

# A Gender-Based Theory of the Origin of the Caste System of India\*

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## Abstract

We propose a theory of the origins of India's caste system by explicitly recognizing the productivity of women in complementing their husbands' occupation-specific skill. The theory explains the core features of the caste system: its hereditary and hierarchical nature, and its insistence on endogamy (marriage only within castes). Endogamy is embraced by a group to minimize an externality that arises when group members marry outsiders. We demonstrate why the caste system embodies gender asymmetries in punishments for violations of endogamy and tolerates hypergamy (marrying up) more than hypogamy (marrying down). Our model also speaks to other aspects of caste, such as commensality restrictions and arranged/child marriages. We suggest that India's caste system is so unique because the Brahmins sought to preserve and orally transmit the Hindu scriptures for over a millennium with no script. We show that economic considerations were of utmost importance in the emergence of the caste system.

**Keywords:** caste, endogamy, gender

**JEL Codes:** D02, J12, J16, Z13, Z12

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# 1 Introduction

The caste system of India, having lasted for around 3,500 years, has proved to be one of the most enduring of Indian institutions.<sup>1</sup> Despite India’s rapid economic development in recent decades, it still insinuates itself into the social, economic, and political fabric of the country.<sup>2</sup> Caste is recognized as a salient basis for discrimination (Deshpande (2011)) and violence (Esteban, Mayoral, and Ray (2012)), as a source of market failure (Anderson (2011)), and as a means to address market failures by utilizing existing social relationships (Munshi and Rosenzweig (2006, 2009, 2013), and Munshi (2011)). Economists have studied the experience of low caste groups in response to policies, especially in the political realm, that have been enacted to address the ill effects of caste (e.g. Pande (2003), Banerjee and Somanthan (2007), and Hnatkovska, Lahiri, and Paul (2012)).

In view of the continuing economic salience of caste in India, our paper takes a step back to investigate the economic *origins* of this hierarchical and socially insular social system. Any understanding of the caste system, including the likely effect of policy, is incomplete without a solid appreciation of the key forces that forged the system. As we argue in Sections 1.1 and 4.4, existing research sheds little light on this issue. The economics literature provides insight into the equilibrium logic of some caste-like behaviors and into the various ways that the caste system is used to achieve various ends, but it does not provide a persuasive account of the origins of the system. Given the continued relevance of caste, our paper attempts to do just this.

Since no theory can hope to explain every nuance of the elaborate caste system of India, we follow Bougle (1971) in focusing on the following core features at its incipience: (i) caste was hereditary and largely based on occupation, (ii) it was strictly endogamous (marriage occurred only within castes), and (iii) there was usually a well-established hierarchy between castes. Our theory offers a parsimonious explanation for these and related features of the caste system, and highlights the essential role that the oppression of women has played in its establishment. The gender effects of caste have eluded the attention of analysts<sup>3</sup> because they have ignored the productive role of women. By explicitly recognizing this, we resolve many puzzling aspects of the caste system and also explain the asymmetric treatment afforded to women within this institution.

We explicitly state at the outset that in our analysis caste is tied to occupation because we are modeling a period of India’s history when this was the case. That caste-based work requires skill on the part of the husband has been always understood because the occupation of the husband determines the couple’s livelihood. What has been missing in theoretical formulations of caste, however, is explicit recognition of the simple fact that

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<sup>1</sup>At a broad aggregate level, there are four castes (called *varnas*). These are the Brahmins (priests), the Kshatriyas (the warriors), Vaishyas (the merchants), and the Shudras (the menial workers). There is one other aggregate (now called Dalits) that fell outside the caste system and its people were deemed ‘untouchable’. Nowadays, there are thousands of sub-castes (called *jatis*) within each *varna*, and the caste system essentially operates at the level of the *jati*. For the purpose of theorizing, however, we shall focus on the *varnas* first—referring to these as the castes—and then explain the rise of sub-castes.

<sup>2</sup>For instance, using data from matrimonial advertisements, Banerjee et al. (2013) show that strong preferences for within-caste marriage persist to the present day, even among highly educated urban populations.

<sup>3</sup>Chakravarti (1993, 2003) is among the few exceptions.

wives also require suitable skills because they, too, contribute to the caste-activity. The neglected productivity of women thus takes center-stage in our analysis; just like men acquire their skills from their fathers, women acquire theirs from their mothers. Because occupational activities of families in ancient India, though determined by that of the husband’s father, are jointly executed by the spouses, the complementary skills a wife brings are important to family income. A wife from a family plying a different trade has less appropriate skills and this reduces the family income. Likewise, if a person cannot find a spouse, family income is reduced. Thus, our analysis resonates closely with the position of Dube (1996) when she writes: “The necessity of continuing with occupational work is an important basis for marrying within caste.” We elaborate upon the complementary role of wives in production in Section 2 below.

We model the formation of a caste as arising from the decision of a social planner if he sees it as beneficial in terms of a Benthamite welfare function. In the decentralized scenario that is more likely the realistic case, such implementation would require coordination amongst group members who opt for endogamy. Since the caste system first began with the Brahmins, this feat of coordination was probably accomplished relatively easily because the relevant group members would have congregated frequently for religious occasions. Once the Brahmin occupation became the Brahmin caste by choice of endogamy, the Brahmin mechanism for forming and enforcing a caste would have provided a ready-made template for other groups.

If a member of a group conceives a preference for an outsider and marries (a ‘love marriage’), why should the group object? After all, this can happen only if the member values this preference more than the fall in income due to skill mismatch between the spouses. There is, however, an externality associated with out-group marriages. When a member marries outside the group, a group member of the opposite sex will not find a spouse within the group. This is a cost that is not internalized, and if endogamy is to obtain out-group marriages must be prevented. We model deterrence by having non-violators of endogamy norms punish violators in subsequent in-group interactions. Such punishments, however, are costly to both the punished and the punisher, and so endogamy may not be sustainable. When endogamy can be sustained, the occupational groups become castes. Thus, the regulations of the caste system rationalize the various caste norms and the attendant punishments for violations.

The benefit of endogamy is determined by the skill complementarity dictated by the technology of the husband’s occupation and, as we shall see below, also in the (unmodeled) complementarity in the raising of children. Groups that perceive the greatest spousal complementarities are the ones that are most zealous of forming castes and would be willing to impose the harshest punishments for violations of endogamy. These punishments, we show, are *gender dependent*: at least in the groups with strong complementarities, women have greater incentives to out-marry and, therefore, face greater punishments. This gender asymmetry would be enhanced if in our formal model we include (which we do not) the fact that, in patriarchal societies the perceived social cost of not finding a spouse is greater for men than for women. If violations to endogamy were to occur, we further show that the punishments inflicted on women are asymmetric in terms of which castes

they out-marry into: marrying into a caste with greater skill complementarity between spouses invites a lower punishment than when marrying into castes that exhibit lower complementarities. Whether or not a caste would permit a woman to marry into another becomes the measure of the relative status of the two castes, and this status is endogenously determined here. When the degrees of skill complementarities can be ranked across castes, this translates into a hierarchy in castes—giving meaning to the terms ‘marrying up’ and ‘marrying down’. In effect, we explain why women marrying ‘up’ (hypergamy) is considered more acceptable to a caste than its women marrying ‘down’ (hypogamy). To our knowledge, ours is the first paper in economics to explain caste endogamy and caste hierarchy from first principles. In the light of our model, we can also explain many other puzzling features of the caste system: arranged marriages, child marriages, and the obsessive preoccupation with notions of purity and pollution.

If the view set out above is correct, it suggests that, whatever the uses and abuses of the caste system were over its long and infamous history, its *origin* may have been more benign—with no caste group having an ulterior motive of exploiting or suppressing other caste groups of society. In this sense, Dumont (1970) may have been right in his claim that power was a secondary factor in the formation of castes. We do not, of course, agree with his more general claim that *all* political economy considerations are secondary; in our theory of caste, economics is fundamental. Our claim that the origin of caste may have been benign needs to be heavily qualified, however, for its implementation exacted a disproportionately high price from half the members within each caste, namely, women.

## 1.1 Existing Perspectives on Caste

Historians of caste since the 19<sup>th</sup> Century had long conjectured based on references in the Rig Veda, the earliest of Hindu scriptures, that the caste system arose after an Aryan invasion from the north-west around 1,500 BCE after which the victors imposed an oppressive system on the vanquished. However, both archaeological evidence (Shaffer (1984), Shafer and Lichtenstein (2005)) and genetic evidence (e.g. Sahoo et al (2006)) firmly imply that the caste system of India was an entirely *indigenous* development—not one foisted by foreign invaders—it therefore has to be explained in these terms.

In anthropology, the dominant theory of caste that prevails is that of Dumont (1970). In his highly influential *Homo Hierarchicus*, he claims that the twin concepts of ‘purity’ and ‘pollution’ are key to the caste system and he takes this as the premise of his theory.<sup>4</sup> To an economist, however, this is somewhat unsatisfactory for it leaves unexplained why these concepts should be taken as given. Rather, it would seem that their importance needs to be explained in terms of more compelling primitives. Similarly, sociological theories start from the premise that each caste comes with a different status, designed by one or more groups (see, for example, Milner (1994)). Our theory has the advantage that it does not require one group, like the Brahmins, to impose the caste system on other groups. Although the Brahmins have undoubtedly had a strong influence in shaping the

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<sup>4</sup>To be sure, there have been criticisms of this view. See, for example, Olivelle (1998) and the references contained therein.

caste system, it is too much to believe that a small group could unilaterally impose such a system on the rest of the population.<sup>5</sup>

Our treatment of caste endogamy sharply contrasts with these approaches, which rationalize endogamy as an attempt to preserve the ‘purity’ or ‘status’ of a caste. The proposition that endogamy acts to strengthen the caste system is somewhat tautological if we take endogamy to be a central feature of the caste system. Our theory explains the genesis of endogamy and demonstrates that the purity/pollution dichotomy, the rituals associated with it, and the notions of status that figure so prominently in discussions of caste were the *means* employed to establish the caste system, and were not its cause. In this, our theory is in line with the arguments of the Indologist Olivelle (1998), who comes to a similar conclusion: “We can consider impurity rules as a system of socialization. Individuals within the society must be made to acknowledge and support the social boundaries imposed on them, and this is effected primarily through social rituals.” (p. 214)

Among economists, attempts to explain the caste system are few and far between. A first set of papers helps us understand the equilibrium logic of certain caste behaviors, but do not speak to the purposes that such behaviors may ultimately serve. In the first formal treatment of caste, Akerlof (1976) shows how obedience to a discriminatory caste ‘code’ can be supported as an equilibrium. Relatedly, although in a model dealing with class (but not caste), Cole, Mailath, and Postelwaite (1998) generate classes endogenously in equilibrium and in which upper-class members, concerned about loss of status, might behave differently than lower class members. As in Akerlof (1976), punishments are enacted out of a concern of being punished oneself rather than because the violations themselves harm the group in some way. These models display multiple equilibria, some with adherence to a code and some without. In contrast to this vein of research, we are more interested in understanding the motivation for a group to impose caste codes.

A more recent set of papers shed light on the role that groups, such as castes, play in overcoming enforcement problems. Focusing on enforcement problems that arise *between* groups, Freitas (2006) views caste as arising in order to enforce compliance of those that the group trades with. Specifically, she considers a scenario of one-sided moral hazard, whereby sellers exert effort but buyers of a product may renege on payment. Castes, based on occupations, are formed, and buyer payment is induced by the threat that all caste members will deny future service. Thus, the mechanism is similar to that stressed by Greif (1993) in a different context. In contrast to this approach, we stress the importance of caste enforcing compliance among its own members, with a specific focus on compliance to marriage norms.

Focusing on enforcement problems that arise *within* groups, Choy (2011) views caste as a means for agents to enforce cooperation within the context of a repeated Prisoners’ Dilemma, in which partnerships occasionally break up. Various distinct groups arise

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<sup>5</sup>We show, in fact, that it is only people in those occupations that have no overwhelming reason for endogamy that may be hurt by the formation of other castes. They would see a *de facto* restriction on their choice of marriage partners without a compensating benefit. This is not to suggest that, *after* the caste system was established and a hierarchy has emerged, the upper castes did not exploit their position in the hierarchy.

because the consequence of cheating is worse in smaller groups, implying that more co-operation can be sustained. This perspective speaks to the insular nature of castes, as an agent who has been a ‘mixer’ in the past is punished because others believe that he is myopic and will therefore cheat. In contrast, we treat the insularity that arises from restrictions on marriage as primary, viewing other efforts at insularity (e.g. commensality restrictions) as a means that ultimately serves this larger purpose.

A related stream of research puts aside the issue of caste origins and focuses instead on the ways that caste is *used* in order to deliver myriad benefits to members. For instance, caste networks are important in facilitating the entry of men into traditional occupations (Munshi and Rosenzweig (2006)). Caste networks are also used to help facilitate valuable cooperation within business communities (Damodaran (2008), Munshi (2011)). Caste networks also play an important role in the realm of politics (Munshi and Rosenzweig (2013)). Finally, caste networks play an important role in facilitating consumption smoothing by providing the means through which informal insurance and credit relationships can operate (Munshi and Rosenzweig (2009), Mazzocco and Saini (2012)).

