 2012.

disutility suffered by the bride's parents from any harsh treatment that the bride is exposed to in the marital household. The bride's treatment is not verifiable and, therefore, cannot be specified in the marriage contract. We assume that this issue does not arise in the case of an older bride as she is able to resist such harsh treatment. Thus, the parents experience disutility when the daughter becomes a pre-pubescent bride but not if she remains in the parental household till she is older. As such, the psychological cost ψ is a social loss that occurs in the case of a pre-pubescent marriage, due to the non-verifiability of the treatment of young brides.

Utility from singlehood: As noted above, we denote by u_b and u_g , respectively, the utility obtained by the families of type b and g when they choose not to (or fail to) marry off a daughter or a son. In the case of b , this captures the social disapproval they are subject to when they have a grown up (unmarried) daughter living in the household. In societies where most women are expected to marry, the social disapproval may be quite severe, with adverse consequences for most types of social interactions. In the case of g , this captures the potential contribution that the absent bride could have made towards household production and reproduction.⁵

3.1.6 Efficiency of Investments

We define the efficient level of investments as $I^e = \arg \max_I v(I) - I$. In the case of pre-pubescent brides, the groom's family opts for the efficient level of investment as all the returns from the investment accrue to them. For families who plan to take their daughters to the marriage market for post-pubescent brides, the level of investment is, again, efficient if the returns to investment are reflected in the bride price (in particular $\tau'_s(I) = v'(I)$).⁶

⁵While we assume that both the prospective brides and prospective grooms are homogeneous in terms of the utility obtained from singlehood, our main results hold in the setting where they are heterogeneous in this respect. Heterogeneity in u_g could arise from the fact that households with more productive assets would place higher value on the contribution that a bride can make; while heterogeneity in u_b could arise from the fact that households with a higher social status have more to lose in terms of social reputation from having a grown-up unmarried daughter living within the household.

⁶There is a number of ways in which the assumption regarding the slope of the price schedule in the spot market for post-pubescent brides may be microfounded. For example, we can suppose that the price schedule $\tau_s(I)$ is chosen by a market-maker to ensure market clearing and efficiency in investment. If so, we obtain $v(I) > \tau_s(I) > I$ for each level of investment, to ensure that a marriage with transfers $\tau_s(I)$ is mutually beneficial, and $\tau'_s(I) = v'(I)$ to ensure that the level of investment is efficient.

By contrast, in the case of a forward marriage contract, the level of investment may be inefficient because of the hold-up problem (Williamson 1975; Grossman and Hart 1986). We can demonstrate this as follows. We assume that the marriage transfers are renegotiated at $t = 2$; and that the renegotiated transfers are given by the Nash bargaining solution using singlehood for both parties as the threat point.⁷ Hence, using the Nash bargaining solution, the renegotiated transfers in the forward contract are given by

$$\tau_f(I) = \arg \max_{\tau} [\tau - u_f] [v(I) - \tau - u_g].$$

Solving the optimisation problem, we obtain $\tau_f(I) = \frac{1}{2}v(I) - \frac{1}{2}u_g + \frac{1}{2}u_f$. Thus, the bride's family receives just half the return on any investment. This means that parents who enter into a forward contract will make lower investments than those who marry off their daughters on the spot market for post-pubescent brides, i.e. $I_f < I^e$. We define ϵ as the efficiency loss as a result of this under-investment:

$$\epsilon = [v(I^e) - I^e] - [v(I_f) - I_f].$$

3.2 Equilibrium Concept

Given the above description, the exogenous variables in the model are: the value function $v(\cdot)$; search costs σ_b, σ_g ; psychological cost ψ ; and the levels of utility obtained from singlehood u_b and u_g . The endogenous variables are (for all the families in the economy): contract choices (spot/forward and date of marriage), the distribution of the quality of realized matches, levels of investment I ; and transfers (schedules) $\tau_s(I), \tau_f(I), \tau_0$.

Definition 1 *A stable marriage-market equilibrium is an allocation that specifies, for each family: the contract choice (spot/forward and the date of marriage), the quality of the match, the value of investment I^* , and the transfers (schedules) $\tau_s^*(\cdot), \tau_f^*(\cdot), \tau_0$, such that, given the value function $v(\cdot)$, search costs σ_b, σ_g , psychological cost ψ , and singlehood utility levels u_b*

⁷Alternatively, we may assume that the prospective bride and groom enter the spot market for post-pubescent brides when renegotiation breaks down. If there is a positive probability that they will not be able to find another match on the spot market, we obtain a hold-up problem which leads to an inefficient level of investment.

and u_g :

- the market is cleared (i.e. all the brides and grooms are matched),
- each family acts rationally (i.e. investments are privately optimal given the contract structure), and
- no family or pair of families would like to deviate from their existing contracts.

3.3 Characterising the Equilibrium

To characterise stable equilibria, we proceed as follows. For each configuration of parameters (in particular, the relative ranking of search costs, psychological costs, and the cost of inefficient investment), we consider a candidate allocation. Given that for any given structure of contracts, equilibrium I and transfer schedules are well-defined, we only need to verify that the candidate allocation is stable in terms of contracts. Specifically, we verify that the pairs of matched families have (i) no incentive to change their contracts, and (ii) no incentive to break up the match to (successfully) re-match with another family.

