PROPERTY RIGHTS OVER MARITAL TRANSFERS*

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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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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 it 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 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 such a shift. In short, total available marital resources would increase if marriage payments were instead invested in daughters, yet contracting fric-

[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)).

tions within marriage make brides offering marriage payments particularly attractive partners. As such, bridal families have private incentives to make the socially inefficient transfer because it boosts their prospects in the marriage market. The presence of this inefficiency has important implications for how the development process affects welfare. In particular, 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 mindful of the fact that such transfers will shape their child's marriage market prospects. 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 of contracting frictions: it is prohibitively costly to enforce deals forged in the marriage market regarding the division of future household resources. Instead, once marriages are formed in the marriage market, married couples leave the market and bargain over the total available marital resources. 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] Property rights are thus valuable because they influence how much can be consumed in the event of a break-down in household bargaining, and therefore raise a party's outside option. The essential trade-off facing bridal families is that allocating 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.[5]

[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. Some empirical evidence demonstrates how legal changes that improve the individual property rights of women can enhance their relative bargaining position within the household (Combs (2006)). 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]Of course, in reality this is not the only motivation for bridal families to pay dowries. Another is to provide a form of insurance, especially for the bride as she has the right to sell it without the consent of her husband and to keep it in the case of his death. Similarly, the allocation of property rights over dowry may be subject to constraints imposed by social norms. We abstract from the issues of risk and social norms, but note that the roles played by these forces are

In this set up, we demonstrate how aspects of the development process can reduce 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, in equilibrium, 'offering more' does not mean investing more and raising the quality of brides. Instead it 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) and **?**), 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.[6] 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 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 key modeling challenge lies in analyzing the equilibrium outcomes of a marriage market in which participants have endogenous multi-dimensional characteristics in a manner that is sufficiently tractable to permit clear comparative statics.

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 bargain-

potentially also shaped by the development process.

[6] 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.

ing. 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.[7] 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 are generally difficult to enforce. This inability to write perfect contracts over the future division of marital surplus in the marriage market is an important point of contrast with related work since it is at the core of the inefficiency that we identify.

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 marriage 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 - a possible explanation for inefficiently low investment in female human capital. Third, whilst a wide

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

range of matching patterns are supported in equilibrium, we show how positive assortative matching on family wealth is the most robust in terms of satisfying the constraints facing families.

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 groomprices (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.[8]

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.[9] 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.[10]

[8]See Anderson (2007a) for a survey of the prevalence of dowries. Marriage payments in the other direction, from the grooms' family to the brides', in the form of a brideprice or dower, are prevalent throughout Africa and the Islamic world respectively. Classical China also required the neogotiation of a brideprice for the validity of marriage and these transfers continue to be the norm in many rural areas today.

[9]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.

[10]Studies have also emphasized the similarity between the amounts of dowry given to daughters and inheritances

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 "groom-price", consists of wealth transferred directly to the groom and his parents from the bride's parents, with the bride having no ownership rights over the payment. There are numerous historical instances where dowry as bequests appear to have been superseded by groom-prices. 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)).[11] 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.[12] 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. Dowries shaped around a cash base were the norm in the thirteenth century in Siena, thirteenth and fourteenth centuries in Genoa, fourteenth and fifteenth centuries in Toulouse, and fifteenth century in Provence (Hughes (1985)). 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.

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

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.

[11] 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)).

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

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

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 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.

These periods of economic expansion, which correlate with the emergence of groomprices in lieu of dowries as bequests in historical Europe, correspond most directly to increased economic opportunities for men. There was no concurrent wave of new employment opportunities for women. It was a time, however, when women's formal property rights were improving. There is significant notarial evidence of women buying and selling property and lending and borrowing money (Reimer (1985), Weickhardt (1996)). During this period, throughout the Mediterranean countries of Western Europe and Russia, women could conduct their own legal and economic affairs, they were no longer subject to the guardianship of their fathers and husbands. Likewise, the property ownership rights of widows became more secure during this time (Hughes (1985)). Thus, the effective loss of property rights for women over their dowries occurred alongside other legal rights improving. Early feminists involved in the debates regarding the equality of women, attacked the dowry system and specifically objected to husbands' control over the funds (Goody (2000) and Cox (1995)).

There is no evidence suggesting a return transformation from groomprices back into dowries as bequests in later periods. The eventual disappearance of dowries all together in historical

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

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

Europe corresponds with increased independent earnings potential for women. Investing directly in daughters human capital began to replace dowries during the industrialization period of the 18th and 19th centuries (Goody (2000)). In societies less directly affected by modernization, such as remote communities in southern Italy, Portugal, and Greece, dowry remained pervasive into the 20th century (Lambri-Dimaki (1985)).

In contemporary times, India represents the most dramatic example of a transformation of dowries as bequests to groomprices. 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, a man's caste (status group) innately determined his 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 male 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)) 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

[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.

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 males of 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)).

There is no sign of abatement in these soaring groomprices in South Asia and the political outcry against this dowry "evil" has prevailed in the media over the last decade. As in the historical case, this loss of property rights for women over thier dowries has coincided with improvements in formal property rights. Recent work by Roy (2013) empirically examines the effects of state-level variation in amendments to the Hindu Succession Act of India which alloted equal inheritance rights to sons and daughters in some states before others. She demonstrates, using individual-level data, that women who resided in states with improved female inheritance rights, subsequently made higher dowry payments to their husbands.

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.

[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).

Contributing factors include the return to male and female human captial as well as the legal economics rights of women. To theoretically explore these issues, we develop a model which incorporates all of these components in the determination of female property rights over their 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.

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 is a transaction between the bride's family and the groom.

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 $w_k = \theta_k \cdot e$.[25] 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,[26] 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

[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.

[25] Thus, there is one-dimensional heterogeneity among offspring in the marriage market. One straightforward way to incorporate multidimensional characteristics would be to view w_k as an index of many different characteristics and have families solve a two-stage problem of choosing the optimal w_k and then choosing the least costly mix of characteristics to deliver w_k.

[26] This 'wealth' can be interpreted broadly and may reflect both earning capacity in the labor market and productivity in home production.

transfer more than one unit of offspring consumption per unit of parental consumption.[27]

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 $t(w_m, w_f)$.[28] This payment is a pure wealth transfer,[29] and the resulting payment becomes the property of the 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, if we let $z_f \equiv w_f$ and $z_m \equiv w_m + t$ be the formal property of brides and grooms, then consumption for offspring of gender k is given by $c_k(z_f, z_m)$, 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 z_f than to z_m, whereas the reverse is true for c_m. To make this as clear as possible,

[27] 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.

[28] 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 $t \geq 0$. We discuss how this specification introduces a gender asymmetry in section 3.4 below.

[29] We effectively normalize the return to the marriage payment to unity so that θ_k is interpreted as the relative return to investing in gender k. The assumption that $\theta_m, \theta_f \geq 1$ reflects the idea that, since human capital investments are made early in life, it is not feasible for the bride's family to invest in the human capital of her groom by the time the pair meet. However, if one wanted to consider such a possibility then we would set $\theta_m = 1$ and $\theta_f \in (0, 1]$. Doing so would only raise the importance of marriage payments, and would only change the nature of the inefficiency we identify. Specifically, inefficiency would arise because female families would still have incentives to invest in their daughter (which would be inefficient relative to the marriage payment).

we utilize a structure (explained below) in which c_k is linear:

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

where $0 < a_m < b_m$, and $0 < b_f < a_f$.[30]

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

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

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

$$x_m = (1-\lambda) \cdot z_f + z_m = (1-\lambda) \cdot w_f + w_m + t(w_f, w_m).$$[31]

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.[32] Consumption levels in the productive regime, (c_f, c_m), are determined by generalized Nash bargaining - that is, they solve

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

where $\beta \in [0,1]$ parameterizes the bargaining power of women.[33] The solution is easily veri-

[30]We consider a general non-linear consumption function in the online appendix and show how our qualitative results remain. Peters and Siow (2002) also assume consumption is linear (with $t = 0$), although the coefficients are equal because only a public good is consumed.

[31]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.

[32]Note that this specification assumes that parents do not make additional transfers in the event that their offspring's marriage turns unproductive, or that such additional transfers are non-credible.

