Property Rights Over Marital Transfers*

Siwan Anderson† Chris Bidner‡

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Abstract

In developing countries, the extent to which women possess property rights is shaped in large part by transfers received at the time of marriage. Focusing on dowry, we develop a simple model of the marriage market with intra-household bargaining in order to understand the incentives for brides' parents to allocate the rights over the dowry between their daughter and her groom. In doing so, we clarify and formalize the 'dual role' of dowry – as a pre-mortem bequest and as a market clearing price – identified in the literature. We use the model to shed light on the intriguing observation that, in contrast to other rights, women's rights over the dowry tend to deteriorate with development. We show how marriage payments are utilized even when they are inefficient, and how the marriage market mitigates changes in other dimensions of women's rights even to the point where women are worse off following a strengthening of such rights. We also generate predictions for when marital transfers will disappear and highlight the importance of female human capital for the welfare of women.

Keywords: dowry, gender, property rights, marriage
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†Vancouver School of Economics and CIFAR `siwan.anderson@ubc.ca`
‡School of Economics, University of New South Wales. `c.bidner@unsw.edu.au`

1 Introduction

In most societies, women historically were the property of their husbands (or fathers before marriage) with very few legal rights of their own. In the absence of extensive legal rights, transfers received at the time of marriage represented an important source of property ownership for women. This remains true in many parts of the developing world, especially in South Asia, where the *dowry*[1] remains an integral component of marriage and often represents women's only source of individual property. Yet, the fact that the dowry accompanies the bride into the groom's household makes in unclear as to whether the dowry effectively becomes the property of the bride or of the groom. Indeed, the accounts of historians, anthropologists, and sociologists (as documented in section 2) suggest that women's property rights over their dowries deteriorate in the initial stages of development.[2] This loss of property rights for women over the marriage transfer have raised great concern amongst policy makers and typically prompt legislation is designed to curb its spread. Furthermore, this shift 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), Doepke *et al.* (2012), and Duflo (2012)).

In this paper we develop a model designed to illuminate the incentives for brides' parents to allocate the property rights over the dowry between their daughter and her groom.[3] We use the model to demonstrate how prominent features of the development process, such as changes in the returns to human capital, but also strengthened economic rights of women, produce an equilibrium shift in property rights over dowry away from brides and toward grooms. This is manifested in brides' families making greater marriage payments to the groom at the expense of lower direct transfers to, or investments in, their daughters. We highlight a potential inefficiency associated with making marriage payments to the groom – simply, such payments are socially suboptimal when the return to investing in females is relatively high, yet female families have private incentives to make such payments because it makes them more attractive in the competition for grooms. We show how the presence of this inefficiency has important implications for how the development process affects welfare, and in particular, show how the inefficiency leads the welfare of women to fall following a strengthening in other dimensions of womens' rights. Furthermore, because of the inefficiency, the model also generates predictions for when dowries will disappear altogether.

Specifically, we model an economy in which parents make transfers to their children mind-

[1]Dowry payments, which are a transfer from the bride's side of the family at the time of marriage, are widespread 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. See Anderson (2007a) for an overview of the economics of dowry.

[2]In the only study that we are aware of that attempts to empirically examine this, Arunachalam and Logan (2008) provide evidence from Bangladesh over the 20**th** century that suggests that brides have lost rights over their dowry as the role of dowry has transformed from a pre-mortem bequest to daughters toward a marriage payment for grooms.

[3]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 jewelry 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)).

ful 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. 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.[4] 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 obtaining a greater share of the pie against obtaining a larger pie.

In this set up, we demonstrate how aspects of the development process can lead to less property rights for women over their marital transfers. As would be expected, increases in the economic return to investing in males leads to higher quality grooms, which requires female families to offer more in the competition for such grooms. We show how 'offering more' does not mean similarly raising the quality of brides, but rather, means offering a larger marriage payment (at the *expense* of bride quality). In this way, a rising return to investments in males translates into lower female rights over the dowry. Somewhat less intuitively, legal changes that seem to benefit women – such as those resulting in an increase in female bargaining power or in the stronger enforcement of womens' property rights – also lead to shifts in rights over the dowry toward the groom and away from the bride. Intuitively, competition for marriage partners ensures that the stronger ex-post bargaining position of women is offset by ex-ante changes in marriage market prices. While it is reasonably well-known that the marriage market can have such offsetting effects (e.g. Lundberg and Pollak (1993)), we are interested in *how* this manifests itself when female families use two instruments to compete for grooms: the offering of a higher quality bride and the offering of a larger marriage payment.[5] Furthermore, the explicit consideration of this richer description of the options available to the female family produces a new result: women can actually be made worse off following such changes in their

[4]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 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.

[5]If bridal quality were fixed (e.g. Becker (1991)), then the market would clearly require a larger up-front marriage payment following a strengthening in womens' legal rights. On the other extreme, if marriage payments are ruled out (e.g. Iyigun and Walsh (2007)), then the market would require a higher quality bride following such a change. It is therefore not ex-ante obvious which instrument will be employed following a strengthening in womens' legal rights, and therefore unclear how such changes will impact the equilibrium allocation of rights over the dowry.

legal rights because such changes encourage the use of marriage payments which are the less efficient instrument.

The model developed here clarifies and formalizes the 'dual role of dowry' identified in the literature (e.g. Botticini (1999) and Arunachalam and Logan (2008)). This literature recognizes that dowries potentially act as both a pre-mortem bequest to daughters and as a means to compete for desirable grooms in the marriage market. 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. To the best of our knowledge, ours is the first attempt to formally model the simultaneous operation of these two roles.

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 pre-mortem bequests to brides in patrilocal societies, whereas the latter two stress intra-household 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. The 'marriage payment' feature of dowry is the focus of 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 literature 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 modelling 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), which model the equilibrium division of marital output.[6] 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.

Our model also produces some additional results of interest regarding the general functioning of marriage markets. First, competition for grooms unfolds purely via the allocation of property rights over a given expenditure level. Without the capacity to allocate property rights, this competition is forced to occur via changes in expenditure. In this sense, the explicit consideration of property rights contains material consequences for the study of mar-

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

riage markets. Second, despite the competitive nature of the marriage market, inefficiencies arise because bridal families have incentives to make marriage payments to the groom even when such transfers yield a lower social return than investing in their daughter. Third, the analysis reveals the sense in which positive assortative matching on family wealth is robust, but not guaranteed, in equilibrium.

The next section serves as further motivation for our analysis by providing a historical overview of property rights over dowries and the link to development. Our basic model is introduced in Section 3 and analyzed in Section 4. We demonstrate how aspects of the development process affect property rights for women over their marital transfers in Section 5 and analyse the welfare implications in Section 6. Section 7 concludes.

2 Historical Overview

The main aim of this section is to provide a historical synopsis of property rights over dowries. We will see that far from being fixed, property rights over dowry have typically shifted from the bride to the groom during the early stages of modernization. To demonstrate this, we will trace the links between the transformation from dowries as bequests (when the bride holds property rights) into dowries as grooprices (when the groom holds property rights), in the historical record, to characteristics of the modernization process.

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 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.[7]

Dowry paying societies practice arranged marriage and are patrilocal (upon marriage the bride joins the household of her groom); 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.[8] Goody and Tambiah (1973) in particular have 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.[9]

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,

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

[8] 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.

[9] 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.

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)).[10] Reimer (1985) and Krishner (1991) discuss similar patterns of legislations across northern and central Italy 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.[11] Reher (1997) 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.[12] 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)).

This emergence of a groomprice in lieu of dowry as a bequest in the European context 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.[13] 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 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.[14] Northern and central Italy were

[10]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)).

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

[12]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)).

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

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

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)).[15] England 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. 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.

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.[16] 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.[17] 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)).[18]

The emergence of dowry as a groomprice also seems also 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 returns to human capital within each caste.[19] There is direct evidence that increased earning opportunities 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))

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

[16]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).

[17]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).

[18]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.

[19]See Singh (1987) for a survey of case studies which analyze occupational mobility within caste groups. The recent work of Deshpande (2000) and Darity and Deshpande (2000) shows that within-caste income variation is increasing in India. This notion of modernisation causing increased wealth possibilities within status groups also applies to Pakistan and Bangladesh. There too, there existed a traditional hierarchical social structure based on occupation, where group membership was inherited. 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.

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).

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.[20] 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.[21] 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 of urban India,[22] but the escalation of these groom payments lead to them being made a punishable offense by the Dowry Prohibition Act of 1980.[23] The same connection between modernisation and groomprices has been made in Bangladesh to explain their emergence post-Independence (See, for example, Kishwar and Vanita (1984), White (1992), and Rozario (1992)).

3 Model

The historical record suggests an interconnection between the two roles, 'bequest' and 'price', for dowry, and how aspects of the process of development can determine their relative salience. To theoretically explore these issues, we develop a model which incorporates both of these components of bridal marital transfers.

3.1 Fundamentals

There are N 'male' families and N 'female' families. Each family has one offspring, where male families have a son and female families have a daughter.[24] Each family is endowed with a wealth, W, that is distributed according to G_m for male families and to G_f for female families.

[20] See Lindenbaum (1981), Esteve-Volart (2003), Ambrus *et al.* (2010), and Arunachalam and Logan (2008) for investigations on dowry payments in rural Bangladesh.

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

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

[23] 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).

[24] We assume equal measures of males and females for convenience and transparency but nothing hinges on this. As will become clear, having different measures of males and females would simply change a constant in the marriage market pricing function.

Families have preferences defined over 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 $\lim_{C\to 0} V_C(C,c) = \lim_{c\to 0} V_c(C,c) = \infty$ for all $(C,c) \in \mathbb{R}^2_{++}$.

An offspring's consumption is determined by the wealth that they bring to the marriage - what we call their *quality* - as well as the quality of their marriage partner. This latter feature induces competition for marriage partners, which is mediated via a competitive marriage market in which marriage payment levels are determined. The payment is conditional on bride and groom qualities and we model the payment as a transaction between the bride's family and the groom.[25]

Each offspring's quality is endogenously determined by 'investments' made by their parents. Specifically, by forgoing $e \geq 0$ units of consumption, a gender k family can produce an offspring quality of $w_k = \theta_k \cdot e$. The parameter θ_k thus captures the "return" to investment in gender k. Given that an offspring's quality is interpreted as the "wealth" that they bring to a marriage, one can interpret θ_k in at least two ways.