## 2 The Complementary Role of Wives

In marital arrangements that are patrilocal, that is, where the wife moves to her husband’s household, it is natural to assume that the wife adopts the husband’s occupation. The husband and his extended family have expertise only in his parents’ occupation and not her parents’ (in case they are different). So, if she wished to pursue her own parents’ occupation, she would receive little help from the household she has married into. Besides, to enable the husband to do his work, the extended family would put pressure on the wife to adopt his work even if her skills are mismatched.<sup>6</sup>

In describing occupations that remain closely tied to caste, ranging from the *purohit* (priest), to traditional cultivators, to artisans, and to the ‘ritually polluting’ activities of leather workers, barbers, washermen and midwives, Dube (1996) notes that “the work of women, carried out as members of households—the basic units of production—is indispensable.” She explains:

“It is difficult for weavers and potters to carry on the complex processes of their craft without the continuous help of the women and children of the household, who in turn have well-defined tasks. Women can also take on aspects of men’s work; it is not unusual for women from a potter’s family to establish contacts with clients and go to the market to assist with the selling of goods ... it is common for women from households of petty traders and shop-keepers to grind spices and prepare fries, fritters and preserves for sale in the family shop. Despite regional variations, the illustrations underscore the fact that occupational continuity in a large measure depends on women” (p. 3)

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<sup>6</sup>The wife’s adoption of her husband’s occupation could also arise because of scale economies or, as an anonymous referee has suggested, because contracts are easier to enforce within the household.

The fact that children also assist in the household's occupation adds support to our assertion that children develop occupation-specific skills. The more specific assertion that girls are also imparted occupation-specific skills in childhood, and are done so mindful of marriage prospects, is suggested by Dube noting that

“... in order that women pursue these traditional occupations, they have to be trained in them from childhood and have to be socialized into accepting them as proper work ... Not formal education, but the capacity and willingness to do traditional work tends to make a girl useful in the husband's family. It is understandable then that a landowning cultivator family of the Kunbi caste in rural Maharashtra should be unhappy when one of its sons, after acquiring education, decides to marry an educated Brahmin girl. Even home-based work linked to cultivation is seen as outside the arena of her experience and below her status.” (pp. 4-5)

This also highlights the ‘horizontal’ elements of caste preferences that we stress in the model: while we develop a notion of hierarchy across castes, each caste views their own as the most desirable to marry into.<sup>7</sup>

The complementary role of household women in production is further described in the ethnoarchaeological study of potters in David and Kramer (2001). They explain:

“In the case of Indian potters, as elsewhere where pottery is wheel-thrown, men make almost all the vessels. Their mothers, wives, sisters, daughters, and daughters-in-law, however, are active participants in every other stage of production: processing clays and pigments, decorating vessels, assisting with firing, and distributing the final products”. (p. 308)

In fact, even when they do not engage in certain caste activities reserved for males, mothers give detailed instructions regarding these to their young sons and make corrections [Kramer (1997, pp. 47-49)].

There is little doubt that the caste system was initiated by the Brahmin (or priestly) occupation. So if our theory is correct, there must have been a reason why skill complementarity between spouses was particularly important to this occupation. Brahmin women—although usually forbidden from performing sacrificial rituals—perform many other rituals to aid their husbands and, indeed, their presence is essential.<sup>8</sup> In short: “The wife is the back half of the ritual” says Jamison (1996, p. 30), quoting from a classical exegetical Hindu text.

But in addition to any role played in performing ceremonies, Brahmin women played an especially crucial role in providing a suitable home environment, as we outline here and elaborate on in Section 4.2. The Brahmins saw their role in society as the preservers of the

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<sup>7</sup>This aspect is important in understanding the persistence of the caste system and is discussed further in section 4.4.

<sup>8</sup>For instance, in describing the Kashmiri Pandits, a northern Brahmin sub-caste, Madan (1996) notes that “While the performance of rituals is primarily the responsibility of men and women cannot be the principal officiants, the participation of the latter is nevertheless required in the roles of wife or mother”, going on to note the duty of Pandit women to “chant auspicious songs at initiation ceremonies and weddings.”

Hindu scriptures. Since there was no script around 1,500 BCE (when the scriptures started appearing) and for at least another millennium, the scriptures had to be memorized and transmitted intact from one generation to the next. The Hindu scriptures thus had to be converted into durable capital in an era where the technologies for storing and transmission were very limited. This was accomplished by memorization and oral transmission. The elaborate methods devised by the Brahmins to facilitate accurate memorization from an early age by Brahmin boys are described in detail in Section 4.2. We shall see that the methods relied on social learning so as to ensure the accuracy of learning and transmission. The stringent conditions required for such rote learning warranted a home environment that would be conducive to such learning. It would have been of paramount importance for a Brahmin man to have a wife who came from a family with the same occupation because she could provide precisely this type of home environment to the children. For the Brahmins, to whom social learning was important and skills could be passed on intact to their progeny, out-marrying would have been accompanied by another externality (an intergenerational one). By preventing the dilution of skills and the attenuation of the stock of knowledge over time, endogamy conferred even greater benefits in this case. As we argue more fully in Section 4.2, this observation offers a clue to why India was unique in the extent to which its social stratification got so rigidly embedded: the Brahmins of India had to transmit their stock of knowledge without the benefit of written script for more than a millennium.

## 3 The Model

### 3.1 Fundamentals

Consider a population partitioned into  $C$  groups, where group  $c \in \{1, \dots, C\}$ . The unit of analysis in our model is the household. Each household has one offspring, either male or female. The utility of each member of a household is the sum of the payoffs of the parents and offspring in their various interactions. We assume that group  $c$  contains  $N^c$  male offspring and  $N^c$  female. Presuming equal numbers of males and females is a reasonable assumption to invoke in a model, but the consequences of a biased sex-ratio can be intuitively discerned after we spell out the model. The households participate in the marriage market and then enter into a series of periodic interactions with other group households. Household  $i$  receives a total payoff that depends on the payoffs arising from each of these stages according to  $U_i \equiv U_i^{\text{marriage}} + U_i^{\text{interaction}}$ . These components are considered in turn.

#### 3.1.1 Marriage

To capture this economic contribution of wives, we posit that when both members of a couple hail from families that practice the same trade, the skills of the spouses are complementary. Marrying someone from one's own occupational group enables the production



of an output  $Y$  that is jointly consumed by the couple.<sup>9</sup> However, when a male marries outside his group the couple’s output falls to  $\alpha_c Y$ , where the parameter  $\alpha_c \in [0, 1]$  is an inverse measure of the male-female complementarity in the activity of group  $c$ . This implies that when a female of group  $c'$  marries outside their group, the couple’s output falls from  $Y$  to  $\alpha_c Y$ , where  $c$  corresponds to her husband’s group. The parameter  $\alpha_c$  determines how exacting the required skills are in the occupation of caste  $c$ , being smaller for occupations that require highly specific matches.<sup>10</sup> As alluded to earlier, although skill complementarity is modeled here in terms of its effect on income, we expect that in reality the complementarity is also very important in the raising of children. We are assuming  $Y$  to be the same for all occupations. Other than affording simplicity, this enables us to separate caste from class considerations in our theory; our purpose is to isolate the former.

In modelling the marriage market, we intend to capture the tension that arises from families having a *ceteris paribus* preference for marrying within the group, while occasionally facing temptations to marry outside the group. Our model is based on the standard frictionless setting of Becker (1973). Relative to the standard setting, here matters are complicated by the fact that agents do not share a common preference ranking of partners. Specifically, spousal complementarity means that, all else equal, males from group  $c$  prefer a female from group  $c$  to a female from group  $c' \neq c$ , whereas the opposite is true for males from group  $c'$ . Nevertheless, it is clear that any stable matching will involve forming as many in-group marriages as possible.

To capture the occasional temptation to marry outside the group, we augment the Beckerian market with a stage in which household pairs realize preference shocks. Such shocks generate a (cardinal) utility  $b$ , where  $b$  is a random variable with a distribution function denoted by  $G$ . This allows for the possibility that individuals, perhaps by falling in love or by perception of a mutual temperamental compatibility, may prefer to marry someone outside their group.<sup>11</sup> We adopt a very simple structure describing the arrival of the preference shocks. Each household faces a probability of ‘encountering’ some other household and realizing a preference shock.<sup>12</sup> With probability  $\mu^{\text{in}} \geq 0$  the other household belongs to the same group and with probability  $\mu^{\text{out}} > 0$  they belong to some other group.<sup>13</sup> We take these probabilities as exogenous here, but we shall discuss their endogeneity subsequently. The pair of households have the opportunity to marry once the preference shock is realized. All families that do not marry at this stage find partners in the Beckerian market.

It is convenient, but inessential, to adopt a timing in which the Beckerian market opens after the preference shocks (and related marriage decisions) are realized.<sup>14</sup> To summarize

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<sup>9</sup>Assuming  $Y$  to be a household public good in this manner is merely a simplification that sidesteps any bargaining issues between the couple, a consideration that is not the focus here.

<sup>10</sup>In principle, the parameter  $\alpha$  could also depend on the group  $c'$  that the wife comes from, but we abstract from that possibility here to keep the model tractable.

<sup>11</sup>We restrict ourselves to heterosexual alliances since endogamy is precisely about these.

<sup>12</sup>Of course, an ‘encounter’ need not be a physical encounter—rather this language is simply being used as a convenient way to describe the shock distribution process.

<sup>13</sup>Since these events are mutually exclusive, we require  $1 - \mu^{\text{in}} - \mu^{\text{out}}$ , which is the probability of not encountering another family, to be non-negative.

<sup>14</sup>We could have instead supposed that the Beckerian frictionless outcome is first conditionally imposed,

then, the marriage market operates as follows.

**Stage 1** Households potentially encounter another household and observe a preference shock,  $b \sim G$ . The households marry if and only if both agree. If a marriage is formed between families of the same group, then a marriage payoff of  $U_i^{\text{marriage}} = Y + b$  is produced. If a marriage is formed between families of different groups, then a marriage payoff of  $U_i^{\text{marriage}} = \alpha_c Y + b$  is produced, where  $\alpha_c$  is the inverse complementarity parameter associated with the husband’s group. If a household is yet to find a marriage partner, they proceed to the following stage.

**Stage 2** Households form stable matches within a frictionless marriage market. This involves forming as many in-group marriages as possible. Those that get an in-group partner receive a marriage payoff of  $U_i^{\text{marriage}} = Y$ . Those that do not get an in-group partner receive a marriage payoff of  $U_i^{\text{marriage}} = y$ , where  $y < Y$ .<sup>15</sup>

This simple structure delivers the key features of interest: for a fixed preference shock, all households prefer to marry within their group in order to benefit from spousal complementarities, yet each is tempted to marry outside the group when a large enough preference shock is realized.<sup>16</sup> Importantly, the structure is symmetric across genders and groups: there is no assumed difference in the propensity to encounter out-group members, in-group members, or in the distribution of shocks, across genders or groups.<sup>17</sup> As such, our results that highlight asymmetries across genders and groups are not ‘wired’ by this structure. Rather, they emerge from the interaction of the asymmetry across groups in the importance of spousal complementarity and the asymmetry across genders arising from the fact that the household adopts the husband’s occupation.

### 3.1.2 Interactions

The parents in our model have economic interactions amongst themselves within their group (occupation), a phase into which they move after their offspring’s matching stage. The setting of these interactions provides groups with the facility to enforce endogamy in

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*then* the preference shocks are realized, and then those that are ‘abandoned’ by their partner are once again married in a secondary marriage market. This adds extra layers of notation for no benefit—the ex-ante marriage prospects remain the same.

<sup>15</sup>In general,  $y$  could depend on gender. Furthermore, we might expect that  $y$  also depends on the extent of the complementarity in production, with occupations of high complementarity having lower  $y$  because the consequences to not having a spouse are worse. But we abstract from these ramifications in the formal model. We interpret  $Y$  and  $y$  in present value terms.

<sup>16</sup>A more general treatment would allow preference shocks to be realized across a larger subset of other households. This would lead to households obtaining larger preference shocks in expectation and to a greater prominence of in-group marriages forming in the first stage. These sorts of effects can be easily incorporated in the present set-up by varying the distribution of preference shocks and raising  $\mu^{\text{in}}$ . An alternative treatment would be to consider frictional matching markets (e.g. Burdett and Coles (1997)). While we anticipate that our mechanism would apply equally well in such a setting, we do not pursue this possibility because such models are designed to highlight issues that are not our main concern (primarily marriage patterns among vertically differentiated agents) and adopt assumptions (large, anonymous, and stationary marriage markets) that seem unsuitable for our purposes.

<sup>17</sup>We will argue that some groups will have greater interests in altering the ‘encounter’ process by actively attempting to discourage cross-group interaction.

the marriage market, if that is the agreed-upon social norm. Parents of violators of the norm are punished through these interactions, which we model as an infinitely repeated game.<sup>18</sup>

In this phase, households within a group are randomly paired each period and play the following stage game. Parents in household  $i$  take action  $a_i$  at a strictly convex cost of  $c(a_i)$ , with  $c'(0) < 1$ . We posit that  $\min\{a_i, a_{-i}\}$  units of a local public good are produced and jointly consumed by the pair of households, where  $-i$  denotes the household other than  $i$  in the pair. The stage payoff to  $i$  is  $u(a_i, a_{-i}) \equiv \min\{a_i, a_{-i}\} - c(a_i)$ .

The efficient action in the stage game is  $a_i^* = a_{-i}^* = a^* \in \arg \max_a 2(a - c(a))$ . The advantage of this formulation is that any  $a \in [0, a^*]$  is a Nash equilibrium of the stage game, and lower actions produce lower payoffs. This allows us to support simple asymmetric equilibria in which there are two subgroups of players, the *punishers* and the *punished*, where the punishers are norm-respecters and the punished are norm-violators. In essence, the equilibrium unfolds as follows. If neither party belongs to the punished group then the efficient action is played. If at least one party belongs to the punished group, then a lower action is played. The ‘punishing’ lower action can vary by gender so that gender-specific punishments are feasible.

