Property Rights Over Marital Transfers*

[Preliminary Draft]

Siwan Anderson† Chris Bidner‡

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Abstract

We develop a simple competitive model of the marriage market in which bridal families decide how much to transfer to their daughter *and* how much to transfer to a potential groom. By allocating property rights over total marital transfers in this way, the bridal family influences the outcome of intra-household bargaining. This approach formalizes and clarifies the dual roles of dowry as both as bequest for daughters and a market-clearing payment to grooms. The analysis helps explain the historical record of dowries, whereby the prominent role of dowries transforms from bequest to price during early modernization. The model produces some further results of interest: we show that positive assortative matching is not a robust prediction in this setting, and that equilibrium transfers are generally not Pareto efficient when transfers to the bride are in the form of human capital investment. We argue that the price component of dowry disappears once the return to female human capital is sufficiently high.

Keywords: dowry, gender, property rights, marriage
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†Department of Economics, University of British Columbia siwander@interchange.ubc.ca
‡School of Economics, University of New South Wales. c.bidner@unsw.edu.au

1 Introduction

Most societies have been characterized by marriage payments at some point in their history. Dowry payments, which are a transfer from the bride's side of the family at the time of marriage, have been an integral component of marriage in most traditional societies of Europe and Asia (where more than 70% of the world's population reside), and often represent a significant financial burden for the bride's family.[1]

The dowry serves two functions - it acts as a pre-mortem bequest to daughters, and as a means to compete for desirable grooms in the marriage market.[2] Conceptually, the dowry serves as a bequest to the extent that brides have property rights over the dowry transfer and serves as a marriage payment to the extent that grooms have such rights. Far from being fixed, property rights over dowry have typically shifted from the bride to the groom during the early stages of modernization (see section 2). This transformation effectively represents a loss of property rights for women over the marriage transfer, and all incidences of this shift in the function of dowry have raised great concern amongst policy makers and typically prompt legislation designed to curb its spread. The weakening of this aspect of the economic rights of women is somewhat puzzling given that other dimensions of the economic rights of women seem to strengthen with development (Geddes and Lueck (2002), Doepke and Tertilt (2009), Fernández (2010), and Doepke *et al.* (2011)).

We present an equilibrium model of the marriage market that formalizes and analyses the dual functions of dowry. The model is used to help understand the economic forces that shift the relative importance of each function. We show how prominent features of the development process, including strengthened economic rights of women, produce an equilibrium shift in property rights over the dowry away from brides and toward grooms. The model also suggests that the 'marriage payment' function of dowry will disappear when the productivity of female human capital becomes sufficiently great.

Specifically, we model an economy in which parents make transfers to their children mindful of the fact that such transfers will shape their child's marriage market prospects. Once marriages are formed in the marriage market, married couples leave the market and bargain over the total available marital resources. Our main departure from existing work is that we allow bridal parents to allocate property rights over their total transfer (i.e. the dowry). Such rights are valuable because they determine how much can be consumed in the event of a break-down in household bargaining. Specifically, we assume that marital resources are divided according to generalized Nash bargaining where the outside option is an 'unproductive marriage' in which each side consumes the resources for which they hold property rights.[3]

[1] See Anderson (2007a) for an overview of the economics of dowry.

[2] This dual function is discussed in Botticini (1999), Zhang and Chan (1999), Botticini and Siow (2003), Anderson (2007a) and Arunachalam and Logan (2008) among others.

[3] This notion of intra-household bargaining is in the spirit of Chen and Woolley (2001) and Lundberg and Pollak (1993) whereby outside options are given by alternatives within marriage, as opposed to Manser and Brown (1980) and McElroy and Horney (1981) in which the outside option is divorce. There is a reasonably large literature suggesting that such intra-household bargaining matters. Browning and Chiappori (1998) provide

The 'bequest' component of the dowry is interpreted as that part over which the bride holds rights, and the 'marriage payment' component as that part over which the groom holds rights. The essential trade-off facing bridal families is that greater property rights to their daughter allows her to negotiate a greater share of household resources, but also makes her less attractive to wealthier potential grooms. Thus, bridal families must trade off a greater share of the pie with obtaining a larger pie.

One can interpret the allocation of property rights literally, whereby the bride's parents register a portion of the dowry in the name of the bride and a portion in the name of the groom. Alternatively, one can think of the allocation of property rights being embodied in the type of assets that form the dowry. For instance, given that the bride lives with the groom's family a cash dowry is more easily controlled by the groom than is jewelery or household appliances, which in turn are more easily controlled by the groom than land or the bride's human capital (Arunachalam and Logan (2008)).

The 'bequest' feature of dowry is the focus of Botticini and Siow (2003), Zhang and Chan (1999), and Suen *et al.* (2003). The first stresses the incentive advantages of premortem bequests to brides in patrilocal societies, whereas the latter two stress intrahousehold bargaining. In contrast to our paper, these contributions either take the marriage market as exogenous (in the sense that transfers in the marriage market are determined by an exogenous function of bride and groom characteristics) or abstract from it altogether.

A number of papers focus on the 'marriage payment' aspect of dowry, such as Becker (1991), Rao (1993), Anderson (2003), and Anderson (2007b). Our paper shares with this body of work the feature that marriage market transfers (including dowry) are determined as an equilibrium outcome of the marriage market. In contrast to our work, these contributions take bride and groom characteristics as exogenous.

More closely related to our work is a series of papers in which premarital investments act as a bequest as well as a means to attract partners (Peters and Siow (2002), Cole *et al.* (2001), and Iyigun and Walsh (2007)). Our paper extends this work by allowing these two roles of dowry to operate independently by introducing and explicitly modeling the allocation of property rights over the premarital investment.

The allocation of property rights is irrelevant in Peters and Siow (2002) since both the bride and groom's consumption is given by a fixed function of the *sum* of marital contributions (in their case because of a household public good). That is, both the bride and groom find a unit of wealth transferred to the bride to be a perfect substitute for a unit of wealth transferred to the groom. This is not the case in Cole *et al.* (2001) and Iyigun and Walsh (2007), where total marital resources are given by a (supermodular) function of both investments. These papers rule out an ability for parents to 'invest' in their child's

evidence in favor of the 'collective' approach over the 'unitary' approach to modeling the household. In a dowry setting, Brown (2009) finds evidence that dowries improve outcomes for wives in China. Zhang and Chan (1999) find evidence that brides that enter a marriage with a high dowry have higher welfare (in terms of having help with chores). Arunachalam and Logan (2008) cite evidence from the Survey on the Status of Women and Fertility indicating that brides in India report having more say over how their dowry is used when the dowry is in the form of jewelry, gold or silver compared to cash. See Lundberg and Pollak (1996) for a review of bargaining in marriage.

partner - a very natural assumption when 'investments' are in terms of human capital, but perhaps less so when 'investments' are pure transfers such as the dowry. Unlike Peters and Siow (2002), these papers model the equilibrium division of marital output.[4] As such, the benefit from a premarital investment generally accrues to both sides of the marriage in equilibrium in these models. However there is no scope for offering pure transfers to potential spouses in order to secure a better match. Furthermore, these papers assume the marital resources are divided using alternative marriage partners as outside alternatives, and therefore implicitly assume either that divorce and re-marriage is not costly, or that the agreed-upon division of marital surplus can be enforced once the couple marry and leave the marriage market. While this may be quite suitable in many settings, our approach of having an 'unproductive marriage' as an outside option seems highly reasonable in the context of developing countries, where divorce is far from costless and contracts generally difficult to enforce.

The model also produces some additional results of interest. First, competition for grooms unfolds purely via the allocation of property rights over a given investment level. Without the capacity to allocate property rights, this competition is forced to occur via changes in the investment level. In this sense, the explicit consideration of property rights contains material consequences for the study of marriage markets. Second, despite the competitive nature of the marriage market, investments are generally not Pareto efficient. One component of this is that bridal families have incentives to make direct transfers to the groom even when such transfers are less efficient than transfers to the daughter when there is a positive return to female human capital. Third, the analysis reveals the sense in which positive assortative matching on family wealth is robust, but not guaranteed, in equilibrium.

The following section provides a historical overview of the transformation of dowries from bequests to brides into prices for grooms, and its link to the modernization process. The basic model is introduced in Section 3, is analyzed in Section 4. Results are collected in Section 5, and Section 6 concludes.

2 Historical Overview

The main aim of this section is to trace the links between the transformation from dowries as bequests into dowries as groomprices, in the historical record, to characteristics of the modernization process. We first establish historical instances where there has been a transformation in the institution of dowries and then identify concurrent economic forces.

2.1 The transformation of dowry

The dowry system dates back to at least the ancient Greco-Roman world (Hughes (1985)). With the Barbarian invasions, the Greco-Roman institution of dowry was eclipsed for a

[4] That is, they are models of matching with 'transferable utility', whereas Peters and Siow (2002) assumes 'non-transferable utility'.

time as the Germanic observance of bride-price became prevalent throughout much of Europe; but dowry was widely reinstated in the late Middle Ages. Dowry continued to be prevalent in Renaissance and Early Modern Europe and is presently widespread in South Asia.[5] Dowry paying societies are patrilocal (upon marriage the bride joins the household of her groom) and dowry payments are wealth transfers from the bride's family at the time of marriage which travel with the bride into her new household. Most commonly, the traditional dowry transfer is considered to be a "pre-mortem inheritance" to a daughter, which formally remains her property throughout marriage.[6] Goody and Tambiah (1973) in particular has emphasized this role of dowry in systems of "diverging devolution," where both sons and daughters have inheritance rights to their parent's property. As Botticini and Siow (2003) summarize, a strong link exists between women's rights to inherit property and the receipt of a dowry. This is seen in ancient Rome, medieval western Europe, and the Byzantine Empire.[7] However, property rights over this transfer can vary. In particular the traditional institution can transform from its original purpose of endowing daughters with some financial security into a so-called 'price' for marriage. This component of dowry, often termed a "groomprice", consists of wealth transferred directly to the groom and his parents from the bride's parents, with the bride having no ownership rights over the payment.

There are numerous historical instances where dowry as bequests appear to have been superseded by groomprices. Chojnacki (2000) documents the emergence of a gift of cash to the groom (*corredo*) as a component of marriage payments in Renaissance Venice. In response, the Venetian Law of 1420 limited the 'groom-gift' component to one third of the total marriage settlement (Chojnacki (2000)).[8] Reimer (1985) discusses laws implemented in the late thirteenth century Siena which are akin to the formal emergence of groom price. These comprised both an increase in the proportion of a woman's dowry her husband had rights over, and forbade a woman from using her portion of the dowry without the consent of her husband. Krishner (1991) similarly confirms a pattern of legislations across northern and central Italy granting husbands broader control over a wife's dotal assets beginning in the fourteenth century. Herlihy (1976) argues that outside of Italy, numerous indicators of the financial treatment of women in marriage were also deteriorating after the late middle ages in Europe.[9] For example, common law, in which dowry came under immediate control of husbands, predominated in England during the sixteenth and seventeenth centuries (Erickson (1993) and Stone (1977)). Reher (1997)

[5] See Anderson (2007a) for a survey of the prevalence of dowries.