First, the investment could represent a pure wealth transfer, e.g. parents give cash, jewelery, household items, and/or land to their offspring. The fact that female families must forgo one unit of wealth for each unit of wealth they give to their daughter (normalize transactions costs to zero) implies that we have $\theta_f = 1$ in this case. The case of male families is similar, except that the patrilocal norm plausibly implies $\theta_m > 1$: e.g. if the son is more productive in the use of land than are his parents, then by giving land to their son, male parents are able to transfer more than one unit of offspring consumption per unit of parental consumption.[26]

Second, the investment could represent the generation of human capital. In this case, θ_k represents the returns to human capital, which depend on the economic opportunities available to each gender. If individuals of gender k work in occupations in which output is insensitive to skill, then we would expect θ_k to be low. Conversely, θ_k is relatively high when individuals of gender k have access to labour markets offering skill-sensitive occupations. Put broadly, θ_k is increasing in the economic opportunities available to gender k.

When economic opportunity is limited for gender k workers, investing in human capital will be dominated by making pure wealth transfers. Since the transfer with the highest return is used, we have $\theta_k \geq 1$. Similarly, patrilocality and the wider economic opportunities typically afforded to males means that we would expect $\theta_m > \theta_f$. Regardless of the interpretation, offspring have (possibly imperfect) property rights over the wealth embodied in their quality.

Once determined, these qualities are taken to the marriage market. Marriage partners are selected taking as given the marriage market pricing function, t. If a male and female with qualities (w_m, w_f) are to marry, then the bride's family must pay the groom $t(w_m, w_f)$.[27] This payment is a pure wealth transfer,[28] and the resulting payment becomes the property of the

[25]While the 'true' beneficiary of a marriage payment - the groom or his parents - is unclear in patrilocal society, we use this assumption with the understanding that one could think of the payment as a transaction between the bride's parents and the groom's parents where the groom's parents pass on the payment/liability directly to their son.

[26]Another possibility is that grooms' parents are able to indirectly benefit from their transfer of wealth to their son due to their physical proximity and consumption spillovers.

[27]This amount can be negative - in which case the groom pays a positive amount to the bride's family - although much of the analysis to follow will focus on the case where $t \geq 0$.

[28]For instance, since human capital investments are made early in life, it is not feasible for the bride's family to invest

groom. In light of our original motivation, we view the parental investment in bride quality, w_f, as the "bequest" component of dowry and the marriage payment, t, as the "price" component. We are therefore interested in understanding how various features of the economic environment promote one component relative to the other.

The consumption enjoyed by an offspring depends on all the forms of wealth brought into their marriage, but is more sensitive to the wealth that they hold property rights over. That is, consumption for offspring of gender k is given by $c_k(w_f, w_m+t)$, where c_k is increasing in both arguments. Furthermore, in order for property rights to matter we need c_f to be more sensitive to w_f than to $w_m + t$, whereas the reverse is true for c_m. To make this as clear as possible, we utilize a structure (explained below) in which c_k is linear:

$$c_k = a_k \cdot w_f + b_k \cdot \left[w_m + t(w_f, w_m)\right], \tag{1}$$

where $0 < a_m < b_m$, and $0 < b_f < a_f$.[29]

In terms of structure, 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 allocation of property rights. Specifically, for females we have

$$x_f = \lambda \cdot w_f,$$

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

$$x_m = (1-\lambda)\cdot w_f + w_m + t(w_f, w_m).$$ [30]

In the unproductive regime, total household resources available for consumption is therefore $R = x_f + x_m = w_f + w_m + t$.

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

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

where $\beta \in [0,1]$ parameterizes the bargaining power of women.[31] The solution is easily verified to accord with (1), where $a_f \equiv \lambda + \alpha\beta$, $b_f \equiv \alpha\beta$, $a_m \equiv 1-\lambda+\alpha(1-\beta)$, and $b_m \equiv 1+\alpha(1-\beta)$.

in the human capital of her groom by the time the pair meet. This however may provide a partial rationale for arranged child marriage.

[29] Peters and Siow (2002) also assume consumption is linear (with $t = 0$), although the coefficients are equal because only a public good is consumed.

[30] We could have also allowed for the possibility that males have imperfectly effective rights over their property by including a parameter analagous to λ for males. This possibility is less plausible and less interesting given our focus on women's rights, and therefore we opted to abstract from it for notational clarity.

[31] 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'

That is

$$c_m(w_f, w_m) = [1-\lambda+\alpha(1-\beta)]\cdot w_f + [1+\alpha(1-\beta)]\cdot\{w_m + t(w_f, w_m)\} \tag{2}$$

$$c_f(w_f, w_m) = [\lambda+\alpha\beta]\cdot w_f + [\alpha\beta]\cdot\{w_m + t(w_f, w_m)\}. \tag{3}$$

Intuitively, females benefit from their quality, w_f, and their parents' marriage payment to the groom, $t(w_f, w_m)$, but more so from the former. Similarly, males benefit both from their bride's quality and the marriage payment received from the bride's family, but more so from the latter. Female families can therefore attract higher quality grooms by offering both a higher marriage payment and a higher quality daughter.

Given $t(w_f, w_m)$, parental consumption levels are given by

$$C_m(W, w_f, w_m) = W - w_m/\theta_m \tag{4}$$

$$C_f(W, w_f, w_m) = W - t(w_f, w_m) - w_f/\theta_f. \tag{5}$$

Families that participate in the marriage market take the marriage payment function $t(w_f, w_m)$ as given and choose the characteristics of their offspring as well as the characteristics of the partner that they wish to marry. The problem for a gender k family is therefore

$$\max_{w_f, w_m} V\left(C_k(W, w_f, w_m), c_k(w_f, w_m)\right), \tag{6}$$

subject to $w_f, w_m \geq 0$,[32] where $C_k(W, w_f, w_m)$ and $c_k(w_f, w_m)$ are given by equations (2)-(5). Let the maximized value associated with this problem be denoted $U_k^1(W)$.

A family's strategy consists of a participation decision and a choice of marriage characteristics. If a family of gender $k \in \{m, f\}$ does not participate in the marriage market, then by investing $e \geq 0$ in their offspring, their offspring can consume $w_k = \theta_k \cdot e$ and they face the problem

$$\max_{w_k} V\left(W - \frac{1}{\theta_k}\cdot w_k, w_k\right) \tag{7}$$

subject to $w_k \geq 0$. Let the maximized value of V be denoted $U_k^0(W)$.

A family's strategy is *optimal* with respect to $t(w_f, w_m)$ if (i) participation occurs if and only if $U_k^1(W) \geq U_k^0(W)$, and (ii) the marriage characteristics solve the associated optimization problem; (6) for participating families and (7) for non-participating families. In competitive marriage markets (Rosen (1974), Peters and Siow (2002)), the marriage payment function, $t(w_f, w_m)$, is *market clearing* if the measure of participating female families choosing $(w_f, w_m) \in A$ equals the measure of participating male families choosing $(w_f, w_m) \in A$, for all $A \subseteq \mathbb{R}_+^2$. An equilibrium is a marriage payment function and family strategies such that the strategies are optimal given the marriage payment function and the marriage payment function is market clearing.

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.

[32] There is also implicitly a constraint that the marriage payment, t, not be so negative that the groom has negative property: $w_m + t \geq 0$. This is automatically satisfied when $t \geq 0$, a case that we focus on. Similarly, there are also constraints specifying that families do not spend more than their wealth. This is equivalent to $C_f, C_m \geq 0$, and will be always be satisfied by our assumptions on V.

4 Analysis

4.1 Deriving the Pricing Function

We begin by deriving the marriage market pricing function. To do so, we suppose that no constraint binds for any family and then verify that this must be the case in equilibrium.

Proposition 1. *For some constant, φ_0, the marriage payment function is*

$$t(w_f, w_m) = \varphi_0 + \varphi_m \cdot w_m + \varphi_f \cdot w_f \tag{8}$$

where φ_f and φ_m are constants defined below in equations (9) and (11) respectively.

The formal proof is in the appendix, but we now provide an intuition that will aid in understanding later results.

Starting with male families, from (4), we see that parental consumption $C_m(w_f, w_m)$ does not depend on w_f. As such, a male family chooses w_f to maximize their son's consumption c_m. The essential trade-off facing male families is that higher values of w_f raise consumption to the extent that such brides bring greater wealth to the marriage, but lower consumption to the extent that such brides are not required to pay as high a marriage payment. A male family's optimal choice of w_f balances this trade-off. Since female families will generally supply positive finite values of w_f, it must be that males' optimal choices of w_f are interior in equilibrium if the marriage market is to clear. If the optimal choice is interior, then the first-order condition must hold. That is, given (1), if t is an equilibrium marriage price function, then it must be that

$$\frac{d\,t(w_f, w_m)}{d\,w_f} = \varphi_f \equiv -\frac{a_m}{b_m} \tag{9}$$

at all (w_f, w_m) chosen in equilibrium. To be sure, if the slope were more negative then all males would demand the lowest possible bride quality, and if the slope were less negative then all males would prefer the highest possible bride quality. A consequence of this is that, for some function τ, it must be that the equilibrium marriage market payment function is expressed as

$$t(w_f, w_m) = \tau(w_m) + \varphi_f \cdot w_f.$$

We now turn to female families. Using (1) and (5), and given the above, the rate at which female families are able to convert parental consumption into offspring consumption via investment in bride quality is fully determined. That is, marginally raising quality, w_f, involves lowers parental consumption, C_f, at the rate of $\frac{1}{\theta_f} + \varphi_f$ but raises offspring consumption, c_f, at the rate of $a_f + b_f \varphi_f$. Thus, C_f can be converted to c_f at the rate of

$$\delta_f \equiv \frac{a_f + b_f \varphi_f}{\frac{1}{\theta_f} + \varphi_f}. \tag{10}$$

In an analogous way to males, the rate that C_f can be converted to c_f by choosing a higher quality groom, depends on $\tau(w_m)$ and is determined as follows. Marginally raising w_m involves lowering C_f at the rate of $\tau'(w_m)$ but raises c_f at the rate of $b_f \cdot (1 + \tau'(w_m))$. Thus, female families can transform C_f into c_f at the rate of $b_f \cdot (1 + \tau'(w_m))/\tau'(w_m)$. In order for a female family to optimally choose some positive finite male quality (as they must in equilibrium to clear the marriage market), this return must coincide with δ_f.[33] Thus, $\tau'(w_m)$ must satisfy

$$\frac{b_f \cdot (1+\tau'(w_m))}{\tau'(w_m)} = \frac{a_f + b_f \varphi_f}{\frac{1}{\theta_f} + \varphi_f}$$

at all w_m that are chosen by males. If this did not hold, then it would be profitable for female families to reallocate a given total expenditure across w_f and w_m. Re-arranging the above indicates that the derivative of τ is a constant:

$$\tau'(w_m) = \varphi_m \equiv \frac{\frac{1}{\theta_f} - \frac{a_m}{b_m}}{\frac{a_f}{b_f} - \frac{1}{\theta_f}}. \tag{11}$$

Proposition 1 follows since (9) and (11) indicate that the derivative of t with respect to each variable is a constant.