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

fied 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 $b_m \equiv 1+\alpha(1-\beta)$. 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.[34]

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

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

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

Thus the payoff for a family of gender k with wealth W that participates in the marriage market can be summarized by

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

where $C_k(W, w_f, w_m)$ and $c_k(w_f, w_m)$ are given by equations (2)-(5). If a family of gender k does not participate in the marriage market, then by investing $e \geq 0$ in their offspring, their offspring can consume $w_k = \theta_k \cdot e$. Their payoff is therefore summarized by

$$\tilde{v}_k(W, w_k) \equiv V\left(W - \frac{1}{\theta_k} \cdot w_k, w_k\right). \tag{7}$$

3.2 The Marriage Market

For given characteristics, $\mathbf{w} = (w_f, w_m)$, the marriage market specifies a marriage market pricing function, $t : \mathbb{R}^2_+ \to \mathbb{R}$, which indicates a price, $t(w_f, w_m)$, for each characteristic pair. In choosing optimal characteristics, this price will shape families' choice sets since we require that the formal property controlled by each side be non-negative: $z_f \geq 0$ and $z_m \geq 0$.[35] That is, we let

$$\mathscr{W} \equiv \left\{\mathbf{w} \mid \mathbf{w} \in \mathbb{R}^2_+, t(\mathbf{w}) \geq -w_m\right\} \tag{8}$$

[34] While unproductive marriages do not materialize in equilibrium, it is straightforward to incorporate the possibility that they did (for exogenous reasons). If we let s be the probability that the marriage is unproductive, then consumption for gender k is $(1-s) \cdot c_k + s \cdot x_k$ which is readily seen to accord with (1).

[35] Note that the former is implied by the assumed non-negativity of offspring quality, and the latter is always satisfied when $t \geq 0$, a case that we focus on.

denote the implied equilibrium feasible choice set. Taking the marriage market pricing function as given, families of gender k that participate in the marriage market choose characteristics by solving

$$\max_{(w_f, w_m)\in\mathcal{W}} v_k(W, w_f, w_m). \tag{9}$$

Let the maximized value of this problem be denoted $v_k^*(W)$. Similarly, families of gender k that do not participate choose characteristics by solving

$$\max_{w_k\geq 0} \tilde{v}_k(W, w_k). \tag{10}$$

Let the maximized value of this problem be denoted $\tilde{v}_k^*(W)$.

3.3 Equilibrium

We adopt a competitive notion of marriage market equilibrium (Rosen (1974), Peters and Siow (2002)). To this end, we note that a family's strategy consists of a participation decision and a choice of characteristics. A family's strategy is *optimal* with respect to $t(w_f, w_m)$ if (i) participation occurs if and only if $v_k^*(W) \geq \tilde{v}_k^*(W)$, and (ii) the marriage characteristics solve the associated optimization problem; (9) for participating families and (10) for non-participating families. Let $D^k(A \mid t)$ denote the measure of participating gender k families that optimally choose a characteristic in $A \subseteq \mathbb{R}_+^2$ when the marriage market pricing function is t.

Definition 1. *A marriage market pricing function, t^*, is an* equilibrium *if $D^f(A \mid t^*) = D^m(A \mid t^*)$ for all $A \subseteq \mathbb{R}_+^2$.*

That is, t^* is an equilibrium if it clears the marriage market when families optimize taking it as given.

We note that this approach accommodates the 'non-transferable utility' equilibrium of Peters and Siow (2002) whereby marriage payments are infeasible. Such an outcome involves $t(\mathbf{w}) \equiv 0$ for each $\mathbf{w}$ chosen in equilibrium. In such cases, the market is forced to clear by choice of $\mathcal{W}$.[36] Since it is the transfers that we are primarily interested in, we focus on equilibria in which outcomes are guided by prices rather than marriage market restrictions. That is, are interested in equilibria where families generically choose points in the interior of $\mathcal{W}$.

[36]Specifically, the central equilibrium object in Peters and Siow (2002) is a matching function $\mu : \mathbb{R}_+ \to \mathbb{R}_+$ whereby a groom with w_m expects to be able to marry a bride with $w_f = \mu(w_m)$. Thus, in their setting $\mathcal{W} = \{(w_f, w_m) \mid w_f = \mu(w_m)\}$. In contrast, we focus on a setting where agents of a given characteristic face a non-trivial choice as to who they marry (e.g. females are free to marry high quality males, but are required to pay a higher transfer to do so). Nevertheless, it is important to note that the 'non-transferable utility' equilibrium will also exist here: for a given μ, set $t(w_f, w_m) = (0,0)$ if $w_f = \mu(w_m)$ and $t(w_f, w_m) = -\infty$ otherwise.

3.4 Discussion of Gender Asymmetries

In this section we briefly clarify and explain some of the key gender asymmetries embedded in the model. We allow males and females to differ with respect to their bargaining power (as captured by β) and the effectiveness of their formal property rights (as captured by λ). However the key asymmetry underlying positive marriage payments is the difference in gender-specific investment returns, $\theta_m > \theta_f$. Simply, differences in investment returns translates into differences in quality between a groom and bride and thus also into the size of the ex-ante compensating payment commanded by males in the marriage market.

It is important to highlight how part of our specification, whereby we allow marriage payments between female families and grooms but not between male families and brides, builds in a further asymmetry. Although we accommodate payments 'in the other direction' by allowing the payment to be negative, the specification introduces an asymmetry because only female families are faced with the problem of dividing their total dowry expenditure between offspring quality and the marriage payment. We will see that this asymmetry translates into an asymmetry in the roles of θ_f and θ_m in many of the results to follow.

However, in the online appendix we develop the natural symmetric version of the model (whereby there can also be payments between male families and brides) and use it to demonstrate that our specification is adopted purely for simplicity given that we are primarily interested in the empirically relevant case of positive marriage payments. Specifically, for the same reasons identified above, when θ_m is large relative to θ_f the symmetric version of the model permits a "groom-price equilibrium". Such equilibria involve all marriage payments being made by the bride's family to the groom, and are thus essentially identical to the equilibria considered in our (much simpler) set-up.

4 Analysis

4.1 Deriving the Pricing Function

We begin by deriving the marriage market pricing function. To do so, we suppose that each family chooses a point in the interior of $\mathscr{W}$ and then verify that this is the case in equilibrium.

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

$$t(w_f, w_m) = \varphi_0 + \varphi_m \cdot w_m + \varphi_f \cdot w_f \tag{11}$$

where φ_f and φ_m are constants defined below in equations (12) and (14) 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

$$\frac{d\,t(w_f, w_m)}{d\,w_f} = \varphi_f \equiv -\frac{a_m}{b_m} \tag{12}$$

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

$$\delta_f \equiv \frac{a_f + b_f \varphi_f}{\frac{1}{\theta_f} + \varphi_f}. \tag{13}$$

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.[37] 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:

$$\tau'(w_m) = \varphi_m \equiv \frac{\frac{1}{\theta_f} - \frac{a_m}{b_m}}{\frac{a_f}{b_f} - \frac{1}{\theta_f}}. \tag{14}$$

[37] 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.

Proposition 1 follows since (12) and (14) indicate that the derivative of t with respect to each variable is a constant.

The marriage payment function takes a linear form because of Nash bargaining as well as the linearity we employ in some of our assumptions: investment in quality exhibits constant returns,[38] a productive marriage scales up the resources available to a couple, and females have effective rights over a proportion of their formal property. The basic logic of our results does not hinge upon this linearity, but the assumptions are valuable to adopt because they provide a great deal of tractability.[39] For instance, 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 $(1/\theta_f)+\varphi_f$ units of female parental consumption must be forgone in order to deliver each unit of female quality in equilibrium, it follows that the female families' problem is well-defined only if this cost is positive. Specifically, we make the following assumption.

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

$$\theta_f < \frac{b_m}{a_m} = 1 + \frac{\lambda}{1+\lambda+\alpha\cdot(1-\beta)}. \tag{15}$$

If this did not hold, then female families would want to invest as much as possible in the quality of their daughter. To see this from a different perspective, note that the assumption requires that the return to female investment is not so great that male families would also benefit from a reallocation of female family expenditure toward bride quality and away from the marriage payment. 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 (15) holds. This condition will play an important role in analysis to follow.

[38] It is not important that there is no heterogeneity in the male return. This can be seen by noting that the male families' problem only affects the price of the female characteristic, and the argument establishing (12) is unaffected by the value of the male return. Intuitively, male families only invest in quality, and as such having heterogeneous male returns would only affect the optimal total expenditure (i.e. it would play the same role as the existing heterogeneity in wealth). On the other hand, heterogeneity in the female return would introduce a second dimension of heterogeneity among female families: wealth heterogeneity generates differences in optimal total expenditure and female return heterogeneity would generate differences in the optimal composition of a given total expenditure. This added dimension may put extra structure on equilibrium marriage patterns–intuitively, female families with a low return tend to have a comparative advantage in paying the groomprice and will thus tend to marry grooms from wealthier families–but will otherwise only complicate the analysis without qualitatively affecting our main results.

