YOUR CONSCIENCE YOU MUST KEEP, OR IT MUST BE KEPT FOR YOU

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Abstract. Parents in several cultures 'discipline' their daughters to inculcate the supposedly feminine virtues. This process invariably involves imposing restrictions on the behavior, movement, and social relations of girls. We formalize the idea that this cross-cultural process can be understood as an equilibrium outcome of an (*impure*) signaling game between parents of girls and prospective suitors. The model allows us to discuss how factors like population density, production technology, and rules of descent affect the severity of restrictions faced by girls. (*JEL* C72, J16, Z13)

I. Introduction

First Lady Eleanor Roosevelt begins her list of America's greatest women with Anne Hutchinson. In the first half of the seventeenth century Anne Hutchinson used to organize meetings to discuss sermons by ministers of the Massachusetts Bay Colony, and express her own theological views. She stressed the individual's intuition as a means of reaching God and salvation, rather than the observance of institutionalized beliefs and the precepts of ministers. In response, she was charged with heresy, sedition, and lewd conduct as both men and women used to attend her meetings. During the trial the Governor of the colony told her that she had troubled the peace of the commonwealth and the churches because her meetings were not tolerable nor comely in the sight of God nor fitting for a woman. She tried to defend herself by saying that her views were guided by her conscience. The Governor's response was–"Your conscience you must keep, or it must be kept for you."[1]

The trial of Anne Hutchinson is but one example representing how women have been expected to, and subjected to, play a subservient role to men during a significant part of our history. It also highlights the interaction between the legal institutions and the religious orientation of a society in determining the extent of 'confinement' of women, where confinement should be intuitively interpreted as restrictions faced by women regarding their behavior, and social relations.

In this paper we focus on the pre-marital confinement of unmarried girls by their parents. Confinement of girls has been observed across societies differing along various

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[1]See, for example, Carnes and Winship (2004).

dimensions (like the level of economic development, religion, family structure, patterns of marriage, direction of transactions associated with marriage, and rules of inheritance (Murdock, 1964; Barry, 2007)). The prime motivation of parents for confining daughters has been preserving the virginity and preventing unwed motherhood of their daughters. The importance of an unmarried girls virginity can be gauged from the fact that in the United States (till 1935) the legal punishment of a man for the 'breach of promise' to marry a girl was greater if the girl had lost her virginity during courtship (Brinig, 1990).

We explain the phenomenon of confinement with a model where (i) men care for post marital fidelity of their wives because they would prefer to spend resources on their 'own' children, and (ii) parents confine their daughters as, among other things, it helps signal that their daughter will remain fidel to her husband.

The conspicuous form in which confinement has manifested itself across societies and over time ranges from plain seclusion of girls inside homes, to the now extinct footbinding of girls in China and the ongoing female genital mutilation (FGM) in several parts of Africa. Irrespective of the particular form of confinement, one of the major aims of each form of confinement is to control the premarital sexual behavior of girls. For example, Mackie (1996) summarizes the findings of sociologists regarding footbinding and FGM as follows.

"[B]oth customs are nearly universal where practiced...control sexual access to females and ensure female chastity and fidelity...seem to have a past of contagious diffusion...are believed to be sanctioned by tradition and necessary for proper marriage and family honor."

Edlund and Korn (2002, pp. 208-209) capture this succinctly with the remark that "...women have suffered seclusion, bound feet, and mutilation as a result of inability to commit to fidelity." It is worthwhile to note that it is the husbands who would want the commitment of fidelity. This probably explains why we observe post-marital confinement of women by their husbands. But, it used to be the parents who would bind the feet of their daughters in China (Dorothy, 2005), and it is primarily young unmarried girls who have to undergo mutilation under the supervision of their parents in several African communities (see Table 1 below). The timing of both these practices is consistent with the claim that they could serve as signals.

In fact, confinement may serve as more than a mere signal. For example, in societies where married women are primarily expected to be housewives, confinement may 'train' girls for their future role. It is also well documented that bound feet were considered to be aesthetically more pleasing, while FGM is considered to be hygienic (Levy, 1966). Confinement may also be used by parents to reflect 'commitment' on part of their daughter to abide by the norms of the society. In essence such considerations suggest that confinement may positively affect the value of a girl as perceived by prospective suitors.

We show that pre-marital confinement of girls can be understood as an equilibrium

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outcome of an *impure* signaling game between parents of girls and prospective suitors. The qualifier 'impure' means that confinement not only serves as a signal of a girl's potential for fidelity, it may also be valued in and of itself by prospective suitors for other reasons (like those mentioned above).

The unique equilibrium in a society can either involve all girls being confined to the same level (the pooling equilibrium), or different types of girls being confined to different levels (the separating equilibrium).[2] We shall interpret the common level of confinement in a pooling equilibrium as representing a *society-wide norm* regarding the behavior of girls prior to marriage. Confinement can no longer function as a signal in a pooling equilibrium because all types of girls are confined to the same level. But this is precisely the reason for a pooling equilibrium to be thought of as a norm. It is the defining feature of societal norms that a common pattern of behavior is observed despite heterogeneities in individual characteristics.

Recall that the extreme practices mentioned earlier are rarely practiced by isolated families (Mackie, 1996). If they are present, they are practiced by a sizable majority of the families in the society. The conditions in such a society must structure the incentives of the decision makers in a manner that helps sustain a common level of confinement for all types of girls despite differences in their individual characteristics. This is why it becomes important to identify the conditions that make a pooling equilibrium feasible; in particular, the conditions that lead to pooling at high levels of confinement.