Let's introduce some additional notation. Let λ stand for the share of population (pairs of families) that choose Spot/Post contract (i.e. do not participate in the marriage market at $t = 0$). Denote by $\sigma(\lambda)$ the sum of search costs of the potential bride's and groom's family, as a function of the size of the population on the spot market at $t = 2$. Let $\bar{\sigma} = \sigma(0)$ and $\underline{\sigma} = \sigma(1)$.⁸

Case 1. $\underline{\sigma} > \psi > \epsilon$ or $\psi > \underline{\sigma} > \epsilon$.

Consider the allocation where all families enter into Forward/Post contracts (in $t = 0$). Given that we are in $t = 0$, the brides from these families are homogeneous among themselves (because they are ex-ante homogeneous and no investment has yet taken place). Individuals in matched pairs in the forward market would not want to deviate from this match and switch to the Forward/Post contract with another partner in the population (because no other match yields a higher surplus). Moreover, they would not want to switch to a Spot/Pre contract,

⁸We assume, implicitly, that there is a non-zero probability of being finding a match on the post-spot marriage market even if there is a zero mass of agents who opt for this segment of the market. This is a reasonable assumption if there are other prospective brides and grooms, external to the model, who belong to a different marriage market but occasionally search in the marriage market in question. Therefore, the search cost $\sigma(0)$ is well-defined, positive, and finite.

with the same partner (as this would entail higher psychological costs). In addition, no one would wish to try their luck in the Spot/Post market, because even in the best possible case (when everyone else is on the spot market in $t = 2$ and the level of investment is efficient), the search costs are, by assumption, higher than ϵ .

Case 2. $\underline{\sigma} > \epsilon > \psi$ or $\epsilon > \underline{\sigma} > \psi$.

Consider the allocation where all families enter into Spot/Pre contracts in $t = 0$. Given that we are in $t = 0$, brides of these families are homogeneous among themselves (no investment yet has taken place). Individuals in matched pairs would not want to deviate from this match and switch to the Spot/Pre contract with another partner in the population (because no other match would yield a higher surplus). Moreover, they would not want to switch to a Forward/Post contract, with the same partner (as this would entail higher costs arising from under-investment). In addition, no one would wish to try their luck in the Spot/Post market, because even in the best possible case (when everyone else is on the spot market in $t = 2$ and the level of investment is efficient), the search costs are, by assumption, higher than ψ .

Case 3. $\epsilon > \psi > \underline{\sigma}$ or $\psi > \epsilon > \underline{\sigma}$

Consider the allocation where all families enter no agreement/contract in $t = 0$ but wait until the Spot/Post market in $t = 2$. Then, the expected cost of a match is $\underline{\sigma}$. No pair would like to get matched early (i.e. in $t = 0$) for the following reason. Suppose one family proposes (in $t = 0$), with a specific transfer τ , to another family to enter either into a Spot/Pre or a Forward/Post contract. Given that everyone else is staying in the Spot/Post market, there exists no contract whereby both families are better off compared to their expected welfare in the Spot/Post market.

3.3.1 Uniqueness of Contractual Form

We can also establish that in Case 1 and Case 2 above, the equilibrium is unique in terms of the contractual form. For the parameter conditions specified in Case 1, if any pair of families are engaged in a Spot/Pre contract, or are on the Spot/Post market, then they can improve their welfare by deviating to a Forward/Post contract. Therefore, no other

equilibrium is sustainable. For the parameter conditions specified in Case 2, if any pair of families are engaged in a Forward/Post contract or are on the Spot/Post market, then they can improve their welfare by deviating to a Spot/Pre contract. Therefore, no other equilibrium is sustainable.

In Case 3, the equilibrium may not be unique. In particular, if $\bar{\sigma} > \epsilon$ or $\bar{\sigma} > \psi$, we obtain multiple equilibria. We can see this as follows. If $\epsilon, \bar{\sigma} > \psi > \underline{\sigma}$ then a strategy profile where all families enter into pre-pubescent marriage contracts can be sustained as an additional equilibrium: because no family or pair of families would be able to improve their welfare by deviating to the Spot/Post market or entering into a Forward/Post contract. If $\psi, \bar{\sigma} > \epsilon > \underline{\sigma}$ then a strategy profile where all families enter into forward contracts can be sustained as an additional equilibrium: because no family or pair of families would be able to improve their welfare by deviating to the Spot/Post market or entering into a Spot/Pre contract. On the other hand, if $\epsilon, \psi > \bar{\sigma} > \underline{\sigma}$ then the only type of equilibrium that is sustainable is one where all families go on the Spot/Post market because, for any other strategy profile, a deviation to the Spot/Post market is welfare-improving.

We summarise these results in terms of the following proposition.