[39] The logic behind most of our key results is that a strengthening of women's bargaining position within the household will cause changes in marriage market prices in such a way that effectively requires women to make a larger ex-ante transfer (the groomprice) to compensate for the males' weakened ex-post bargaining position. Linearity greatly aids in demonstrating this point, but is otherwise inessential. See the online appendix for an elaboration upon this point.

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 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 (11) 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

$$c_m = \delta_m \cdot E_m, \tag{16}$$

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

$$\delta_m \equiv \theta_m \cdot b_m(1+\varphi_m). \tag{17}$$

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

Similarly, we can use (11) 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

$$c_f = \delta_f \cdot E_f, \tag{18}$$

where δ_f is the rate at which female families can transform parental consumption into offspring consumption as defined in (13). Note that $\delta_f > 0$ if and only if (15) holds.

From (16) and (18) 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 (16) and (18), the 'reduced-form' problem facing gender k families is:

$$\max_{E_k} V(W - E_k, \delta_k \cdot E_k). \tag{19}$$

The assumptions on V and the fact that $\delta_k > 0$ under condition (15) implies that the solution is well-defined and characterized by the first-order condition $V_C/V_c = \delta_k$.

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 (19), 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.[40] 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 (19). 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,

[40] 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.

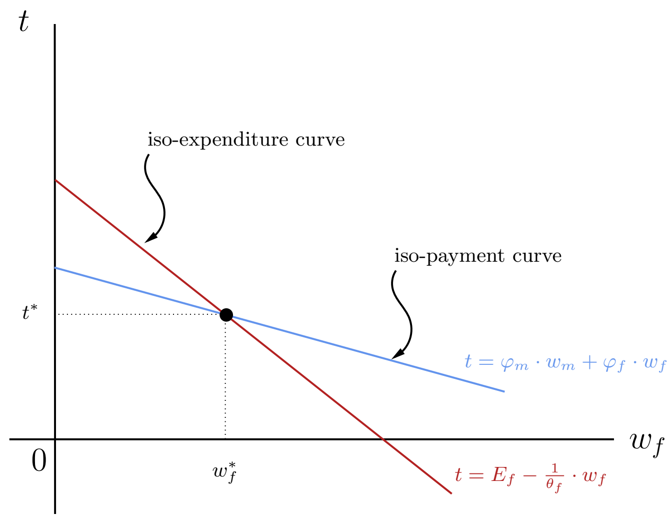

Figure 1: The Equilibrium Composition of Dowry

as depicted in Figure 1. Alternatively, simple algebra gives

$$t^* = \left[\frac{\varphi_m}{1+\theta_f \cdot \varphi_f}\right] \cdot w_m + \left[\frac{\theta_f \cdot \varphi_f}{1+\theta_f \cdot \varphi_f}\right] \cdot E_f^* \quad (20)$$

$$w_f^* = \left[\frac{\theta_f}{1+\theta_f \cdot \varphi_f}\right] \cdot E_f^* - \left[\frac{\varphi_m \cdot \theta_f}{1+\theta_f \cdot \varphi_f}\right] \cdot w_m. \quad (21)$$

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 by the female family to the couple is $R_f = t + w_f$. We can therefore identify an *iso-resource 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. That is, points A and B involve the same expenditure but B involves more of a resource transfer because it is more heavily weighted toward bride quality than is A.[41]

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.

4.4 Matching patterns and Interior Choices

We now turn to how males and females are matched in the marriage market. The previous analysis has demonstrated that families only care about their total expenditure in equilib-

[41] 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 $\theta_f > 1$).

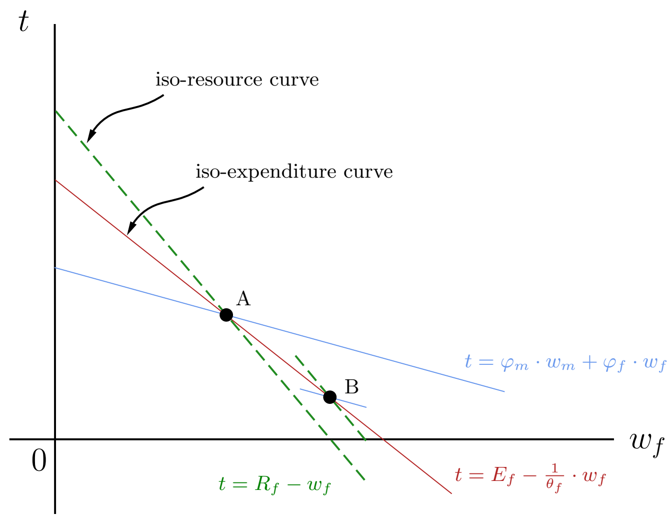

Figure 2: Marriage payments and (in)efficiency

rium. Conditional on this total, they are indifferent as to whom they marry: grooms are indifferent between brides from rich and poor families since the former offer fewer property rights over a large total dowry expenditure whereas the latter offer more property rights over a small total dowry expenditure. Similarly for brides. Yet it is premature to conclude from this that any matching pattern can arise in equilibrium, since we have not verified that optimal choices will be interior in arbitrary matches.

To examine this, we can use the equilibrium marriage market prices to derive the equilibrium choice set, defined in (8), as follows:

$$\mathscr{W}^* = \left\{ \mathbf{w} \mid \mathbf{w} \in \mathbb{R}^2_+, w_f \leq \frac{1+\varphi_m}{-\varphi_f} \cdot w_m \right\} \tag{22}$$

The equilibrium outcomes identified in the preceding section will tend to lie outside of this feasible choice set in matches that are lop-sided in terms of family wealth. For instance, if a groom from a very wealthy family were to marry a bride from a very poor family, then the required marriage payment will tend to be large. This is problematic since the only way that the female family can make a small total expenditure and a large marriage payment is if the implied choice of w_f is negative. Similarly, if a groom from a very poor family were to marry a bride from a very wealthy family, then required marriage payment will be very negative. This is problematic since the groom will have insufficient property with which to make the required marriage payment.

Despite the general indeterminacy of matching patterns, we are able to identify a particular matching pattern that is the most robust to the possibility of such lop-sided matches, in the sense that it produces interior choices if any matching pattern does. This matching is the one that is positive assortative on family wealth. That is, the groom from the wealthiest male family marries the bride from the wealthiest female family and so on–specifically, females of wealth W marry males of wealth $G_m^{-1} G_f(W)$.

To establish this formally, let $t^*(W_f, W_m)$, $w_f^*(W_f, W_m)$, and $w_m^*(W_f, W_m)$ be the implied values of t, w_f, and w_m in a marriage between families with wealth levels of (W_f, W_m). Noting that we always have $w_m^*(W_f, W_m) \geq 0$, define a match between families with wealth levels (W_f, W_m) to be *interior* if $t^*(W_f, W_m) + w_m^*(W_f, W_m) \geq 0$ and $w_f^*(W_f, W_m) \geq 0$. The following result establishes that if we re-organize families that belong to interior matches in a positive assortative manner, then the resulting matches will always be interior.

Lemma 1. *Let $\overline{W}_f \geq \underline{W}_f$ and $\overline{W}_m \geq \underline{W}_m$. If the matches $(\overline{W}_f, \underline{W}_m)$ and $(\underline{W}_f, \overline{W}_m)$ are both interior, then so too are the matches $(\overline{W}_f, \overline{W}_m)$ and $(\underline{W}_f, \underline{W}_m)$.*

Since this argument can be repeatedly applied to any pair of 'mixed' matches until the positive assortative matching is achieved, it follows that if some matching produces interior matches then the positive assortative matching also will. In other words, in determining whether a matching that produces interior matches exists, it is sufficient to verify that it exists under positive assortative matching. In other words still, the positive assortative matching will produce interior matches for the largest set of parameters.

To give an intuition for the result, 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.

We further elaborate upon equilibrium matching patterns in appendix section A.3. There we offer an alternative perspective on our model and use this to show how male and female characteristics can each be aggregated into an index in such a way that matching is positive assortative with respect to these indices. We show how wealthier male families always produce a higher index, but that all female families are indifferent to which index they produce in equilibrium. This perspective also helps demonstrate how the inability to predict positive assortative matching on wealth arises purely because of female families' capacity to allocate property rights over the dowry.