The linearity of t admits a convenient interpretation, as φ_m is the "price" of male quality (to be paid to the groom from the female family) and φ_f is the "price" of female quality. As expected, we have $\varphi_f < 0$: female families make a lower net marriage payment to the groom when delivering a higher quality bride. Since there is a net cost of $(1/\theta_f) + \varphi_f$ to deliver each unit of female quality, it follows that an interior solution to the female families' problem requires that $1/\theta_f > -\varphi_f$. Specifically, we make the following assumption.

Assumption 1. *The return to female investment is not too much greater than unity:*

$$\theta_f < \frac{b_m}{a_m} = 1 + \frac{\lambda}{1+\lambda+\alpha \cdot (1-\beta)}. \tag{12}$$

If this did not hold, then female families would want to invest as much as possible in the quality of their daughter. It is straightforward to verify that the price of male quality is positive – i.e. higher quality grooms attract a higher payment – if and only if (12) holds. This condition will play an important role in analysis to follow. [34]

The value of φ_0 is a constant that acts like a fixed cost of entering the marriage market. Females benefit from lower values and males benefit from higher values. The value of φ_0 must

[33] If $b_f \cdot (1+\tau'(w_m))/\tau'(w_m) > \delta_f$, then the female family would prefer a higher quality groom, and if $b_f \cdot (1 + \tau'(w_m))/\tau'(w_m) < \delta_f$ they would prefer a lower groom quality.

[34] It is perhaps useful to clarify at this point why it is the *female* return that matters. In attempting to raise the consumption of their daughter, a bride's parents have two options; they can invest in their daughter's quality or they can offer a larger marriage payment to prospective grooms. Given that each unit of marriage payment adds one unit to the resources available to the married couple yet each unit invested in their daughter's quality adds θ_f units, the return to investing in their daughter will have important implications for efficiency. Furthermore, the relative attractiveness of the two available options will naturally depend on the return to investing in their daughter. This trade-off could be mitigated to a large extent if post-marriage transfers between the bride and her natal family were costless: for instance, the bride's family makes the marriage payment up front and the bride repays her parents at a later date once the investments in her quality start yielding income. In this case, brides are effectively able to make marriage payments by drawing from the income derived from their quality. However, patrilocal norms imply that the ties between the bride and her natal family are greatly weakened following her marriage, making such a possibility prohibitively costly. On the other hand, patrilocal norms imply that such post-marriage transfers are relatively costless for grooms. As such, even if grooms were required to pay a positive marriage payment in equilibrium, they are effectively able to do so by drawing on the wealth generated by their quality. This, along with our focus on the empirically relevant case where grooms are recipients of marriage payments, means that male families do not face the 'offspring quality versus marriage payment' trade-off in the way that female families do.

be such that the aggregate measure of participating families is the same across the genders. There will, in general, be a range of values that will ensure this. This range will always cover zero since marriage is productive (via α), and will converge on zero as the lowest wealth on each side goes to zero. Thus, in what follows, we set $\varphi_0 = 0$ for simplicity (since it is a constant, it would not change the results if we were to select any other suitable value). We elaborate on this further in the Appendix.

4.2 Total Expenditures

In deriving the equilibrium marriage payment function, $t(w_m, w_f)$, we saw that prices adjust so that: male families are indifferent to reallocations across w_f for a given w_m; and female families are indifferent to reallocations across w_f and w_m for a given expenditure. In what follows, we will see that the implication of this is that family payoffs only depend on their total expenditure in equilibrium.

We can use (8) in (2) to write the equilibrium consumption level for males as:

$$c_m = \left[b_m(1+\varphi_m)\right] \cdot w_m.$$

Since $w_m = \theta_m \cdot E_m$, where E_m is the total expenditure of a male family, this can be expressed as

$$c_m = \delta_m \cdot E_m, \tag{13}$$

where δ_m is the rate at which male families can transform parental consumption into offspring consumption:[35]

$$\delta_m \equiv \theta_m \cdot b_m(1+\varphi_m). \tag{14}$$

Note that $\delta_m > 0$ since $\varphi_m > -1$.

Similarly, we can use (8) in (3) to write the equilibrium consumption level for females as a function of total female expenditure, E_f, only. Noting that $E_f = \frac{1}{\theta_f} \cdot w_f + t(w_m, w_f)$, we have

$$c_f = \delta_f \cdot E_f, \tag{15}$$

where δ_f is the rate at which female families can transform parental consumption into offspring consumption as defined in (10). Note that $\delta_f > 0$ if and only if (12) holds.

From (13) and (15) we see that, in equilibrium, marriage market prices adjust so that each family only cares about their total expenditure. That is, in order for the marriage market to clear, it must be that grooms find that the added benefit of having a higher quality bride is exactly offset by the added cost of receiving a lower marriage payment. Similarly, female families find that if they were to reallocate a given total expenditure toward a higher marriage payment at the expense of delivering a lower quality bride, then the added benefit of the higher quality groom is exactly offset by the added cost of having a lower quality bride.

Given (13) and (15), the 'reduced-form' problem facing gender k families is:

$$\max_{E_k} V(W - E_k, \delta_k \cdot E_k). \tag{16}$$

The assumptions on V and the fact that $\delta_k > 0$ under condition (12) implies that the solution is well-defined and characterized by the first-order condition $V_C / V_c = \delta_k$.

[35] That is, male families can convert one unit of parental consumption into θ_m units of w_m which translates into $\theta_m b_m(1+\varphi_m)$ units of offspring consumption.

4.3 Allocation of Female Expenditure

While the first-order condition $V_C/V_c = \delta_f$ pins down the optimal total expenditure of the female family, it does not specify the allocation of this expenditure across investments in the quality of their daughter and marriage market payments. To address this, we turn to the marriage market clearing condition. From (16), we see that, in equilibrium, marriage market prices are such that families care only about their total expenditure, E_k. Specifically, t adjusts so that each side is indifferent to who they end up marrying in equilibrium. We can therefore clear the marriage market by proposing any measure preserving function from the set of participating females to the set of participating males.[36] If a female family is to marry a groom with the characteristic w_m, then the equilibrium allocation of their optimal total expenditure between marriage payment and transfer to their daughter, (t^*, w_f^*), are those values that simultaneously satisfy two conditions. The first is that the marriage payment equals that demanded by the market: i.e. $t^* = t(w_f^*, w_m)$, or

$$t^* = \varphi_m \cdot w_m + \varphi_f \cdot w_f^*.$$

This relationship, referred to as the *iso-payment curve* is plotted as the relatively flat line in Figure 1. The second condition is that the total expenditure equals the family's optimal total expenditure: i.e. $\frac{1}{\theta_f} \cdot w_f^* + t^* = E_f^*$, or

$$t^* = E_f^* - \frac{1}{\theta_f} \cdot w_f^*,$$

where E_f^* solves (16). This relationship, referred to as the *iso-expenditure curve* is plotted as the relatively steep line in Figure 1. The equilibrium allocation of a female family's total expenditure is indicated by the intersection of the iso-payment and iso-expenditure curves, as depicted in Figure 1. Alternatively, simple algebra gives

$$t^* = \left[\frac{\varphi_m}{1 + \theta_f \cdot \varphi_f}\right] \cdot w_m + \left[\frac{\theta_f \cdot \varphi_f}{1 + \theta_f \cdot \varphi_f}\right] \cdot E_f^* \tag{17}$$

$$w_f^* = \left[\frac{\theta_f}{1 + \theta_f \cdot \varphi_f}\right] \cdot E_f^* - \left[\frac{\varphi_m \cdot \theta_f}{1 + \theta_f \cdot \varphi_f}\right] \cdot w_m. \tag{18}$$

Figure 1 can also be used to understand the inefficiencies involved with using marriage payments. For any given (t, w_f), the total resources transferred to the couple is $R_f = t + w_f$. We can therefore identify an *iso-transfer curve* described by $t = R_f - w_f$, as depicted as the dashed line in Figure 2. Since this curve is steeper than the iso-expenditure curve when $\theta_f > 1$, we have that more resources are transferred from a given expenditure when that expenditure is allocated more heavily toward w_f. Formally, since $t = E_f - (1/\theta_f) \cdot w_f$ (from the iso-expenditure relationship) we have $R_f = E_f + \frac{\theta_f - 1}{\theta_f} \cdot w_f$. That is, more is transferred from a fixed expenditure when that expenditure involves a relatively large allocation toward w_f (when $\theta_f > 1$).

If female families transfer more resources in total from a given expenditure when they allocate that expenditure more heavily toward w_f, then why do female families not allocate all of their expenditure to w_f? Simply, because they have an incentive to employ the less efficient transfer method in order to secure better grooms.

[36] Having participating males and females matched in an arbitrary way may not always work however, since 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 characteristics, then so too will the assortative matching (but not vice versa). We elaborate on this below.