[6] In several countries, dowry as a pre-mortem inheritance given to women was written into the constitution. Refer to Botticini and Siow (2003) for a historical synopsis of dowries and inheritance rights.

[7] Studies have also emphasized the similarity between the amounts of dowry given to daughters and inheritances awarded to sons. Botticini and Siow (2003) show that average dowries in Renaissance Tuscany corresponded to between 55 and 80 percent of a son's inheritance.

[8] Legislation of dowries was pervasive in Early Europe. For example, the Venetian Senate first limited Venetian dowries in 1420 and payments were abolished by Law in 1537. Dowries were limited by Law in 1511 in Florence and prohibited in Spain in 1761. Similarly, the Great Council in Medieval Ragusa (Dubrovnik) repeatedly intervened to regulate the value of dowries between the thirteenth and fifteenth centuries (Stuard (1981)).

[9] Relative to Italy, a limited number of surviving marriage agreements make the evolution of customs more difficult to follow in other parts of Europe.

remarks that during the Early Modern period in Spain, husbands had greater control over their wives' dowries in Castile relative to other parts of the country. Kleimola (1992) documents a decline of female property rights over their dowries in seventeenth century Muscovy, Russia. Historians also point out that the transformation from dowry in the form of property to dowry as cash, which occurred throughout the Western Mediterranean after the late middle ages, is indirect evidence of a loss of property rights for wives over their dowries.[10] A cash dowry was more easily merged with the husband's estate whereas dowry as property was a more visible sign of the wife's patrimony. Further indirect evidence of dowries working to the detriment of women is given by early feminists who attacked the dowry system and objected to husbands' control over the funds (see, for example, Goody (2000) and Cox (1995)).

Nowhere, however, has there been a more dramatic example of this transformation than in present-day India. The traditional custom of *stridhan*, a parental gift to the bride, has changed into modern-day groomprices which have a highly contractual and obligatory nature. Generally a bride is unable to marry without providing such a payment.[11] The amounts of these payments typically increase in accordance with the 'desirable' qualities of the groom, and the total cash and goods involved are often so large that the transfer can lead to impoverishment of the bridal family.[12] Accordingly, the Dowry Prohibition Act of 1961 attempted to distinguish and discriminate between the two components of the payment: that which was a gift to the bride, and that which was transferred to the groom and his parents. The aim was to abolish the groomprice component but allow bridal transfers to remain in tact (see, Caplan (1984)).[13]

There is comparatively little research explaining the dowry phenomenon in the rest of South Asia, despite substantial suggestive evidence that the transformation into groomprice is occurring.[14] Following numerous complaints, the Pakistan Law Commission reviewed dowry legislation and suggested an amendment in 1993 which updated the limits placed on dowries and also added a sub-clause stating grooms should be prohibited from demanding a dowry.[15] In Bangladesh there seems to be a clear distinction between the traditional dowry, *joutuk*, gifts from the bride's family to the bride, and the new groom payments referred to as *demand*, which emerged post-Independence in the 1970s, (Amin and Cain (1995)). The scale of these demands do not appear to have reached that

[10] For example, the transformation to cash dowries from real property occurred during the thirteenth century in Siena, thirteenth and fourteenth centuries in Genoa, fourteenth and fifteenth centuries in Toulouse, and fifteenth century in Provence (Hughes (1985)).

[11] For evidence of a groom-price in India, see, Caldwell *et al.* (1983), Rao and Rao (1980), Upadhya (1990), Caplan (1984), Billig (1992), Srinivas (1984), Hooja (1969) and Bradford (1985).

[12] In the economic literature, see Rao (1993), Deolalikar and Rao (1998), and Edlund (2000). Within the sociological and anthropological literature, see, Caldwell *et al.* (1983), Rao and Rao (1980), Billig (1992), Caplan (1984), and Hooja (1969).

[13] The practice of dowry in India has essentially continued unabated despite its illegal standing. It has been argued that it is the clause in the Law which aimed to maintain the gift component of the dowry which provided a legal loophole (see Caplan (1984)). The original Law of 1961 continues to be amended to address these issues.

[14] See Lindenbaum (1981), Esteve-Volart (2003), and Arunachalam and Logan (2008) for investigations on dowry payments in rural Bangladesh.

[15] The Pakistani parliament first made efforts to reduce excessive expenditures at marriages by an Act in 1976.

of urban India,[16] but the escalation of these groom payments lead to them being made a punishable offense by the Dowry Prohibition Act of 1980.[17]

We now trace the connection between the occurrences of groomprices outlined above, in both historic Europe and present-day South Asia, to characteristics of the modernization process.

2.2 Dowry transformation and modernization

In both the European and South Asian context, the emergence of a groomprice in lieu of dowry as a bequest seems to have corresponded with increased commercialization.

Several countries in Europe experienced rebirths in their economies during the late Middle Ages and Early Renaissance period. This was a period of commercial revolution, discovery, and trade corresponding with a burgeoning of commercial capitalism and the emergence of urban centers.[18] The growth of commerce and banking reshaped economic lines as the increased variety and volume of commercial opportunities altered the income earning potential of men. Massive recruitment of talented men into the urban centers from villages and small towns occurred, and social change accompanied this, as men of newly acquired wealth were drawn into the upper and middle urban classes (Herlihy (1978)). Watts (1984) argues that by the late fifteenth/early sixteenth century, in almost all areas of Europe to the west of the Elbe, the urban social structure bore little relationship to the high medieval ordering of society as wealth inequality began to increase in the main centers of merchant capitalism during this period (Van Zanden (1995)).

But this commercial revolution did not spread evenly.[19] Northern and central Italy were the homes of great mercantile centers, such as Venice, Florence, and Genoa, in the late fourteenth and fifteenth centuries, Siena was a center of commerce in the thirteenth century, but fell into relative decay following the Black Death of the fourteenth century (Molho (1969), Luzzatto (1961), Riemer 1985). Spain's mercantile period came later when Castile dominated in the sixteenth and seventeenth centuries (Vives (1969)).[20] England

[16]See, for example, Kishwar and Vanita (1984), White (1992), and Rozario (1992).

[17]In addition to the economic repercussions, the increasing demands of groom-prices in South Asia have led to severe social consequences. The custom has been linked to the practice of female infanticide and, among married women, to the more obvious connection with bride-burning and dowry-death, i.e., physical harm visited on the wife if promised payments are not forthcoming (Bloch and Rao (2002), Kumari (1989), and Sood (1990) address these issues). The National Crime Bureau of the Government of India reports approximately 6000 dowry deaths every year. Numerous incidents of dowry-related violence are never reported and Menski (1998) puts the number to roughly 25000 brides who are harmed or killed each year. Relative to research on dowry related violence in India, there are few corresponding investigations for the rest of South Asia. However, this does not imply that such abuse towards women does not occur. In a recent international conference on the 'dowry problem', it was stated that consolidated research on the Pakistani and Bangladeshi experience is urgently needed (see Menski (1998). The case of Pakistan was particularly emphasized, where there was argued to be a need for legislation in light of the growing number of dowry abuse reports.

[18]See, for example, Gies and Gies (1972), Lopez (1971), and Miskimin (1969).

[19]During this time, urbanisation first occurred in areas of northern and central Italy, southern Germany, the Low Countries, and the Spanish Kingdoms.

[20]Catalonia was also an early economic center in the thirteenth and fourteenth centuries (Vives (1969)).

was also undergoing its mercantile period at this time (Lipson (1956)). These periods of economic expansion in different centers of Europe corresponded with the emergence of groomprices in late thirteenth century Siena, in the urban centers of northern and central Italy during the fourteenth and fifteenth centuries, and in Early Modern Spain and England, as outlined in the previous section. Moreover, there is evidence that, over these periods, the groomprice component of dowries served to secure matches with more desirable grooms of high quality. For example, Chojnacki (2000) documents the evolution of groom-gift in fifteenth century Venice. At a time of social and economic upheaval, it was used to secure grooms from prominent families.

The emergence of dowry as a groomprice also seems to coincide with modernization in present-day India. Traditionally, one's caste (status group) innately determined one's occupation, education, and hence potential wealth. Modernization in India has weakened customary barriers to education and occupational opportunities for all castes and, as a result, increased potential wealth heterogeneity within each caste.[21] There is direct evidence that increased heterogeneity amongst married men forces dowries to serve as a price in present-day India - several studies (e.g. Srinivas (1984), Nishimura (1994), and Caplan (1984)) connect groomprice to competition amongst brides for more desirable grooms. For instance, Srinivas (1984) dates the emergence of groomprices in India to the creation of white collar jobs under the British regime. High quality grooms filling those jobs were a scarce commodity, and bid for accordingly. In the same vein, Chauhan (1995) links the widespread transformation of dowries into a groomprice to directly after Independence in 1947. This was a time of significant structural change where unprecedented opportunities for economic and political mobility began to open up for all castes (see also Jayaraman (1981). The same connection has been made in Bangladesh for the emergence of their post-Independence groomprices (See, for example, Kishwar and Vanita (1984), White (1992), and Rozario (1992)).

3 Model

3.1 Fundamentals

There is a continuum of families, each of which is either a 'male' family or a 'female' family. Both types of families exist with measure N. Each family has one offspring, where male families have a son and female families have a daughter. Each family is endowed with a wealth, W, that is distributed on $[0, \bar{W}]$ according to G_m for male families and to

[21]See Singh (1987) for a survey of case studies which analyze upward and downward occupational mobility within caste groups. The recent work of Deshpande (2000) and Darity and Deshpande (2000) shows that within-caste income disparity is increasing in India. This notion of modernisation causing increased heterogeneity within status (caste) groups also applies to Pakistan and Bangladesh. Despite that caste is rooted in Hinduism and is not a component of Islamic religious codes, for the purposes here, caste (or status group) does exist amongst Muslims in both Pakistan and Bangladesh. That is, there traditionally exists a hierarchical social structure based on occupation, where group membership is inherited and endogamy is practised within the different groups. See, for example, Korson (1971), Dixon (1982), Beall (1995), Ahmad (1977), and Lindholm (1985) for Pakistan. Ali (1992) provides an in-depth study of this issue for rural Bangladesh.

G_f for female families.

Families care about their consumption, C, and the consumption of their offspring, c. These preferences are captured by the payoff function, $V(C, c)$, where $V_C, V_c > 0$, $V_{Cc} \geq 0$, $V_{CC} < 0$, $V_{cc} \leq 0$, and $\lim_{C \to 0} V_1(C, c) = \lim_{c \to 0} V_2(C, c) = \infty$ for all $(C, c) \in \mathbb{R}^2_{++}$.[22] Families influence the consumption of their offspring via transfers and their decision whether to participate in the marriage market.