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 (21) the equilibrium investment in

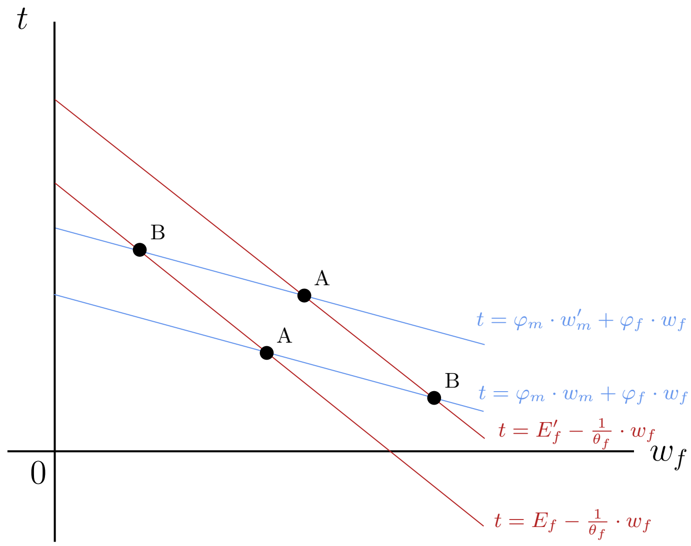

Figure 3: Intuition for Robustness of Positive Assortative Matching

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:

$$\pi(E_f^*, E_m^*) \equiv \frac{w_f^*/\theta_f}{E_f} = \frac{1-\varphi_m \cdot \theta_m \cdot \frac{E_m^*}{E_f^*}}{1+\varphi_f \cdot \theta_f}. \tag{23}$$

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 (19) 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.[42] Given this, we focus on how the various parameters affect π for fixed values of (E_m^*, E_f^*).

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 sec-

[42] See section A.5 for a discussion of this in the context of CES preferences.

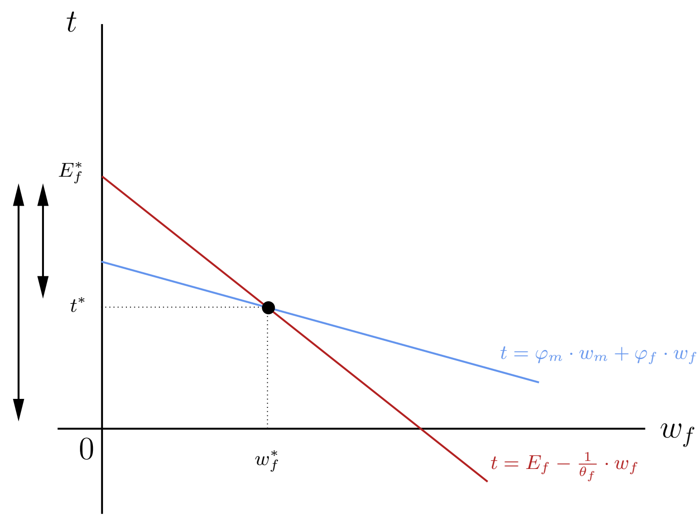

Figure 4: Measure of Female Property Rights

tion, 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.[43]

5.1 Declining Women's Rights over Dowry

5.1.1 Male Return

As discussed in section 2, the emergence of the 'price' component of dowries in lieu of the 'bequest' component has been directly linked to increased economic opportunities for men. 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 (12) and (14)), nor does if affect female families' total expenditure decision (as is apparent from (19) and (13)). 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 2. *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

[43] Given that we are looking at a measure of property rights, (23), that holds expenditure levels constant, changes in the wealth levels of parents, W, would not affect things.

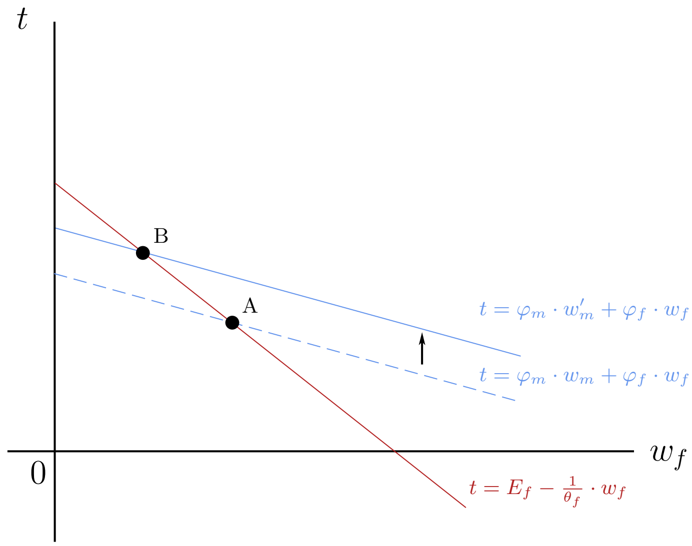

Figure 5: The Effect of Male Productivity, θ_m

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.*

5.1.2 Economic Rights of Women

Section 2 documents how the prevalence of dowries as groomprices coincided with improved economic and legal rights for women. This observation is puzzling given that, in both the historical and contemporary contexts, the 'price' component of dowries is fraught with feminist criticisms. By analyzing the effect of λ and β–both aspects of the economic rights of women–we show in this section how our model speaks to this puzzle by delivering the counter-intuitive implication 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 3. *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 section A.4 of the appendix for further details. The effect of λ in the case where $\theta_f = 1$ is shown in Figure 6, whereby an increase in λ shifts the equilibrium allocation from point A to point B. If $\theta_f > 1$, then the flatter line would also have a higher intercept, exaggerating the effect.

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.

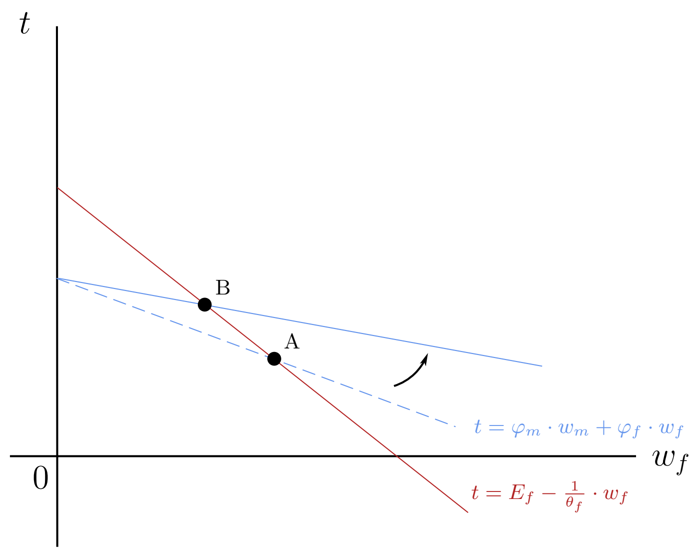

Figure 6: The Effect of λ

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 4. *An increase in β increases φ_f and φ_m.*

The effect of β is shown in Figure 7, whereby an increase in β shifts the equilibrium allocation from point A to point B. 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.

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

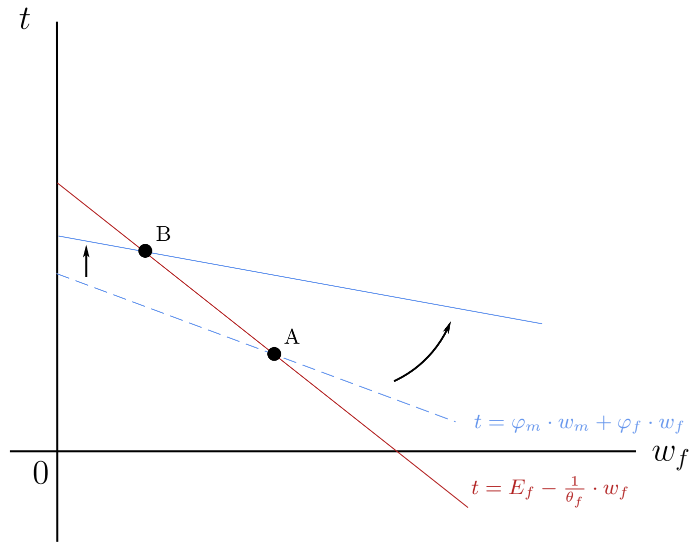

Figure 7: The Effect of β

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

Section 2 discusses how groomprices seem to decline only with significant increases in the independent earnings potential of women. At this point, investing directly in daughters human capital replaces dowries. 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 5. *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 (13) 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 6. *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.*

The effect of θ_f is shown in Figure 8. Here an increase in θ_f shifts both the iso-expenditure curve and the iso-payment curve and, as a result, the equilibrium allocation shifts from point A to point B.