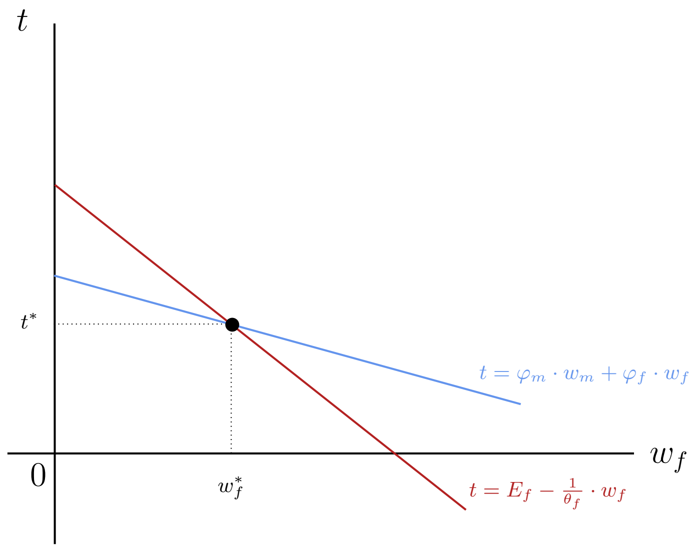

Figure 1: The Equilibrium Composition of Dowry

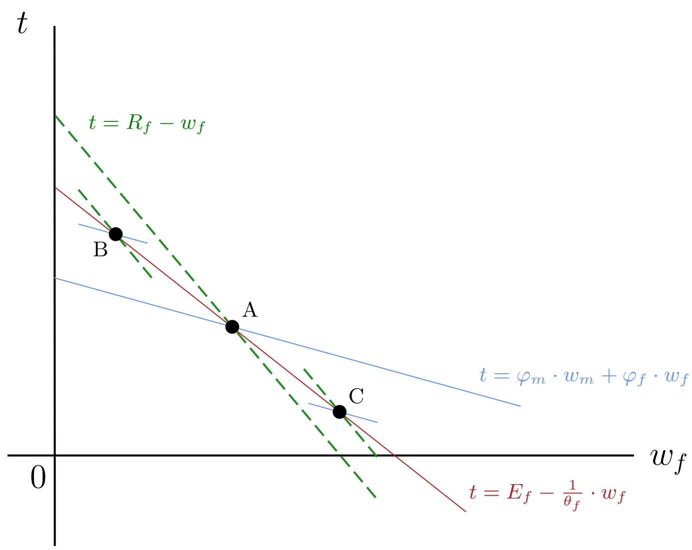

Figure 2: Marriage payments and (in)efficiency

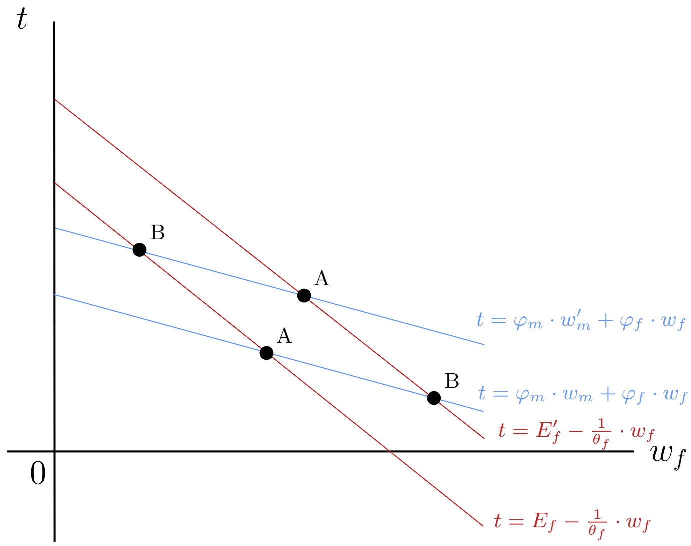

Figure 3: Intuition for Positive Assortative Matching

4.4 Matching patterns

We now turn to how males and females are matched in the marriage market. It has been demonstrated that families only care about their total expenditure in equilibrium. Conditional on this total, they are indifferent as to whom they marry. We can not automatically conclude from this that any one-to-one matching will clear the marriage market, since we have not verified that optimal choices will be interior in arbitrary matches. For instance, if a very wealthy groom were to marry a very poor bride then the required marriage payment may well be too large (i.e. the implied choice of w_f is negative).

Positive assortative matching, whereby the groom from the wealthiest male family marries the bride from the wealthiest female family and so on,[37] does the best job at ensuring interior solutions. To give an 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 together and the poor families married together, and a non-assortative matching would have marriages containing one rich and one poor family. Figure 3 shows the pair of equilibrium expenditure compositions under each of these matchings. The points marked B are the compositions that arise in the non-assortive matching and the points marked A are those that arise in the assortative matching. If the B points lie in a given rectangle, then so too will the A points. The reverse is clearly not true. In short, positive assortative matching limits the extent to which these 'lop-sided' marriages arise.

[37]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.

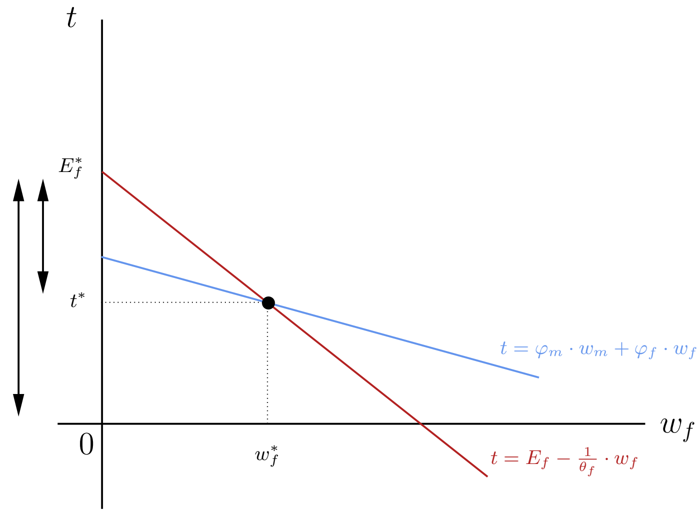

Figure 4: Measure of Female Property Rights

4.5 Measuring Property Rights over Dowry

In order to quantify the extent to which brides hold rights over their dowry, we analyze the proportion of total female family expenditure that is allocated to investments in the quality of their daughter. To derive this, we first note that from (18) the equilibrium investment in female quality, w_f^*/θ_f, is

$$w_f^*/\theta_f = \left[\frac{1}{1+\theta_f \cdot \varphi_f}\right] \cdot E_f^* - \left[\frac{\varphi_m}{1+\theta_f \cdot \varphi_f}\right] \cdot w_m.$$

This, along with the fact that $w_m = \theta_m \cdot E_m^*$, allows us to find an expression for the proportion of total female family expenditure that is allocated to female bequests:

$$\pi(E_f^*, E_m^*) \equiv \frac{w_f^*/\theta_f}{E_f} = \frac{1 - \varphi_m \cdot \theta_m \cdot \frac{E_m^*}{E_f^*}}{1 + \varphi_f \cdot \theta_f}. \tag{19}$$

This quantity will serve as our measure of female rights over dowry. Figure 4 provides a graphical intuition for this measure – since the iso-expenditure curve intersects the vertical axis at the total expenditure, and the expenditure on the bequest component is what is left after expenditure on marriage payments, our measure of female property rights captures the ratio of $E_f^* - t^*$ to E_f^* and therefore the ratio of the shorter vertical arrow to the longer vertical arrow.

We see that π depends on (E_f^*, E_m^*) which are endogenous variables. From (16) we see that such values will be determined by family wealth levels (W_m, W_f) as well as the value of the equilibrium returns (δ_m, δ_f). The effect of δ_k on E_k^* will be ambiguous in general because of standard income and substitution effects.[38] Given this, we focus on how the various parameters affect π for fixed values of (E_m^*, E_f^*).

[38]For instance, E_k^* is independent of δ_k if V is Cobb-Douglas. More generally, if V is CES :

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

where $\sigma > 0$ is the elasticity of substitution and $\nu \in (0,1)$ captures parental altruism toward their offspring, then since $\delta_k > 1$ (when (12) holds) we have that E_k is decreasing in δ_k if $\sigma < 1$ and is increasing in δ_k if $\sigma > 1$.

5 The Development Process and Marital Property Rights

Section 2 documents how, far from being fixed, property rights over dowry have typically shifted from the bride to the groom during the early stages of modernization. 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 the return to male and female characteristics.[39]

5.1 Declining Women's Rights over Dowry

5.1.1 Male Return

We will see in this section that an increase in the male return, θ_m, lowers bridal property rights over their dowry. The return to directly investing in male quality, θ_m, plays no role in the pricing of characteristics in the marriage market (as is apparent from (9) and (11)), nor does if affect female families' total expenditure decision (as is apparent from (16) and (10)). As such, θ_m does not affect the equilibrium behavior of female households conditional on the quality of their groom. However, increases in the return to male investment provides the incentive for all male families to raise the quality of grooms.

Lemma 1. *An increase in θ_m increases w_m^* for all male families.*

As such, a higher θ_m requires that all female families make a greater marriage payment. Furthermore, the fact that their total expenditure is unchanged implies that this greater marriage payment comes at the expense of female quality. It is clear that brides must offer more when grooms become of a higher quality, but it is not clear whether this will be achieved via a higher total expenditure or via a shift in the composition of a given total expenditure toward marriage payments and away from quality (or some combination of the two). This result indicates that brides offer more in the marriage market *purely* by raising transfers to the groom at the expense of investments in bride quality. This is in contrast to the case when 'property rights' are ignored, whereby competition in the marriage market forces greater total marital expenditure on behalf of bridal parents.

The effect of θ_m is illustrated in Figure 5, where $w_m < w'_m$. The initial equilibrium allocation occurs at point A and then shifts 'northwest' to point B. Thus, we see that bridal families compete for the more desirable grooms by reallocating a fixed total expenditure away from investments in the quality of their daughter and toward marriage payments to their groom. Without the transfer dimension, brides would be forced to compete via greater total expenditures, and in this way, this result highlights a qualitative difference between this model and models without marriage market payments.

Bringing all this together gives us the following.

Proposition 2. *An increase in the male return, θ_m, lowers bridal property rights over their dowry (as measured by π). This is brought about by brides making a larger marriage payment, for a higher quality groom, with no change in their total expenditure.*

[39] Given that we are looking at a measure of property rights, (19), that holds expenditure levels constant, changes in the wealth levels of parents, W, would not affect things.

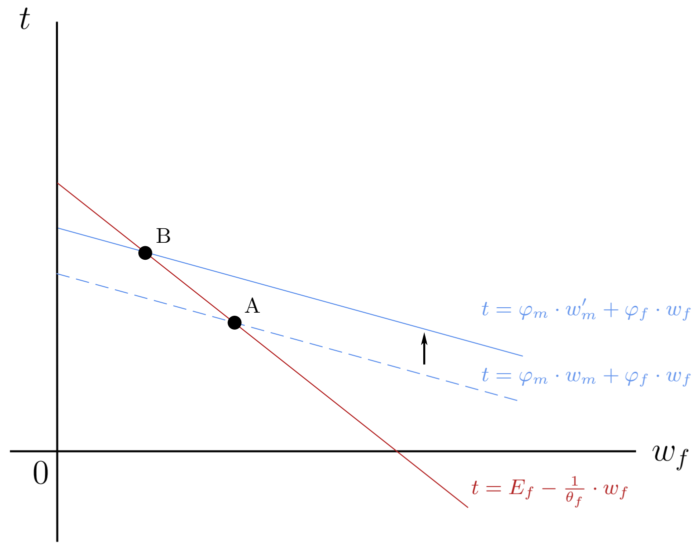

Figure 5: The Effect of Male Productivity, θ_m

5.1.2 Economic Rights of Women

This section examines how equilibrium transfers are affected by the strength of women's economic rights as captured in the parameters λ and β. Somewhat counter-intuitively, we demonstrate that increases in either of these parameters leads to a decrease in bridal property rights over their dowry.