Proposition 1 (i) *For the parameter values specified in Case 1 ($\underline{\sigma} > \psi > \epsilon$ or $\psi > \underline{\sigma} > \epsilon$), the equilibrium is unique in terms of contractual form, with all families entering into Forward/Post contracts.*

(ii) *For the parameter values specified in Case 2 ($\underline{\sigma} > \epsilon > \psi$ or $\epsilon > \underline{\sigma} > \psi$), the equilibrium is unique in terms of contractual form, with all families entering into Spot/Pre contracts.*

(iii) *For the parameter values specified in Case 3 ($\epsilon > \psi > \underline{\sigma}$ or $\psi > \epsilon > \underline{\sigma}$), we obtain an equilibrium where no families enter into a contract at $t = 0$ but enter the Spot/Post market. If $\epsilon, \bar{\sigma} > \psi > \underline{\sigma}$, there is another set of equilibria where all families enter into Spot/Pre contracts. If $\psi, \bar{\sigma} > \epsilon > \underline{\sigma}$, there is another set of equilibria where all families enter into Forward/Post contracts.*

3.4 Comparative Statics

3.4.1 Changes in Parameter Values

The equilibrium characterisation above provides a framework for investigating how marriage contracts are affected by the production technology, search costs and the psychological costs associated with pre-pubescent marriages. For this exercise, we parameterise the value function for investment in the bride as follows. Let $v(I) = Af(I)$, where A is a positive constant and $f(\cdot)$ is a concave function. Then it is easy to show that ϵ is increasing in A . In other words, with increasing productivity of the bride, there is an increase in the inefficiency of investments in forward contracts.

Figure 1(a) shows, for a specific value of ϵ , the unique contractual form that emerges in different parts of the $\underline{\sigma}$ - ψ parameter space. In Figure 1(b), we show how varying the parameters $\underline{\sigma}$, ψ and ϵ changes the contractual arrangement. A decrease in $\underline{\sigma}$ due, for example, to an increase in population density makes forward contracts and pre-pubescent marriages less likely and post-pubescent marriages more likely. Similarly, a decrease in psychological costs due, for example, to more effective protection of child brides against abuse, would make forward contracts and post-pubescent marriages less likely and pre-pubescent marriages more likely.

An increase in A would lead to an increase in ϵ and thus reduce the parameter space where forward contracts emerge. Thus, forward contracts give way to either post-pubescent or pre-pubescent spot-market marriages, depending on the relative values of $\underline{\sigma}$ and ψ .

Note that changes in the utilities of singlehood (u_g or u_b) affect the level of transfers, but do not affect the relative attractiveness of contractual forms, because ϵ does not depend on them.⁹

⁹This holds true not only in the case of symmetric Nash bargaining but also in a more general bargaining model where bargaining power is asymmetric.

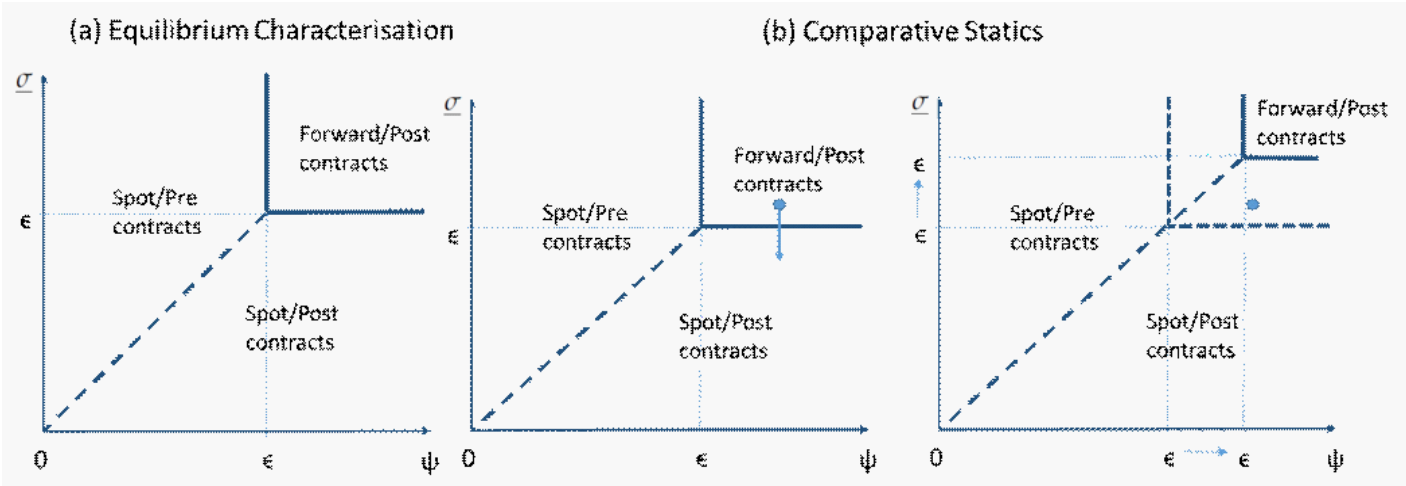


Figure 1: Equilibrium Characterisation and Comparative Statics.

3.4.2 Interpreting Comparative Statics Results

In this section, we consider what implications the comparative statics results above have in terms of the types of marriage contracts we should observe in different types of societies.