Specifically, if the interaction involves two punishers then both play  $a^*$ . If a punisher interacts with a punished of gender  $g$ , then both play some  $\hat{a}_g \in [0, a^*]$ . This is construed as a ‘punishment’ of  $\hat{\phi}_g \equiv u(a^*, a^*) - u(\hat{a}_g, \hat{a}_g)$ , noting that punishment is costly to inflict since both sides experience the punishment. The same punishment arises when two punishers of the same gender interact: i.e. both play  $\hat{a}_g$ . If punished players of different genders interact, then we assume that an ‘average’ punishment of  $\hat{\phi}_{mf} \equiv (\hat{\phi}_m + \hat{\phi}_f)/2$  arises.<sup>19</sup>

This formulation allows us to express interaction payoffs in a simple manner. Specifically, for norm-conformers we can write  $U^{\text{interaction}} = u^* - \bar{\phi}$ , where  $u^*$  is the present value of efficient-play payoffs and  $\bar{\phi}$  is the present value of expected punishments incurred by a ‘punisher’. Similarly, the interaction payoff for norm-violators of gender  $g$  can be expressed as  $U^{\text{interaction}} = u^* - \phi_g$ , where  $\phi_g$  is the present value of expected punishments incurred by a ‘punished’.<sup>20</sup>

The key is that it is costly to be classified as punished, but it is also costly for the punishers to inflict this punishment. The threat of acquiring “punished” status potentially dissuades deviations from endogamy if the punishment is severe enough. An advantage of this construction is that the extent of punishment can be continuously chosen with a

<sup>18</sup>Having the *parents* of violators be punished is consistent with fact, but is employed for a more fundamental reason: if interactions occur within occupation groups and wives adopt the occupation of their husband (as we assume), then it is impossible to enforce endogamy by punishing the married couple. We elaborate upon this in Section 4.1.2 below.

<sup>19</sup>That is, both play  $\hat{a}_{mf}$  where  $u(\hat{a}_{mf}, \hat{a}_{mf}) = (u(\hat{a}_m, \hat{a}_m) + u(\hat{a}_f, \hat{a}_f))/2$ .

<sup>20</sup>Formally, let  $\beta$  be the common discount factor and define  $u^* \equiv \sum_{t=1}^{\infty} \beta^t u(a^*, a^*)$  as the present value of efficient-play payoffs and  $\bar{\phi}_g \equiv \sum_{t=1}^{\infty} \beta^t \hat{\phi}_g$  and  $\tilde{\phi}_{mf} \equiv \sum_{t=1}^{\infty} \beta^t \hat{\phi}_{mf}$  as the present value of punishments. Suppose that  $\hat{N}_g$  of the  $N^c$  members of gender  $g$  in group  $c$  are to be punished. Then, if we let  $z_g \equiv \hat{N}_g/(2N^c - 1)$  be the probability that a punisher interacts with a punished of gender  $g$ , then  $\bar{\phi} \equiv z_m \cdot \bar{\phi}_m + z_f \cdot \bar{\phi}_f$ . Similarly, if we let  $Z_g \equiv \hat{N}_{-g}/(2N^c - 1)$  be the probability of a punished agent of gender  $g$  interacting with a punished agent of the other gender, then  $\phi_g \equiv (1 - Z_g) \cdot \tilde{\phi}_g + Z_g \cdot \tilde{\phi}_{mf}$ .

trade-off in mind, namely, higher punishments are better able to dissuade norm violations but are also more costly to impose.

### 3.2 Discrete Shocks

We begin with the most transparent setting. We assume that preference shocks are discrete:  $b \in \{0, B\}$ , with  $p$  as the probability that  $b = B$ . We assume that  $B$  is small enough that we have

$$B + \alpha_c Y + y < 2Y, \tag{1}$$

for some group  $c \in \{1, \dots, C\}$ . In other words, we assume the above inequality holds for the group with the highest degree of complementarity (the smallest  $\alpha_c$ ). The right hand side is the total payoff of an in-group couple's households in the absence of a preference shock. The left hand side is the sum of the payoff to person who has received (and has embraced) an out-group shock and a person in the group left without a spouse as a consequence. The assumption above implies that there is an externality associated with marrying outside the group when all others are marrying within the group, in the sense that the total payoff when a pair from the group marry is larger than the total payoff when one person marries outside the group. If this did not hold, it would never be optimal to interfere with marriage decisions (at least on the basis of expected payoff).

In this sub-section, we deal with the case in which the positive shock is large in the sense that all individuals who receive an out-group shock would prefer to marry outside the group when the punishment is zero. We assume here that

$$B \geq (1 - \alpha_c) Y, \tag{2}$$

for all  $c \in \{1, \dots, C\}$ . The left hand side is the preference-related benefit to an individual of embracing an out-group spouse and the right hand side is the income penalty borne due to the mismatched spouses in production. This penalty is naturally the largest for groups with the most complementary spousal inputs. In effect, we are assuming that the above inequality holds for the group with the highest degree of complementarity (the smallest  $\alpha_c$ ).

It would never be optimal, of course, to punish people if it did not alter behavior (in terms of dissuading marriage outside the group). Given the binary nature of the shock, and the above assumption on  $B$ , it is therefore either optimal to have zero punishments or to have punishments sufficiently high to discourage deviation by all (an endogamy norm).<sup>21</sup> Notice that punishments will not actually have to be inflicted in either case—the benefit of positive punishments is to ensure more even marriage market participation, while the cost is the forgone positive shocks. We now describe the relative payoffs.

For notational simplicity, we focus on one group. Note that, regardless of punishment levels, marriage will always occur between in-group members that encounter one another in the first stage—they can do no better than find another in-group partner in the second

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<sup>21</sup>To be sure, our assumption rules out the possibility that it is optimal to punish the household of one gender sufficiently highly while not punishing the other.

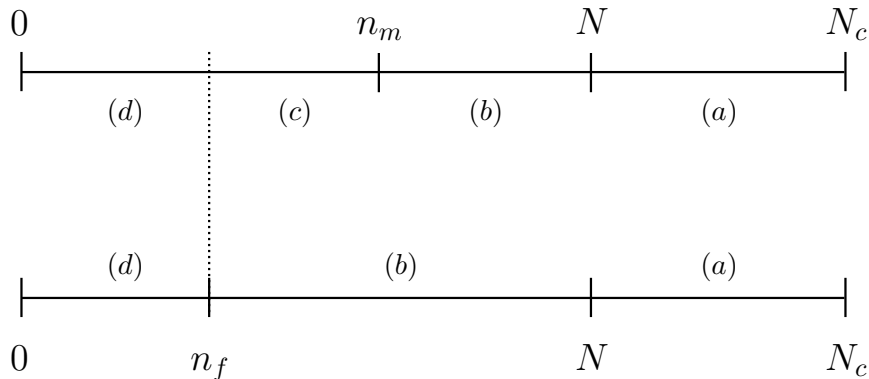


Figure 1: Possible Marriage Market Outcomes

stage and may do worse. All the action comes from analyzing the incentives to marry outside the group in order to benefit from the preference shock. As such, we proceed to analyze the payoffs arising when there are exactly  $N$  males and females within the group that do not encounter an in-group member in the first stage and are therefore liable to encounter a preference shock with an out-group member. The probability that exactly  $N$  males and females do not encounter an in-group member in the first stage is  $\tilde{\pi}(N) = \text{Bin}(N \mid N^c, 1 - \mu^{\text{in}})$ , and the equality of this probability across genders follows from the fact that in-group marriages occur in pairs.

We begin with the case in which there is no punishment. Suppose that  $n_m$  of the  $N$  males and  $n_f$  of the  $N$  females do not marry in the first stage and therefore seek an in-group member in the second stage. An example of this situation is depicted in Figure 1, where the top line describes the male population and the bottom line describes the female population. The number of in-group alliances that will be formed is the smaller of  $n_m$  and  $n_f$ , as represented by the dashed line in Figure 1. In terms of computing the aggregate payoff to households with offspring of gender  $g \in \{m, f\}$  for a particular realization of the pair  $(n_m, n_f)$ , we note that there are four possible outcomes to consider. The first, represented by those in region (a), are those who encounter an in-group member in the first stage; the second, represented by those in region (b), are those who form an out-group alliance in the first stage; the third, represented by those in region (d), are those who find in-group partners in the second stage; and the fourth, represented by those in region (c), are those who do not find in-group partners in the second stage.<sup>22</sup> Putting these together, the aggregate payoff to households with offspring of gender  $g$  is:

$$U_g(n_m, n_f \mid N) = (N^c - N)(Y + p \cdot B + u^*) + (N - n_g)(\alpha_g Y + B + u^*) \\ + \min(n_m, n_f)(Y + u^*) + [n_g - \min(n_m, n_f)](y + u^*), \quad (3)$$

<sup>22</sup>Note that at most one gender will have members in region (c) since the marriage market forms as many in-groups marriages as possible.

where  $\alpha_m = \alpha_c$  and  $\alpha_f = \bar{\alpha}_{-c}$  (the average  $\alpha$  among groups that females out-marry into). The aggregate Benthamite payoff of all members in the group is

$$U(n_m, n_f | N) \equiv U_m(n_m, n_f | N) + U_f(n_m, n_f | N). \quad (4)$$

The above payoffs, of course, are conditional on the realization of  $(n_m, n_f)$ . The probability of drawing the pair  $(n_m, n_f)$  from  $N$  males and  $N$  females is given by the product of two binomial random variables:

$$\pi(n_m, n_f | N) = \text{Bin}(n_m | N, 1 - q) \cdot \text{Bin}(n_f | N, 1 - q),$$

where

$$q \equiv p \mu^{\text{out}} / (1 - \mu^{\text{in}})$$

is the probability of receiving the positive preference shock with an out-group member conditional on not encountering an in-group member. The expected aggregate payoff, conditional on  $N$ , in the *no punishment* case is then

$$U^{NP}(N) \equiv \sum_{n_m=0}^N \sum_{n_f=0}^N \pi(n_m, n_f) \cdot U(n_m, n_f). \quad (5)$$

The expected aggregate payoff, conditional on  $N$ , in the case whereby an *endogamy norm* is enforced with full punishment<sup>23</sup> is simply:

$$U^E(N) = 2(N^c - N)(Y + p \cdot B + u^*) + 2N(Y + u^*). \quad (6)$$

Thus, conditional on there being  $N$  males and  $N$  females liable to encounter preference shocks with out-group members, the net payoff to the group of endogamy, as perceived by a Benthamite planner, is the difference  $U^E(N) - U^{NP}(N)$ . The unconditional net benefit to endogamy is therefore  $\sum_{N=1}^{N^c} \tilde{\pi}(N) \cdot [U^E(N) - U^{NP}(N)]$ .

**Proposition 1.** *The net benefit to endogamy is (a) increasing in  $Y$ , (b) decreasing in  $y$ , (c) decreasing in  $B$ , and (d) decreasing in  $\alpha_m$  and  $\alpha_f$ .*

This proposition gives some sense of the groups with the largest incentives to adopt endogamy norms. In understanding the proposition, it is sufficient to focus on the net benefit to endogamy for a given value of  $N$  - i.e. the difference between  $U^E(N)$  from (6) and  $U^{NP}(N)$  from (5) - since the parameters do not affect  $\tilde{\pi}(N)$ . We begin by noting that out-marrying carries an income penalty due to skill mismatch and that this is internalized by the couple. However, there is also the externality associated with marrying an outsider in that it inflicts an income penalty of  $(Y - y)$  on a group member who cannot find a spouse as a result. So the net benefit of endogamy increases in  $Y$  and decreases in  $y$ , explaining parts (a) and (b) of the proposition. This net benefit is naturally decreasing in  $B$ , by part (c), because endogamy forces people to abandon their out-group preference

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<sup>23</sup>Note that, as long as the punishment is severe enough, it never has to be inflicted in equilibrium because all violations are prevented.

shock. Part (d) brings home the importance of spousal complementarity in production. Groups with a high degree of spousal complementarity in production (low  $\alpha_m$ ) will tend to favor endogamy norms because of the greater income loss due to mismatch. Individuals who out-marry internalize the attendant income penalty but they do so because they are more than compensated by the preference shock  $B$ . Nevertheless, since the surplus from a given  $B$  is increasing in  $\alpha_m$  and  $\alpha_f$ , the net benefit to endogamy decreases in the latter. This is part (d) of the above proposition.

It may seem at first blush that endogamy may not necessarily be most attractive to groups with high spousal complementarity because groups with a low  $\alpha_m$  will tend to have a high  $\alpha_f$  since females from such groups will tend to encounter males from relatively high  $\alpha$  groups on average. In other words, even if endogamy benefits the males of high complementarity groups it will tend to not benefit the females, and a planner who weights them equally (as does the Benthamite planner we are invoking while aggregating payoffs) may not deem endogamy optimal. However, starting from a position in which no group enforces endogamy, the sum  $\alpha_m + \alpha_f$  is smallest for the group with the highest spousal complementarity when all groups are the same size.<sup>24</sup> We can then be sure that groups with a high degree of gender complementarity have the most to gain from initiating the adoption of endogamy.

The following result, the proof of which is in the Appendix I, provides a sufficient condition for when endogamy is definitely preferred.

**Proposition 2.** *Endogamy with full punishment is preferred to no punishment if the probability of an individual encountering an out-group member,  $\mu^{out}$ , is sufficiently small (but positive).*

This is a counterintuitive result. At first blush it might appear that endogamy would have little benefit when the probability of an out-group preference shock is small. Why insist on endogamy when the chances of out-marriage are small in any case? The case for endogamy hinges on externalities. The externality associated with an individual embracing an out-group shock is that there is the possibility of a group member of the opposite sex not finding a spouse as a result and thereby receiving a reduced payoff. However, if equal numbers of males and females embrace out-group shocks, there is no such externality and insisting on endogamy would needlessly force some people to relinquish their preferred out-group partners of choice. Thus the cost of the externality associated with out-group marriages depends on there being a *difference* in the numbers of males and females opting to marry outside the group. Even though the expected value of this difference is zero (given

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<sup>24</sup>To see this, note that when groups are of equal size, an out-marrying female from group  $c$  is equally likely to marry into each other group (under the assumptions in this section). As such, we have  $\alpha_f = (\sum_{k=1}^C \alpha_k - \alpha_c) / (C - 1)$ . Therefore  $\alpha_m + \alpha_f = \alpha_c \cdot (C - 2) / (C - 1) + (\sum_{k=1}^C \alpha_k) / (C - 1)$ . The final term is constant across groups, so the group with the lowest value of  $\alpha_m + \alpha_f$  is the group with the highest complementarity (i.e. lowest  $\alpha_c$ ). This holds strictly when there are more than two groups. In the case with just two equal-sized groups the value of  $\alpha_m + \alpha_f$  must be the same across the groups. If the income  $y$  of being without a spouse is lower in the high-complementarity group (which would make sense precisely because of the greater need for a spouse in production), or if the Benthamite planner were even marginally biased toward the utility of males, then this group will again have the stronger preference for endogamy even when there are only two groups.



that  $q$  is the same for males and females), this is not the relevant entity of interest. Rather, it is the expected value of the *absolute* difference that matters because the externality is incurred regardless of whether it is males or females who are on the long side of the marriage market.