Formal female property rights Consider first an increase in λ. A higher λ means that women have greater effective rights over the wealth embodied in their quality.

Lemma 2. *An increase in λ increases φ_f. If $\theta_f > 1$, then an increase in λ also increases φ_m.*

To get the intuition for this, consider the case where $\theta_f = 1$. From the perspective of male families, a higher λ implies a lower marginal benefit of bridal quality, but no change to the marginal benefit of the marriage payment. That is, w_f becomes less attractive relative to t. If marriage market prices did not change, all male families would demand the lowest possible female quality (since males are now more willing to trade off a larger marriage payment for a lower quality bride). In order for grooms to become willing to demand higher quality brides, and thereby to clear the marriage market, the price of the female characteristic must increase (i.e. the marriage payment 'discount' for the female characteristic is reduced). Basically, the fall in the amount that a groom can expropriate from his wife's property is offset by a larger marriage payment - he is granted de jure rights over property for which he previously only held de facto rights.

There is a secondary effect when the marriage payment is inefficient (i.e. when $\theta_f > 1$), but the effect works in the same direction. Refer to the Appendix for further details. The effect of λ in the case where $\theta_f = 1$ is shown in Figure 6. If $\theta_f > 1$, then the flatter line would also have a higher intercept, exaggerating the effect.

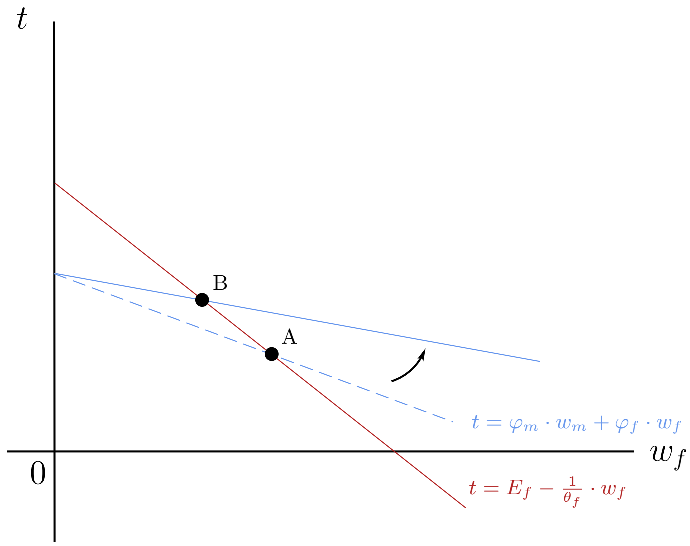

Figure 6: The Effect of λ

Proposition 3. *An increase in the effectiveness of female formal rights over their property, λ, leads to a decrease in property rights over their dowry (as measured by π). This is brought about by an increase in the marriage market price of characteristics.*

Female Bargaining Power We now turn to the effect of β. An increase in β means that females are able to obtain a larger fraction of the surplus generated from marriage. For males, an increase in β lowers the marginal benefit to both t and w_f, but more so for the latter since males possess property rights over the former. Thus for males, a higher β makes t more attractive relative to w_f. If marriage market prices did not adjust, then this implies that males would all strictly prefer the lowest quality females (since they are now more willing to trade-off off a lower w_f for a higher t). The price of female characteristics (received by males) must therefore increase in order for males to demand higher quality brides and thereby to restore equilibrium in the marriage market.

For females, a greater bargaining power raises the marginal benefit of both $w_m + t$ and w_f, but more so for the former since they already enjoy property rights over the latter. Thus for females, a higher β makes w_m more attractive relative to w_f. Without a change in marriage market prices, this would imply that all females would demand the highest quality male (since they are more willing to sacrifice w_f to get more w_m). The price of male characteristic (paid by females) must increase in order for females to demand lower quality grooms and thereby restore equilibrium in the marriage market.

Lemma 3. *An increase in β increases φ_f and φ_m.*

The effect of β is shown in Figure 7. We see that an increase in β raises the price of both male and female characteristics so that brides end up allocating a greater share of their expenditure to the marriage payment. Intuitively, a larger β means that grooms are less able to obtain consumption via the ex-post division of surplus, which in turn requires them to obtain consumption via the ex-ante allocation of property rights.

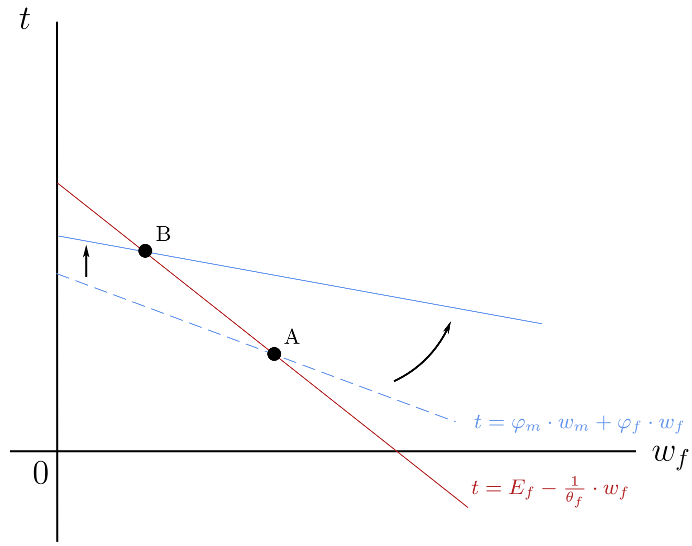

Figure 7: The Effect of β

Proposition 4. *An increase in the bargaining power of women, β, leads to a decrease in property rights over their dowry (as measured by π). This is brought about by an increase in the marriage market prices of characteristics.*

A conclusion from this section is that the marriage market tends to 'undo' gains from the strengthened economic rights of women. This feature in line with Lundberg and Pollak (1993) who conjecture that changes in the bargaining environment (for example, a policy change which gives mothers the rights over government child transfers) will be partially undone by adjustments in the marriage market. Here we are interested in *how* the gain is undone: a compositional change in the total dowry expenditure 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 a stronger command over a given set of marital resources relative to their husbands we expect to see dowry transfers containing less property for wives relative to husbands.

Given that gains in women's legal rights (λ,β) are, at best, undone by the marriage market, what about gains in the female return, θ_f? It will be demonstrated in the next section that gains along this dimension have a positive effect and do promote women's rights over their dowry.

5.2 Female Return and the Disappearance of Marriage Payments

In the early stages of development, where female labour market opportunities are greatly limited, we conceive of female 'quality' as being composed of a pure wealth transfer and $\theta_f = 1$. As labour force opportunities arise for women, the return to investing in female capital increases, and 'quality' is composed of a stock of human capital and $\theta_f > 1$. In the model, investment in female human capital forms a legitimate part of the dowry's bequest component, although in reality it is not usually conceptualized in such terms. If human capital is ignored as a component of dowry, then the induced shift away from a wealth transfer to a human capital investment would see marriage payments become a very large proportion of the dowry (indeed, if all of the investment in quality is via human capital, as it is in the model when $\theta_f > 1$, then it would *appear* as if the dowry were composed purely of the marriage payment).

We now explore how property rights over dowry are affected by increases in the female return. To do so, we interpret $\theta_f > 1$ as the return to female human capital and conceive of the female 'quality' as arising from their human capital. To begin, we note a sense in which investment in female human capital rises as θ_f rises.

Lemma 4. *For a given E_f and (φ_f, φ_m), bride quality w_f is weakly increasing in θ_f. The relationship is strict if $w_f^* > 0$.*

The effects of the return of the female investment are more subtle than those associated with male return. Specifically, unlike the male return, θ_m, the female return, θ_f, changes the price of characteristics in the marriage market. Specifically, from (10) we see that an increase in θ_f raises the return associated with investing in w_f: simply, a higher productivity means that more w_f can be produced from a given input level. If there were no changes in marriage market prices, then all female families would find it strictly preferable to invest in w_f - as such, they all demand the lowest possible groom quality. In order for the marriage market to clear, the price of grooms must fall.

Lemma 5. *An increase in θ_f decreases φ_m but has no effect on φ_f.*

There is no effect on the price of bride quality since this price is set so that males are indifferent between brides (and this trade-off is independent of θ_f). Thus, an increase in θ_f, has two effects on dowry property rights: there is a direct effect whereby a given expenditure is reallocated toward bridal bequests and away from marriage payments, and an indirect effect arising from the fact that male characteristics become less expensive. Bring this all together gives the following.

Proposition 5. *An increase in θ_f raises the equilibrium property rights over dowry (as measured by π). This is brought about in part by a shift in the allocation of female family expenditure toward investment in the quality of their daughter, and in part by a lower price of male characteristics.*

As the female return continues to rise, marriage payments eventually become negative (i.e. the groom pays the bride's family). The are two reasons for this. First, the price of male quality falls. This means that a given groom commands less of a marriage payment. Second, the net marginal cost of producing female quality, $(1/\theta_f) + \varphi_f$, goes to zero.[40] This encourages female families to produce brides of increasingly high quality, which commands an increasingly high marriage payment.

This process of increasingly large (negative) marriage payments and increasing large female quality levels is limited by the constraint that the groom can not make a marriage payment so large that they end up with negative property: i.e. we require $w_m + t(w_f, w_m) \geq 0$.[41] Equi-

[40] The analogous effect does not arise for male families. This is because they do not get the marriage payment - their son does.

[41] In addition, it is reasonable to suppose that female families are credit constrained in the sense that the have a limited capacity to fund investment in their daughter by borrowing against the marriage payment that she will later receive. If such borrowing were ruled out, then we would require $(1/\theta_f) \cdot w_f \leq W_f$.