If a family of gender $k \in \{m, f\}$ does not participate in the marriage market, then they can make an 'investment' in their offspring's consumption of t, at a cost of t/θ_k where $\theta_k \geq 1$ parameterizes the return to investing in gender k. Therefore families that do not participate in the marriage market face the problem

$$\max_t V\left(W - t/\theta_k, t\right). \tag{1}$$

Let the maximized value of V be denoted $U_k^0(W)$.

If a family does participate in the marriage market, then offspring consumption depends on the transfers made by each family. The groom's parents make a one-dimensional investment in their son, $w \geq 0$. The bride's parents make a two-dimensional investment, $\tau = (\tau_f, \tau_m)$, where $\tau_f \geq 0$ is an investment that acts as a bequest as it is directed at their daughter, whereas $\tau_m \in \mathbb{R}$ acts as a groomprice as it is directed at their daughter's husband (this may be negative).[23] Consumption for gender k is given by $c_k(\tau, w)$, where c_k is increasing in all arguments. In order that the distinction between τ_f and τ_m be relevant, we assume that c_f is more sensitive to τ_f than to τ_m or w, whereas the reverse is true for c_m. We make the simplifying assumption that c_k is linear: $c_k = a_{1k} \cdot \tau_f + a_{2k} \cdot \tau_m + a_{3k} \cdot w$, where $0 < \max\{a_{2f}, a_{3f}\} < a_{1f}$, and $0 < a_{1m} < \min\{a_{2m}, a_{3m}\}$.[24]

To put some structure on this assumption, we assume that consumption levels are determined as the result of intra-household bargaining (as in Lundberg and Pollak (1993) and Chen and Woolley (2001)). Specifically, marriage unfolds in one of two regimes: productive and unproductive. In the productive regime, consumption levels are determined by bargaining, using the consumption levels in the unproductive regime as outside options. The consumption levels in the unproductive regime, (x_f, x_m), are determined by the parental investments - for females we have

$$x_f = \lambda \cdot \tau_f, \tag{2}$$

where $\lambda \in [0, 1]$ parameterizes the extent to which females have rights over their property (Geddes and Lueck (2002), Doepke and Tertilt (2009), Fernández (2010), and Geddes *et al.* (2010)), and for males we have

$$x_m = (1 - \lambda) \cdot \tau_f + \tau_m + w. \tag{3}$$

[22]Since the utility of the offspring depends only on their consumption, this specification is general enough to accommodate parental preferences over their consumption and the *utility* of their offspring.

[23]We argue the plausibility of our assumption that male families make a one-dimensional transfer based on the fact that the bride resides with the groom and his family, making direct transfers to the bride non-credible.

[24]Peters and Siow (2002) also assume consumption is linear in (one-dimensional) transfers, although the coefficients on each transfer are equal because only a public good is consumed.

We say that investments are *interior* if $\tau_f \geq 0$, $w \geq 0$, and $\tau_m \geq -w$. In the unproductive regime, total household resources available for consumption is therefore $R = \tau_f + \tau_m + w$.

In the productive regime we assume that total available resources are expanded to $\bar{R} = (1+\alpha) \cdot R$, where $\alpha > 0$ parameterize the benefits arising from a productive marriage. Consumption levels in the productive regime, (c_f, c_m), are determined by generalized Nash bargaining - that is, they solve

$$\max \left[c_f - x_f\right]^{\beta} \left[c_m - x_m\right]^{1-\beta}, \quad \text{s.t. } c_f + c_m \leq \bar{R} \tag{4}$$

where $\beta \in [0, 1]$ parameterizes the bargaining power of women.[25] The solution, expressed as a function of parental transfers, is easily verified to be

$$c_f(\tau, w) = Q(\tau) + \alpha\beta \cdot w \tag{5}$$

$$c_m(\tau, w) = [1 + \alpha(1 - \beta)] \cdot w + q(\tau), \tag{6}$$

where $Q(\tau)$ and $q(\tau)$ are indices that capture the extent to which females and males (respectively) benefit from an investment bundle τ, and are given by:

$$Q(\tau) \equiv [\lambda + \alpha\beta] \cdot \tau_f + \alpha\beta \cdot \tau_m \tag{7}$$

$$q(\tau) \equiv [1 - \lambda + \alpha(1 - \beta)] \cdot \tau_f + [1 + \alpha(1 - \beta)] \cdot \tau_m. \tag{8}$$

Intuitively, females benefit from both types of investment but more so from the bequest component. Similarly, males also benefit from both types of investment but more so from the price component. We refer to $q(\tau)$ as an index of bridal quality (from the perspective of grooms).

This ability to condense the mutli-dimensional characteristics of brides into a single dimension is convenient because it allows for a much simpler analysis of the marriage market. Specifically, all females prefer to marry males with higher values of w and all males prefer to marry females with higher values of q. Thus, stability in the marriage market requires that those grooms with the highest w marry those females with the highest q (i.e. positive assortative matching on the characteristics w and q). To describe this, we assume that the marriage market is competitive, so that marriage outcomes are described by a strictly increasing function, $m(q)$, where brides with a quality of q marry grooms with an investment of $w = m(q)$ and grooms with an investment of w marry brides with a quality of $m^{-1}(w)$. The marriage market 'clears' if for all $z \in \mathbb{R}$, the measure of brides with $q \geq z$ equals the measure of grooms with $w \geq m(z)$.

The cost to male families of investing w is $\kappa_m(w) = w/\theta_m$, and the cost to female families of the investment bundle τ is $\kappa_f(\tau) = \tau_m + \tau_f/\theta_f$, where $\theta_k \geq 1$ parameterizes the return to investment for gender $k \in \{m, f\}$. In addition, a male that participates in the

[25]The literature on the expansion of womens' economic rights tends to focus on this parameter as capturing the strength of such rights. For example, Doepke and Tertilt (2009) compare a setting in which $\beta = 0$ (their 'patriarchy' regime) to one in which $\beta = 1/2$ (their 'empowerment' regime) - in both cases, outside options are set to zero. We use the parameter λ to capture the extent of womens' economic rights, and interpret β as capturing the extent to which unmodeled features of the bargaining situation, such as "asymmetry in the bargaining procedure or in the parties' beliefs" (Binmore *et al.* (1986)) - are more or less favorable to women.

marriage market incurs a fixed cost of $H \geq 0$ associated with housing the bride.[26] Families that participate in the marriage market choose the characteristics of their offspring as well as the characteristics of the partner that they wish to marry (taking the 'price' of partners, as captured by m, as given). For female families, this problem is:

$$\max_{\tau,w} V\left(W - \kappa_f(\tau), c_f(\tau, w)\right), \text{ s.t. } w \leq m(q(\tau)), \tag{9}$$

and for male families this problem is:

$$\max_{\tau,w} V\left(W - \kappa_m(w), c_m(\tau, w)\right), \text{ s.t. } w \geq m(q(\tau)). \tag{10}$$

Let the maximized values associated with these problems be denoted $U_f^1(W)$ and $U_m^1(W)$ respectively.

A family's strategy consists of a participation decision and an investment decision. Such a strategy is optimal (with respect to m) if (i) they participate if and only if $U_k^1(W) \geq U_k^0(W)$, and (ii) the investments solve the associated optimization problem; (9) for participating females, (10) for participating males, and (1) for non-participating families.

Following Peters and Siow (2002), a marriage market return function, m, is an equilibrium if there exist optimal strategies such that the marriage market clears. An equilibrium is *interior* if it involves interior investments for each family.

4 Analysis

In calculating equilibria, we start with the non-participating families in order to determine their payoff. We then turn to the investment problem facing participating families under the assumption that equilibrium transfers are interior.

4.1 Non-Participating Families

We begin with non-participating families. From (1), the optimal transfer for non-participating families of gender $k \in \{m, f\}$, denoted $t_k^*(W)$, satisfies the first-order condition

$$\frac{V_1(W - t_k^*(W)/\theta_k, t_k^*(W))}{V_2(W - t_k^*(W)/\theta_k, t_k^*(W))} = \theta_k, \tag{11}$$

so that $U_k^0(W) = V(W - t_k^*(W)/\theta_k, t_k^*(W))$.

4.2 Participating Families

Since males are differentiated by w and females by q, each married couple have associated characteristics (q, w). Let $u_k(q, w \mid W)$ be the payoff to a family of gender k when their offspring belongs to a (q, w) marriage.

[26] This is incurred in both the productive and unproductive regime, and therefore does not enter the bargaining problem.

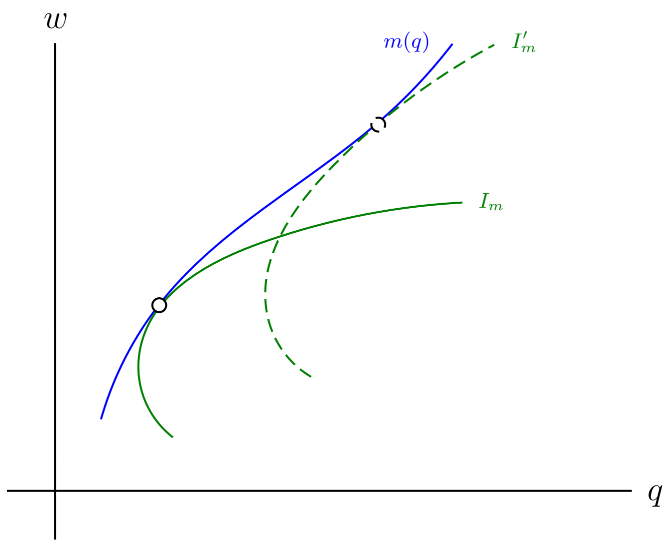

Figure 1: The Marriage Market: Males

4.2.1 Male Families

Since c_m only depends on τ to the extent that it depends on $q(\tau)$, we can describe male consumption as a function of (q, w) simply by letting $\tilde{c}_m(q(\tau), w) \equiv c_m(\tau, w)$. Then, we have

$$u_m(q, w \mid W) \equiv V\left(W - \kappa_m(w), \tilde{c}_m(q, w) - H\right). \tag{12}$$

The problem facing participating males given by (10) is then equivalently stated as

$$\max_{q,w} \; u_m(q, w \mid W), \;\; \text{s.t. } w \geq m(q). \tag{13}$$

To get a geometric intuition for this problem, note that the slope of the associated indifference curve in (q, w) space is

$$-\frac{\frac{\partial u_m}{\partial q}}{\frac{\partial u_m}{\partial w}} = \frac{\frac{\partial c_m}{\partial q}}{\frac{V_1}{V_2} \cdot \frac{\partial \kappa_m}{\partial w} - \frac{\partial c_m}{\partial w}}. \tag{14}$$

Since V_1/V_2 is decreasing in W for a fixed (q, w) (and the other terms are constants), we have that wealthier male families have steeper indifference curves on the upward-sloping section. Two such indifference curves are depicted in Figure 1, where the dashed curve belongs to a family with a higher wealth. Points to the 'right' are more preferred.