1. Population density: As discussed in Section 3.1, searching for a compatible bride or groom on the post-pubescent spot marriage market is costly, because of resources that need to be devoted to the search or the time that elapses before a match can be found. If the search is being conducted in a more densely populated area, it is reasonable to postulate that fewer resources would have to be devoted, or less time would be required, to find a suitable match. Therefore, we posit that higher population density – assuming social homogeneity in terms of language, religion, tribe, caste, etc. – lowers search costs on the post-pubescent spot marriage market and, in particular, lowers $\underline{\sigma}$. It follows from the comparative statics results above that in a society which is more densely populated, forward contracts and pre-pubescent marriages are less likely and post-pubescent marriages are more likely. Similarly, rising population density in a society over time should make post-pubescent marriages more common, while forward contracts and pre-pubescent marriages become less common.
2. Social homogeneity: Suppose that unions are limited to intra-group marriages. It is

then evident that social heterogeneity within a population – in terms of language, religion, tribe, caste, etc. – makes the marriage market more fragmented. Therefore, for a given population density, increased social heterogeneity would also increase search costs on the post-pubescent spot marriage market and lead us to the opposite prediction to that above; i.e. in a society which is more heterogeneous, we are more likely to observe forward contracts and pre-pubescent marriages and less likely to observe post-pubescent marriages.

3. Geographic barriers that restrict travel: Search on the post-pubescent marriage market may also be constrained by geographic barriers that limit travel, communication, etc. within a population. These barriers could take the form of ruggedness of terrain, the land taking the form of an archipelago as opposed to a single landmass, the absence of waterways that may facilitate travel, etc. In terms of our model, any of these factors would raise the value of the search parameter $\underline{\sigma}$ and, consequently, make forward contracts and pre-pubescent marriages more likely.
4. Marriages between distant families: In some societies, marrying off a daughter may mean, inevitably, sending her to a groom household a long distance away, with little opportunity to see her for long periods. This would hold true for sparsely populated regions, and especially for nomadic societies, in which families would be on the move for large parts of the year. By contrast, among sedentary, high-density populations, it would be feasible to marry one's daughter into another household in the same village or the next village (even if the society imposes exogamy rules on itself to discourage such practices). For any of the marriage contractual forms we have discussed, sending off a married daughter to a distant place would involve grief and pain for parents, but we argue that it is most pertinent in the case of pre-pubescent marriages because parents are deprived of the opportunity of seeing their daughter grow up. On this basis, we can argue that ψ , the psychological cost of pre-pubescent marriages, is – exogenously – higher among nomadic groups compared to sedentary groups with high population density. It follows that, other things equal, we are more likely to observe

marriage forward contracts among low-density nomadic groups, while pre-pubescent and post-pubescent spot market marriages are more likely in high-density, sedentary groups.

5. Production technology and returns to investments in girls: A long literature, starting from Boserup (1970), has highlighted the limited role of female labour in certain traditional agrarian societies, and their potential consequences for other social outcomes, including differential investments in boys and girls. In a society that generally makes limited investments in girls, the cost associated with underinvestments in forward contracts, ϵ will also be lower. Therefore, the model implies that, other things equal, if the existing production technology makes limited use of female labour, we are more likely to observe forward marriage contracts as opposed to pre-pubescent marriages and spot market marriages for post-pubescent brides.

Interestingly, the same reasoning applies to different strata of the same society which differ in terms of the contribution of female labour to production. For example, women in the aristocracy may have a much more limited role in production compared to middle-class women. Consequently, the returns to investment in female human capital, and the inefficiency cost of marriage forward contracts, will also be lower in the former case. Then we obtain the prediction that, other things equal, we are more likely to observe forward contracts among the aristocracy than among the middle-class within the same society.

4 Extensions

4.1 Credit-Constrained Households

What happens when a household is credit-constrained and unable to make the optimal level of investment? This type of constraint generates another source of inefficiency that may affect the contractual choice.

A simple way of introducing credit constraints in our model is to assume that all the households have the same endowment \bar{I} , which is the highest investment cost an individual

household can afford. Given our assumption that the level of investment obtained is equal to the cost of the investment, a household is credit-constrained if $\bar{I} < I^e$. To make the problem interesting, we assume that $2\bar{I} > I^e$; in other words, two families pooling their resources allows to overcome the credit constraint sufficiently so as to implement the efficient level of investment.

Under these assumptions, the investment would be sub-optimal for brides on the post-spot marriage market. However, the two families can pool their resources through one of the other two contractual forms (Spot/Pre or forward contract). Under the forward contract, the bride's family receives a payment enabling it to increase the level of investment beyond \bar{I} (although the equilibrium investment level would still be inefficient because of contractual incompleteness as discussed in Section 3.1.6). Similarly, under the Spot/Pre contract, the groom's family receives transfers to ensure that it can cover the cost of the optimal level of investment. Thus, compared to the Spot/Pre and forward contracts, marriage on the Spot/Post market entails two sources of inefficiency: the cost of search – as discussed above – and the cost of inefficient investments due to binding credit constraints.

Consider a combination of parameter values for which, in the absence of credit constraints, the least costly contractual form is a forward contract (as per the characterisation in Section 3.3). Introducing credit constraints in this setting would have no effect on the equilibrium contractual form – although it may affect the equilibrium level and direction of transfers. More precisely, imposing a credit constraint (upon the bride's family) does not increase the inefficiency of investment because the transfers can be adjusted so as to enable the bride's family to make the same level of investment as in the unconstrained equilibrium.

If the equilibrium (in the absence of credit constraints) is a Spot/Pre contract, then, a credit constraint may lead to an inefficient level of investment. This is because the endowment of the investing party (g) is, by assumption, insufficient to cover the efficient-level cost of investment (and any transfers received by the groom's family in the unconstrained equilibrium may not be sufficient to offset this shortfall). The groom's family may propose a side agreement with the bride's family whereby the former receives a transfer from the latter – or makes a lower transfer towards the latter – with repayment scheduled at some point in

the future when the investment has been made and its fruits have been realised. But the fact that the two parties have a spot contract on the marriage market means that the terms of the loan are not necessarily enforceable. And if there were external mechanisms to enforce the terms of the loan, then the groom's family would not be credit-constrained in the first place. Figure 2 provides a characterisation of the effect of imposing credit constraints on the equilibrium level of investments.