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.[44] This encourages

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

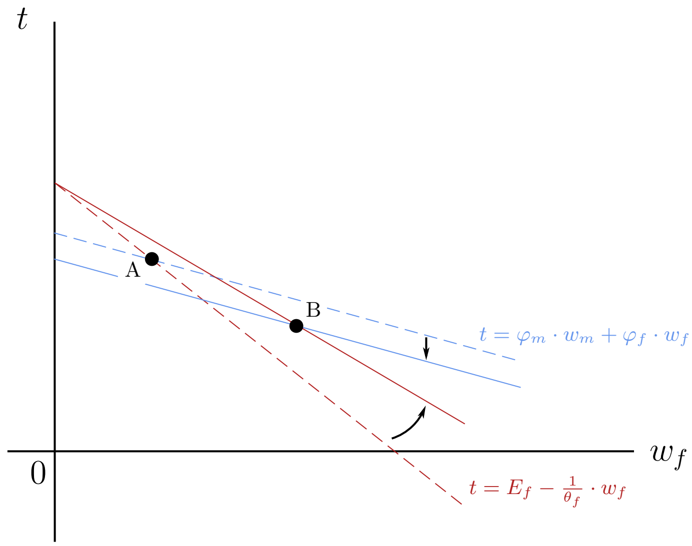

Figure 8: The Effects of θ_f

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 $w_m + t(w_f, w_m) \geq 0$.[45] Equilibrium 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 (15) 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).

[45] 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 $(1/\theta_f) \cdot w_f \leq W_f$.

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.[46]

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. These parameters will have a *direct* effect (holding marriage market prices constant) and an *indirect* effect (from changing marriage market prices). Rather than tracking these separate effects, we make use of fact that the reduced-form problems facing families, given by (19), indicates that the effect of parameters on equilibrium welfare is completely captured by the effect of parameters on the equilibrium return to expenditure, δ_k. In order to understand the effect of parameters on welfare, we therefore first consider the key determinants of δ_k.

The value of δ_k is the rate at which a family of gender k can convert their parental consumption into consumption for their offspring. By investing one unit, θ_k units of offspring quality is produced, and given that marriage is productive, this delivers a total of

$$\delta_k^* \equiv (1+\alpha)\cdot\theta_k \tag{24}$$

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.

If marriage partners were fixed, then a standard hold-up problem arises since part of this full return accrues to the other side because of bargaining. However there is competition for partners. Any ex-post bargaining is anticipated in the marriage market and is 'undone' by ex-ante transfers – here, marriage payments. This standard competitive logic implies that each family is the full residual claimant after providing the market-determined consumption to their offspring's spouse. This however does not in general imply that the equilibrium return equals δ_k^* since the ex-ante compensation is not costless when $\theta_f > 1$. That is, the rel-

[46] 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.

atively inefficient marriage payment must be utilized in order to transfer consumption from the bride to the groom.[47] To explicitly see the connection between δ_k and δ_k^*, we can use (12) and (14) in (13) and (17), along with the fact that $a_f + a_m = b_f + b_m = 1 + \alpha$, to get

$$\delta_f = \delta_f^* \cdot \left[\frac{1 - \left\{ \frac{a_m}{b_m} \right\}}{1 - \theta_f \cdot \left\{ \frac{a_m}{b_m} \right\}} \right] \tag{25}$$

$$\delta_m = \delta_m^* \cdot \left[\frac{\left\{ \frac{a_f}{b_f} \right\} - 1}{\left\{ \frac{a_f}{b_f} \right\} - \frac{1}{\theta_f}} \right] \tag{26}$$

The following result describes the magnitude of the equilibrium returns relative 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. When the female family marginally raises w_f, the groom is made better off since they are able to bargain a fraction of the additional surplus generated. 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 compensate the bride ex-ante (by accepting a lower marriage payment as part of a reallocation of property rights to the bride) until his added consumption is exhausted. If the savings in marriage payment were simply given to the bride as cash then the female family achieves full expropriation. However, if $\theta_f > 1$ then the female family can achieve an even greater return by using the saved marriage payment to invest in their daughter. Thus *females achieve more than full expropriation when $\theta_f > 1$ since the required ex-ante compensation generates an efficiency gain.* Similarly, when the male family marginally raises w_m, the bride is made better off. The competitive logic tells us that the bride has to compensate the groom ex-ante (by offering a higher marriage payment as part of a reallocation of property rights to the groom) until her added consumption is exhausted. But when $\theta_f > 1$ this reallocation of property rights is costly, and as such one unit of bride consumption can be converted into less than one unit of groom consumption. Thus *males fail to achieve full expropriation when $\theta_f > 1$ since the required ex-ante compensation generates an efficiency loss.*

The above discussion indicates that a parameter can affect δ_k–and thus the welfare of gender k families–even if it does not affect the full-appropriation return, δ_k^*. Specifically, if $\theta_k > 1$ then δ_k is also affected by factors that influence the extent to which ex-ante compensation utilizes marriage payments.

[47] It would seem that 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.

Proposition 7. *If $\theta_f > 1$, then δ_f is increasing in $\frac{a_m}{b_m}$ and δ_m is increasing in $\frac{a_f}{b_f}$.*

To give the intuition for this, first consider females. They benefit from the efficiency gain arising from being ex-ante compensated by a reduced marriage payment. They therefore obtain a higher return when a change in their quality induces a *larger* change in the marriage payment. This arises when groom consumption is more sensitive to w_f since a larger utility change must be compensated, but also when groom consumption is less sensitive to t since a given utility compensation requires a relatively large change in t. That is, δ_f is increasing in a_m and decreasing in b_m.[48]

Now consider males. They suffer from the efficiency loss arising from being ex-ante compensated via a greater marriage payment. They therefore obtain a higher return when a change in their quality induces a *smaller* change in the marriage payment. This arises when bride consumption is less sensitive to w_m since a lower utility change must be compensated, but also when bride consumption is more sensitive to w_f since a given utility compensation requires a relatively small change in t. Thus, δ_m is decreasing in b_f and increasing in a_f.[49]

Recalling that a parameter affects the welfare of a gender k family only through its effect on δ_k, we now use the above results to understand how various parameters affect welfare.

Womens' Legal Rights We first consider the parameters λ and β. These parameters are purely *distributional* in that, conditional on expenditures, they only affect the allocation of household resources. 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 (24), 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, these parameters do have an effect when ex-ante consumption transfers are costly.

[48] To get a sense of why it is the *ratio* a_m/b_m that matters, suppose that w_f were increased by Δw_f. Then in order to keep E_m constant we need $\Delta w_m = 0$ and to keep c_m constant we need $a_m \cdot \Delta w_f + b_m \cdot \Delta t + b_m \cdot \Delta w_m = 0$. That is, the change in the marriage payment satisfies $\Delta t = (a_m/b_m) \cdot \Delta w_f$.

[49] To get a sense of why it is the *ratio* a_f/b_f that matters, suppose that w_m were increased by Δw_m. Then in order to keep E_f constant we need $(1/\theta_f) \cdot \Delta w_f + \Delta t = 0$ and to keep c_f constant we need $a_f \cdot \Delta w_f + b_f \cdot \Delta t + b_f \cdot \Delta w_m = 0$. That is, the change in the marriage payment satisfies $\Delta t = (1 + (a_f/b_f) \cdot \theta_f)^{-1} \cdot \Delta w_m$.

Proposition 8. *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 strengthening in the effective command women have over their formal property lowers their welfare and raises that of men. 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)).

The fact that womens' rights, as captured by λ, has an impact on welfare when $\theta_f > 1$ can be anticipated from Proposition 3. There we showed how an increase in λ induces an equilibrium reallocation of female family expenditure toward the inefficient marriage payment. However, this intuition is incomplete since it does not explain why the burden of this added inefficiency falls disproportionally on female families (and, indeed, why the welfare of males actually *increases*). The intuition for this latter aspect follows from Proposition 7, using the fact that an increase in λ lowers a_m/b_m and raises a_f/b_f. That is, females enjoy less of an efficiency gain since the marriage payment is less responsive to a change in w_f. This is because a higher λ means that grooms value w_f less, implying that less ex-ante compensation is required. On the other hand, males suffer less of an efficiency loss since the marriage payment becomes less responsive to changes in w_m. This is because a higher λ means that brides value w_f more, and this ensures that a given change in female consumption is achieved with less of a reallocation from w_f to t.