Figure 1 also depicts a marriage market return function. The problem facing male families is to choose their most preferred point belonging 'above' this curve. The optimal points for the poorer and wealthier families are depicted by the solid and dashed points respectively.

4.2.2 Female Families

Turning to the problem facing participating females, we can construct the payoff function $u_f(q, w \mid W)$ by converting the problem of choosing (τ_m, τ_f) into one of choosing (κ, q).

That is, choosing the magnitude of the total transfer and the division of property rights over it. For a given choice (κ, q), the underlying transfers $\tau(\kappa, q) = (\tau_f(\kappa, q), \tau_m(\kappa, q))$ satisfy

$$\kappa_f(\tau_f(\kappa, q), \tau_m(\kappa, q)) = \kappa \tag{15}$$

$$q(\tau_f(\kappa, q), \tau_m(\kappa, q)) = q. \tag{16}$$

Bride consumption can then be written as a function of (κ, q) in the obvious way:

$$\tilde{c}_f(\kappa, q, w) \equiv c_f(\tau(\kappa, q), w). \tag{17}$$

The payoff to a participating female family is then simply

$$u_f(q, w \mid W) \equiv \max_{\kappa} \{V(W - \kappa, \tilde{c}_f(\kappa, q, w))\}. \tag{18}$$

The problem facing participating females given by (9) is then equivalent to

$$\max_{q,w} u_f(q, w \mid W), \text{ s.t. } w \leq m(q). \tag{19}$$

The slope of the associated indifference curve in (q, w) space is

$$-\frac{\frac{\partial u_f}{\partial q}}{\frac{\partial u_f}{\partial w}} = -\frac{\frac{\partial \tilde{c}_f}{\partial q}}{\frac{\partial \tilde{c}_f}{\partial w}} = \frac{1}{\frac{\partial c_f}{\partial w}} \cdot \frac{\theta_f \cdot \frac{\partial c_f}{\partial \tau_f} - \frac{\partial c_f}{\partial \tau_m}}{\frac{\partial q}{\partial \tau_m} - \theta_f \cdot \frac{\partial q}{\partial \tau_f}}, \tag{20}$$

where the final equality comes from $\frac{\partial \tilde{c}_f}{\partial q} = \frac{\partial c_f}{\partial \tau_f}\frac{\partial \tau_f}{\partial q} + \frac{\partial c_f}{\partial \tau_m}\frac{\partial \tau_m}{\partial q}$, where $\frac{\partial \tau_f}{\partial q}$ and $\frac{\partial \tau_m}{\partial q}$ are derived from differentiating (15) and (16) with respect to q and solving the resulting system of linear equations (see Lemma 3 in the appendix). The slope of these indifference curves is positive as long as the denominator is positive - that is, as long as θ_f is not too much greater than unity: $\theta_f \leq \frac{\partial q}{\partial \tau_m} / \frac{\partial q}{\partial \tau_f}$. Specifically, we assume:

$$\theta_f \leq \bar{\theta}_f \equiv \frac{1 + \alpha(1 - \beta)}{1 - \lambda + \alpha(1 - \beta)}. \tag{21}$$

If this did not hold then female families would never find it optimal to make direct transfers since devoting one unit to τ_f raises bridal quality more than would devoting that same unit to τ_m.

More importantly, the slope is independent of the bridal family's wealth. Although bridal families are heterogeneous with respect to their wealth, they are homogenous in terms of the marginal rate of substitution between q and w. This is because the capacity to allocate property rights means that bride quality can be changed independently of the total transfer, and therefore unlike males, heterogeneity of wealth does not imply heterogeneity of marginal rates of substitution. As we shall see, equilibrium will require that m coincide with one such indifference curve.

These indifference curves are depicted in Figure 2, where 'higher' points are more preferred (the shape of the curve is the same for all wealth levels). A marriage market return function is also illustrated, and the female family chooses their most preferred point 'below' this curve.

It is convenient to define

$$\Omega \equiv \frac{\theta_f \cdot \frac{\partial c_f}{\partial \tau_f} - \frac{\partial c_f}{\partial \tau_m}}{\frac{\partial q}{\partial \tau_m} - \theta_f \cdot \frac{\partial q}{\partial \tau_f}} = \frac{\theta_f \lambda + (\theta_f - 1) \cdot \alpha\beta}{\theta_f \lambda - (\theta_f - 1) \cdot [1 + \alpha(1 - \beta)]}, \tag{22}$$

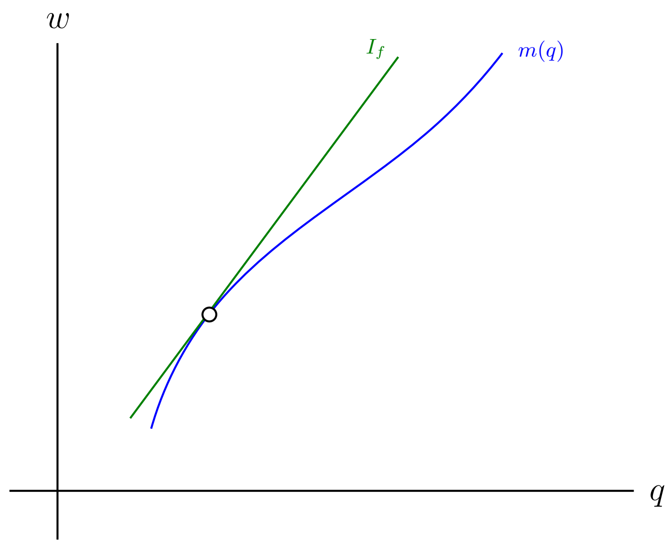

Figure 2: The Marriage Market: Females

so that the slope of female indifference curves is $\Omega / \frac{\partial \tilde{c}_f}{\partial w} = \Omega / \alpha\beta$. Note that $\Omega = 1$ when $\theta_f = 1$, and $\Omega > 1$ otherwise.

4.3 The Marriage Return Function

The fact that the shape of female indifference curves do not change with wealth means that the marriage market return function must coincide with one such curve.

To see this, consider Figure 3. The figure illustrates the case in which there are two male wealth levels in the market (the higher wealth level is associated with the dashed indifference curves). In order for the marriage market to clear, some brides must choose grooms of each wealth level. The only way that this will happen is if the optimal choices of the male families lie on the same female indifference curve, I_f. This then implies that m must be tangential to I_f at such points. When there are many male wealth levels, such as illustrated in Figure 4, it must be that m coincides with I_f. Therefore, a consequence of bridal family optimization is

$$m(q) = \frac{\Omega}{\alpha\beta} \cdot [q - q_0] \tag{23}$$

for some q_0. The value of q_0 is the bride quality that must be offered in order to marry a groom with $w = 0$.

Given $m(q)$, groom consumption can be written as a function of w only by using $q = m^{-1}(w)$ - i.e. $\hat{c}_m(w) \equiv \tilde{c}_m(m^{-1}(w), w)$. Specifically, using the fact that $\tilde{c}_m(q, 0) = q_0 - H$ and $\frac{\partial \hat{c}_m}{\partial w} = \frac{\partial \tilde{c}_m}{\partial q} \frac{\partial m^{-1}(w)}{\partial w} + \frac{\partial \tilde{c}_m}{\partial w}$, we have

$$\hat{c}_m(w) = \delta_0^m + \delta_1^m \cdot w, \tag{24}$$

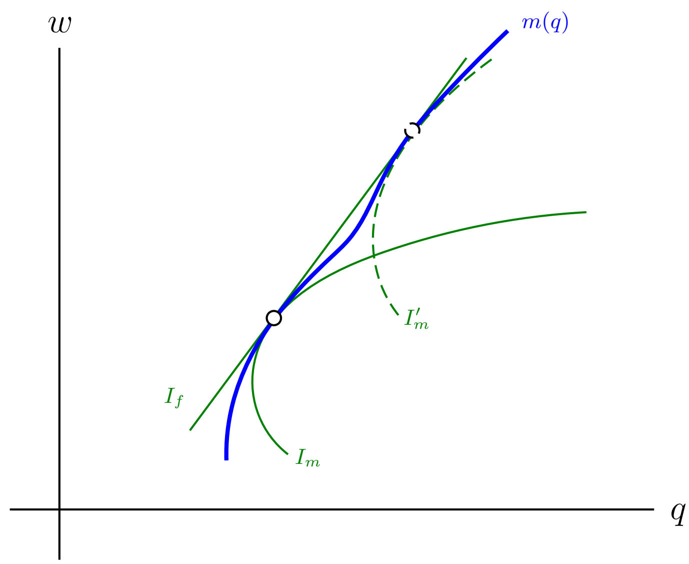

Figure 3: The Marriage Market: Two Male Wealth Levels

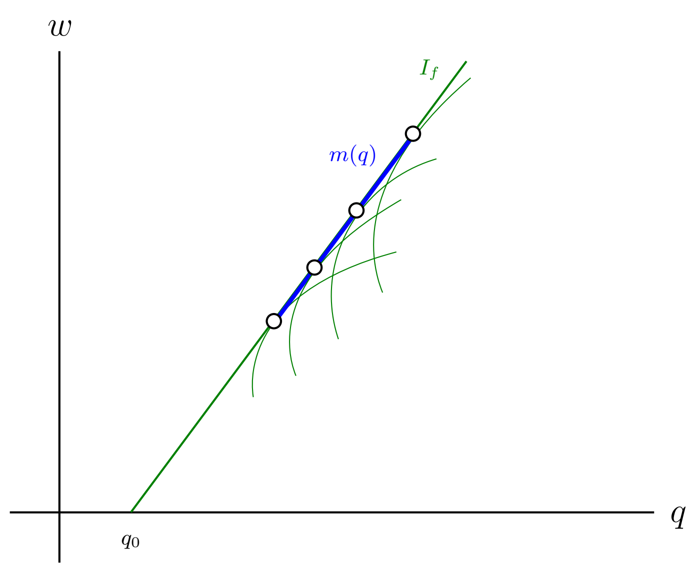

Figure 4: The Marriage Market: A Continuum of Male Wealth Levels

where

$$\delta_0^m \equiv q_0 - H \tag{25}$$

$$\delta_1^m \equiv \Omega^{-1} \cdot \frac{\partial c_f}{\partial w} + \frac{\partial c_m}{\partial w} = \Omega^{-1} \cdot \alpha\beta + 1 + \alpha(1-\beta). \tag{26}$$

Given m, participating male families choose w to solve

$$\max_w \; V\left(W - \kappa_m(w), \delta_0^m + \delta_1^m \cdot w\right). \tag{27}$$

The first-order condition is

$$\frac{V_1}{V_2} = \theta_m \cdot \delta_1^m. \tag{28}$$

Let $U_m^1(W \mid q_0)$ be the maximized value.