When does the credit constraint lead to a change in equilibrium contractual form? Let us consider, first, dowry-based societies where (by assumption) the dowry transfers are sufficiently large so that the Spot/Pre contracts are unaffected by credit constraints. Then, credit constraints do not affect the level of investment in the Spot/Pre contracts or the forward contracts. But they make the Spot/Post contracts less efficient. Therefore, we can argue that, in a dowry-based society, the presence of credit constraints make marriages on the Spot/Post market less prevalent.

Next, let us consider the brideprice-based societies. Here, the presence of credit constraints will adversely affect the efficiency of the Spot/Pre contracts. The credit constraints also affect the efficiency of the Spot/Post contracts (because the groom's family is not receiving any transfers that would help relax its credit constraint) but do not affect the efficiency of the forward contracts. Therefore, we can conclude that in a brideprice-based society, the presence of credit constraints makes forward contracts more prevalent.

4.2 High-Risk Environments

Next, we consider how a high-risk environment may affect the marriage contract type. Suppose that households are exposed to idiosyncratic shocks and marriage contracts involving pre-pubescent girls (either spot marriages or forward contracts) must be entered into before income is realised. The level of income may be high or low. If the income level is high, then the household has adequate resources to choose the optimal level of investment, I^e . But if the income level is low, then the maximum possible investment is $\bar{I} < I^e$. To analyse how this risky environment affects the marriage contract, we assume that the alternative marriage contracts are equally attractive along other dimensions: i.e. $\epsilon = \underline{\sigma} = \psi$.

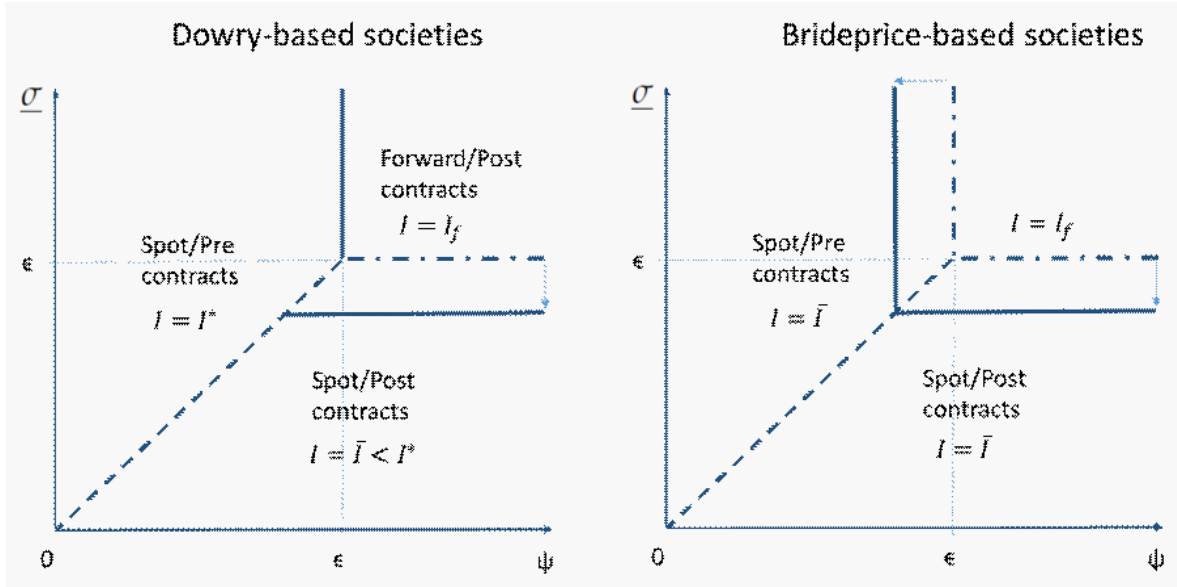


Figure 2: Equilibrium with Credit Constraints. The set of parameter values for which Spot/Post and Spot/Pre contracts arise in equilibrium shrink because of credit constraints (Spot/Post only in the case of dowry-based societies).

It is straightforward to show that the presence of risk makes the prospect of marrying one's daughter in the post-pubescent spot market less attractive. In particular, if the bride's family has a low income realisation, then the level of investment in her will be sub-optimal, at $\bar{I} < I^e$ which contributes to the inefficiency in this type of contract.

If the bride's family enters into a pre-pubescent spot market contract, then they transfer the daughter to the family of the groom before the realisation of their respective incomes. In this case, the income realisation of the bride's family is no longer relevant but investment in the girl will, again, be sub-optimal if the income realisation of the groom's family is low. Thus, risk adds to inefficiency in pre-pubescent spot market marriages.

In this context, forward marriage contracts have an advantage in that transfers between the two parties can occur over the duration of the contract. In particular, the contract can specify that if the bride's family has a low income realisation, then the groom's family makes transfers to them to relax the resource constraint, thus enabling a higher level of investment in the bride than would otherwise be possible. A second transfer may occur at the time of the marriage – in the opposite direction – based on ex-post Nash bargaining – as discussed

above.