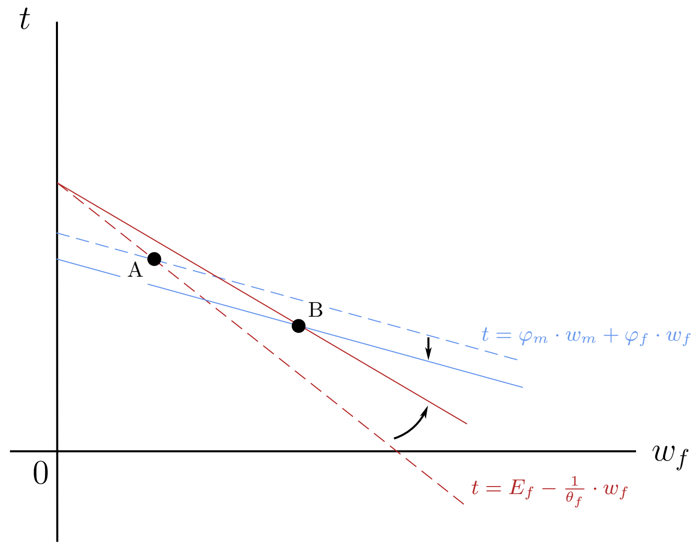

Figure 8: The Effects of θ_f

librium with marriage payments as described here ceases to exist once this constraint starts binding: grooms will be constrained to choose wives with relatively low qualities leading to an excess demand for relatively low quality brides and an excess supply of relatively high quality brides. We leave a full characterization of equilibria in this case, specifically whether marriage payments survive, to future work. Nevertheless, we can say something about the breakdown of marriage payments once θ_f becomes large enough that (12) is violated. Once this occurs, both sides prefer that the female family allocates a unit of expenditure to human capital investment rather than to a marriage payment. That is, the marriage payment becomes so inefficient relative to the human capital investment that the groom obtains more consumption from the additional female human capital via bargaining than they would if they had received the female family's expenditure directly as a marriage payment. Marriage payments cease to exist because they are dominated by investment in quality, and *not* because θ_f becomes large relative to θ_m - it is the absolute value of θ_f that determines efficiency. In the absence of marriage payments, each side competes by investing in their offspring's quality as in Peters and Siow (2002).

This prediction for the disappearance of marriage payments is in line with Becker's 1991 model, where dowries may cease when they become an inferior way of providing brides with future wealth relative to investing in daughters' human capital. Evidence for this conjecture is provided by Goody (2000), who documents how dowry tended to disappear first among the urban workers of northwestern Europe where it was replaced by the aim, already existing in poorer classes, of providing children with education and training. A similar phenomenon affected the middle classes by the end of the nineteenth century.[42]

[42] Other economists have emphasized alternative aspects of the modernization process to explain the disappearance of marriage payments. In the Botticini and Siow (2003) framework, dowry payments disappear when the development process leads male children to become less likely to work and live with their parents. Anderson (2003) attributes the decline and disappearance of dowry to the breakdown in inherited status and endogamous matching.

6 Welfare Implications

We now turn to the welfare implications from changes in our key parameters of interest: the returns of male and female quality, θ_m and θ_f; and the economic rights of women, as captured by λ and β.

The reduced-form problems facing families, given by (16), makes clear that the effect of parameters on equilibrium welfare is completely captured by the effect of parameters on δ_k. As such, it is useful to first consider the key determinants of δ_k.

If a family of gender k forgoes one unit of parental consumption and invests directly in their offspring, then an extra θ_k units of offspring quality are produced. Given that marriage is productive, this delivers a total of

$$\delta_k^* \equiv (1+\alpha)\cdot\theta_k \tag{20}$$

extra units of consumption for the married couple to allocate among themselves. Thus, this is what the return to expenditure would be if families were able to fully expropriate the value of their investment. One may anticipate that the equilibrium return would be lower than this because of ex-post bargaining, but this would ignore the competitive nature of the marriage market. That is, any ex-post bargaining is anticipated in the marriage market and is 'undone' by ex-ante transfers – here, marriage payments. This standard competitive logic would suggest that each family is the full residual claimant after providing the market-determined consumption of their offspring's spouse and therefore the marginal return should coincide with δ_k^*. Despite all families being price takers, this logic does *not* hold in general. The reason is that ex-ante transfers are not costless (i.e. utility is not perfectly transferable) when $\theta_f > 1$: in order for a female family to effectively transfer utility from their daughter to her groom, they have to utilize the relatively inefficient marriage payment.[43] The following result relates the equilibrium return on expenditure to the 'full expropriation' benchmark.

Proposition 6. *If $\theta_f = 1$, then $\delta_f = \delta_f^*$ and $\delta_m = \delta_m^*$. If $\theta_f > 1$, then $\delta_f > \delta_f^*$ and $\delta_m < \delta_m^*$.*

To get at the intuition for this, consider a particular bride and groom, receiving their respective equilibrium consumption levels. The return on expenditure experienced by the female family, δ_f, is the additional consumption that the bride will receive given a one unit increase in female family expenditure. By raising investment in the bride's quality, the groom's payoff is increased. This is because the additional bride quality generates an additional marriage surplus (since $\alpha > 0$), part of which is obtained by the groom via bargaining. The competitive logic tells us that the bride need only provide the groom with his original equilibrium consumption level, and therefore this groom will have to transfer consumption to the bride ex-ante (in the marriage market). This is achieved by accepting a lower marriage payment from the bride, and having the saved marriage payment be invested in bride quality. If $\theta_f = 1$, then each unit of marriage payment saved is converted into one unit of bride quality, and therefore every unit of consumption forgone by the groom allows the bride to consume one unit. Overall then, the

[43]Transfer frictions are not problematic per se - indeed Peters and Siow (2002) use the competitive logic to show how premarital investments are efficient when utility is perfectly non-transferable. The key difference is that families in their model, as in Iyigun and Walsh (2007), do not have the option to make marriage payments and therefore the incentive to use the inefficient instrument does not arise.

bride is able to raise her consumption by exactly the additional social surplus generated by the additional investment. But, if $\theta_f > 1$, then each unit of marriage payment saved is converted into *more* than one unit of bride quality, and therefore every unit of consumption forgone by the groom allows the bride to consume *more* than one unit. Overall then, the bride is able to raise her consumption by *more* than the additional social surplus generated by the additional investment. This is because the process of transferring consumption from groom to bride reduces the use of the inefficient instrument, thereby generating additional social surplus (which too is enjoyed by the bride).

Similarly, the return on expenditure experienced by the male family, δ_m, is the additional consumption that the groom will receive given a one unit increase in male family expenditure. This additional expenditure generates a higher groom quality, which makes the bride better off because of their capacity to bargain over the additional marital surplus so generated. To extract this surplus ex-ante, the groom receives a larger marriage payment from the bride at the expense of bride quality. Again, if $\theta_f = 1$ then each unit reduction in bride quality is converted into one unit of marriage payment, and therefore every unit of consumption forgone by the bride allows the groom to consume one unit. Overall, the groom is able ot raise his consumption by exactly the additional social surplus generated by the additional investment. If $\theta_f > 1$, then each unit reduction in bride quality can be converted into *less* than one unit of marriage payment, and therefore every unit of consumption forgone by the bride allows the groom to consume *less* than one unit. Overall, the groom is able to raise his consumption by *less* than the additional social surplus generated. This is because the required transfer of consumption from bride to groom entails a greater use of the inefficient instrument and therefore entails a social loss (which is borne by the groom).

Given this background, we now examine how the parameters affect δ_k and therefore welfare.

Womens' Legal Rights We first consider the parameters λ and β. These parameters are purely *distributional* in that they only affect the allocation of household resources (conditional on (E_f, E_m)). If consumption can be costlessly transferred between the bride and groom ex-ante, then these parameters will have no effect on welfare.

Corollary 1. *If $\theta_f = 1$, then welfare is unaffected by λ and β.*

This follows from proposition 6 since, from (20), δ_k^* does not depend on λ or β. Welfare is not affected because families are able to make costless ex-ante transfers to compensate for changes in ex-post bargaining conditions. For instance, a higher λ reduces the level of resources that grooms have de facto rights over and this is undone by brides offering greater marriage payments (with associated de facto rights). Similarly, a higher β reduces the consumption that grooms can indirectly obtain from the quality of their bride, which requires the bride to offer a greater marriage payment (and associated de facto rights) up front to compensate. Consumption levels, and therefore welfare, are completely unaffected. On the other hand, when ex-ante consumption transfers are costly, the returns on expenditure no longer coincide with their 'full expropriation' counterparts.

Proposition 7. *If $\theta_f > 1$, then an increase in λ (i) lowers the welfare of female families, and (ii) increases the welfare of male families.*

This result is somewhat striking: a reduction in the extent to which males have effective command over the formal property of women makes women worse off and men better off. One would arrive at precisely the opposite conclusion if one ignored the endogenous determination of marriage payments - e.g. by ruling out such side payments (Peters and Siow (2002)), by treating the marriage market payments as exogenous to quality investment decisions (Zhang and Chan (1999)), or by abstracting from the marriage market altogether (Chen and Woolley (2001), Suen *et al.* (2003)).

To get the intuition for part (i), consider the consequences of a female family raising their expenditure by one unit. In order to extract the additional surplus experienced by her groom, her family makes a lower marriage payment and a larger investment in her quality. If λ is relatively high, then her groom benefits relatively little from her additional quality. As such, the reduction in marriage payment required to keep the groom indifferent is relatively low. A relatively small reduction in the marriage payment entails a relatively small efficiency gain, and therefore the return on female expenditure, δ_f, is relatively small when λ is relatively large.

For part (ii), consider the consequences of a male family raising their expenditure by one unit. In order to extract the additional surplus experienced by his bride, his family receives a larger marriage payment at the expense of a reduction in the bride's quality. If λ is relatively high, then his bride places a relatively large value on bride quality, and as such, the increase in marriage payment required to keep her indifferent is relatively low. A relatively small increase in the marriage payment entails a relatively small efficiency loss, and therefore the return on male expenditure, δ_m, is relatively large when λ is relatively large.

A similar theme arises when we consider the effect of womens' bargaining power, β, but the mechanism is somewhat different - indeed, the effect on males is reversed.

Proposition 8. *If $\theta_f > 1$, then an increase in β (i) lowers the welfare of female families, and (ii) lowers the welfare of male families.*

The first part of this result - that women are worse off following a shift in bargaining power from men to women - is also striking, for similar reasons to those discussed above. To get the intuition for part (i), consider a female family that raises their expenditure by one unit. When β is relatively high, the groom is able to secure relatively little of the additional surplus generated. As such, a relatively small reduction in the marriage payment is required in order to return the groom to their original consumption level. The relatively small reduction in the marriage payment implies a relatively small efficiency gain, and therefore a relatively small return on expenditure for female families.