A similar argument works for brides. Given m, we can write bride consumption as a function of (κ, q) - i.e. $\hat{c}_f(\kappa, q) \equiv \tilde{c}_f(\kappa, q, m(q))$. Given the above argument about m coinciding with a bridal indifference curve, we can anticipate that $\hat{c}_f(\kappa, q)$ is in fact independent of q. Using the fact that $\frac{\partial \hat{c}_f}{\partial \kappa} = \frac{\partial c}{\partial \tau_f}\frac{\partial \tau_f}{\partial \kappa} + \frac{\partial c}{\partial \tau_m}\frac{\partial \tau_m}{\partial \kappa}$, where $\frac{\partial \tau_k}{\partial \kappa}$ are given in Lemma 3, and $\tilde{c}_f(0, q, m(q)) = -\Omega q_0$, we have

$$\hat{c}_f(\kappa, q) = \delta_0^f + \delta_1^f \cdot \kappa, \tag{29}$$

where

$$\delta_0^f \equiv -\Omega q_0 \tag{30}$$

$$\delta_1^f \equiv \frac{\partial c_f}{\partial \tau_m} + \Omega \cdot \frac{\partial q}{\partial \tau_m} = \alpha\beta + \Omega \cdot (1 + \alpha(1-\beta)). \tag{31}$$

Given m, participating female families choose κ to solve

$$\max_\kappa \; V\left(W - \kappa, \delta_0^f + \delta_1^f \cdot \kappa\right). \tag{32}$$

The first-order condition is

$$\frac{V_1}{V_2} = \delta_1^f. \tag{33}$$

Let $\kappa^*(W)$ be the optimal choice and $U_f^1(W \mid q_0)$ be the maximized value.

This gives us the first condition for optimal female transfers: $\kappa(\tau) = \kappa^*(W)$. The second condition arises from the choice of who to marry (recalling that brides are indifferent in equilibrium). If a bride intends on marrying a groom with with a transfer w, then the second condition for optimal female transfers is $q(\tau) = m^{-1}(w)$. These two conditions are described by two curves in (τ_f, τ_m) space as illustrated in Figure 5. The closed-form solution is

$$\tau_m^*(W, w \mid q_0) = \frac{q_0 + \frac{\alpha\beta}{\Omega} \cdot w - \theta_f \kappa_f^* \cdot [1 - \lambda + \alpha(1-\beta)]}{\lambda\theta_f - (\theta_f - 1) \cdot [1 + \alpha(1-\beta)]} \tag{34}$$

$$\tau_f^*(W, w \mid q_0) = \frac{\theta_f \cdot \Big[[1 + \alpha(1-\beta)] \cdot \kappa_f^* - [q_0 + \frac{\alpha\beta}{\Omega} \cdot w]\Big]}{\lambda\theta_f - (\theta_f - 1) \cdot [1 + \alpha(1-\beta)]}. \tag{35}$$

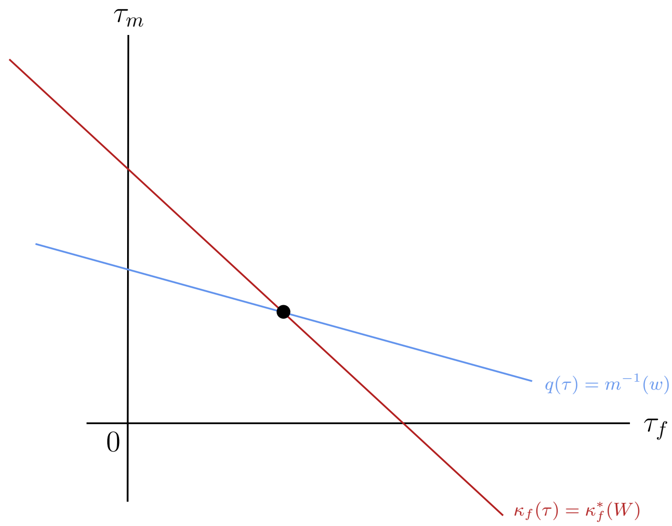

Figure 5: Equilibrium Composition of Transfers

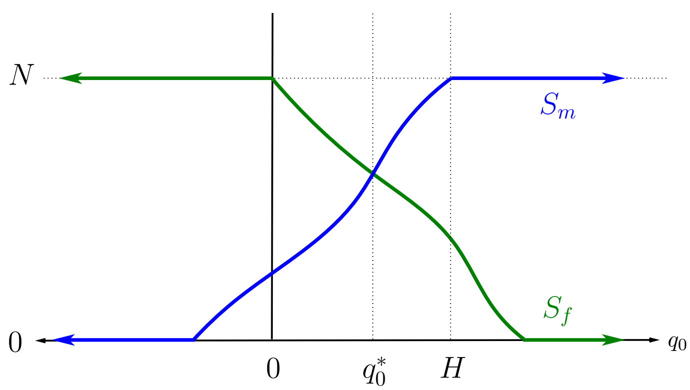

Figure 6: Aggregate Marriage Market Clearing

To summarize, we have determined the optimal total transfers made by each family (as a function of q_0), and have determined the composition of these transfers as a function of which groom marries each bride. These are determined by marriage market clearing.

A necessary condition for clearing the marriage market is that the aggregate supply of grooms equals the aggregate supply of brides. To get at this, let $W_k^0(q_0)$ be the wealth of a family that is indifferent to participating given q_0 - i.e. we have $U_k^1(W_k^0(q_0) \mid q_0) = U_k^0(W_k^0)$. Note that W_m^0 is decreasing, and W_f^0 increasing, in q_0. Lemma 2 in the appendix establishes the slope of $U_k^1(W \mid q_0)$ is greater than the slope of $U_k^0(W)$ at $W = W_k^0(q_0)$. This implies a cut-off rule: families of gender k participate if and only if $W \geq W_0^k(q_0)$. The supply of gender k families is therefore $S_k(q_0) \equiv N \cdot [1 - G_k(W_0^k(q_0))]$. Aggregate market clearing therefore requires that the equilibrium value of q_0, denoted q_0^*, satisfies $S_m(q_0^*) = S_f(q_0^*)$.

Since S_k is decreasing in W_0^k, we have that S_m is increasing and S_f is decreasing, in

q_0. To get a sense of these supply functions, note that zero-wealth gender k families get $V(0,0)$ when not participating and get $V(0,\delta_0^k)$ when participating. They are therefore indifferent when q_0 is such that $\delta_0^k = 0$. That is, for females when $q_0 = 0$, and for males when $q_0 = H$. Therefore S_f is decreasing from N, and S_m is increasing to N, on $[0, H]$. Therefore if there is positive participation in equilibrium,[27] it is generated by a unique market-clearing value of q_0^*. At such a value there is less than full participation.

Note how this formulation would easily accommodate differences in the aggregate measure of males and females. For instance, an increase in the measure of males would shift S_m upwards resulting in a decrease in q_0^*. More importantly, it is apparent that nothing hinges on the measures of males and females being exactly equal and that q_0^* would change smoothly as these measures diverged from one another.

Aggregate market clearing is by itself insufficient to ensure that the marriage market clears since we have yet to specify which bride marries which groom. In equilibrium, m is such that brides are indifferent to their choice of bridal quality, but grooms implicitly demand the particular quality given by $m^{-1}(w)$. Therefore we can clear the marriage market by proposing any measure preserving function from the set of participating females to the set of participating males and have the female choose the quality demanded by their assigned partner.

Given the arbitrary nature of this measure preserving function, we may classify equilibrium matching as 'coarse positive assortative' in the sense that only the relatively wealthy end up with partners, but partners are arbitrarily allocated conditional on participation. This conclusion is seemingly stark in comparison with related models with one-dimensional transfers in which equilibrium matching must be positive assortative on family wealth (e.g. Peters and Siow (2002) and Botticini and Siow (2003)).

There is, however, an important caveat. Nothing so far guarantees that equilibrium transfers will be interior. Positive assortative matching on parental wealth emerges as a 'natural' matching pattern because if any matching pattern induces interior transfers, then so too will the assortative matching (but not vice versa). To give the intuition for this, consider four families - a rich male family, a poor male family, a rich female family, and a poor female family. The assortative match has the rich families married and the poor families married, and a non-assortative matching would have marriages containing one rich and one poor family. Figure 7 shows the pair of equilibrium investment bundles under each of these matchings. The dark dots are the transfers that arise in the non-assortive matching and the light dots are those that arise in the assortative matching. If the dark dots lie in a given rectangle (say $[0, r_1] \times [0, r_2]$) then so too will the light dots. The reverse is clearly not true. Intuitively, non-assortative matchings are liable to have 'lop-sided' households in which one side is much wealthier than the other. To see why this may be problematic, suppose the groom comes from a much wealthier family than his assigned bride. The marriage market would then require that she offer a relatively large quality, but if she comes from a poor family then her parents will want to make a

[27] Positive participation is ensured for H sufficiently small relative to $\overline{W}_k$. For instance, this is ensured if $S^f(H) > 0$ or $S^m(0) > 0$. In the uninteresting case of no equilibrium participation, there will be an interval $I \subset [0, H]$ such that zero participation is supported for all $q_0 \in I$.

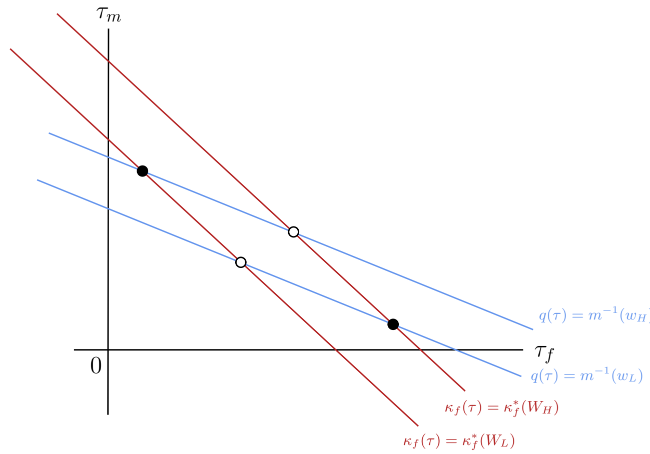

Figure 7: Intuition for Positive Assortative Matching

small total transfer, and as such the only way that she can offer a large quality is to offer a large τ_m and negative τ_f, which is infeasible. Analogous arguments apply when the bride is much wealthier than her assigned groom.

Since assortative matching limits the extent to which these 'lop-sided' marriages arise, we assume from here that matching is positive assortative on parental wealth. Specifically, females of wealth W marry males of wealth $\phi(W)$, where $\phi(W)$ satisfies $N[1 - G_f(W)] = N[1 - G_m(\phi(W))]$. That is, $\phi(W) = G_m^{-1}G_f(W)$. In the case where the distribution of wealth is the same across genders, we have $\phi(W) = W$: marriages form between families with the same wealth. Given ϕ, females of wealth W marry a groom with a transfer of $w = w^*(\phi(W) \mid q_0^*)$, which closes the model.