To begin, consider the extreme case whereby out-group members are never encountered:  $\mu^{\text{out}} = 0$ . In this case all those that do not receive a positive preference shock with an in-group member are certain to find an in-group member in the marriage market nonetheless. There is no particular benefit to endogamy in this case - in fact, the net benefit to endogamy is exactly zero since out-group marriages never occur. As  $\mu^{\text{out}}$  is increased, the possibility of their being a mismatch in the aggregate numbers of males and females receiving out-group shocks emerges. Specifically, for small  $\mu^{\text{out}}$  the set of possible outcomes is dominated by three events: an out-group shock is received by (i) no male and no female, (ii) exactly one male but no female, and (iii) no male but exactly one female. As discussed above, the net benefit to endogamy is zero in case (i). However, in cases (ii) and (iii) there is a positive net benefit to endogamy due to the externality identified above.

We may note that endogamy would never be preferred if all groups in society had identical skills; heterogeneity is essential for this ensures  $y < Y$ . If all groups were perfectly symmetrical in abilities, upon not finding a within-group spouse a person could marry, with no income loss, an out-group individual who has met a similar fate. Then there would be no gains to enforcing endogamy. For our model to be meaningful, we require hereogeneity. This is not an issue, however, in any real-world setting where different occupations require different skills.

There are at least two interesting and important implications that follow from Proposition 2. First, endogamous groups can form *sequentially*. As one group adopts endogamy norms, this effectively decreases  $\mu^{\text{out}}$  since encountering a member of an endogamous group is equivalent to not encountering them at all (since they will never agree to marriage, even if the positive shock is received). This is especially so when the endogamous group puts in place various restrictions on the movements and actions of its members (we shall discuss some of these later in the paper). In accordance with Proposition 2, the subsequent fall in  $\mu^{\text{out}}$  for other groups would encourage them to adopt endogamy norms, and so the process of caste formation can cascade. This is consistent with the evidence, such as there is, on the formation of castes. The oldest reference to caste is in the Rig Veda, a Hindu scripture. This Veda mentions only two castes (Brahmins and Kshatriyas) at the beginning (composed roughly at 1,500 BCE) and by the end (composed some 500 years or so later), some hymns mention three castes (Brahmins, Khatriyas, and Vaishyas). The fourth group of Shudras was a later addition to the caste system after 1,000 BCE. It seems to be the case that the Brahmins were the first endogamous group [Le Bon (2005)]; they separated out from the warriors (Kshatriyas), who subsequently separated from the agriculturists.

The second important implication of the above proposition is that the caste system may be incomplete in the sense that there may exist a group for which there may be no serious spousal complementarity in production and it would rather not circumscribe personal



choice of marriage partners. Nevertheless, this group may be hurt by the formation of other castes because endogamy is *de facto* imposed on them (as no other group will out-marry with them). The group without a caste (the ‘untouchables’, now referred to as Dalits) is a case in point. The Dalits do not accept the validity of the caste system and they see it as a monstrous institution imposed on them without their consent.<sup>25</sup> The fact that individual groups found it beneficial to cordon themselves off from the rest of the population in terms of marriage certainly does not suggest that the collective benefitted as a whole even during the inception of the caste system.

It may be noted in passing that another necessary condition for endogamy to be preferred is that the size of the preference shock not be too large. If the shock is very large, a group’s expected aggregate payoff will clearly be maximized if no constraints are put on personal choices.

#### *Asymmetries by Gender and Caste*

If endogamy is optimal, how do punishments vary across genders and across caste groups? These are the issues we now turn to. To dissuade a deviation we need the payoff from conformity to be at least as large as that from violation:  $Y + u^* \geq \alpha_g Y + B + u^* - \phi_g$ . That is, the punishment must be at least as large as  $\phi_g^*$ , the minimal required punishment:

$$\phi_g \geq \phi_g^* \equiv B - (1 - \alpha_g)Y,$$

where we must remember that when  $g = f$ , the parameter  $\alpha_f$  denotes the (inverse) degree of complementarity of the group the woman has married into. The term  $B - (1 - \alpha_g)Y$  is the benefit conferred by the preference shock less the income penalty suffered due to mismatch of the spouses in production. Since this entity is a measure of the temptation to violate endogamy norms, any punishment that would dissuade violations must be at least as large as this.

**Proposition 3.** *The minimal required punishment to deter violations of endogamy by (i) males,  $\phi_m^*$ , is independent of which group their wives come from, and (ii) by females,  $\phi_f^*$ , is higher when they marry into a group with lower gender complementarity (higher  $\alpha$ ).*

Since a couple’s occupation is determined by the husband’s, no matter which group his wife is drawn from it is the technology of his occupation that dictates the degree of complementarity. If the occupations are sufficiently different (as we are assuming), the training of women drawn from all possible outgroups is equally irrelevant. The fall in output due to spousal mismatch in production is the same for all out-group wives and is determined only by  $\alpha_c$ , where  $c$  is the husband’s group. This explains part (i) of the above proposition. The lower the cost of mismatch between spousal capacities, the greater is the incentive for a woman to violate endogamy norms when she receives a out-group preference shock. She has less incentive to embrace an out-group shock with a man

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<sup>25</sup>While there is a vast literature on this, Ambedkar (1917) offers one of the most compelling critiques of the caste system from the standpoint of the Dalits.

whose occupation requires a high level of complementarity. So the punishment required to dissuade violations by women have to be increasing in  $\alpha_c$ , where  $c$  is the intended husband's group. This explains part (ii) of the proposition. Since it is the groups with the highest complementarities that are most interested endogamy and because it is women from precisely these groups who are most tempted to out-marry, these are the groups that inflict the severest punishments for violations.

It might be objected that, in an inter-caste marriage, the wife's parents' occupation may be different but perhaps not very different from the husband's. So how can we assume that wives drawn from all occupations will lower output by the same amount? The distinction being made here (of slight differences) is between the occupations of *sub-castes*. The generation of sub-castes and when they arise will be discussed subsequently. Here we are addressing the formation of the *varna* system, and the activities of the different *varnas* are substantially different in nature.

A very important implication of the above proposition is that it proposes a hierarchy of groups based on the degree of spousal complementarity in production. It is well recognized that women are punished more when marrying 'down' (called 'hypogamy') than for marrying 'up' (called 'hypergamy'). The terms 'up' and 'down' suggest a hierarchy. We claim that 'down' corresponds to lower complementarity (higher  $\alpha$ ) and 'up' to greater complementarity (lower  $\alpha$ ). Consider four broad castes labeled 1, 2, ...4, with  $\alpha_1 < \alpha_2 < \alpha_3 < \alpha_4$ . The logic of Proposition 3 informs us that members of Caste 2 will punish more severely its women who marry into Caste 3 than those who marry into Caste 1. Likewise, members of Caste 3 will punish more severely its women who marry into Caste 4 than those who marry into Castes 1 and 2. So, if norm violation is to occur for women, Castes 2 and 3 find marriage into Caste 1 less objectionable than the alternatives. Caste 3 finds marriage of their women into Castes 1 and 2 less objectionable than the alternative (which is marriage into Caste 4). Thus, based on the treatment of women who violate endogamy, a hierarchy will be established. In this hierarchy, Caste 1 will be at the top, Caste 2 will follow, then Caste 3, and finally Caste 4. If the four castes are identified as Brahmins, Kshatriyas, Vaishyas, and Shudras, this hierarchy uncannily resembles the dictum laid down by law-giver Manu [Buhler (1886, IV, 12-13)]:

A Shudra woman alone (can be) the wife of a Shudra, she and one of his caste  
(the wives) of a Vaishya, those two and one of his own caste (the wives) of a  
Kshatriya, those three and one of his own caste (the wives) of a Brahmana.

In other words, women can marry 'up' but not 'down', and the dictum lays down the precise hierarchy of the castes. The point to note here is that it is not caste hierarchy that determines whom women can marry; the causation is the reverse.

Our theory of hierarchy in castes hinges on the the degree of complementarity of the spousal inputs into production: Caste 1 exhibits the greatest complementarity and Caste 4 the least. Arguably, this complementarity is reflected in the extent of the specialization in the tasks of the husband and the wife. This specialization is rather extreme among the Brahmins and the Kshatriyas. Among the Brahmins, only men can be priests who specialize in exacting rituals but women aid them in essential ways (see Sections 2 and 4.2

for details). Among the Kshatriyas, usually only men are warriors but since there is no scriptural injunction against women taking up arms, there is a little more substitutability possible than amongst Brahmins. The greatest substitutability is in tasks entailing the least amount of human capital—those that are menial, occupations that comprise the Shudra caste. It is important to realize that, though we have opted to model the husband-wife complementarity in production only, this complementarity is also important in the *raising of children*. Raising children to follow in a particular tradition requires intimate knowledge of the procedures followed in that tradition and this is imbibed from childhood.

Apart from gender asymmetry exhibited in hypergamy and hypogamy, there is a more pernicious gender asymmetry in that women are punished more harshly than men in the group with the highest complementarity (i.e. the group that is most likely to favor endogamy).

**Proposition 4.** *In the group with the most spousal complementarity, females face higher punishments than males.*

Following the labeling used above, the group with the highest complementarity is the one that is uppermost in the caste hierarchy and has a complementarity parameter  $\alpha_1$ . Thus the minimal punishment required to dissuade its males from intercaste marriages is  $B - (1 - \alpha_1)Y$ . For its females, however, the minimal punishment needed to thwart deviation is the smallest value of  $B - (1 - \alpha_f)Y$ , for  $\alpha_f \in \{\alpha_2, \alpha_3, \alpha_4\}$ . Since  $\alpha_1 < \alpha_2 < \alpha_3 < \alpha_4$ , it follows that the smallest punishment that women face is  $B - (1 - \alpha_2)Y$ , which is larger than  $B - (1 - \alpha_1)Y$ .

This proposition provides one rationale for gender asymmetry in punishments that is frequently observed, at least for women of the uppermost castes, and also ordained in the sacred Hindu texts [Chakravarti (1993)]. There is another reason that is at least as compelling which we have not incorporated here but the validity of which can be easily discerned in the light of our model. The key reason for endogamy norms of the caste system here is the externality that out-group alliances inflict on the group, which results in a mismatch between the number of marriageable males and females in the group. Now in a patriarchal society, the perceived cost to a male member of not leaving behind progeny is deemed much higher than that of a female remaining without children. There is evidence to suggest that patriarchy was in place in the pastoral and agricultural economy of India well before the caste system evolved [Chakravarti (2003, Ch. 4)].<sup>26</sup> Therefore, a social planner would deem the external effects of a woman's defection to be much more deleterious to the group than a man's, and that the punishment needed to thwart women's violations have to be even more severe. The severity of the punishments meted out to women perhaps has at least as much to do with patriarchal values as with the incentives confronting women, but the two effects work in the same direction, namely, making punishments harsher on women than on men.

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<sup>26</sup>Holden and Mace (2003) have shown that the move from horticulture to pastoralism led to the switch from matrilineality to patrilineality among the Bantu speaking regions in Africa. Recently, Alesina, Giuliano, and Nunn (2013) have shown that geographical regions around the world which historically used the plough in agriculture promoted patriarchal values that are visible even today.

Note that we cannot assert that the result in Proposition 4 holds for all other castes. For example, to dissuade a Caste 3 female from marrying into Caste 1 it will require a minimal punishment of  $B - (1 - \alpha_1)Y$ , which is smaller than the minimal punishment of  $B - (1 - \alpha_3)Y$  that would dissuade a male of Caste 3 from an inter-caste marriage. However, if we had added a relatively greater cost to males for not leaving behind progeny that we have alluded to above, the result in Proposition 4 would likely hold for the lower castes, too.

The advantage of endogamy identified here is a lower bound if we think of the planner as also caring about dynamic skill spill-overs. That is, the planner would prefer endogamy even more if they are concerned about avoiding skill dilution as a result of out-group marriages. We discuss this argument in 4.2 below and formalize it in Appendix II because it is very relevant to understanding the Brahmin insistence on endogamy.

### 3.3 Continuous Shocks

The benefits of endogamy in the simplified discrete-shock model disappear as the population becomes infinitely large. Intuitively, a “law of large numbers” comes into play whereby individuals are almost surely able to find an in-group partner in the marriage market as long as the *proportion* of males and females out-marrying is the same (as it is in this case, given by  $q$ ). There is thus a cost but no benefit to endogamy in the limit. This occurs because we have assumed the discrete shock is large enough that it is always embraced in the absence of punishments; there is no incentive-dependent margin of the preference shock below which an individual will not violate endogamy. This is not so, however, when the preference shock is a continuous variable. In this case, groups with high complementarity find that their males are less likely to agree to an out-marriage than the females (who face lower complementarity partners on average). In this case, when punishment levels are equal, there is an expected mismatch in the marriage market even as the population size grows to infinity.