The second part the result - that men are worse off following a shift in bargaining power from men to women - seems intuitive on the surface: men consume less when they are weaker bargainers. Given the above discussion, it is not surprising that this basic intuition is incorrect. Rather, to get the intuition for part (ii) consider a male family that raises their expenditure by one unit. When β is relatively high, the bride is able to secure a relatively large share of the additional surplus generated. As such, a relatively large increase in the marriage payment is required in order to return the bride to their original consumption level. The relatively large increase in the marriage payment implies a relatively large efficiency loss, and therefore a relatively small return on expenditure for male families.

To summarize the effect of womens' legal rights, propositions 3 and 4 indicate that stronger legal rights for women are 'undone' in the marriage market insofar as brides lose property rights over dowry to grooms. Propositions 6, 7, and 8 together indicate that such changes, at best, have no effect the welfare of women, and can actually lower their welfare. The latter possibility arises when the marriage payment is inefficient relative to investment in quality. As such, these effects can not arise if one ignored the possibility that such payments are socially costly - e.g. by taking bride and groom qualities as exogenous (Becker (1991)), or by assuming the perfect enforceability of agreements struck between brides and grooms in the marriage market regarding the future distribution of household resources (Iyigun and Walsh (2007)).

Male Return We now consider the effect of male and returns on welfare. We begin with the male return, where we find that a rising male return does not 'spill over' to the welfare of women.

Proposition 9. *An increase in θ_m (i) raises the welfare of male families and (ii) has no effect on the welfare of female families.*

It is unsurprising that a higher male return raises the welfare of males, although it is interesting to note that the increase in δ_m is *less* than the increase in δ_m^* when $\theta_f > 1$. Intuitively, an increase in the male return raises male quality and this induces a greater use of the (inefficient) marriage payment relative to the female quality investment. The fact that women are no better off following an increase in θ_m is a direct consequence of the competitive logic: male families are able to extract ex-ante any additional surplus that would have otherwise accrued to the bride.

Female Return At this point, the welfare of women has been, at best, unaffected by the parameters reflecting economic development. We now turn to the effect of rising female returns, and show that women are indeed made better off as the female return increases.

Proposition 10. *An increase in θ_f (i) raises the welfare of female families and (ii) lowers the welfare of male families.*

Again, it is unsurprising that a higher female return raises the welfare of females, although it is interesting to note that the increase in δ_f is *more* than the increase in δ_f^* when $\theta_f > 1$. Intuitively, a greater female return encourages investment in female quality and discourages the use of the inefficient marriage payment. The added efficiency gains also accrue to the female families, and therefore there is a strong sense in which females benefit when their return increases.

Interestingly, males not only fail to receive any positive benefit from increases in the female return, they are in fact made worse off. This is because increases in male expenditure induce ever greater efficiency losses as the female return increases, and thus δ_m falls even further below δ_m^*.

7 Conclusions

We have constructed a simple equilibrium model of the marriage market with intra-household bargaining in order to help understand the ways in which female property rights over marital transfers can shift. 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 quality. By contrast, an increase in the return to directly investing in female quality would result in a larger proportion of the marital transfer directly in the hands of daughters. We show that if, with development, bequests take the form of human capital (which is similarly used by parents to attract a desirable marriage market for their children), then increasing the returns to female human capital could lead to the disappearance of marriage payments altogether. These key predictions of the model are in accord with the historical record of dowry payments and concur with laws aimed at abolishing the practice of marriage payments to grooms in lieu of bequests to daughters.

Recent research has focused on the positive correlation between development and the economic rights of women (Geddes and Lueck (2002), Doepke and Tertilt (2009), Fernández (2010), Doepke *et al.* (2012), and Duflo (2012)), and understanding this relationship is a high priority for policy-makers (World Bank (2011)). From a welfare perspective, our model demonstrates that, due to inefficiencies in the marriage market, the positive effects for females from directly increasing their economic rights are dampened by incorporating these marriage market consequences. By contrast, increases in the direct returns to female quality improve the welfare of women and these effects are in fact magnified by the marriage market. Interestingly, increasing the returns to male quality do not undermine the welfare of women. These implications highlight the importance of promoting the direct economic returns for women over legal or customary rights in determining welfare.

A Supporting Results and Proofs

A.1 Proofs

Proof of Proposition 1

Proof. The first-order conditions for the general problem stated in (6) are:

$$V_C \cdot \frac{dC_k}{dw_f} + V_c \cdot \frac{dc_k}{dw_f} = 0 \tag{21}$$

$$V_C \cdot \frac{dC_k}{dw_m} + V_c \cdot \frac{dc_k}{dw_m} = 0. \tag{22}$$

For the males' version of the problem, (4) gives us that $\frac{dC_m}{dw_f} = 0$, which, along with $V_c > 0$, implies that (21) becomes

$$\frac{dc_m}{dw_f} = 0. \tag{23}$$

From the males' version of (1), this pins down

$$\frac{dt}{dw_f} = -\frac{a_m}{b_m} \equiv \varphi_f. \tag{24}$$

For the females' version, conditions (21) and (22) give

$$-\frac{V_C}{V_c} = \frac{\frac{dc_f}{dw_f}}{\frac{dC_f}{dw_f}} = \frac{\frac{dc_f}{dw_m}}{\frac{dC_f}{dw_m}}. \tag{25}$$

From the females' version of (1), the final equality gives

$$\frac{b_f\left(1+\frac{dt}{dw_m}\right)}{\frac{dt}{dw_m}} = \frac{a_f + b_f \cdot \frac{dt}{dw_f}}{\frac{1}{\theta_f} + \frac{dt}{dw_f}}, \tag{26}$$

which, along with (24), gives

$$\frac{dt}{dw_m} = \frac{\frac{1}{\theta_f} - \frac{a_m}{b_m}}{\frac{a_f}{b_f} - \frac{1}{\theta_f}} \equiv \varphi_m. \tag{27}$$

The fact that dt/dw_f and dt/dw_m are constants implies that t must be of the linear form indicated in the proposition. □

To aid in the following proofs, note that φ_f and φ_m can be written in terms of underlying parameters as follows:

$$\varphi_m \equiv \frac{\frac{1}{\theta_f} - \frac{a_m}{b_m}}{\frac{a_f}{b_f} - \frac{1}{\theta_f}} = \frac{\alpha\beta\left[\theta_f\lambda - (\theta_f - 1)(1+\alpha(1-\beta))\right]}{(1+\alpha(1-\beta))(\theta_f\lambda + (\theta_f - 1)\alpha\beta)} \tag{28}$$

$$\varphi_f \equiv -\frac{a_m}{b_m} = -\frac{1-\lambda+\alpha(1-\beta)}{1+\alpha(1-\beta)}. \tag{29}$$

Proof of Lemma 1

Proof. Since $E_m = w_m/\theta_m$, the first-order condition for a male family's optimal choice of w_m is

$$\frac{V_C\left(W - \frac{w_m^*}{\theta_m}, \delta_m \cdot \frac{w_m^*}{\theta_m}\right)}{V_c\left(W - \frac{w_m^*}{\theta_m}, \delta_m \cdot \frac{w_m^*}{\theta_m}\right)} = \delta_m. \tag{30}$$

Since $V_{CC}, V_{cc} < 0$ and $V_{Cc} \geq 0$, the left side is increasing in w_m. From (14) we see that δ_m/θ_m is independent of θ_m, and since $V_{CC} < 0$ and $V_{Cc} \geq 0$, the left side is decreasing in θ_m whereas, from (14), the right side is increasing in θ_m. It follows (implicit function theorem) that w_m^* is increasing in θ_m. □

Proof of Proposition 2

Proof. From (28) and (29) it is apparent that marriage market prices are independent of θ_m. Then, from (19) we see that π is decreasing in θ_m. The fact that grooms are of a higher quality comes from Lemma 1. The fact that θ_m does not affect total female expenditure comes from (16) and the fact that δ_f is independent of θ_m (as is apparent from (10) or (39)). □

Proof of Lemma 2

Proof. From (29), it is clear that φ_f is increasing in λ. From (28) we get

$$\frac{d\varphi_m}{d\lambda} = \frac{\alpha(1+\alpha)\beta\theta_f\left(\theta_f - 1\right)}{(1+\alpha(1-\beta))\left(\alpha\beta\left(\theta_f - 1\right) + \theta_f\lambda\right)^2}, \tag{31}$$

which has the same sign as $(\theta_f - 1)$. □

Proof of Proposition 3

Proof. It is clear from (19) that (i) π depends on λ only through the effect on φ_f and φ_m, and (ii) that π is decreasing in φ_f and φ_m. The result then follows from this and lemma 2. □

Proof of Lemma 3

Proof. From (29), we get

$$\frac{d\varphi_f}{d\beta} = \frac{\alpha\lambda}{(1+\alpha(1-\beta))^2} > 0. \tag{32}$$

From (28) we get

$$\frac{d\varphi_m}{d\beta} = \frac{\alpha(1+\alpha)\theta_f\lambda\left\{1 - \alpha(1-2\beta)\left(\theta_f - 1\right) - \theta_f(1-\lambda)\right\}}{(1+\alpha(1-\beta))^2\left(\alpha\beta\left(\theta_f - 1\right) + \theta_f\lambda\right)^2}. \tag{33}$$

The sign of this equals the sign of the term in braces. But

$$1 - \alpha(1-2\beta)\left(\theta_f - 1\right) - \theta_f(1-\lambda) \geq 1 - \alpha(1-\beta)\left(\theta_f - 1\right) - \theta_f(1-\lambda) \tag{34}$$

$$\geq \frac{2\lambda^2}{1+\alpha(1-\beta)+\lambda} > 0, \tag{35}$$

where the first inequality follows from the fact that the left side of (34) is increasing in β, and the second inequality comes from the fact that the right side of (34) is decreasing in θ_f along with the upper bound on θ_f imposed by assumption 1. □

Proof of Proposition 4

Proof. It is clear from (19) that (i) π depends on β only through the effect on φ_f and φ_m, and (ii) that π is decreasing in φ_f and φ_m. The result then follows from this and lemma 3. $\square$

Proof of Lemma 4

Proof. From (18), we have

$$w_f^* = \left[\frac{\theta_f}{1+\theta_f\cdot\varphi_f}\right]\cdot\left[E_f^* - \varphi_m\cdot w_m\right]. \tag{36}$$