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 9. *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 fact that womens' bargaining power, as captured by β, has an impact on welfare when $\theta_f > 1$ can be anticipated from Proposition 4, where we showed how an increase in β induces an equilibrium reallocation of female family expenditure toward the inefficient marriage payment. The way in which the burden of this added inefficiency is allocated across male and female families follows from Proposition 7, using the fact that an increase in β lowers both a_m/b_m and a_f/b_f. To see this, start with females. An increase in β lowers both a_m and b_m but the relative effect on a_m is larger so that a_m/b_m decreases. This is because bargaining involves consuming the wealth over which one holds property rights *plus* a share of the total marital surplus generated. Since the groom holds all the property rights over t but not over w_f, consumption from the former is less sensitive to how the total marital surplus is divided than is the latter. Given this, females enjoy less of an efficiency gain since marriage payments become less sensitive to changes in w_f. This is because a higher β makes grooms value w_f less relative to t, implying that less ex-ante compensation is required.

Similarly for males, an increase in β raises both a_f and b_f but the relative effect on b_f is larger so that a_f/b_f decreases. Again this is because the bride holds property rights over w_f but not over w_m, so that their consumption from the former is less sensitive to how the marital surplus is divided than is the latter. Given this, males suffer more of an efficiency loss since marriage payments become less sensitive to changes in w_m. This is because a higher β makes brides value t more relative to w_f, implying that a given change in female consumption is achieved with less of a reallocation from w_f to t.

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, 8, and 9 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)).

It is very difficult to obtain direct empirical evidence on welfare, since carefully measuring welfare is almost impossible. That being said, there is some empirical evidence that greater womens' rights translate into lower welfare as proxied by domestic violence. Luke and Munshi (2011) find that when women in tea plantations in South India have higher relative bargaining power, the probability of marital violence increases. In the context of Progresa in Mexico, Bobonis *et al.* (2013) find that although women in recipient households were significantly less likely to be victims of physical abuse than women in comparable non-beneficiary households, they were more likely to be victims of emotional violence and more likely to separate. Anderson and Genicot (2014) show that an increase in female property rights in India often increases the likelihood of conflict between husbands and wives. They find that a pro-female property rights regime change lead to an increase in the incidence of wife beating and a larger number of female suicides.

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

In light of the above discussion, an increase in θ_m raises δ_m only because it raises δ^*_m. Specifically, it has no bearing on the extent to which marriage payments are inefficient. 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 11. *An increase in θ_f (i) raises the welfare of female families and (ii) lowers the welfare of male families.*

In light of the above discussion, an increase in θ_f raises δ_f because it raises δ_m^* *and* because it raises the efficiency gain that female families experience when ex-ante compensation occurs. For males, even though θ_f does not affect δ_m^* it does affect δ_m since it shapes the extent of the efficiency loss that males suffer from the ex-ante compensation process. Thus δ_m falls even further below δ_m^*, and males are made worse off.

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.

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A Supporting Results and Proofs

A.1 Proofs

Proof of Proposition 1

Proof. The first-order conditions for the general problem stated in (9) are:

$$V_C \cdot \frac{dC_k}{dw_f} + V_c \cdot \frac{dc_k}{dw_f} = 0 \tag{27}$$

$$V_C \cdot \frac{dC_k}{dw_m} + V_c \cdot \frac{dc_k}{dw_m} = 0. \tag{28}$$

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 (27) becomes

$$\frac{dc_m}{dw_f} = 0. \tag{29}$$

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

$$\frac{dt}{dw_f} = -\frac{a_m}{b_m} \equiv \varphi_f. \tag{30}$$

For the females' version, conditions (27) and (28) give

$$-\frac{V_C}{V_c} = \frac{\frac{dc_f}{dw_f}}{\frac{dC_f}{dw_f}} = \frac{\frac{dc_f}{dw_m}}{\frac{dC_f}{dw_m}}. \tag{31}$$

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

$$\frac{b_f\left(1 + \frac{dt}{dw_m}\right)}{\frac{dt}{dw_m}} = \frac{a_f + b_f \cdot \frac{dt}{dw_f}}{\frac{1}{\theta_f} + \frac{dt}{dw_f}}, \tag{32}$$

which, along with (30), gives

$$\frac{dt}{dw_m} = \frac{\frac{1}{\theta_f} - \frac{a_m}{b_m}}{\frac{a_f}{b_f} - \frac{1}{\theta_f}} \equiv \varphi_m. \tag{33}$$

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:

$$\varphi_m \equiv \frac{\frac{1}{\theta_f} - \frac{a_m}{b_m}}{\frac{a_f}{b_f} - \frac{1}{\theta_f}} = \frac{\alpha\beta\left[\theta_f\lambda - (\theta_f - 1)(1 + \alpha(1-\beta))\right]}{(1 + \alpha(1-\beta))(\theta_f\lambda + (\theta_f - 1)\alpha\beta)} \tag{34}$$

$$\varphi_f \equiv -\frac{a_m}{b_m} = -\frac{1 - \lambda + \alpha(1-\beta)}{1 + \alpha(1-\beta)}. \tag{35}$$

Proof of Lemma 1

Proof. This follows from Lemma 7, letting $\underline{t} = \underline{w}_f = 0$ and $\overline{t} = \overline{w}_f = \infty$. □

Proof of Lemma 2

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

$$\frac{V_C\left(W - \frac{w_m^*}{\theta_m}, \delta_m \cdot \frac{w_m^*}{\theta_m}\right)}{V_c\left(W - \frac{w_m^*}{\theta_m}, \delta_m \cdot \frac{w_m^*}{\theta_m}\right)} = \delta_m. \tag{36}$$

Since $V_{CC}, V_{cc} < 0$ and $V_{Cc} \geq 0$, the left side is increasing in w_m. From (17) 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 (17), 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 (34) and (35) it is apparent that marriage market prices are independent of θ_m. Then, from (23) we see that π is decreasing in θ_m. The fact that grooms are of a higher quality comes from Lemma 2. The fact that θ_m does not affect total female expenditure comes from (19) and the fact that δ_f is independent of θ_m (as is apparent from (13) or (45)). □

Proof of Lemma 3

Proof. From (35), it is clear that φ_f is increasing in λ. From (34) we get

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

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

Proof of Proposition 3

Proof. It is clear from (23) 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 3. □

Proof of Lemma 4

Proof. From (35), we get

$$\frac{d\varphi_f}{d\beta} = \frac{\alpha\lambda}{(1+\alpha(1-\beta))^2} > 0. \tag{38}$$

From (34) we get

$$\frac{d\varphi_m}{d\beta} = \frac{\alpha(1+\alpha)\theta_f\lambda\left\{1 - \alpha(1-2\beta)\left(\theta_f - 1\right) - \theta_f(1-\lambda)\right\}}{(1+\alpha(1-\beta))^2\left(\alpha\beta\left(\theta_f - 1\right) + \theta_f\lambda\right)^2}. \tag{39}$$

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

$$1-\alpha(1-2\beta)\big(\theta_f-1\big)-\theta_f(1-\lambda)\geq 1-\alpha(1-\beta)\big(\theta_f-1\big)-\theta_f(1-\lambda) \tag{40}$$

$$\geq \frac{2\lambda^2}{1+\alpha(1-\beta)+\lambda}>0, \tag{41}$$

where the first inequality follows from the fact that the left side of (40) is increasing in β, and the second inequality comes from the fact that the right side of (40) 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 (23) 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 4. □

Proof of Lemma 5

Proof. From (21), we have

$$w_f^*=\left[\frac{\theta_f}{1+\theta_f\cdot\varphi_f}\right]\cdot\left[E_f^*-\varphi_m\cdot w_m\right]. \tag{42}$$

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. □

Proof of Lemma 6

Proof. From (35), it is clear that $d\varphi_f/d\theta_f=0$. From (34) we have

$$\frac{d\varphi_m}{d\theta_f}=-\frac{\alpha(1+\alpha)\beta\lambda}{(1+\alpha(1-\beta))\big(\alpha\beta\left(\theta_f-1\right)+\theta_f\lambda\big)^2}<0. \tag{43}$$

□

Proof of Proposition 5

Proof. From (23), the total effect of θ_f on π is

$$\frac{d\pi}{d\theta_f}=\frac{\partial\pi}{\partial\theta_f}+\frac{\partial\pi}{\partial\varphi_m}\cdot\frac{d\varphi_m}{d\theta_f}+\frac{\partial\pi}{\partial\varphi_f}\cdot\frac{d\varphi_f}{d\theta_f}. \tag{44}$$

It is clear from (23) 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 6, $\frac{d\varphi_f}{d\theta_f}=0$, and $\frac{d\varphi_m}{d\theta_f}<0$. It then follows that $\frac{d\pi}{d\theta_f}>0$. □