To formalize, we now suppose that the distribution of the preference shock,  $G$ , is a continuous distribution. We assume a large population comprising two groups, labeled 1 and 2, with the former exhibiting greater complementarity in production (that is,  $\alpha_1 < \alpha_2$ ). As before, recall that a group member encounters another group member with probability  $\mu^{\text{in}}$  and an out-group member with probability  $\mu^{\text{out}}$ .

Encounters between group members in the first stage always end in marriage. Encounters with out-group members, however, end in marriage if the shock is large enough:  $b \geq \bar{b}_g$ , where the critical minimum is depends on the gender  $g$  because, as we have already seen, the incentives to marry outside the group are gender-dependent. The event  $b \geq \bar{b}_g$  occurs with probability  $1 - G(\bar{b}_g)$ . Let  $q_g$  be the probability that a group member of gender  $g$  marries outside the group conditional on not encountering an in-group member. This is given by expression

$$q_g \equiv (1 - G(\bar{b}_g)) \cdot \mu^{\text{out}} / (1 - \mu^{\text{in}}).$$

Simple rearrangement of the above definition allows us to express the magnitude of the cut-off shock  $\bar{b}_g$  as a function of the probability  $q_g$ :

$$\bar{b}_g = \bar{b}(q_g) \equiv G^{-1} (1 - q_g \cdot (1 - \mu^{\text{in}})/\mu^{\text{out}}).$$

To determine the value of  $q_g$  we note that the cut-off shock,  $\bar{b}_g$ , by definition, renders a person of gender  $g$  who receives such a preference shock indifferent between marrying the outsider and relinquishing this option and entering the second stage. The payoff to marrying the outsider is  $\alpha_g Y + \bar{b}_g(q_g) - \phi_g$ , where  $\phi_g$  denotes the punishment that is inflicted on the household of the person for violating the endogamy norm. If the person relinquishes the option of marrying the outsider, it not clear that they will find a spouse within the group, for they may find themselves on the long side of the market if too many people of the opposite gender have out-married. Denote by  $\rho_g$  the probability of finding an in-group partner upon entering the second stage. Since a proportion  $1 - q_g$  of group members that are liable to encounter a preference shock with an out-group member end up entering the second stage, this probability is given by

$$\rho_g \equiv \min \left\{ \frac{1 - q_{-g}}{1 - q_g}, 1 \right\},$$

where  $-g$  denotes the gender other than  $g$ . The probability  $\rho_g(q)$  is determined by the relative scarcities of genders  $g$  and  $-g$  in the market. The expected income of this marginal individual in conforming would then be  $\rho_g(q) Y + [1 - \rho_g(q)] y$ . In determining the expected payoff from entering the second stage, we must subtract the average punishment from this amount:  $\rho_g Y + [1 - \rho_g] y - \bar{\phi}$ .<sup>27</sup>

Since the individual who has received an out-group preference shock  $\bar{b}_g(q_g)$  is indifferent between embracing and relinquishing the out-group member by definition, we must have

$$\alpha_g \cdot Y + \bar{b}(q_g) - \phi_g = \rho_g \cdot Y + [1 - \rho_g] \cdot y - \bar{\phi}, \quad (7)$$

where  $g \in \{m, f\}$ . This expression can be used to show that a role for punishing out-marriages arises with continuous preference shocks despite the large population size. It also provides insight into the punishments that are required to correct this imbalance.

**Proposition 5.** *If there are no punishments, then there will be some males in the high complementarity group that do not get in-group partners. In order to achieve balance in the marriage market, i.e. achieve  $q_f = q_m = q$ , then females are punished more than males in the high-complementarity group.*

The intuition is straightforward. For the higher caste in this two-caste scenario,  $\alpha_m = \alpha_1 < \alpha_2 = \alpha_f$ . Since the income penalty due to spousal mismatch is smaller for females, they have a greater incentive to violate endogamy and hence the punishment on the household has to be more severe. If the punishments are the same, a higher proportion of

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<sup>27</sup>Formally, since a proportion  $q_g \cdot (1 - \mu^{\text{in}})$  of gender  $g$  families are violators, we have  $\bar{\phi} = (q_m \cdot (1 - \mu^{\text{in}})/2) \cdot \bar{\phi}_m + (q_f \cdot (1 - \mu^{\text{in}})/2) \cdot \bar{\phi}_f$ .

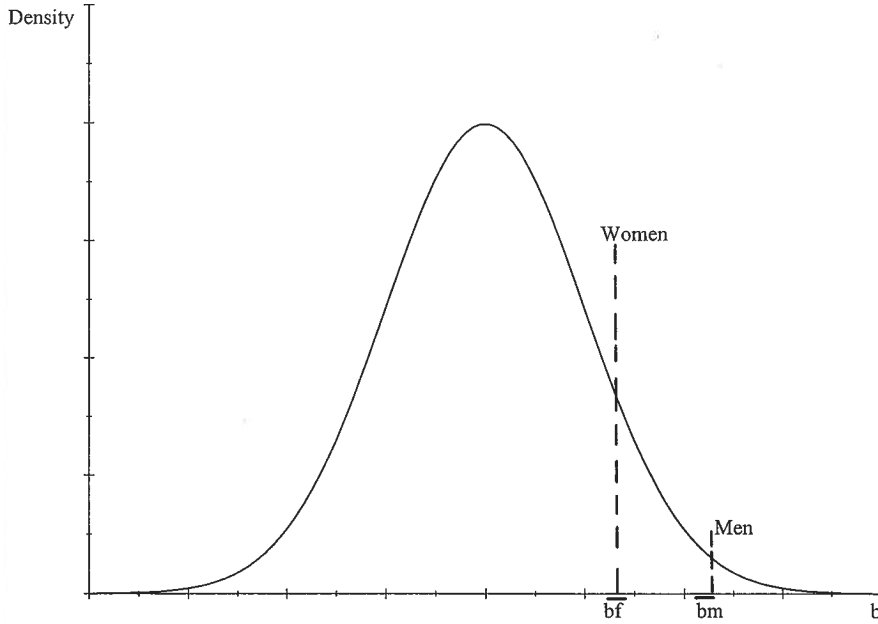


Figure 2: Critical shocks for a given punishment for both genders

women would violate endogamy (see Figure 2). In order to achieve balance in the marriage market, females must be punished more than males.<sup>28</sup>

We can also use (7) to describe the size of a group's average punishment when the group balances the marriage market. Specifically, for a given  $q$  we have that the average punishment is increasing in  $(\alpha_m + \alpha_f)$  and  $\mu^{\text{out}}$  and decreasing in  $Y$ .<sup>29</sup> Intuitively, when the average complementarity increases (i.e. when  $\alpha_m + \alpha_f$  decreases) the lost income resulting from an out-marriage increases, and therefore less of a punishment is required. In a similar vein, when income increases, the lost income resulting from an out-group marriage is larger in absolute terms and therefore less punishment is required to achieve a given  $q$ . When the probability of out-group encounters  $\mu^{\text{out}}$  increases, in order to keep  $q_g$  fixed the cut-off shock  $\bar{b}_g$  must be increased. The indifferent deviator, who now is a person with a larger preference shock for an outsider, therefore requires higher punishment to be dissuaded from marrying the outsider.

<sup>28</sup>For the lower caste, however,  $\alpha_m = \alpha_2 > \alpha_1 = \alpha_f$ , and so this model would suggest a higher punishment for males. The reason this is unlikely in practice is that, as before, we have not incorporated in our model the perceived differential cost to males and females to leaving behind progeny in a patriarchal system.

<sup>29</sup>To see this formally, let  $\hat{q} \equiv q \cdot (1 - \mu^{\text{in}})/2$  be the probability of encountering a violating family of a given gender. The average punishment is  $2\hat{q}^2 \cdot (\tilde{\phi}_m + \tilde{\phi}_f)/2 + 2\hat{q}(1 - \hat{q}) \cdot (\tilde{\phi}_m + \tilde{\phi}_f)$ , which equals  $(2\hat{q} - \hat{q}^2) \cdot (\tilde{\phi}_m + \tilde{\phi}_f)$ . Noting that  $q_f = q_m$  implies  $\rho_m = \rho_f = 1$  and  $\bar{b}_m = \bar{b}_f = \bar{b}(q)$ , we add the male version of equation (7) to the female version to get:  $(\alpha_m + \alpha_f) \cdot Y + 2 \cdot \bar{b}(q) - (\tilde{\phi}_m + \tilde{\phi}_f) = 2Y - 2\bar{\phi}$ . Use  $\bar{\phi} = (\tilde{\phi}_m + \tilde{\phi}_f) \cdot \hat{q}$  and  $\tilde{\phi}_m + \tilde{\phi}_f = (\tilde{\phi}_m + \tilde{\phi}_f)(1 - \hat{q} + \hat{q}) = \tilde{\phi}_m + \tilde{\phi}_f$  to get  $(\tilde{\phi}_m + \tilde{\phi}_f) \cdot (1 - 2\hat{q}) = 2\bar{b}(q) - (2 - (\alpha_m + \alpha_f)) \cdot Y$ . The left side is  $(1 - 2\hat{q})/(2\hat{q} - \hat{q}^2)$  times the average punishment, implying that the average punishment is  $\frac{2\hat{q} - \hat{q}^2}{1 - 2\hat{q}} \cdot [2\bar{b}(q) - (2 - (\alpha_m + \alpha_f)) \cdot Y]$ . The effects of  $Y$  and  $\alpha_m + \alpha_f$  are clear from this expression. A higher  $\mu^{\text{out}}$  raises  $\bar{b}$  for a given  $q$ , and this delivers the remaining result.

## 4 Discussion

### 4.1 Enforcing Endogamy

Caste endogamy is enforced by a litany of highly specific regulations and punishments for violations, many of which are catalogued in the *Code of Manu* (compiled around 300 CE). The punishments are imposed and overseen by caste councils comprising village elders from the caste. The punishments generally seem to fit the perceived crime: minor infractions are punished with fines and penances of various sorts, and major ones can result in excommunication from the caste—which meant that all caste members shun their company—and sometimes even death. The most important punishments, from our point of view, are those pertaining to endogamy. Actions that are likely to lead to violations of endogamy are proscribed and actual violations of endogamy severely punished (often with excommunication).

Punishments for offences depend on the castes of the offender and the victim [Kane (1953, v. 4, pp. 80-81), Tambiah (1973)]. A distinction is made between two sorts of offenses. For one kind, those in the lower castes were given higher punishments. In particular, a lower caste member (deemed ‘impure’) received a harsher punishment for injuring a Brahmin (deemed ‘pure’) than did a Brahmin who inflicted the same injury on a lower caste person. The putative principle here is that the higher the purity (or status) of the victim relative to the offender, the greater the punishment. In fact, this is true even today: experimental evidence by Hoff et al (2011) shows that members of the lower caste are less willing to punish higher caste members who perpetrate harm on a fellow caste member than are higher caste members in a reciprocal scenario. This self-serving preferential treatment of Brahmins does suggest the use (or abuse) of power. But it is also consistent with the goal of maximizing the group size of a caste that is persuaded it is carrying precious intergenerational capital, the nature of which is described in the next subsection. For offenses of another kind, punishments are harsher for the higher castes. Those actions involving pollution by contact with inferiors, for example, fall in this category. The principle here is that the higher the status of the offender, the greater is the fall in purity through contact with inferiors and the penance must be commensurately greater [Tambiah (1973)]. The punishments for both sorts of offenses can be explained quite simply as means through which higher castes maintained group size and endogamy—by preventing other groups from harming the upper castes on the one hand and, on the other, by dissuading the upper castes from mixing with the lower. In either case, we see the notions of purity and pollution as being merely instrumental in serving the goal of endogamy and maintaining group size (for its intergenerational spillover effects).

Among the actions that could lead to pollution, an important one is commensality and the eating of lower-caste food. Eating together necessitates interaction and leads to familiarity, and there are strict restrictions on inter-caste commensality. Again, rules like these are rationalized in terms of the purity/pollution dichotomy: the allegedly purer higher castes cannot afford to pollute themselves through contact or by eating lower caste food. We argue that these restrictions simply arise from the need to minimize the

probability ( $\mu^{out}$ ) of an individual conceiving a preference for out-group members. Once again, notions of purity and pollution are merely vehicles for minimizing violations of endogamy.

Inter-caste marriages were deemed to be among the most serious of offences, naturally enough, because these threatened the very existence of the caste system. Once again, such marriages were deemed offensive (especially hypogamy) for reasons pertaining to purity and pollution.<sup>30</sup> The implementation of strict caste endogamy came with very oppressive measures on women. To prevent women from establishing contact from out-group males, their autonomy was severely curtailed.<sup>31</sup> Here is what Manu said: “By a girl, by a young woman, or even by an aged one, nothing must be done independently, even in her own house. In childhood a female must be subject to her father, in youth to her husband, when her lord is dead to her sons; a woman must never be independent.” [Buhler (1886, V, 147-148)]

Women were repeatedly derided for ostensibly having an excessive sexual appetite in the *Code of Manu* and other *Dharma-Shastras* (Rules of Right Conduct) [Wadley (1977), Chakravarti (1993)]. “Through their passion for men, through their mutable temper, through their natural heartlessness, they become disloyal towards their husbands, however carefully they may be guarded in this (world).” [Buhler (1886, IX, 15)] The passions of women were deemed inately impure, unless channeled into virtuous avenues through unconditional devotion to a husband.<sup>32</sup> “Though destitute of virtue, or seeking pleasure (elsewhere), or devoid of good qualities, (yet) a husband must be constantly worshipped as a god by a faithful wife,” says Manu [Buhler (1886, V, 154)]. The frequently expressed misogyny in Brahmanical literature very likely served several related purposes. First, it attempted to thwart men from falling prey to their own sexual urges—conveniently projected onto women—and from dissipating themselves in sexual escapades instead of pursuing their caste preoccupation of faithfully reproducing the scriptures (as described in the next subsection). Secondly, impugning women’s character would have provided men with the justification to monitor their sexuality in order to enforce endogamy and ensure paternity. Finally, as forcefully argued by Chakravarti (2003), religious approval of the view that women are allegedly inferior to men would have aided the process of socialization whereby women come to internalize these views and thus become unwitting accomplices in their own subjugation. To be sure, oppression of women through the attempted control of their sexuality is a common feature of all patriarchal societies. Our model quite unambiguously suggests, however, that in the Indian context the caste system has exacerbated the oppression of women over and above what they would have suffered in an established patriarchy.