Even if investments are 'more likely' to be interior under positive assortative matching, we still need to check that transfers are in fact interior as assumed, given positive assortative matching. We do not elaborate on this here, but present a discussion in section A.1.

4.4 Measuring Female Property Rights over Dowry

There are various ways that one could potentially measure female property rights associated with the dowry bundle τ. We focus on the nature measure: the proportion of the total transfer which is formally given to the daughters:

$$\Pi(\tau) \equiv \frac{\tau_f}{\tau_f + \tau_m}. \tag{36}$$

Using (34) and (35), we have

$$\Pi(\tau) = \frac{[1 + \alpha(1-\beta)] \cdot \kappa_f^* - [q_0 + \frac{\alpha\beta}{\Omega} \cdot w]}{\lambda \cdot \kappa_f^* - \frac{\theta_f - 1}{\theta_f} \cdot [q_0 + \frac{\alpha\beta}{\Omega} \cdot w]}. \tag{37}$$

5 The Development Process and Property Rights

In this section we examine how the economic environment shapes the equilibrium property rights over marital transfers. Specifically, we examine the impact of social changes such as the economic rights of women (as captured by β and λ) and economic changes such as increases in wealth and the return to male and female human capital.

For clarity in presenting the results in this section, we assume that $H = 0$. This implies that q_0^* is fixed at zero. Using this in (37) gives

$$\Pi(\tau) = \frac{[1+\alpha(1-\beta)] \cdot \left\{\frac{\kappa_f^*}{w}\right\} - \frac{\alpha\beta}{\Omega}}{\lambda \cdot \left\{\frac{\kappa_f^*}{w}\right\} - \frac{\theta_f - 1}{\theta_f} \cdot \frac{\alpha\beta}{\Omega}}. \tag{38}$$

Note that $q_0^* = 0$ also implies $\delta_0^f = \delta_0^m = 0$.

It will at times be useful to assume a functional form for V. In such cases our results will be stated in terms of a constant elasticity of substitution (CES) utility function:

$$V(C,c) = \left[\phi \cdot C^{\frac{\sigma-1}{\sigma}} + (1-\phi) \cdot c^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{39}$$

where $\sigma > 0$ is the elasticity of substitution and $\phi \in (0,1)$. While specialized, this specification covers linear ($\sigma \to \infty$), Cobb-Douglas ($\sigma \to 1$), and Leontief ($\sigma \to 0$) preferences.

5.1 Social Changes: The Economic Rights of Women

This section examines how equilibrium transfers are affected by the strength of womens' economic rights as captured in the parameters λ and β. Neither of these parameters affects non-participating families. If $\theta_f = 1$, then neither parameter affects (δ_1^f, δ_1^m) and therefore does not affect the payoffs to any participating family. As a result, these parameters do not affect the equilibrium payoff of any family, however, they do affect how property rights over bridal transfers are allocated. Specifically, an increase in either λ or β diverts the transfer toward the groom and away from the bride, and therefore Π^0 decreases.

Proposition 1. *If $\theta_f = 1$, then Π is decreasing in λ and β.*

Proof. As argued in the text, (δ_1^f, δ_1^m) is unaffected by (λ, β). This implies that w and κ_f^* are unaffected. Using $\theta_f = 1$ in (38) gives

$$\Pi(\tau) = \frac{1}{\lambda} \cdot \left[1 + \alpha(1-\beta) - \frac{\alpha\beta}{\kappa_f^*/w}\right]. \tag{40}$$

Since $\Pi \geq 0$ (by interior investments) the term in brackets is non-negative. It is then clear that Π is decreasing in λ and β. □

If λ or β become sufficiently low, then τ_m becomes negative (so that a bridal family receives a transfer from the groom family). Intuitively, when brides anticipate that they will be faced with poor bargaining outcomes in marriage they require an upfront transfer (which is used in part to make direct transfers) to compensate. In such a situation there simultaneously exists transfers from the bride's side to the groom's side (via the bride)

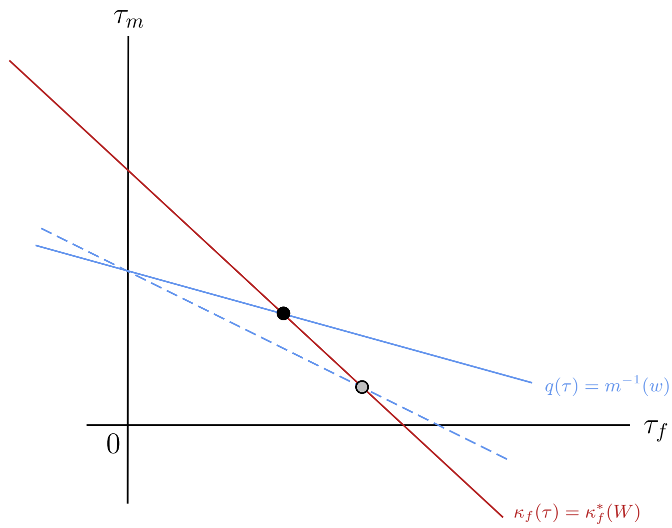

Figure 8: The Effect of λ

and from the groom's side to the bride's side (via the negative transfer) - an outcome stressed in Zhang and Chan (1999) and Botticini and Siow (2003) (among others).

The effect of λ and β are shown in Figures 8 and 9 respectively, where the initially equilibrium transfers lie at the intersection of the dashed line and the steepest line. After the increase in parameter value, the new equilibrium transfers lie at the intersection of the solid line and the steepest line - a 'northwest' shift, reflecting lower property rights over a fixed total marital transfer.

Matters are less transparent when $\theta_f > 1$. An increase in λ decreases δ_1^f and increases δ_1^m.[28] An increase in β decreases both δ_1^f and δ_1^m. The effect of changes in (δ_1^f, δ_1^m) on κ_k^*/w will depend on preferences - e.g. the optimal transfer is independent of δ_1^k when V is Cobb-Douglas (see section B for the more general CES case).[29]

Proposition 2. *If $\theta_f > 1$, and preferences are CES with $\sigma \geq 1$, then Π is decreasing in λ.*

Proof. From (38), the value of Π is clearly decreasing in λ for a fixed Ω and $\{\kappa_f^*/w\}$. It is straightforward to verify that (21) implies Π is increasing in Ω and $\{\kappa_f^*/w\}$. It is also straightforward to verify that Ω is decreasing in λ. Therefore the result follows if $\{\kappa_f^*/w\}$ is not decreasing in λ.

An increase in λ increases δ_1^f and decreases δ_1^m. If preferences are CES with $\sigma \geq 1$, then κ_f^* is non-decreasing in δ_1^f and w is non-decreasing in δ_1^m. Therefore, under this assumption, $\{\kappa_f^*/w\}$ is non-decreasing in λ. □

Proposition 3. *If $\theta_f > 1$, $H = 0$ and preferences are Cobb-Douglas (i.e. CES with $\sigma = 1$), then Π is decreasing in β.*

[28] These follow from the fact that Ω is decreasing in λ when $\theta_f > 1$.

[29] If $H > 0$, then (β, λ) will also affect $(\delta_0^f, \delta_)^m)$. Changes in all the δ terms will in general affect the relative payoff to participating, and will therefore affect q_0^* in general. This 'general equilibrium' aspect of changes in (β, λ) disappear as H goes to zero.

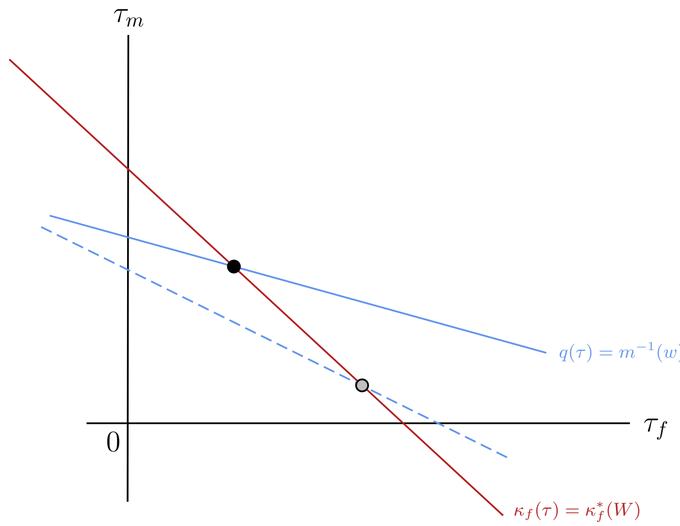

Figure 9: The Effect of β

Proof. From (38), the value of Π is easily shown that Ω is decreasing in β, and therefore $\frac{\alpha\beta}{\Omega}$ is increasing in β. Condition (21) implies $1 + \alpha(1-\beta) < \frac{\theta_f}{\theta_f - 1} \cdot \lambda$, and therefore for a fixed $\{\kappa_f^*/w\}$, $\Pi(\tau)$ is decreasing in β. If preferences are Cobb-Douglas then κ_f^* is independent of δ_1^f and w independent of δ_1^m. Therefore $\{\kappa_f^*/w\}$ is independent of (δ_1^f, δ_1^m) and is therefore independent of β. □

A conclusion from this section is that the marriage market 'undoes' any gain from strengthened economic rights of women. This feature is conjectured in Lundberg and Pollak (1993), but is not our main concern. Rather, we are interested in *how* the gain is undone: a compositional change in the dowry transfer that reflects fewer property rights for females. Thus, *strengthened 'external' economic rights of women induce weakened rights over the marital transfer*. In other words, as wives obtain stronger rights over their property relative to their husbands we expect to see dowry transfers containing less property for wives relative to husbands.

5.2 Economic Changes: Wealth and the Returns to Human Capital

5.2.1 Wealth

An increase in W will increase the total transfer made by all families (regardless of gender and participation). The overall effect on property rights is ambiguous since Π increases in κ_f^* but decreases in w. Placing some structure on preferences gives us the following.

Proposition 4. *If preferences are CES, then Π is independent of W.*

Proof. From (38), note that W only matter insofar as it affects κ_f^*/w. If $H = 0$ and preferences are CES then $\kappa_f^* = A_f W$ and $w = A_m W$ for some pair of constants (A_f, A_m) (given explicitly in section B). This then implies that $\frac{\kappa_f^*}{w} = \frac{A_f}{A_m}$, which is a constant. □

5.2.2 Productivity of Male Human Capital

Increases in the productivity of male human capital increases the investment in all males and therefore endogenously raises the quality of all grooms. This increases the quality that all brides must offer in equilibrium, however this could be achieved by raising the total transfer or reallocating property rights over the existing total transfer (or some combination).