Welfare Results From the reduced form problem facing families, (9), 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 (13) and (17) to produce values of δ_f and δ_m expressed in terms of primitives in order to simplify the proofs to follow:

$$\delta_f = \left[\frac{\lambda}{\lambda\theta_f - (\theta_f - 1)\cdot[1+\alpha(1-\beta)]}\right]\cdot(1+\alpha)\theta_f \tag{45}$$

$$\delta_m = \left[\frac{\theta_f\lambda}{\theta_f\lambda + \alpha\beta\left(\theta_f - 1\right)}\right]\cdot(1+\alpha)\theta_m. \tag{46}$$

Proof of Proposition 6

Proof. Note that δ_f/δ_f^* equals the bracketed term in (45) and that δ_m/δ_m^* equals the bracketed term in (46). When $\theta_k = 1$ the bracketed terms in (45) and (46) equal one, implying $\delta_k = \delta_k^*$ as claimed. The bracketed term in (45) is clearly increasing in θ_f, and the bracketed term in (46) is clearly decreasing in θ_f. Therefore $\theta_f > 1$ implies $\delta_f/\delta_f^* > 1$ and $\delta_m/\delta_m^* < 1$. □

Proof of Proposition 7

Proof. This follows from the expressions for δ_f and δ_m given by (25) and (26). □

Proof of Corollary 1

Proof. From proposition 6, $\theta_f = 1$ implies $\delta_k = \delta_k^*$, and from (24) δ_k^* is independent of λ and β. □

Proof of Proposition 8

Proof. From (45) we have

$$\frac{d\delta_f}{d\lambda} = -\frac{(1+\alpha)(1+\alpha(1-\beta))\theta_f}{\left(1-\alpha(1-\beta)\left(\theta_f - 1\right) - \theta_f(1-\lambda)\right)^2}\cdot\left(\theta_f - 1\right), \tag{47}$$

which is negative when $\theta_f > 1$. Similarly, from (46) we have

$$\frac{d\delta_m}{d\lambda} = \frac{\alpha(1+\alpha)\beta\theta_f\theta_m}{\left(\alpha\beta\left(\theta_f - 1\right) + \theta_f\lambda\right)^2}\cdot\left(\theta_f - 1\right), \tag{48}$$

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

Proof of Proposition 9

Proof. From (45) we have

$$\frac{d\delta_f}{d\beta} = -\frac{\alpha(1+\alpha)\theta_f\lambda}{\left(1-\alpha(1-\beta)\left(\theta_f - 1\right) - \theta_f(1-\lambda)\right)^2}\cdot\left(\theta_f - 1\right), \tag{49}$$

which is negative when $\theta_f > 1$. Similarly, from (46) we have

$$\frac{d\delta_m}{d\beta} = -\frac{\alpha(1+\alpha)\theta_f\theta_m\lambda}{\left(\alpha\beta\left(\theta_f-1\right)+\theta_f\lambda\right)^2}\cdot\left(\theta_f-1\right), \tag{50}$$

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

Proof of Proposition 10

Proof. It is clear from (46) that $d\delta_m/d\theta_m > 0$, and clear from (45) that $d\delta_f/d\theta_m = 0$. □

Proof of Proposition 11

Proof. (i) Differentiate δ_f given by (45) with respect to θ_f, noting that it is positive. (ii) Differentiate δ_m given by (46) with respect to θ_f, noting that it is negative. □

Proof. From (45) we have

$$\frac{d\delta_f}{d\theta_f} = \frac{(1+\alpha)(1+\alpha(1-\beta))\lambda}{\left(1-\alpha(1-\beta)\left(\theta_f-1\right)-\theta_f(1-\lambda)\right)^2} > 0. \tag{51}$$

Similarly, from (46) we have

$$\frac{d\delta_m}{d\theta_f} = -\frac{\alpha(1+\alpha)\beta\theta_m\lambda}{\left(\alpha\beta\left(\theta_f-1\right)+\theta_f\lambda\right)^2} < 0. \tag{52}$$

□

A.2 Determining φ_0

We can use (11) in (2) to write the equilibrium consumption level for males as:

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

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

$$c_m = \left[b_m\varphi_0\right] + \delta_m \cdot E_m, \tag{53}$$

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 (53), the 'reduced-form' problem facing male families is:

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

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 $\varphi_0 \geq \underline{\varphi}_0$.[50] 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).[51]

A.3 More on Matching Patterns

A.3.1 Robustness of Positive Assortative Matching

Recall that $t^*(W_f, W_m)$, $w_f^*(W_f, W_m)$, and $w_m^*(W_f, W_m)$ are the implied values of t, w_f, and w_m in a marriage between families with wealth levels of (W_f, W_m). Let $\tilde{t}^*(W_f, W_m) \equiv t^*(W_f, W_m) + w_m^*(W_f, W_m)$. Fixing a pair of intervals, $I_t \equiv [\underline{t}, \bar{t}]$ and $I_{w_f} \equiv [\underline{w}_f, \overline{w}_f]$, say that a match between families with wealth (W_f, W_m) is *contained* if $\tilde{t}^*(W_f, W_m) \in I_t$ and $w_f^*(W_f, W_m) \in I_{w_f}$.

Lemma 7. *Let $\overline{W}_f \geq \underline{W}_f$ and $\overline{W}_m \geq \underline{W}_m$. If the matches $(\overline{W}_f, \underline{W}_m)$ and $(\underline{W}_f, \overline{W}_m)$ are both contained, then so too are the matches $(\overline{W}_f, \overline{W}_m)$ and $(\underline{W}_f, \underline{W}_m)$.*

Proof. Let $E_k(W_k)$ be the optimal expenditure of a gender k family with wealth W_k, and note that it is increasing in W_k. Using the fact that $w_m = \theta_m \cdot E_m(W_m)$ in (20) and (21), note that for

[50] 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.

[51] 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.

positive coefficients (A_1, A_2, A_3, A_4)[52] we can write

$$t^*(W_f, W_m) = A_1 \cdot E_m(W_m) - A_2 \cdot E_f(W_f) \tag{54}$$

$$\tilde{t}^*(W_f, W_m) = \tilde{A}_1 \cdot E_m(W_m) - A_2 \cdot E_f(W_f) \tag{55}$$

$$w_f^*(W_f, W_m) = A_3 \cdot E_f(W_f) - A_4 \cdot E_m(W_m), \tag{56}$$

where $\tilde{A}_1 = A_1 + \theta_m > 0$.

We see that $\tilde{t}^*(\overline{W}_f, \overline{W}_m) \geq \tilde{t}^*(\overline{W}_f, \underline{W}_m)$ since $E_m(\overline{W}_m) \geq E_m(\underline{W}_m)$ and that $\tilde{t}^*(\underline{W}_f, \underline{W}_m) \geq \tilde{t}^*(\overline{W}_f, \underline{W}_m)$ since $E_f(\underline{W}_f) \leq E_f(\overline{W}_f)$. But we have $\tilde{t}^*(\overline{W}_f, \underline{W}_m) \geq \underline{t}$ since the $(\overline{W}_f, \underline{W}_m)$ match is contained. Thus, we have $\tilde{t}^*(\overline{W}_f, \overline{W}_m) \geq \underline{t}$ and $\tilde{t}^*(\underline{W}_f, \underline{W}_m) \geq \underline{t}$.

Similarly, $\tilde{t}^*(\underline{W}_f, \underline{W}_m) \leq \tilde{t}^*(\underline{W}_f, \overline{W}_m)$ since $E_m(\overline{W}_m) \geq E_m(\underline{W}_m)$ and that $\tilde{t}^*(\overline{W}_f, \overline{W}_m) \leq \tilde{t}^*(\underline{W}_f, \overline{W}_m)$ since $E_f(\underline{W}_f) \leq E_f(\overline{W}_f)$. But we have $\tilde{t}^*(\underline{W}_f, \overline{W}_m) \leq \overline{t}$ since the $(\underline{W}_f, \overline{W}_m)$ match is contained. Thus, we have $\tilde{t}^*(\underline{W}_f, \underline{W}_m) \leq \overline{t}$ and $\tilde{t}^*(\overline{W}_f, \overline{W}_m) \leq \overline{t}$.