As mentioned earlier, the view of anthropologist Dumont (1970) is that the entire caste

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<sup>30</sup>Yalman (1963, p.42) reports that in Sri Lanka (which shares the caste system among the Hindus) if a child was conceived through hypogamy, both mother and child used to be drowned as a deterrent.

<sup>31</sup>Even the *Bhagavad Gita*, a very important scripture for Hindus that was composed around 200 BCE, echoes the idea that the chastity of women is essential to the maintenance of castes (Ch. 1, verse 41).

<sup>32</sup>A telling example is found in the Hindu epic *Ramayana* in which Sita, the wife of god Rama, embodies the highest ideals of the Hindu wife. After she was abducted by Rama’s archrival and Rama rescues her by waging a war, he asked Sita to prove that she had remained chaste during her absence.



system follows from religious notions of purity and pollution. He argues that political economy considerations are secondary; secular notions of power had no play in the establishment of the caste system. Although he has been criticised for this position [e.g. see Marglin (1977)], we agree with Dumont that secular notions of power and exploitation probably had at best a small role in the emergence of the caste system. Our theory certainly requires no such premise. However, it is incumbent on us to inquire where such notions of purity and pollution came from, for invoking them comes close to *assuming* what needs to be explained. In our view, the caste system arose to exploit the complementarities in family production. The degree of complementarity, as we have shown, determines the rank in the caste hierarchy. Once hierarchy has been established, however, there is no doubt that it was subsequently utilized down the millennia for economic and political advantage by the upper castes. Our model only speaks to the issue of the *origin* of the caste system.

In our view, the motivation of endogamy in the caste system was fundamentally socioeconomic and so we reject Dumont’s claim that political-economy considerations were secondary. Notions of purity and pollution that Dumont takes as given were, as we have seen above, merely the means to an end. One thing that stands out in caste interactions is that pollution always trumps purity [Mandelbaum (1970, Vol. 1, Ch. 11)]. If the two come into contact, it is pollution that wins out; it is almost never that purity neutralizes the pollution. The reason for this immediately becomes clear if we assess the notions of purity and pollution in terms of their functions. If endogamy is to be sustained through these twin concepts, pollution *must* always dominate purity. Were the reverse true, the maintained distinctions between the castes would be erased by those who are allegedly pure. A theory that begins with the purity/pollution dichotomy as a given confuses ends and means. The end was to sustain endogamy for socioeconomic reasons; notions of purity and pollution were the means.

#### 4.1.1 The Role of the Sex-Ratio

It may be noted here that, in the formal analysis of this paper, we assumed that the sex-ratio (ratio of males-to-females) in the group is unity. This assumption, however, can be violated—as Sen (1990) and Coale (1991) initially revealed, there are very significant numbers of missing women in India.<sup>33</sup> This is not necessarily only a recent phenomenon. In an analysis of data from 1901, Chakraborty and Kim (2009) have shown that the sex ratios were significantly lower than unity particularly in the upper castes. As is becoming increasingly clear in recent research, it is in patriarchal societies that there is a strong son preference and sex ratios are biased against females. In the context of our analysis, this suggests that a violation of endogamy by upper caste women would invite an even greater punishment from the group because it is already short of marriageable women. In fact, in such a scenario a social planner would require that a higher proportion respect endogamy among females than among males in order to match their absolute numbers in the marriage market. In other words, to compensate for the women who were missing

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<sup>33</sup>See Anderson and Ray (2010) for the most reliable figures for missing women.

because of patriarchal values, caste endogamy would require measures that exacerbate the asymmetric treatment of women. It is plausible that an unbalanced sex ratio was supported by polyandry, most likely fraternal polyandry.<sup>34</sup> In other words, the unbalanced sex-ratio would not have automatically led to an undermining of patriarchy by increasing the perceived worth of women.

#### 4.1.2 Punishing Parents and Arranged/Child Marriages

Our model can explain other features of the caste system like arranged marriages. Quite simply, parents bear the punishment from the endogamy violations of their children and therefore have a direct interest in the determination of their marriage partner. This expedient reduces the probability of offspring unilaterally acting upon a conceived preference for an out-group member. Similarly, child marriage—a practice initiated by the upper castes—commits children to marital alliances before they reached puberty and therefore reduces the probability of offspring even conceiving a preference for an out-group member. In effect, the children involved (and others in society) are told that they have been “spoken for” and cannot participate in the marriage market.

Of course, such explanations beg the question of why it is that the parents of violators are punished rather than the violators themselves. Here we argue that the enforcement of endogamy *necessarily requires* that it is the parents who are punished. To this end, suppose that it were the violators who were punished. Since women adopt the occupation of their husbands, and interactions occur within occupations, it is not possible for a group to punish their female violators.<sup>35</sup> The group, however, certainly can punish male violators and thus women who marry in from other groups. But if a group is unable to punish its violating women, then the group will find that it has more available men than women, and thus would obtain no benefit from imposing endogamy on men. But this implies that the wives of such males—females marrying into the group—will not be punished by the group. But this reasoning is equally true for all groups, implying that no female will experience a punishment by *any* group that she marries into, and therefore no male will experience punishment by their group. Thus, there is simply no way to discourage out-marriage via punishments imposed on violators when women can evade punishment from their own group. As a result, enforcing endogamy necessarily requires that it is the *parents* of violators who are punished.

### 4.2 Source of Uniqueness of the Indian Caste System<sup>36</sup>

Many societies have had institutions that shared some characteristics of caste. For example, European guilds that existed in the Middle Ages have sometimes been compared to caste. But as Senart (1930) and Weber (1946) have persuasively argued, the similar-

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<sup>34</sup>See Singh (1978) for some evidence of polyandry in ancient India. The most widely known instance in literature occurs in the epic *Mahabharata*, in which the woman Draupadi married five brothers.

<sup>35</sup>This is not to mention the fact that the majority of women move to distant villages at the time of marriage (Rosenzweig and Stark (1989)).

<sup>36</sup>This subsection owes much to a conversation with Vinayak Eswaran.

ities are minimal and misleading. (For example, endogamy is not a feature of guilds.) In the 5<sup>th</sup> Century CE emperor Theodosius, to shore up the Roman empire, passed a law making all public functions hereditary but this did not last after the breakup of the empire.<sup>37</sup> Ancient Egypt had something like a caste system. However, specialization was not necessarily hereditary and a strong monarchy prevented the castes from remaining distinct.<sup>38</sup> In the light of such historical examples, the endurance of India's caste system is very puzzling. Furthermore, in the Hindu caste system there was an unparalleled obsession with ritual purity and the 'status' that apparently derived from it. What was the source of this? What historical circumstance led to this peculiar cultural innovation?

Spousal complementarities in jointed executed occupations are a peculiarity of India. The Hindu view of life as conceived from Vedic times, when the caste system was created, has built into it a tremendous amount of complementarities in the lives of couples. Every man was required to follow his particular way of life (*svadharma*) in the pursuit of dharma or righteous living under universal law, the latter being a concept later borrowed and adapted by Buddhism. A man's wife in Vedic culture was seen as his companion (*dharampatni*, literally "dharma-wife") who exhibits complete devotion to him. The wife was expected to second and aid the husband in executing his dharma, and one of her most important of her duties was to produce and raise children—especially sons.

It is agreed by scholars of the caste system such as Dumont (1970) that the Brahmins were the lynch-pin of the caste system and that they initiated the first separation into endogamous groups (between the Brahmins and the Kshatriyas). Why was this? To get at the answer to this, it is important to understand the nature of the Brahmin activity and the considerations that were important to its proper execution. This activity was not merely the performance of religious rituals and ceremonies. A core component of it was the learning of the scriptures for the purpose of oral transmission. As we shall argue below, social learning and the durability of the 'capital' the Brahmins transmitted across generations were of paramount importance. The advantage of endogamy identified in earlier sections represents a lower bound if we incorporate inter-generational skill transmission. In Appendix II we present a simple model that illustrates why but here we merely summarize the argument. In essence, large groups facilitate greater learning by increasing the number of within-group interactions. Furthermore, larger groups are better equipped to ensure the durability of the group's skills.<sup>39</sup> Planners in groups where the occupations lend themselves to group learning and where the techniques of reproducing the output of previous generations have been mastered (so to ensure durability) would be more inclined to adopt endogamy and maximize the gains from them.

The argument above suggests that groups that possess the most human capital would be the most dedicated to enforcing endogamy. Without a doubt, the Brahmins have had by far the greatest amount of human capital in terms of education (which is the reason why only Brahmins were permitted to teach). But this was not all. Their stock of knowledge was of the religious, non-secular kind. The Brahmins were largely responsible

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<sup>37</sup>See Risley (1915, pp. 270-272) for a discussion of this.

<sup>38</sup>See Bougle (1971, pp. 14-16).

<sup>39</sup>Languages routinely die out, for example, when the group size gets too small.

for transmitting the Hindu scriptures intact over the last three millennia. Of this period, for approximately a millennium this transmission was done *orally*, without the benefit of written script.<sup>40</sup> Even after script became available in India, the transmission proceeded orally, it is estimated, for another millennium.<sup>41</sup> To appreciate the enormity of the task, note that the *Rig Veda*, which is the first among four of the Vedas, has around 11,000 verses. (For comparison, *The New Testament* has less than 8,000 verses.). If to the four Vedas, we add the *Upanishads*, the *Brahmanas*, the *Puranas*, etc., we begin to see that the task of transmitting these error-free generation after generation is monumental. That the transmission was indeed largely error-free may be inferred from the fact that there is only a single version of each of these scriptures extant; there are no variants, which surely would have arisen if there were deviations from the originals. In view of this, an enormous burden was placed on the memory of those who were of the priestly occupation.

An entire educational system was invented and perfected in Vedic times (starting around 1,500 BCE) to accomplish the task of oral transmission because script was unknown in India until 300 BCE [Scharfe (2002, Ch. 2)]. The task was accomplished by children (usually boys) who start memorizing and constantly repeating the scriptures from a very early age. If a boy were to memorize 10 verses a day, it would take him three years to memorize the entire *Rig Veda*. And, no doubt, constant repetition is required to continue retaining it in memory. Under the careful supervision of a teacher for many months of the year, Vedic Brahmin students recited the scriptures in pairs, so that one boy may step in and correct the other were he to falter.<sup>42</sup> The benefit from learning through interaction here (as captured by the parameter  $\sigma$  in the model of Appendix II) should be clear enough.

Various techniques were devised by the Brahmins to ensure the authenticity of the oral reproduction. There were upto eleven different variants of memorization techniques developed [Filliozat (2004)]. One was the ordinary continuous memorization; another was a halting word-by-word recitation; a third was repetition of successive pairs of words; a fourth followed the correct order of these pairs with a reverse order recitation and then followed again by the correct order repetition; and so on. The purpose of these many techniques was to familiarize the student with viewing the scripture from every possible angle so as to embed the verses in the mind permanently. These various methods also facilitated accurate transmission by enabling comparisons across the versions from different techniques and an immediate correction of errors. In this manner, the scriptures were transmitted with precision from teachers to students across generations without break.<sup>43</sup> In the concepts of the previous section, this degree of accuracy corresponded to

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<sup>40</sup>Scharfe (2002) claims, “The Brahmin reciters of the Veda have done a stupendous service to India and indeed to humanity by preserving in immaculate poetry the religious purity of the poetry of their ancestors who lived more than three millennia ago—without the aid of writing or other mechanical devices” (Ch. 13). See also Avari (2007, pp. 76-80).

<sup>41</sup>See Witzel (2003, p. 69).

<sup>42</sup>See Scharfe (2002, p. 26).

<sup>43</sup>“This ensured an impeccable textual transmission superior to the classical texts of other cultures; it is, in fact, something like *tape-recording* of ca. 1,500–500 BCE. Not just the actual words, but even the long-lost musical (tonal) accent (as in old Greek or in Japanese) has been preserved up to the present.” [Witzel (2003,

a high degree of durability in reproduction (the parameter  $\delta$  in the model of Appendix II).

Transmission of the scriptures across generations was further facilitated by the division of labor: different scriptures were relegated to different family lines. Some specialized in the *Vedas*, others in the *Upanishads*, etc. Even among these, there was further sub-specialization. (For example, there is a distinction between those who specialized in two of the four *Vedas*, in three of them, or in all four. They formed separate subcastes among the Brahmins, with the rules of endogamy separating them.) This division of labor would have made it essential that the group size not diminish, for that would have meant a loss of scriptures. This underlines the importance of ensuring progeny who will carry forward the tradition, which of course requires the availability of women for marriage. The preferred women would clearly be those with skills complementary to those of their husbands and with an upbringing conducive to the Brahmin's way of life. The choice of wives would also have been thought very important because mothers spend more time with the children than do fathers. There is considerable evidence in contemporary settings suggesting that religious beliefs and practices are most effectively transmitted across generations when the parents have similar beliefs [see Clark and Worthington (1990) for a review]. Myers (1996) finds that the family context is extremely important to belief transmission; the absence of conflict between parents increases the efficacy of religious socialization of children.