Since the first bracketed term is positive (by assumption 1), the fact that $\varphi_f < 0$ implies that the first term is clearly increasing in θ_f. The fact that $w_f^* \geq 0$ (and the fact that the first bracketed term is positive) implies that the second bracketed term is non-negative. Thus, w_f^* is weakly increasing in θ_f for fixed E_f and (φ_f, φ_m). When $w_f^* > 0$, the second bracketed term is positive and the relationship is strict. $\square$

Proof of Lemma 5

Proof. From (29), it is clear that $d\varphi_f/d\theta_f = 0$. From (28) we have

$$\frac{d\varphi_m}{d\theta_f} = -\frac{\alpha(1+\alpha)\beta\lambda}{(1+\alpha(1-\beta))\left(\alpha\beta\left(\theta_f-1\right)+\theta_f\lambda\right)^2} < 0. \tag{37}$$

$\square$

Proof of Proposition 5

Proof. From (19), the total effect of θ_f on π is

$$\frac{d\pi}{d\theta_f} = \frac{\partial\pi}{\partial\theta_f} + \frac{\partial\pi}{\partial\varphi_m}\cdot\frac{d\varphi_m}{d\theta_f} + \frac{\partial\pi}{\partial\varphi_f}\cdot\frac{d\varphi_f}{d\theta_f}. \tag{38}$$

It is clear from (19) that $\frac{\partial\pi}{\partial\theta_f} > 0$ (since $\varphi_f < 0$), $\frac{\partial\pi}{\partial\varphi_m} < 0$, and $\frac{\partial\pi}{\partial\varphi_f} < 0$. From lemma 5, $\frac{d\varphi_f}{d\theta_f} = 0$, and $\frac{d\varphi_m}{d\theta_f} < 0$. It then follows that $\frac{d\pi}{d\theta_f} > 0$. $\square$

Welfare Results From the reduced form problem facing families, (6), we have that for $z \in \{\theta_m, \theta_f, \lambda, \beta\}$ we have $d/dz\{U_k^1(W)\} = V_c \cdot E_k \cdot d/dz\{\delta_k\}$ by the envelope theorem. Since $V_c, E_k > 0$ we have that the sign of $d/dz\{U^1(W)\}$ is the same as the sign of $d/dz\{\delta_k\}$. We can use (10) and (14) to produce values of δ_f and δ_m expressed in terms of primitives in order to simplify the proofs to follow:

$$\delta_f = \left[\frac{\lambda}{\lambda\theta_f - (\theta_f - 1)\cdot[1+\alpha(1-\beta)]}\right]\cdot(1+\alpha)\theta_f \tag{39}$$

$$\delta_m = \left[\frac{\theta_f\lambda}{\theta_f\lambda + \alpha\beta\left(\theta_f - 1\right)}\right]\cdot(1+\alpha)\theta_m. \tag{40}$$

Proof of Proposition 6

Proof. Note that δ_f/δ_f^* equals the bracketed term in (39) and that δ_m/δ_m^* equals the bracketed term in (40). When $\theta_k = 1$ the bracketed terms in (39) and (40) equal one, implying $\delta_k = \delta_k^*$ as claimed. The bracketed term in (39) is clearly increasing in θ_f, and the bracketed term in (40) is clearly decreasing in θ_f. Therefore $\theta_f > 1$ implies $\delta_f/\delta_f^* > 1$ and $\delta_m/\delta_m^* < 1$. □

Proof of Corollary 1

Proof. From proposition 6, $\theta_f = 1$ implies $\delta_k = \delta_k^*$, and from (20) δ_k^* is independent of λ and β. □

Proof of Proposition 7

Proof. From (39) we have

$$\frac{d\delta_f}{d\lambda} = -\frac{(1+\alpha)(1+\alpha(1-\beta))\theta_f}{\left(1-\alpha(1-\beta)\left(\theta_f-1\right)-\theta_f(1-\lambda)\right)^2}\cdot\left(\theta_f-1\right), \tag{41}$$

which is negative when $\theta_f > 1$. Similarly, from (40) we have

$$\frac{d\delta_m}{d\lambda} = \frac{\alpha(1+\alpha)\beta\theta_f\theta_m}{\left(\alpha\beta\left(\theta_f-1\right)+\theta_f\lambda\right)^2}\cdot\left(\theta_f-1\right), \tag{42}$$

which is positive when $\theta_f > 1$. □

Proof of Proposition 8

Proof. From (39) we have

$$\frac{d\delta_f}{d\beta} = -\frac{\alpha(1+\alpha)\theta_f\lambda}{\left(1-\alpha(1-\beta)\left(\theta_f-1\right)-\theta_f(1-\lambda)\right)^2}\cdot\left(\theta_f-1\right), \tag{43}$$

which is negative when $\theta_f > 1$. Similarly, from (40) we have

$$\frac{d\delta_m}{d\beta} = -\frac{\alpha(1+\alpha)\theta_f\theta_m\lambda}{\left(\alpha\beta\left(\theta_f-1\right)+\theta_f\lambda\right)^2}\cdot\left(\theta_f-1\right), \tag{44}$$

which is also negative when $\theta_f > 1$. □

Proof of Proposition 9

Proof. It is clear from (40) that $d\delta_m/d\theta_m > 0$, and clear from (39) that $d\delta_f/d\theta_m = 0$. □

Proof of Proposition 10

Proof. (i) Differentiate δ_f given by (39) with respect to θ_f, noting that it is positive. (ii) Differentiate δ_m given by (40) with respect to θ_f, noting that it is negative. □

Proof. From (39) we have

$$\frac{d\delta_f}{d\theta_f} = \frac{(1+\alpha)(1+\alpha(1-\beta))\lambda}{\left(1-\alpha(1-\beta)\left(\theta_f-1\right)-\theta_f(1-\lambda)\right)^2} > 0. \tag{45}$$

Similarly, from (40) we have

$$\frac{d\delta_m}{d\theta_f} = -\frac{\alpha(1+\alpha)\beta\theta_m\lambda}{\left(\alpha\beta\left(\theta_f-1\right)+\theta_f\lambda\right)^2} < 0. \tag{46}$$

□

A.2 Determining φ_0

We can use (8) in (2) to write the equilibrium consumption level for males as:

$$c_m = [b_m\varphi_0] + [b_m(1+\varphi_m)] \cdot w_m.$$

Since $w_m = \theta_m \cdot E_m$, where E_m is the total expenditure of a male family, this can be expressed as

$$c_m = [b_m\varphi_0] + \delta_m \cdot E_m, \tag{47}$$

where $\delta_m \equiv \theta_m \cdot b_m(1+\varphi_m)$ is the rate at which male families can transform parental consumption into offspring consumption. Given (47), the 'reduced-form' problem facing male families is:

$$\max_{E_m} V\left(W - E_m, \delta_m \cdot E_m + [b_m\varphi_0]\right).$$

Since $\delta_m > \theta_m$, this problem has a higher maximum value than that applying to a non-participating family when $\varphi_0 = 0$. It follows then that all male families participate when $\varphi_0 = 0$ (and for lower values too, depending on the lowest wealth). The analogous argument applies for female families - all prefer to participate when $\varphi_0 = 0$ (and for higher values too, depending on the lowest wealth).

The value of φ_0 is the marriage payment made when both the bride and groom have zero transfers, and can be thought of as a fixed cost associated with entering the marriage market. Aggregate marriage market clearing determines the equilibrium value(s) of φ_0. Specifically, note that all participating male families have an equilibrium payoff that is increasing in φ_0, whereas the opposite is true for participating female families. If $S^k(\varphi_0)$ denotes the supply of participating gender k families at φ_0, then an equilibrium value of t_0 satisfies $S^f(\varphi_0^*) = S^m(\varphi_0^*)$. Since marriage (via α) is productive, all N families on each side of the marriage market prefer participation to non-participation at $\varphi_0 = 0$. This can be seen by noting that $\delta_m > \theta_f$ and $\delta_f > \theta_f$ and comparing the problems of participating and non-participating families. Thus, there exists values $(\underline{\varphi}_0, \bar{\varphi}_0)$, where $\underline{\varphi}_0 < 0 < \bar{\varphi}_0$, such that all female families prefer participation for all $\varphi_0 \leq \bar{\varphi}_0$ and all male families prefer participation for all $\varphi_0 \geq \underline{\varphi}_0$.[44] Therefore, there are multiple equilibrium values of φ_0 since the aggregate supply of males and females coincide (at N) for any $\varphi_0 \in [\underline{\varphi}_0, \bar{\varphi}_0]$. We resolve this multiplicity in a simple way by fixing $\varphi_0 = 0$. This is convenient because we can ensure that $\varphi_0 = 0$ will always clear the market (regardless of parameter values or wealth distributions).[45]

[44]That is, $\bar{\varphi}_0$ is the value of φ_0 that makes the poorest female family indifferent to participating, and $\underline{\varphi}_0$ is the value of φ_0 that makes the poorest male family indifferent to participating.

[45]A unique equilibrium value will exist if the measure of males and females differed (either $\underline{\varphi}_0$ or $\bar{\varphi}_0$ depending on which side was longer). We want to avoid having our results rely on relative numbers in the marriage market, so we do not pursue this approach. From another perspective, the interval $[\underline{\varphi}_0, \bar{\varphi}_0]$ collapses to zero as the lowest wealth level on each side of the market goes to zero. In any case, since φ_0 is a constant, nothing would qualitatively change if we were to select any other admissible value.

A.3 Additional Effect of An Increase in λ

Lemma 2 indicated that there is a secondary effect of an increase in λ when the marriage payment is inefficient (i.e. when $\theta_f > 1$): the price of the male characteristic also increases. To get an intuition for this, note that if a female family were to increase their total expenditure by one unit, then they can reallocate some of the expenditure away from t in order to keep the groom indifferent. But, the amount of reallocation that is required is lower when λ is higher because of the fact that males are less willing to trade off a higher w_f for a lower t. The fact that there is less of a reallocation required means that there is less of an efficiency gain associated from an increase in E_f, and, as such, the 'excess' return enjoyed by female families is lowered. But if the return to human capital expenditure is lowered, then in the absence of changes in marriage market prices, all female families become more willing to trade off a lower w_f for a higher quality groom. As such, all female families end up demanding the highest quality grooms. In order to induce females to choose lower quality males, thereby restoring equilibrium in the marriage market, the price of the male characteristic must increase.

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