Together we have $\tilde{t}^*(\underline{W}_f, \underline{W}_m) \in [\underline{t}, \overline{t}]$ and $\tilde{t}^*(\overline{W}_f, \overline{W}_m) \in [\underline{t}, \overline{t}]$. The analogous arguments can be applied with respect to $w_f^*(\cdot, \cdot)$, and the conclusion that $(\underline{W}_f, \underline{W}_m)$ and $(\overline{W}_f, \overline{W}_m)$ are contained follows. □

Note that the same arguments can be applied if we were instead to rule out negative transfers and consider a match to be *interior* only if $t \geq 0$. Since $A_1 > 0$, the above proof can be followed, replacing $\tilde{t}$ with t.

A.3.2 An Alternative Perspective

The main text establishes that there are no strong predictions with regards to matching patterns because prices end up such that families have an optimal total expenditure but are indifferent as to how it is allocated (and thus whom they marry) in equilibrium. This section offers an alternative perspective on equilibrium matching by casting the model as one of non-transferable utility with multidimensional characteristics.

Let q_f aggregate the valuable characteristics of a bride from a groom's perspective:

$$q_f \equiv a_m \cdot w_f + b_m \cdot t, \tag{57}$$

and let q_m aggregate the valuable characteristics of a groom from a bride's perspective:

$$q_m \equiv b_f \cdot w_m. \tag{58}$$

It is straightforward to see that we can then write the male family's payoff as:

$$v_m(q_f, q_m \mid W) \equiv V\left(W - \frac{1}{\theta_m} \cdot \frac{1}{b_f} \cdot q_m, q_f + \frac{b_m}{b_f} \cdot q_m\right). \tag{59}$$

Writing the female's problem in terms of (q_f, q_m) is slightly more involved since females have two instruments within which to deliver q_f. In essence, $v_f(q_f, q_m \mid W)$ is the payoff from

[52] The precise value of these coefficients can be deduced from (20) and (21), but are irrelevant for the argument here.

marrying a male with q_m subject to delivering a q_f in the 'least cost' manner. Specifically, we have that $v_f(q_f, q_m \mid W)$ is the indirect payoff function associated with the following problem:

$$\max_{w_f, t} V\left(W - \frac{1}{\theta_f} \cdot w_f - t, q_m + a_f \cdot w_f + b_f \cdot t\right) \text{ s.t. } q_f = a_m \cdot w_f + b_m \cdot t. \tag{60}$$

The trade-off between the two instruments arises since w_f raises utility more effectively but t satisfies the constraint more effectively.[53]

Having specified $v_k(q_f, w_m \mid W)$, the model then fits the framework of Peters and Siow (2002). That is, pre-marital investment (in q_k) with non-transferable utility. As such, the marriage market forms matches once the values of q_m and q_f are determined. As in Peters and Siow (2002), the equilibrium matching is straightforward: it must be positive assortative on the q dimension since all males strictly prefer higher q_f and all females prefer higher q_m. That is, the market will specify some increasing function, μ, with the interpretation that females with q_f are to marry males with $q_m = \mu(q_f)$ (and males with q_m marry females with $q_f = \mu^{-1}(q_m)$). Given this matching function, male families solve $\max_{q_m} \; v_m(\mu^{-1}(q_m), q_m \mid W)$ and female families solve $\max_{q_f} \; v_m(q_f, \mu(q_f) \mid W)$. The equilibrium matching function, μ^*, is one that clears the marriage market when families solve their respective problems taking μ^* as given.

Knowing that matching is positive assortative on the q dimension does not imply that it must be positive assortative on the family wealth dimension since we have not established that higher wealth families must choose higher q in equilibrium. To explore this, we first note that higher wealth male families must indeed choose higher q_m in equilibrium–regardless of μ–because of the fact that the marginal rate of substitution between q_m and q_f is increasing in W. Specifically

$$\frac{\frac{\partial v_m(q_f, q_m \mid W)}{\partial q_m}}{\frac{\partial v_m(q_f, q_m \mid W)}{\partial q_f}} = \frac{-V_1 \cdot \frac{1}{\theta_m} \cdot \frac{1}{b_f} + V_2 \cdot \frac{b_m}{b_f}}{V_2} = -\frac{V_1}{V_2} \cdot \frac{1}{\theta_m} \cdot \frac{1}{b_f} + \frac{b_m}{b_f}, \tag{61}$$

where $-\frac{V_1}{V_2}$ is increasing in W. This single-crossing condition implies that a high wealth male prefers a high value of q_m over a low one whenever a low wealth male does, and as such it must be that higher wealth males choose higher q_m.

The same does not hold for females though. The marginal rate of substitution between q_f and q_m is independent of W. Specifically, if we let ℓ be the Lagrange multiplier associated with the female family's problem, we get

$$\frac{\frac{\partial v_f(q_f, q_m \mid W)}{\partial q_f}}{\frac{\partial v_f(q_f, q_m \mid W)}{\partial q_m}} = \frac{\ell}{V_2} = \frac{\theta_f \cdot a_f - b_f}{b_m - \theta_f \cdot a_m}, \tag{62}$$

which is independent of W.[54] This means that the shape of female family indifference curves

[53] The former arises since $\frac{1}{\theta_f} \leq 1$ and $a_f > b_f$, and the latter arises because $b_m > a_m$.

[54] The Lagrangian is $\mathscr{L} = \left(W - \frac{1}{\theta_f} \cdot w_f - t, q_m + a_f \cdot w_f + b_f \cdot t\right) - \ell \cdot [q_f - a_m \cdot w_f - b_m \cdot t]$. By dividing the first-order conditions for optimal w_f and t by V_2 gives a system of linear equations in V_1/V_2 and ℓ/V_2. The resulting solution for ℓ/V_2 is that given above.

in (q_f, q_m) space are the same for all families.[55] As such, μ^* must coincide with one of these indifference curves in equilibrium (otherwise the market can not clear). Females are thus indifferent to their choice of q_f in equilibrium and therefore there are no strong predictions with respect to how families of different wealth levels will match.

Finally, note that the inability to predict positive assortative matching arises because of the multiple instruments that female families have available to deliver q_f. Indeed, if t were fixed (e.g. if marriage payments were prohibitively costly) or if w_f were fixed (e.g. if female families of different wealth levels competed for grooms only via offering marriage payments) then the equilibrium choice of q_f would be increasing in W (for the same reasons as the males) and positive assortative matching on wealth would be the unique prediction.

A.4 Additional Effect of An Increase in λ

Lemma 3 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.

A.5 Illustration with Functional Forms

In order to explicitly derive the equilibrium outcomes (w_m, w_f, t) within a match, we suppose that V belongs to the CES class of preferences:

$$V(C,c) = \left((1-\nu)\cdot C^{\frac{\sigma-1}{\sigma}} + \nu\cdot c^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{63}$$

where $\sigma > 0$ is the elasticity of substitution and $\nu \in (0,1)$ measures altruism toward offspring. Since a family's problem in equilibrium becomes $\max_{E_k} V(W - E_k, \delta_k \cdot E_k)$, it is straightforward

[55] In this case, straight lines.

to derive the solution:

$$E_k^*(W) = \frac{1}{1+\left(\frac{1-\nu}{\nu}\right)^{\sigma} \cdot \delta_k^{1-\sigma}} \cdot W. \tag{64}$$

From here we see that E_k^* is increasing in δ_k if $\sigma < 1$, is decreasing in δ_k if $\sigma > 1$, and is independent of δ_k if $\sigma = 1$ (i.e. Cobb-Douglas).

This exercise is useful in terms of providing sufficient conditions for interior optimal choices. Specifically, we note that in order to verify whether all families make interior choices that it is sufficient to verify that they do when matched positive assortative on family wealth (see section 4.4). Assuming that the distribution of wealth is the same for male and female families, each family matches with a family from the other side with the same wealth. Given this, we can use $w_m = \theta_m \cdot E_m^*(W)$ and the above solution to determine the choice of w_m for a male family with wealth W. This can be used in (20) and (21) to get expressions for w_f and t. For instance in the Cobb-Douglas case ($\sigma = 1$) we get

$$w_f^*(W) = \left[\frac{1-\varphi_m \cdot \theta_m}{1+\theta_f \cdot \varphi_f}\right] \cdot \theta_f \cdot \nu \cdot W, \tag{65}$$

which is non-negative if and only if $1 \geq \varphi_m \cdot \theta_m$. That is,

$$\frac{a_f}{b_f} - \frac{1}{\theta_f} \geq \theta_m \cdot \left[\frac{1}{\theta_f} - \frac{a_m}{b_m}\right], \tag{66}$$

which holds if θ_f is large relative to θ_m (e.g. if $\theta_m = \eta \cdot \theta_f$, then it holds for θ_f large enough), or if a_m/b_m or a_f/b_f are sufficiently large (e.g. if β is sufficiently small).

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