The theoretical work of Bisin and Verdier (2000) has shown that those in society who subscribe to certain cultural and religious beliefs which they would like to pass on to their children are more likely to have homogamous marriages (that is, both partners share the same beliefs). They also put more effort into socializing their children, and in the long-run minorities manage to retain their identities despite being embedded in a "melting pot". These insights are quite relevant to the situation under consideration here. It is not surprising that the Brahmins of India, who had very compelling reasons starting three millennia ago for transmitting their knowledge and beliefs to future generations, would have opted to be homogamous.

A household environment that was not conducive to this peculiar form of learning invented by the Brahmins would have resulted in the loss of the capital the Brahmins deemed most precious. Any distraction or incompatibility would have proved detrimental to a Brahmin's task. We submit that the self-perceived mandate of the Brahmins to preserve the scriptures *at a time when there was no script* was the unique circumstance in India that led to the exacting features of the Brahmanical caste system.<sup>44</sup>

Given the Hindu way of life, we would expect spousal complementarities in other occupations, too, at the incipience of the caste system. The examples provided in the

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pp. 68-69). Emphasis in the original]

<sup>44</sup>An anonymous referee wonders whether the fact that script was not used by Brahmins for a long time after it became available suggests a collective exercise of power to perpetuate the caste system. In other words, was the new technology blocked because the old one (oral transmission) generated rents for the Brahmins? It seems unlikely. The new technology wouldn't necessarily have undermined the complementarities that sustained the Brahmins as an exclusive caste. Since only Brahmins knew the scriptures, only they could have transcribed them and only they were required by tradition to read them. So women who were raised in families that valued reading and writing would still be more valued by Brahmin families.

Introduction allude to this. We have hints of this complementarity in literary sources. We can make informed conjectures for the warrior (Khastrīya) caste, for example. The various gods in Hinduism were also rulers of kingdoms. For example, Rama was king of Ayodhya and Krishna of Dwarka, and so they were seen as the upholders of dharma. Thus in the warrior occupation, too, wives would have played an important role in upholding the traditional occupation, which would have required the skillful raising of children. The venerable elder warrior Bhishma in the Hindu epic Mahabharata claimed that there is no greater guru for a child than the mother.<sup>45</sup> Thus, for the wife to have come from a warrior family would have been deemed very important.

### 4.3 The Origin of Sub-Castes (*Jatis*)

We now explain the emergence of sub-castes (*jatis*). Once the practice of endogamy came to be established through the means described above, our model suggests that these very means can be employed to sustain endogamy between subgroups (sub-castes). Thus subgroups with slightly differentiated occupations requiring complementary spousal skills came into existence. So within the varna of Brahmins, there were many different specializations and each specialized branch would have liked to enforce endogamy. Likewise for specializations within the Ksatriya, Vaishya, and the Shudra varnas. The demand for sub-castes within each varna would depend upon the extent of *differentiation* in occupations within the varna and how transferrable or untransferrable skills were across these occupations. Differentiation in occupations would depend on the specialization warranted by the economy. Thus economic development, which would increase the number of activities and occupations, would lead to an increase in the number of sub-castes. Even within the occupations relating to textiles, for example, during the mid-18<sup>th</sup> through mid-19<sup>th</sup> centuries in South India, weavers, bleachers, dyers, printers, etc. all formed separate sub-castes. [Kumar (1982, Vol. II, p. 355)]. As long as the size of each subgroup is sufficiently large (which, again, depends on the extent of the market), knowledge-spillovers across generations would motivate endogamy within these subgroups and *jatis* would obtain. Thus we could say, paraphrasing Adam Smith, that division into *jatis* is dependent on the extent of the market. We would expect the number of *jatis* to also increase with population size. It is in this manner, we claim, that thousands of sub-castes have come into existence over the millennia and endogamy came to operate at the level of these sub-castes. Our theory, then, clearly predicts that *jatis* emerged from *varnas*; the *jatis* did not emerge first and then sort themselves out into *varnas*.

There are some examples of how some sub-castes have sought to move higher up in the hierarchy by relinquishing practices that are eschewed by the higher castes and adopting some of their practices [Stevenson (1954)]. Srinivas (1956) has referred to this process as ‘Sankritization’, whereby the lower castes seek to emulate the higher. But this process is usually also accompanied by changes in economic activities and occupations. Blunt

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<sup>45</sup>The full quote is: “The teacher who teaches true knowledge is more important than ten instructors. The father is more important than ten such teachers of true knowledge and the mother is more important than ten such fathers. There is no greater guru than mother.” (Mahabharata, Shantiparva, 30: 9).

(1969, pp. 50-57) gives many examples of the fissioning of castes as a result of slight changes in occupations. He also gives numerous examples of sub-castes rising in the social ranks by giving up certain customs. However, he points out that “*the change of custom is the result of fission and not its cause*” (p. 53, emphasis added). This observation fits in well with our theory: shifts in economic activities change the requirements of spousal complementarity and rationalize a separate endogamous sub-caste that rejects potential spouses from the original sub-caste. But this would occur only when the size of the subgroup is large enough because only then can we expect intergenerational spillovers to be significant.<sup>46</sup> The change in ritual practices then are merely signals that separate in-group members from former group members who are no longer deemed appropriate for alliances.

#### 4.4 On the Persistence of the Caste System

As mentioned, the caste system has existed in India for around 3,500 years. While there have been many social organizations elsewhere in the world that have had a de facto caste system in antiquity and also in more recent periods,<sup>47</sup> it is in India alone that the caste system seems to have developed to a point that it still manages to retain importance in the contemporary social organization. This peculiar Hindu institution has withstood the influence of Buddhism (which eschewed caste), a religion that spread to the far East but could not take permanent root in its country of origin. It has withstood the Muslim invasion of India from the 13<sup>th</sup> Century CE and the subsequent establishment of the Mughal empire. It has survived the colonization of India by the British for two hundred years. No researcher with any familiarity with India would claim that caste is a thing of the past.

While explaining the remarkable longevity of the caste system is not our main focus, we use this section to outline how our model helps understand its persistence. We begin by observing that much of the persistence of the caste system can simply be accounted for by the fact that the economic environment that we describe also displays a great deal of persistence. This is especially true in rural areas where males inherit their occupation from their father and benefits from the complementary input of their wives. Economic growth and mobility, to the extent that they have arisen, are very recent phenomena when viewed in perspective.

Nevertheless, caste seems to retain significance in modern times, even among highly educated urban groups (Banerjee et al. (2013)). To help understand this, we point out that the caste system as described here contains various elements of resilience built into it. For instance, the system is resilient to deviations at the individual level. Parents remain reluctant to grant autonomy to their children in the choice of marriage partners since it is the parents who bear the punishment. Strict control is not necessary, however, since children remain reluctant to respond to changing conditions by bucking the endogamy norm owing to the fact that it is their parents that bear the consequences. Parents

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<sup>46</sup>Large subgroup sizes would also be required for the obvious reason of avoiding too much in-breeding.

<sup>47</sup>The classic article by Davis (1941) has a discussion of caste in a non-Indian context.



continue to find it optimal to punish norm violators—their actions in the interaction phase are Nash equilibria of the stage game, but even if this were not the case, the fear of “being punished for not punishing others”, as stressed by Akerlof (1976) among others, likely remains.

More significantly, the system tends to be resilient to even deviations at the group level. We saw as an implication of Proposition 2 that when  $\mu^{\text{out}}$ , the probability of out-group encounters, is low endogamy is effectively imposed in a group when other groups adhere to endogamy. In other words, a group tends to prefer embracing endogamy norms when other groups do. This essentially implements coordination in caste norms whereby all groups retain adherence to the caste system despite changes in the underlying economic conditions.

Perhaps the strongest source of resilience is the valuable by-product that the caste system generates: ready-made social groups with characteristics most suitable for supporting group enforcement mechanisms. Munshi and Rosenzweig (2009), drawing on Coleman (1988), describe how the “closed” nature of caste networks makes them particularly effective in delivering group enforcement. Thus, the literature on the modern uses of the caste system as a means to enforce various mutually beneficial transactions, such as those related to insurance and credit, also help explain the resilience (but, as we have argued, not origins) of the caste system. Simply, abandoning the system entails abandoning an effective means with which to support valuable but vulnerable transactions.

A further threat to the caste system arises when we step outside the model and consider heterogeneity in an individual’s ‘quality’. As highlighted in Banerjee et al. (2013), this is because the caste system, which obviously impinges upon marriage decisions, could potentially produce distortions resulting in highly inefficient matches. The viability of the caste system would be greatly undermined in such conditions. However, they show that this threat is low when caste preferences tend to be more ‘horizontal’ than ‘vertical’ (i.e. when there are preferences for marrying within one’s group as opposed to marrying into some desirable group). Intuitively, strong vertical preferences encourage marriage into the top caste group. This makes low quality types from the top group more attractive than the high quality types from lower groups, and therefore encourages non-assortative matches in equilibrium. If vertical preferences are weaker, the low quality type from the top group is less attractive than the high quality type from a lower group, and this, in contrast, fosters assortative matching in equilibrium. In short, the caste system is relatively costless when the vertical dimension of caste preferences is weak. Banerjee et al. (2013) show that this is the case, using data from matrimonial advertisements placed in a major Bengali newspaper. In our model, ‘caste preferences’ are horizontal in nature: all else equal, all individuals prefer to marry within their own caste.<sup>48</sup> As such, our account of the caste system helps understand *why* observed caste marriage preferences are horizontal (while

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<sup>48</sup>For males, preferences are horizontal in an even stronger sense: they rank all other groups equally. This is because the output loss that arises when they marry outside their caste is independent of *which* caste their bride hails from. The same is true for females in the case where  $\alpha$  is the same for all occupations. Naturally, female preferences *over other groups* will contain a vertical element when  $\alpha$  varies across occupations, but each female will nonetheless rank her group the highest.



retaining an explanation for a hierarchy), which in turn helps explain the persistence of the caste system.

Apart from illuminating the uses of the caste system, the existing literature on caste also offers valuable insight into the resilience of the caste system (Munshi and Rosenzweig (2009)). Indeed, this literature is more explicit about marriage and the role of endogamy. Munshi (2011, p. 1071) writes

“The marriage institution is key to the maintenance of a strong network. The basic marriage rule in Hindu society is that no individual can match outside the subcaste or jati, which typically has a population of a few hundred thousand. The dense web of marriage ties that consequently forms over the course of many generations improves information flows and reduces commitment problems and, not surprisingly, networks serving different functions have historically been organized at the level of the subcaste.”

We now argue that this literature on the uses of the caste system stops short of also offering a compelling explanation of the origins of the system. This is for three main reasons.

First, while intra-group marriage undoubtedly acts to strengthen a network it is not the only way, and it is by no means clear that it would be the cheapest way. For instance, occupational associations would also serve in strengthening business-related networks. Such networks have at least two advantages over those generated by a “dense web of marriage ties” insofar as the former relies far less on bilateral ties. Specifically, under marriage ties the burden of punishment falls heavily on the relatively small group of families that have strong marriage ties to the deviator. Such families will face strong incentives to ‘forgive and forget’, thereby undermining the credibility of punishment threats. Furthermore, these families have their ties to the rest of the group weakened, producing a risk of network unraveling. To be sure, it is the day-to-day interaction within the occupational group—a sort of decentralized occupational association—that generates network strength in our model and marriage plays no role in this regard.

Second, the observation that caste networks serve “different functions” suggests that ‘providing network strength’ is too broad an explanation for the origins of caste, since the desirable group composition will likely vary by function. For instance, groups optimally designed to support business networks would presumably be relatively occupationally-homogeneous, as in the case of diamond traders in Munshi (2011), whereas groups optimally designed to support informal risk-sharing would presumably be relatively occupationally heterogeneous in order to reduce the correlation of income shocks. Furthermore, no specific function offers an overwhelmingly convincing account of caste origins. For instance, while the business network aspect is consistent with an orientation around occupations, it seems unlikely that the majority of occupations, especially in historical and rural contexts, rely heavily on interpersonal trust in order to mitigate the high risks inherent in the occupation. Furthermore, the observation that “The Indian experience is in many respects similar to the historical and contemporary U.S. experience” (Munshi (2011, p. 1072)) suggests that extra-caste forces are at play. On the other hand, the value

of informal risk-sharing and credit networks seems more omnipresent. However, it seems quite sub-optimal to have groups form along occupation lines owing to the relatively high correlation of income shocks. Indeed, the desire to reduce such correlation is suggested by the practice of women moving to distant, geographically diverse villages at the time of marriage (Rosenzweig and Stark (1989)).

Third, even if desire to strengthen a network speaks to endogamy in general, it remains silent about important aspects of the specific way in which endogamy plays out in the caste system. In particular, there is no obvious reason for asymmetric treatment across genders. A family that marries outside the caste harms the group by reducing the opportunity for network-strengthening endogamous marriages to form, but the nature of this harm is independent of whether it is a son or daughter that is marrying outside the caste. The related notions of caste hierarchy and the asymmetric treatment of ‘marrying down’, are similarly unexplained.

In short, the literature documenting the various uses of the caste system also provides a compelling account of the forces that maintain the strength of the caste system, but largely leaves open the issue of why the caste system, with all of its specific features, arose in the first place.

## 5 Conclusions

In this paper we have proposed a theory of how the caste system originated in India, providing a parsimonious explanation for many of its essential features. This Hindu institution is embedded so inescapably in the country’s social fabric that even Christians and Muslims living in India are known to adhere to the caste system.<sup>49</sup> Our theory posits that women’s economic contributions to household production are essential to the income from their husband’s occupations. When both spouses hail from families in the same occupations, spousal complementarities in production enable incomes to be at maximal levels. When there is a mismatch in spousal skills, income falls. When a member of an occupational group out-marries, there is an externality in that some group member of the opposite sex does not find a match within the group. To minimize this externality the group enforces endogamy with the threat of punishments, and a caste is born. We showed that the punishments for violations are harsher for women than for men. We also explained why there is less resistance to women marrying up (hypergamy) than to them marrying down (hypogamy), where ‘up’ and ‘down’ are determined by the relative degrees of complementarities of the two castes. If the castes can be ranked by these measures of complementarities, we showed that a hierarchy in castes obtains. Our theory also brings out the fact that caste is integral to the subjugation of women in the Indian context, a claim that has been made by some feminist writers [especially Chakravarti (2003)].