Thus, a forward contract enables income-smoothing in a risky environment, while this is not possible under the two other types of marriage contracts. Therefore, our model predicts that forward marriage contracts are more likely to emerge in high-risk environments.

4.3 Delayed Realisation of Male Productivity

At the early stages of development, when an economy transitions from a primarily agrarian economy to one with some job opportunities in the industrial and service sectors, there is an increase in the variety of jobs available to male workers. The non-agricultural jobs may be more lucrative than those in agriculture but only a small fraction of men would be able to access them. Moreover, prior to entering the labour force, there may be uncertainty about who will manage to get the coveted jobs. We argue that this situation of uncertainty has implications for the equilibrium type of marriage contracts.

Formally, we introduce the value of male income into the model, which we denote by \tilde{v}_m (for simplicity, this value does not require any human capital investments). In a traditional, predominantly agrarian economy, all men have the same realisation of \tilde{v}_m , in which case our basic model would apply. In a developing economy, the value of \tilde{v}_m will be realised only when men enter the labour market. Prior to labour market entry, there is uncertainty about its value. We follow Bergstrom and Bagnoli (1993) in assuming that some men have good job prospects; more precisely, they have a high probability of obtaining a lucrative, non-agricultural job. Moreover, these probabilities are private information for the men. Then, men with good job prospects would find it less attractive to enter into a pre-pubescent marriage (before their employment outcome becomes public knowledge), compared to marrying (an identical) bride on the spot market for post-pubescent brides at a later date, after their employment outcome becomes public knowledge. This is because they would command a higher price on the marriage market after their employment outcome becomes public knowledge. Forward contracts do not suffer from the same problem as pre-pubescent marriages, at least in the first instance, as they allow transfers to be renegotiated at a later date when the man's employment outcome becomes known.

However, it is possible that the good employment outcome is so attractive on the marriage market that no amount of renegotiated transfer in a forward contract would be sufficient reward for this prize. In this case, the males with good prospects would prefer to wait and marry on the marriage market for post-pubescent brides rather than enter a forward contract at an earlier date.

Therefore, we can argue that when the economy moves from being primarily agrarian to one that includes a significant non-agricultural sector, this transition will produce (i) a decline in pre-pubescent marriages, (ii) an increase in transfers towards the groom in forward contracts, (iii) a decline in forward contracts, in the order stated.

5 Policy Effects

In this section, we use our model to investigate how a variety of policies aimed at poverty alleviation or at improving economic outcomes of adolescent girls and women, affect marriage contracts.

1. Conditional cash transfers: Conditional cash transfer programmes have been an important tool for poverty alleviation in different parts of the world since the 1990s. In such programs, typically, cash transfers are conditional on the household meeting certain targets regarding the health and education of children. Within our theoretical framework, this type of conditionality is significant in that it provides parents additional incentives, beyond the returns on the marriage market, to make investments in a girl. Recall that the model predicts that, in the case of a forward marriage contract, the level of investment by the bride's family is inefficient because of the hold-up problem. The conditional cash transfers alleviates this problem and thus improves investments and reduces inefficiency within a forward contract.

By contrast, it does not affect investment incentives in pre-pubescent brides because conditionality is generally linked to investments in one's own offspring rather than in a bride. We can also argue that it does not investment incentives in girls who will

enter the marriage market following puberty.¹⁰ Then it follows that the presence of conditional cash transfers makes marriage forward contracts relatively more attractive. Therefore, the introduction of conditional cash transfers can shift the marriage market equilibrium from pre-pubescent or post-pubescent spot-market marriages towards forward marriage contracts.

2. Unconditional cash transfers: Recent policy discussion on cash transfer programmes have focused on the question whether they should include conditionality and the pros and cons of conditionality. In the context of marriage outcomes, our model makes substantially different predictions when conditionality is removed. In the absence of conditionality, the programme provides parents no additional incentives to invest in their daughters.

Nevertheless, an unconditional cash transfer programme, by relaxing credit constraints, can affect the relative attractiveness of different types of marriage contracts. Recall that credit constraints lowers investments – and thus increase inefficiency – in post-pubescent spot market marriages and, potentially, pre-pubescent spot market marriages as well, but has little effect on investments in girls who enter forward marriage contracts. Thus, in the presence of credit constraints, unconditional cash transfers make forward contracts less attractive relative to the other two types of marriage contracts. Therefore, such transfers can shift the marriage market equilibrium towards pre-pubescent or post-pubescent marriages, and lead to a decrease in the use of forward contracts.

3. Improved access to female schooling: A variety of policies aim at lowering the cost of female schooling, by providing school stipends for girls, developing the school infrastructure, etc. In terms of our model, these policies would increase the optimal

¹⁰Recall our assumption that the investment-price schedule on the post-pubescent spot market is set by a market maker to ensure efficient investments. In the presence of conditional cash transfers, the market maker would alter the investment-price schedule making it flatter so as to ensure that investments remain efficient. If the investment-price schedule is not adapted in this manner in response to the conditional cash transfer programme, then this will lead to excessive investments in girls who enter the post-pubescent spot market, creating an inefficiency that reinforces our reasoning below.

level of schooling. For a broad class of value functions, it would also increase the inefficiency from under-investment in the forward contract, but it would not affect the costs associated with the two other types of contracts. Therefore, if forward contracts are prevalent in the initial equilibrium, such policy would give way to one of the other types of contracts. Hence, spot marriage contracts for post-pubescent brides may become more prevalent as a result of improved access to schooling, but the model predicts that it may also lead to the emergence of spot contracts for pre-pubescent brides, depending on the relative importance of search costs versus psychological costs.