Proposition 5. *An increase in θ_m increases w for all male families but does not affect κ_f^* for any participating female family.*

Proof. Since $H = 0$, we have that $q_0^* = 0$ and $\delta_0^f = \delta_0^m = 0$. Both δ_1^f and δ_1^m are independent of θ_m. Since (δ_0^f, δ_1^f) is independent of θ_m, we have that κ_f^* is independent of θ_m.

From the male family's first-order conditions, we get $V_1/V_2 = \theta_m \delta_1^m$. Since (δ_0^m, δ_1^m) is independent of θ_m, we have that V_1/V_2 must increase in θ_m. If w were not changed, then an increase in θ_m increases C (which equals $W - w/\theta_m$) and c (which equals $\delta_0^m + \delta_1^m w$) is unchanged, and therefore V_1/V_2 decreases. Therefore the FOC require that C must decrease and/or c increase - i.e. w must increase. □

This result indicates that bridal families generate the increase in bride quality purely via compositional changes in property rights over a given total bridal transfer. This is noteworthy because a restriction to one-dimensional bridal transfers requires that competition for grooms unfolds via higher total bridal transfers. In this way we see that the nature of competition is qualitatively different when bridal families are modeled as also choosing the allocation of property rights. This feature offers an different perspective on how allowing for the endogenous division of property rights alters predictions about equilibrium matching patterns - in models with one-dimensional investment, wealthier families have a lower marginal cost of investment and therefore must be the families that offer the highest quality in equilibrium (ensuring positive assortative matching). This no longer need be the case when the allocation of property rights is endogenous since quality can be increased via compositional changes, and therefore it is no longer the case that wealthier families must have a lower marginal cost of bridal quality.

If brides offer a higher quality in response to an increase in the productivity of male human capital, but do not offer a higher total transfer, it must be that property rights are shifted from the bride toward the groom.

Proposition 6. Π *is decreasing in θ_m.*

Proof. If $H = 0$ then Π is given by (38), which is decreasing in w (since (21) implies $1 + \alpha(1 - \beta) < \frac{\theta_f}{\theta_f - 1} \cdot \lambda$). An increase in θ_m increases w but does not affect any other term in (38). □

The effect of θ_m is illustrated in Figure 10, where the initial equilibrium allocation occurs at the intersection of the dashed line and the steep line, then shifts 'northwest' to the intersection of the solid line and the steep line.

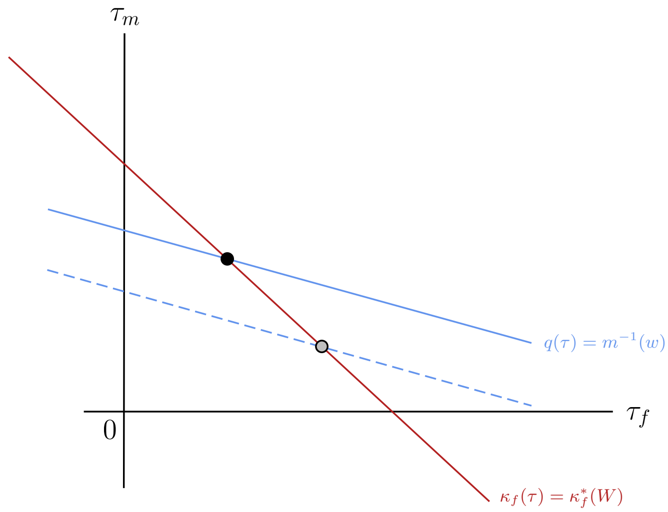

Figure 10: The Effect of θ_m

5.2.3 Productivity of Female Human Capital

Changes in the return to female human capital affect the equilibrium allocation of property rights via three channels.

First, an increase in θ_f provides incentives for bridal families to increase transfers to their daughter: fixing marriage market conditions and the total bridal transfer expenditures, if θ_f increases then this outlay produces more total marital resources and therefore some property rights can be re-allocated toward the bride without lowering bridal quality (and therefore the quality of groom attracted).

Second, marriage market conditions change: fixing total bridal transfer expenditures, if θ_f increases then shifting property rights to raise q is relatively more expensive (since transfers are diverted to the lower-return investment) and therefore the slope of each female indifference curve increases.[30] The marriage market return function therefore also becomes steeper in equilibrium. In other words, the bridal quality required to marry a given groom is lowered.

These two effects work in the direction of shifting property rights toward the bride, as illustrated in Figure 11. The first effect is shown by the flattening of the iso-κ curve, which acts to increase Π as can be seen in the figure as a shift in equilibrium transfers from the lightly filled dot to the unfilled dot. The second effect is shown by the downward shift in the flatter curve. This further strengthens rights over the dowry, as reflected in equilibrium transfers shifting from the unfilled point to the dark point.

The third effect captures the fact that a change in the marriage market conditions will in general change the optimal total transfer on both sides of the marriage market. Specifically, the return to total investment for brides (as captured by δ_1^f) increases and for grooms (as captured by δ_1^m) decreases. Because of standard income and substitution effects, it is not possible to predict whether this leads to higher or lower total transfers

[30] This fact can be seen directly from (20).

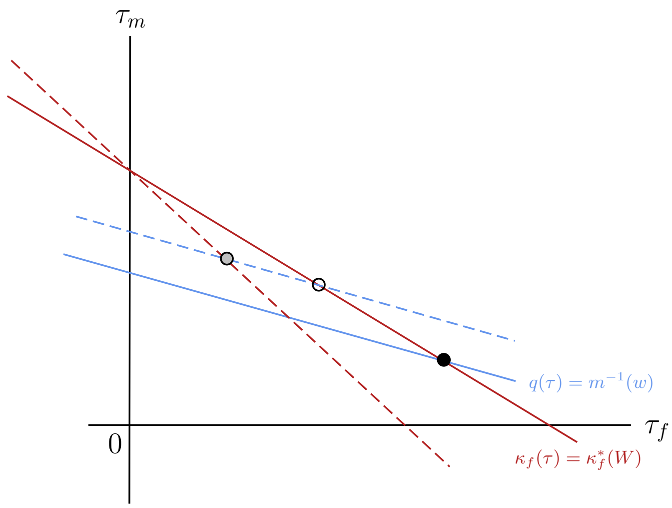

Figure 11: The Effect of θ_f

without placing more structure on preferences. If it turns out that brides invest no less, and grooms no more, in total then this third effect will also act to shift property rights toward the bride.

Proposition 7. *If preferences are CES with* $\sigma \geq 1$*, then* Π *is increasing in* θ_f*.*

Proof. For a fixed Ω and κ_f^*/w, from (38) Π is increasing in θ_f. Furthermore, Π is increasing in Ω and Ω is increasing in θ_f. Therefore we can be sure that Π is increasing in θ_f if we are sure that κ_f^*/w is non-decreasing in θ_f. To get at this, note that δ_1^f is increasing, and δ_1^m is decreasing in θ_f. If preferences are CES and $\sigma \geq 0$, then an increase in δ_1^f raises κ_f^* and a decrease in δ_m^* lowers w. As such, we can be sure that κ_f^*/w is non-decreasing in θ_f when preferences are CES and $\sigma \geq 0$. □

Apart from changing the extent to which grooms have property rights over bridal transfers, increases in the return to female human capital may destroy the custom of marriage payments altogether.

5.2.4 The Breakdown of Marriage Payments

As the return to female human capital gets large, the relative cost of making payments directly to the groom will become increasingly great. At some point - once equation (21) is violated - female families will never find it optimal to make a transfer to the groom because their daughter's bridal quality will be greater if the transfer were instead invested in the daughter's human capital. Once this point is reached, all families only make investments in the human capital of their offspring and marriage payments as such cease to be made. A model with one-dimensional investments along the lines of Peters and Siow (2002) would become appropriate in this case.

Note also that the violation of (21) need not be caused solely by increases in θ_f. Since $\bar{\theta}_f$ is decreasing in α, a sufficiently high value of marriage could also induce a breakdown in the 'price' component of dowry.

5.3 Efficiency

In many related settings (e.g. Peters and Siow (2002), Cole *et al.* (2001), and Iyigun and Walsh (2007)), the marriage market acts to internalize the externalizes associated with premarital investment. In this setting, this is only true in the special case in which $\theta_f = 1$. To get a sense of why this is true, note that it is inefficient for bridal families to make direct transfers to the groom since human capital investments provide a higher return. However bridal families have an incentive to make direct transfers to the groom because of competition in the marriage market.

Inefficiency extends beyond this because the marriage market adjusts in ways that alter families' (on both sides) incentives to invest. When $\theta_f > 1$, female families invest too much and male families invest too little. To see this, for female families we have

$$\frac{V_1}{V_2} = \delta_1^f \geq (1+\alpha) \cdot \theta_f, \tag{41}$$

where the inequality is strict if $\theta_f > 1$. Transfers would be efficient if the right side were $(1+\alpha)\theta_f$ (the social return to investment). Similarly, for male families we have

$$\frac{V_1}{V_2} = \delta_1^f \cdot \theta_m \leq (1+\alpha) \cdot \theta_m, \tag{42}$$

where the inequality is strict if $\theta_f > 1$. The fact that females invest more than is efficient perhaps also speak to the perception that dowry payments constitute an excessively heavy financial burden for bridal families.

6 Conclusions

We have constructed a simple equilibrium model of the marriage market in order to help understand the ways in which the role of dowry shifts from one of a pre-mortem bequest into a marriage payment in the competition for grooms. Specifically, we show how a reallocation of property rights toward grooms is induced by i) an increase in the economic rights of women as captured by bargaining power and the strength of their de facto rights over their formal property, and ii) an increase in the returns to male human capital.

The analysis reveals that, unlike similar models without the endogenous division of property rights, competition in the marriage market is via the allocation of property rights over a fixed total transfer rather than via aggregate transfers, and that equilibrium sorting need not be positive assortative (but discussed forces that may emerge that lead to this pattern). Increases in female human capital distort incentives away from efficiency, and can lead to the breakdown of dowry as a marriage payment.