Our theory of the origin of the caste system suggests that an *inter-group* exercise of power may not have been a necessary part of the formation. That exercise of power (and the attendant inequity) seems to have arisen after the establishment of hierarchy. Our

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<sup>49</sup>For Christians, see Tharamangalam (1996); for Muslims, see Bhatta (1996).

theory has shown that to implement the caste system, there had to be mostly only a *within-group* exercise of power. Women had to be treated with greater severity than men to enforce endogamy. Ironically, it is women of the upper castes that have borne the brunt of this. This aspect of caste is very visible in India even today: the actions of upper caste women are monitored and circumscribed much more than those of lower caste women. Patriarchy—possibly originating at least partially from the need for paternity assurance in a world where only maternity is certain—is itself oppressive to women because of the male need to control their sexuality [Smuts (1995), Lerner (1986)]. When the exigencies of caste are added to this, the oppression of women is that much worse. Caste is not patriarchy, but the elaborate caste system of India as it has come down certainly requires it.

In recent decades, the empowerment of women has become an important component of the development agenda in poor countries. The theory of this paper has demonstrated that the caste system depends on the oppression of women. This theoretical finding has policy implications that go beyond those implied by theories which identify the *uses* to which the caste system is put in contemporary times. For example, while women were traditionally allowed to own property that facilitated day-to-day living, they were not allowed exclusive ownership of immovable property (especially land) [Altekar (1962, Ch. IX)]. This bias against Hindu women owning land has come down through the centuries. It may be reasonably conjectured that, by minimizing their outside options, this asymmetry in the treatment of women may well have been a way to ensure compliance with the oppressive caste rules foisted on them. If this is correct, it is likely that the empowerment of women (e.g. by the recent move towards equalizing inheritance laws in India and towards the education of girls) will weaken the caste system. Greater access to labor markets by women would also have the same result. Caste-based punishments for violations of endogamy will have little bite if women have lucrative outside options. This possible link between the empowering of women and the undermining of the caste system, as implied by our theory of the origin of the caste system, is worth recognizing.

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## Appendix I

*Proof of Proposition 1.* Since  $\tilde{\pi}(N)$  is independent of the parameters stated in the proposition, it is sufficient to analyze their effect on  $U^E(N) - U^{NP}(N)$ . To this end, note that we can write

$$U(n_m, n_f | N) = 2(N^c - N) \cdot (Y + p \cdot B + u^*) + 2N \cdot (Y + u^*) - w(n_m, n_f) \quad (8)$$

where  $w(n_m, n_f | N)$  is the net cost of endogamy:

$$w(n_m, n_f) = [\max\{n_m, n_f\} - \min\{n_m, n_f\}] (Y - y) - (N - n_m) [B - (1 - \alpha_m) Y] - (N - n_f) [B - (1 - \alpha_f) Y]. \quad (9)$$

The first term represents the loss from having some group members being unable to find an in-group partner. The second term represents the gain that males obtain from the preference shock net of the output loss. The third term is this same net gain for females. The net gain from endogamy,  $U^E(N) - U^{NP}(N)$ , can thus be written as

$$U^E(N) - U^{NP}(N) = \sum_{m=0}^N \sum_{f=0}^N \pi(n_m, n_f) \cdot w(n_m, n_f). \quad (10)$$

The results for  $Y$ ,  $y$  and  $B$ , parts (a), (b) and (c) of the proposition respectively follow from noting that  $\pi$  is unaffected by  $\{Y, y, B\}$  and  $w$  is increasing in  $Y$  and decreasing in  $y$  and  $B$ .

The fact that  $q$  is the same across genders implies that  $\pi(n_m, n_f) = \pi(n_f, n_m)$ . Therefore, we can write

$$U^E(N) - U^{NP}(N) = \sum_{n=0}^N \pi(n, n) w(n, n) + \sum_{n_m=1}^N \sum_{n_f=0}^{n_m-1} \pi(n_m, n_f) \tilde{w}(n_m, n_f), \quad (11)$$

where

$$\tilde{w}(n_m, n_f) \equiv w(n_m, n_f) + w(n_f, n_m) = 2[\max\{n_m, n_f\} - \min\{n_m, n_f\}] (Y - y) - (N - n_m + N - n_f) [2(B - Y) + (\alpha_m + \alpha_f) Y]. \quad (12)$$

We see that  $\tilde{w}$  is clearly decreasing in  $\alpha_m + \alpha_f$ . Part (d) of the proposition follows since

$$w(n, n) = -(N - n) [2(B - Y) + (\alpha_m + \alpha_f) Y] \quad (13)$$

is also decreasing in  $\alpha_m + \alpha_f$ . □

*Proof of Proposition 2.* Since  $\tilde{\pi}(N)$  is independent of  $\mu^{\text{out}}$ , it is sufficient to analyze the effect of  $\mu^{\text{out}}$  on  $U^E(N) - U^{NP}(N)$ .

When  $\mu^{\text{out}} = 0$ , there are no instances of out-marriage and therefore  $U^E - U^{NP} = 0$ . Since  $p > 0$  and  $q = \mu^{\text{out}} \cdot p / (1 - \mu^{\text{in}})$ , the result follows once we show that  $d(U^E -$

$U^{NP})/dq > 0$  when evaluated at  $q = 0$ . Using (11), we have

$$\frac{d}{dq}(U^E - U^{NP}) = \sum_{n=0}^{N-1} \frac{d}{dq} \pi(n, n) w(n, n) + \sum_{n_m=1}^N \sum_{n_f=0}^{n_m-1} \frac{d}{dq} \pi(n_m, n_f) \tilde{w}(n_m, n_f), \quad (14)$$

where we have dropped  $\pi(N, N) w(N, N)$  in the first term because it is zero.

Letting  $\xi_1 = n_m + n_f$  and  $\xi_2 = N - n_m + N - n_f$ , we have

$$\frac{d}{dq} \pi(n_m, n_f) = \binom{N}{n_m} \binom{N}{n_f} \cdot [\xi_2 q^{\xi_2-1} (1-q)^{\xi_1} - \xi_1 (1-q)^{\xi_1-1} q^{\xi_2}] \quad (15)$$

$$= \binom{N}{n_m} \binom{N}{n_f} \cdot q^{\xi_2-1} \cdot [\xi_2 (1-q)^{\xi_1} - \xi_1 q (1-q)^{\xi_1-1}]. \quad (16)$$

Notice that the limit of the bracketed term as  $q \rightarrow 0$  is  $\xi_2$ . Therefore, we have

$$\lim_{q \rightarrow 0} \frac{d}{dq} \pi(n_m, n_f) = \lim_{q \rightarrow 0} \frac{d}{dq} \binom{N}{n_m} \binom{N}{n_f} \xi_2 q^{\xi_2-1} = \begin{cases} 0 & \text{if } \xi_2 > 1 \\ 1 & \text{if } \xi_2 = 1. \end{cases} \quad (17)$$

Since  $\xi_2 > 1$  if and only if  $(n_m, n_f) \notin \{(N, N-1), (N-1, N), (N, N)\}$ , and  $\xi_2 = 1$  if and only if  $(n_m, n_f) \in \{(N, N-1), (N-1, N)\}$ , it follows that

$$\begin{aligned} \lim_{q \rightarrow 0} \frac{d}{dq} (U^E - U^{NP}) &= \lim_{q \rightarrow 0} \frac{d}{dq} \pi(N, N-1) \tilde{w}(N, N-1) \\ &= 2(Y - y) - [2(B - Y) + (\alpha_m + \alpha_f)Y], \end{aligned}$$

which is positive by (1). Since the net benefit  $(U^E - U^{NP})$  is zero at  $q = 0$  but is increasing at this point, endogamy is beneficial for sufficiently small  $q$  and therefore for small  $\mu^{\text{out}}$ .  $\square$

*Proof of Proposition 5.* For the first statement, note that zero punishments implies  $\phi_m = \phi_f = 0$ . Using this, subtract the female version of equation (7) from the male version to get:  $\bar{b}(q_m) - \bar{b}(q_f) = (\alpha_f - \alpha_m) \cdot Y + (\rho_m - \rho_f) \cdot (Y - y)$ . If  $q_f \leq q_m$ , then the left side is negative. Since the first term on the right is positive for the high complementarity group, it must be the case that the last term is strictly negative. But this requires  $\rho_m < \rho_f$ , which in turn requires  $q_f > q_m$ , which is a contradiction. Therefore  $q_f > q_m$ , implying that some males are unable to find in-group partners.

For the second statement, note that  $q_f = q_m$  implies  $\rho_m = \rho_f = 1$  and  $\bar{b}_m = \bar{b}_f$ . Using this, subtract the male version of equation (7) from the female version to get:  $\phi_f - \phi_m = (\alpha_f - \alpha_m) \cdot Y$ . This is positive for the high complementarity group, and therefore females must be punished more than males in this group.  $\square$

## Appendix II

### The Importance of Skill and its Externalities

In the core model presented in the text, we interpreted  $Y$  as the exogenous output of a couple comprising in-group members. Here we endogenize  $Y$  as the steady state value derived from a learning process in which human capital is generated and transmitted. To get at this in the simplest manner possible, suppose that the maximal output level,  $Y$ , of generation  $t$  individuals depends on (i) a constant,  $Y_0$ , (ii) a depreciated value of the maximal output level of the previous generation,  $\delta Y_{t-1}$ , (with  $0 < \delta \leq 1$ ), and (iii) the average actual output produced in the preceding generation,  $\bar{Y}_{t-1}$ . Aspect (iii) captures the learning feature of skills; what was actually produced in the previous period contributes this period's maximal output. Note that  $\delta$  here is a durability parameter, with  $\delta = 1$  if the human capital is transmitted intact from one generation to the next even when the output is at its maximal rate. Specifically, we suppose that

$$Y_t = Y_0 + \sigma \bar{Y}_{t-1} + \delta Y_{t-1},$$

where  $\sigma$  measures the extent of social learning. It should be mentioned for future reference that we expect the parameters  $\sigma$  and  $\delta$  to be increasing in the group size. Larger groups would facilitate greater learning by increasing the number of within-group interactions. Furthermore, larger groups would also be better equipped to ensure durability of the group's skills. So we can write  $\sigma = \sigma(N^c)$  and  $\delta = \delta(N^c)$ , with  $\sigma'(\cdot) > 0$  and  $\delta'(\cdot) > 0$ .

We shall focus on males because it is their occupations that are inherited by the next generation. If the expected proportion of males who do not get in-group partners is  $z_1$  and the expected proportion of males who marry outside the group is  $z_2$ , then

$$\bar{Y}_{t-1} = (1 - z_1 - z_2)Y_{t-1} + z_1 y_{t-1} + z_2 \alpha Y_{t-1}.$$

The first term on the right hand side is the average output from couples comprising same-caste members, the second is the output (now time-dependent) from unmarried members, and the last term is the output from inter-caste couples. We let  $\tau \equiv y_t/Y_t$  denote the output of a single-member household relative to the maximal output and we take this to be a constant independent of the generation. Then  $\bar{Y}_{t-1} = [(1 - z_1 - z_2) + z_1 \tau + z_2 \alpha]Y_{t-1}$ . Substituting this expression into that for  $Y_t$ , we obtain the long-run steady state maximal output level that, abusing notation, we denote by  $Y$ :

$$Y = \frac{Y_0}{1 - \delta - \sigma[1 - (1 - \tau)z_1 - (1 - \alpha)z_2]}.$$

As expected, this output is increasing in  $\sigma$  and  $\delta$ , and therefore  $Y$  is increasing in the group size,  $N^c$ . This output is decreasing in  $z_1$  and  $z_2$ , thereby providing an added reason why the group may benefit from endogamy. Out-marriages (an increase in  $z_2$ ) reduce social learning by reducing the size of the group. And when there is an increase in the number of people who cannot find spouses in the marriage market (an increase in  $z_1$ ), caste

skills are again lost. Note that  $z_1$  is decreased by raising female punishment, whereas  $z_2$  is decreased by raising male punishment. Thus, in general, the punishments a planner would implement would reflect the skill consequences of endogamy violations.

We may reasonably interpret the effect on  $Y$  of a small reduction in  $z_1$  and  $z_2$  as the marginal benefit to greater endogamy. The following result obtains from the partial differentiations of the above expression.

**Proposition 6.** *The marginal benefit to greater endogamy is higher for groups with occupational human capital that is more subject to social learning (captured by  $\sigma$ ) and/or is more durable (captured by  $\delta$ ).*

Since we have posited  $\sigma$  and  $\delta$  to be increasing in group size, the benefits of endogamy would be higher for larger groups. Proposition 6 suggests that planners in groups with occupations for which group learning is important and with the techniques that ensure the durability of the output would be more inclined to adopt endogamy.

This model also suggests a plausible reason why widow remarriages were banned, especially in the upper castes, but not widower remarriages. Widows are typically older and so further along in their reproductive cycle. If they remarry, the chances are higher that they will find younger grooms because older men would mostly be married and widowers would be few and far between. Marriages of widows with younger men would result in fewer descendants, something that castes would have wanted to avoid because group size mattered. This may also explain the exacting requirements of ‘purity’ imposed on widows. The fact that an exception to the ban on widow remarriage is made so that a married man can take on his brother’s widow as a second wife lends some credence to this view. The need to ban widower remarriages is less pressing, however, because males can have children until much later in their lives and the reproductive costs to the community of remarriage would be correspondingly lower. Once again we see gender asymmetries, accentuated here by group size considerations, arising from the need to maintain caste integrity.