4. Legal minimum age at marriage: Most countries around the world have a legal minimum age of marriage. However, the institutions required for enforcing these laws may be weak or missing, particularly in developing countries (for example, the absence of a birth registration system that would allow age verification of the prospective groom and bride at the time of marriage). A variety of policies aim at improving enforcement of the legal minimum age at marriage.

If improved enforcement increases the risk of detection and punishment of parents who enter into early marriage arrangements, then this increases the cost of spot marriage contracts for pre-pubescent brides. In our model, this increased cost can be represented as an increase in the value of the parameter ψ . On the other hand, it does not affect the cost associated with forward contracts or with spot marriage contracts for post-pubescent brides (assuming that the bride has reached the minimum legal age at the time of marriage according to these contracts).

Then improved enforcement of minimum age laws would affect marriage outcomes if, and only if, the initial situation is that described in Case (ii) of Proposition 1 above. If enforcement improves sufficiently, then marriage of pre-pubescent brides will give way to a new equilibrium characterised by either post-pubescent marriages or forward contracts, depending on the relative importance of search costs versus the cost of under-investment.

5. Agency of adolescent girls in marriage decisions: Adolescent girls may become more aware of their legal rights, specifically as it pertains to marriage, through a variety of social programmes. NGOs and para-legal organisations may develop programmes with such objectives. Access to information or examples in the media may also improve the awareness of adolescent girls of the options and opportunities available to them. These changes may increase the risk that the bride reneges on a forward contract and thus lowers the incentives of the bride's family to make investments in a forward contract, which exacerbates the inefficiency associated with these contracts.

We can also argue that such programmes increase the search costs on the post-pubescent spot market because it would become more difficult to persuade a girl to marry a prospective groom who she finds incompatible. On the other hand, it does not affect the costs associated with pre-pubescent marriages as, at a younger age, the girl is less likely to have the awareness or well-developed preferences to oppose a marriage. Therefore, programmes that aim to improve the agency of adolescent girls may, as an unintended consequence, increase the prevalence of pre-pubescent marriages.

6. Female training on income-generation and entrepreneurship: There are numerous examples of development programmes that focus on training women to improve their livelihood skills. If these programmes increase the productivity of *all* women, they do not affect the pros and cons of different types of marriage contracts. On the other hand, if they increase the returns to education (or, more broadly, pre-marital investments), then it raises the optimal level of investment in girls. As per the reasoning for education-policies above, this would increase the inefficiency associated with forward marriage contracts. However, these policies do not affect the costs associated with the two other types of marriage contracts. So, if forward contracts are prevalent in the initial equilibrium, they would give way to spot contracts, either for pre-pubescent or for post-pubescent brides.
7. Laws prohibiting gender inequality in wages: It is well-documented that, most societies exhibit a gender gap in wages, with women earning less than men for the same

level of education and in similar occupations. Such practices effectively act as a tax on the returns to female education. Laws which make it more difficult for employers to maintain a gender gap in wages would reduce the tax and, thus, increase the returns to female education. In terms of our model, it would increase the inefficiency cost of forward contracts without affecting the other parameters. Therefore, if there is (some) prevalence of forward marriage contracts in the initial equilibrium, such a policy would lower the incidence of forward contracts in favour of pre-pubescent or post-pubescent marriages.

8. Insurance against adverse (idiosyncratic) shocks: In Section 4.2, we argued that marriage forward contracts are more attractive relative to spot contracts in high-risk environments as they provide the bride and groom’s family a means to engage in risk-sharing, contrarily to spot contracts. Therefore, providing families access to formal insurance against adverse idiosyncratic shocks would increase the relative attractiveness of spot contracts. Thus, forward contracts may give way to either pre-pubescent or post-pubescent marriages.

6 Conclusion

In this paper, we have analysed an important but understudied aspect of marriage contracts: their temporal structure. For this purpose, we presented a model where the pre-marital productive investments into the human capital of brides is hampered by contractual incompleteness. We have shown that the temporal structure of marriage contracts – whether the marriage occurs through a spot market interaction before puberty, through a spot market after puberty, or through a forward contract (agreed before puberty, executed after puberty) – can be understood as the second-best optimal agreements between families of brides and grooms. Each contractual form suffers from a specific problem (respectively, the psychological cost of early separation from a daughter, the risk of failing to find a suitable match after onset of puberty, and the underinvestment into brides by their parents because of the classical hold-up problem). The second-best optimal arrangement is the one that leads to

the least costly problem among these.

Our model delivers several testable predictions concerning the variation in marriage contracts, both over time and across societies. Also, the model's results imply a set of interesting policy conclusions, in particular, concerning the effects of such policies as conditional and unconditional cash transfers, improving access to schooling for girls, stricter enforcing of the minimum legal age at marriage, policies aiming at the empowerment of adolescent girls, training programmes for women aimed at income generation and entrepreneurship, gender pay gap policies, and better insurance against idiosyncratic shocks. In addition, we have explored the robustness of the model's main findings to relaxing some of its key assumptions.