APPENDIX

A Supporting Results and Proofs

Lemma 1. *Let $V : \mathbb{R}^2 \to \mathbb{R}$ be a differentiable function where $V_1 > 0$, $V_2 > 0$, $V_{11} < 0$, $V_{22} \leq 0$ and $V_{12} \geq 0$. For a constant, v, let $\psi(x)$ be implicitly defined by*

$$V(x, \psi(x)) = v. \tag{43}$$

Then we have

$$\frac{V_1(x, \psi(x))}{V_2(x, \psi(x))} > \frac{V_1(x', \psi(x'))}{V_2(x', \psi(x'))} \Leftrightarrow \; V_1(x, \psi(x)) > V_1(x', \psi(x')). \tag{44}$$

Proof. Implicitly differentiating gives $\psi'(x) = -V_1/V_2 < 0$. Therefore $V_1(x, \psi(x))$ is strictly decreasing in x since $\frac{\partial}{\partial x} V_1 = V_{11} + \psi'(x) \cdot V_{12} < 0$, and $V_2(x, \psi(x))$ is non-decreasing in x since $\frac{\partial}{\partial x} V_2 = V_{12} + \psi'(x) \cdot V_{22} \geq 0$. Therefore $V_1(x, \psi(x))/V_2(x, \psi(x))$ is strictly decreasing in x. Therefore $\frac{V_1(x,\psi(x))}{V_2(x,\psi(x))} > \frac{V_1(x',\psi(x'))}{V_2(x',\psi(x'))} \Leftrightarrow \; x < x' \; \Leftrightarrow \; V_1(x, \psi(x)) > V_1(x', \psi(x'))$. □

Lemma 2. *For $k \in \{f, m\}$, if W is such that $U_k^0(W) = U_k^1(W \mid q_0)$, then $\frac{d}{dW} U_k^1(W \mid q_0) > \frac{d}{dW} U_k^0(W)$.*

Proof. Let C_0 and c_0 be the optimal family and offspring consumption (respectively) when unmarried and C_1 and c_1 be the optimal family and offspring consumption (respectively) when married. By construction we are considering a wealth such that $V(C_0, c_0) = V(C_1, c_1)$. From the first-order conditions

$$\frac{V_1(C_0, c_0)}{V_2(C_0, c_0)} = \theta_k < \tilde{\delta}_1^k = \frac{V_1(C_1, c_1)}{V_2(C_1, c_1)}, \tag{45}$$

where $\tilde{\delta}_1^f \equiv \delta_1^f$ and $\tilde{\delta}_1^m \equiv \theta_m \delta_1^m$. Therefore $V_1(C_1, c_1)/V_2(C_1, c_1) > V_1(C_0, c_0)/V_2(C_0, c_0)$. By Lemma 1, we have $V_1(C_1, c_1) > V_1(C_0, c_0)$. But $V_1(C_1, c_1) = \frac{d}{dW} U_k^1(W)$ and $V_1(C_0, c_0) = \frac{d}{dW} U_k^0(W)$ by the envelope theorem. □

Lemma 3. *Let $(\tau_f(\kappa, q), \tau_m(\kappa, q))$ satisfy (15) and (16). Then*

$$\frac{\partial \tau_f(\kappa, q)}{\partial q} = -\frac{\theta_f}{\frac{\partial q}{\partial \tau_m} - \theta_f \frac{\partial q}{\partial \tau_f}} \tag{46}$$

$$\frac{\partial \tau_m(\kappa, q)}{\partial q} = \frac{1}{\frac{\partial q}{\partial \tau_m} - \theta_f \frac{\partial q}{\partial \tau_f}} \tag{47}$$

$$\frac{\partial \tau_f(\kappa, q)}{\partial \kappa} = \frac{\theta_f \frac{\partial q}{\partial \tau_m}}{\frac{\partial q}{\partial \tau_m} - \theta_f \frac{\partial q}{\partial \tau_f}} \tag{48}$$

$$\frac{\partial \tau_m(\kappa, q)}{\partial \kappa} = -\frac{\theta_f \frac{\partial q}{\partial \tau_f}}{\frac{\partial q}{\partial \tau_m} - \theta_f \frac{\partial q}{\partial \tau_f}}. \tag{49}$$

Proof. Partially differentiate the identities (15) and (16) with respect to q and solve the resulting system of two linear equations to get (46) and (47). Partially differentiate the identities (15) and (16) with respect to κ and solve the resulting system of two linear equations to get (48) and (49). □

A.1 Interior Investments

Non-participating families always make interior transfers since $\lim_{C\to 0} V_1 = \lim_{c\to 0} V_2 = \infty$. Since $q_0^* \in [0, H]$, we have $\delta_0^k \leq 0$. This implies that optimal total transfers will be positive for participating families (otherwise their child will surely end up with negative consumption - an outcome that is worse than giving them something positive, which is affordable for all non-participators). Therefore we need only verify that the composition of bridal family transfers are interior.

To get a sense of why bridal transfers may not be interior, we consider various scenarios. First, suppose that θ_m is very large. Given that each bridal family has an optimal total transfer regardless of who they marry, and that a large θ_m requires the bride offer a large quality, it could be that the bridal family needs to allocate more than 100% of property rights to the groom (i.e. transfer a negative τ_f). Second, suppose that λ is small. This raises the quality of brides for any given transfer bundle. To lower the quality offered to the level required by the market, bridal families transfer rights to the bride and away from the groom. If λ is small enough bridal families will find that they have to offer more than 100% of property rights to the bride (i.e. a negative τ_m). This effect may be sufficiently strong that male families find it optimal to make negative net transfers to their son. Finally, if the returns to marriage are large relative to the fixed costs of another household member (α is high relative to H) then very poor families on both sides will wish to participate. For instance, male families with a wealth less than $(H - q_0^*)\theta_m$, and female families with a wealth less than $q_0^*\theta_f$ will wish to participate. Brides from these families can not offer a quality of q_0^* (since they can not transfer more than their entire wealth) without offering more than 100% of property rights to the groom (i.e. a negative τ_f).

Investments are interior for any α in the case where $H = 0$, $\theta_m = \theta_f = \lambda = 1$, and $\beta = 1/2$. In this case males and females are symmetric, so $\kappa_m^* = \kappa_f^* = \kappa^*$, and $H = 0$ implies $q_0^* = 0$. Then, we have $\tau_m = 0$ and $\tau_f = \kappa^*$. Of course, this is not a particularly interesting case given that all property rights go to the bride, but it does serve as a base case demonstrating that equilibria do exist. More concrete parameter restrictions can be derived by assuming V takes the CES form in (39) - see appendix B - but we shall not dwell on this here.

B Some Analytical Results

Let V belong to the constant elasticity of substitution family:

$$V(C, c) = \left[\phi \cdot C^{\frac{\sigma-1}{\sigma}} + (1-\phi) \cdot c^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{50}$$

where $\sigma > 0$ is the elasticity of substitution. While specialized, this specification covers linear ($\sigma \to \infty$), Cobb-Douglas ($\sigma \to 1$), and Leontief ($\sigma \to 0$) preferences. Consider the problem:

$$\max_{\kappa} \; V\left(W - \kappa, \delta_0^k + \delta_1^k \cdot \kappa\right). \tag{51}$$

Direct calculation reveals that the solution is given by $\kappa_k^*(W) = A_{0k} + A_k \cdot W$, where

$$A_{0k} \equiv \frac{\delta_0^k \cdot \left(\frac{\phi}{1-\phi} \cdot \frac{1}{\delta_1^k}\right)^\sigma}{1 + \left(\frac{\phi}{1-\phi}\right)^\sigma \cdot \left(\delta_1^k\right)^{1-\sigma}} \tag{52}$$

$$A_k \equiv \frac{1}{1 + \left(\frac{\phi}{1-\phi}\right)^\sigma \cdot \left(\delta_1^k\right)^{1-\sigma}}. \tag{53}$$

The case in which $\delta_0^k = 0$ (e.g. generated by $H = 0$) is convenient because each transfer is a fixed proportion of wealth:

$$\tau_m^*(W) = \left\{ \frac{\frac{\alpha\beta}{\Omega} \cdot \theta_m A_m - \theta_f A_f \cdot [1 - \lambda + \alpha(1-\beta)]}{\lambda\theta_f - (\theta_f - 1) \cdot [1 + \alpha(1-\beta)]} \right\} \cdot W \tag{54}$$

$$\tau_f^*(W) = \left\{ \frac{\theta_f \cdot \left[[1 + \alpha(1-\beta)] \cdot A_f - \frac{\alpha\beta}{\Omega} \cdot \theta_m A_m\right]}{\lambda\theta_f - (\theta_f - 1) \cdot [1 + \alpha(1-\beta)]} \right\} \cdot W. \tag{55}$$

This provides concrete parameter restrictions that ensure interior transfers. For instance, if $\beta = 1/2$, $\sigma = 1$ (Cobb-Douglas), and $\theta_f = 1$, then both τ_m and τ_f are non-negative if $\theta_m \in [1, 1 + \frac{2}{\alpha}]$, which holds for sufficiently small α.

Furthermore, this allows us to examine the relationship between δ_1^k and κ_k^*. Since $\delta_1^k > 1$, we have that κ_k^* is (i) increasing in δ_1^k for $\sigma > 1$, (ii) constant for $\sigma = 1$, and (iii) decreasing in δ_1^k for $\sigma \in (0,1)$. Intuitively, a higher return on investment induces a standard income and substitution effect, and investment is increased (the substitution effect dominates) if the elasticity of substitution is relatively high, and vice versa.

C A Household Public Good Version

In effect, we generate a benefit to marriage via a household production function, as in Becker (1973) and Iyigun and Walsh (2007). A common alternative is to introduce household public goods (Chen and Woolley (2001), Zhang and Chan (1999), Suen *et al.* (2003), Peters and Siow (2002)). If we were to base the benefit from marriage on the existence of a household public good, then we would need to extend standard treatments since there would be no scope for bargaining. This section outlines one possibility, where the public good exists in a range of *varieties*.

There is a private good and a household public good that exists in a range of varieties indexed by ϕ. The private good can be converted into the public good one-for-one. In an uncooperative regime only the private good is consumed: $x_f = \tau_f$ and $x_m = \tau_m + w$ as before. In the cooperative regime, the private goods are converted into the public good and the pair bargain over the variety of public good to choose. Brides prefer higher values and grooms prefer lower values. Specifically, if R units of the public good is produced, then $c_f = \frac{1+\phi}{2} \cdot R$ and $c_m = \frac{2-\phi}{2} \cdot R$. Nash bargaining implies that ϕ solves

$$\max_\phi \left[\frac{1+\phi}{2} \cdot [\tau_f + \tau_m + w] - \tau_f\right]^\beta \cdot \left[\frac{2-\phi}{2} \cdot [\tau_f + \tau_m + w] - [\tau_m + w]\right]^{1-\beta}. \tag{56}$$

This gives[31]

$$\phi^* \equiv 2 \cdot \left[\frac{3\beta - 1}{2} - \beta \cdot \frac{\tau_m + w}{\tau_f + \tau_m + w} + (1-\beta) \cdot \frac{\tau_f}{\tau_f + \tau_m + w} \right], \tag{57}$$

so that

$$c_f = \overbrace{\left(\frac{2+\beta}{2}\right) \cdot \tau_f + \left(\frac{\beta}{2}\right) \cdot \tau_m}^{Q(\tau)} + \left(\frac{\beta}{2}\right) \cdot w \tag{58}$$

$$c_m = \underbrace{\left(\frac{1-\beta}{2}\right) \cdot \tau_f + \left(\frac{3-\beta}{2}\right) \cdot \tau_m}_{q(\tau)} + \left(\frac{3-\beta}{2}\right) \cdot w. \tag{59}$$

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[31] We have $\phi^* \in [0,1]$ if and only if $\tau_f/[\tau_f + \tau_m + w] \in [(1-\beta)/2, (2-\beta)/2]$.

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