The natural next direction for research is testing the model's implications, either using contemporary or historical sources. For instance, this can be done by first documenting across-ethnicity variation in marriage contract forms and then identifying whether the empirical proxies of the model's fundamentals – population density, geographic features of places where various ethnic groups live, and social heterogeneity – carry a causal effect on the contractual form. In similar vein, the model's policy predictions can be tested by exploiting a rich variation in development policies (cash transfers, changes in the legal age at marriage, etc.) and identifying their causal effects on changes in marriage contracts and arrangements.

Finally, we feel that additional theoretical work is needed for exploring the changes in the model when one allows for a more general environment. For example, would unbalanced gender ratios affect the relative severity of the three above-mentioned problems and hence influence the equilibrium marriage arrangements? Or, how would the model's result change under alternative bargaining environments? We hope that our analysis will encourage the study of these and related theoretical issues in the near future.

7 Appendix

7.1 Microfoundation for Search Costs

We have noted, in the presentation of the model that σ_b and σ_g capture the time required to find a suitable partner. In this section, we specify the search and matching process within the

marriage market, and derive expressions for σ_b and σ_g in terms of the underlying parameters that govern this process.

In our theoretical presentation above, we have differentiated between pre-pubescence and post-pubescence and modelled them as discrete stages of life. Within each stage of life, we model time as being continuous, and normalise the length of post-pubescent life to 1 unit of time.

Following Shimer and Smith (2000), we assume that the probability, per unit time, of finding a suitable partner in any marriage market segment is proportional to the mass of potential suitors on the other side of the market in that segment. We denote by λc the hazard rate of marriage in the post-pubescent marriage market, where λ , as above, is the fraction of brides and grooms on the marriage market for post-pubescent brides and c is a constant.¹¹

A post-pubescent unmarried female also faces a risk of ‘loss of reputation’ with a hazard rate of h_b . A female who has lost her reputation is no longer marriageable. A post-pubescent unmarried male engages in risky behaviour which can lead to loss of health or economic prospects, with a hazard rate of h_g . If such an event occurs, the male will no longer be marriageable. An unmarried male receives an instantaneous utility of u_g and an unmarried female receives an instantaneous utility of u_b . Similarly, married males and females receive instantaneous utilities of W_g and W_b respectively, as defined in Section 3.1.4.

As per the description above, there are two ways in which a post-pubescent female may leave the marriage market at a point in time. She could become unmarriageable, an event which has a hazard rate of h_b . If not, she may find a match, an event which has a hazard rate of λc . Therefore, the overall hazard rate is $h_b + \lambda c(1 - h_b)$. Thus, the "survival" probability at time T is given by $\exp[-\{h_b + \lambda c(1 - h_b)\}T]$. At time T , she may lose her reputation with probability h . In this case, she obtains a utility of u_b during her entire post-pubescent life. This results in a total utility loss of $(W_g - u_g)$ compared to a female who begins her

¹¹We implicitly assume that the mass of potential suitors is constant over time; i.e. the mass of brides and grooms exiting the marriage market at any point in time is equal to the mass of new prospective brides and grooms entering the marriage market. This is a reasonable assumption for a marriage market in a steady state.

married life immediately following the onset of puberty. If the female does not lose her reputation at time T , she finds a match with probability λc . In this case, she experiences a utility loss of $(W_g - u_g) T$ compared to a female who begins her married life immediately following the onset of puberty. Therefore, the total expected utility loss can be written as follows:

$$\sigma_b = \int_0^1 (W_b - u_b) \{T\lambda c(1 - h_b) + h_b\} d[\exp[-\{h_b + \lambda c(1 - h_b)\} T]]$$

Based on the same reasoning, the total expected utility loss for a male who enters the post-pubescent marriage market (relative to a male who starts his married life immediately following the onset of puberty) can be written as follows:

$$\sigma_g = \int_0^1 (W_g - u_g) \{T\lambda c(1 - h_g) + h_g\} d[\exp[-\{h_g + \lambda c(1 - h_g)\} T]]$$

We argue that there is no risk of loss of reputation, health or economic prospects for pre-pubescent males and females who are too young to engage in risky behaviour. Similarly, there is no time cost of search in the pre-pubescent marriage market because married life will not begin, in any case, till after the onset of puberty (by which time, we assume a match will have been found with probability very close to 1). Therefore, σ_b and σ_g represent the expected search costs for potential brides and grooms who enter the post-pubescent marriage market, while the corresponding costs for the pre-pubescent spot market and the pre-pubescent forward market are equal to zero.

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Table 1: Marriage Contractual Forms among Indian Women

	Cohabitation Timing		Total
	Pre-Menarche	Post-Menarche	
Spot Contract	3,031 3.6%	62,283 73.8%	65,314 77.3%
Forward Contract	1,750 2.1%	17,381 20.6%	19,131 22.7%
Total	4,781	79,664	84,445

The table shows the marriage contractual form for the sample of married women in the Indian National Family Health Survey 1992-93; 109 married women are excluded from the sample because of missing data. A 'spot contract' is a marriage in which cohabitation starts in the same year as the marriage ceremony. A 'forward contract' is a marriage where cohabitation starts with a longer delay.