The following section motivates the formal model by providing the relevant empirical evidence. The model is presented in Section III. Section IV derives the equilibrium predictions. Section V provides a detailed analysis of the conditions that increase the feasibility a society-wide norm of confinement. Section VI concludes with a discussion of the usefulness and the limitations of the model. Technical details are provided in the Appendix.

II. Motivation

Pre-marital confinement of girls has taken various forms across space and time. Seclusion remains a fact of daily life for millions of girls in various parts of the world even today. Depending upon the region, about 50-80% of women in China used to have bound feet around mid-eighteenth century (Levy, 1966). It is estimated that the number of women living in various parts of Africa who have undergone FGM exceeds 100 million. Table 1 lists the prevalence of FGM in some African countries. For example, a Demographic and Health Survey (DHS, 1998-9) estimates that nearly 72% of women in Burkina Faso have undergone FGM, and 97% of those who underwent FGM had been mutilated by age fourteen.[3]

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[2]We discuss the classification of girls into different types in the following section.

[3]This fraction is calculated using only those respondents who answered the question regarding age at

Table 1: PREVALENCE OF FGM

Country	Fraction of women who underwent FGM	Among women who underwent FGM fraction that had it by age 14
Burkina Faso (1998-9)	72%	97%
Central Af. Rep.(1994-5)	43%	89%
Cote d'Iviore (1998-9)	45%	92%
Eritrea (1995)	95%	100%
Egypt (1995)	97%	97%
Mali (1995-6)	94%	98%
Nigeria (1999)	25%	87%

Source: DHS Comparative Reports, No.7 (2004)

In Sub-section A we provide additional arguments regarding why a signaling approach is suitable for analyzing the phenomenon of confinement. Sub-section B explains what is being signaled by confinement. Sub-section C explains how we shall model the costs incurred by parents in confining their daughters.

A. Fidelity

The model we use rests upon the implicit assumption that men would prefer to spend resources on their 'own' children. Therefore, controlling for other factors, men would prefer those girls as marriage partners who are more likely to remain fidel.[4] There is ample evidence that men use the information regarding sexual behavior of women in evaluating their desirability as a long term partner, and that girls themselves are aware of this (Crawford and Popp, 2003). In particular, though premarital sex is no more as strictly stigmatized as before, women who engage in sex on the first date, or at a non-committed stage in a relationship are valued less by men for a long term relationship even in contemporary developed societies (Oliver and Sedikides, 1992; Frome and Emihovich, 1998).

Thompson (1995) finds that girls realize this, draw fine lines as to what constitutes good and bad behavior, and use these to orient themselves as 'good' rather than 'easy' girls. These findings are consistent with, if not direct evidence for, the claim that men are concerned about the post marital fidelity of their partner; and girls realize that in order to be considered for a long term relationship they need to signal that they are of the 'good' type. Moreover, the usage of the term 'good' seems equivalent to 'likely to remain fidel.'

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mutilation.

[4]See Ortner (1978), Dickemann (1981), and Posner (1992) for similar arguments.

B. Fidelity and docility

The likelihood that a girl will remain fidel after marriage is hard to estimate. If men care about post-marital fidelity of their prospective wives, then they would value other attributes in girls that *they believe* are correlated with the likelihood of her remaining fidel. We claim that one such trait is *docility*.

We shall use the word docility precisely in it's dictionary sense: 'easily managed or handled', and 'readily trained or taught.' Fisman et al. (2006) conduct a speed dating experiment and conclude that "...on average men do not *value* intelligence or ambition in women when it exceeds their own; moreover, a man is less likely to *select* a woman whom he perceives to be more ambitious than he is." Men probably entertain the belief that more intelligent and ambitious women are not likely to be 'easily managed or handled.' We assume that (ceteris paribus) men prefer a docile girl over a non-docile girl as a wife, and believe that docility is positively correlated with a girl's likelihood of remaining fidel.

It is to be expected that how strongly men value docility would vary across space and time. While cohabitation and unwed motherhood is becoming increasingly common in some societies, girls in some other societies are killed for the sake of family honor "...by her male family members for a perceived violation of the social norms of sexuality, or a suspicion of having transgressed the limits of social behavior imposed by traditions. This includes seeing or meeting a man even if this is only a suspicion or a gossip."[5] It is reasonable to conclude that prospective suitors must value the docility and observed confinement of girls highly in societies where the family members of a girl kill her for transgressing norms of behavior.

C. Costs of confinement

Observable confinement helps advertise a girl's unobservable docility, and thereby her unobservable potential for fidelity (since docility is assumed to be positively correlated with fidelity from the perspective of men). We assume that it is the parents of a girl that choose a level of confinement for her.[6] The supply of confinement can be costly for parents in several ways. There may be economic opportunity costs involved in confining daughters and there may be psychic costs of carrying out confinement. We shall only consider psychic costs of confinement in our analysis.

Following up on the discussion in the previous sub-section, we shall capture the heterogeneity across girls *within* a society by assuming that girls can be of two types: docile

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[5]This excerpt is taken from a report on honor-killings in Egypt which is available at: www.un.org/womenwatch/daw/egm/vaw-gp-2005/docs/experts/khafagy.honorcrimes.pdf.

[6]It will become clear in the following section that the qualitative results of our model would remain unchanged if girls were to be the decision makers.

Table 2: Beliefs of Ethiopian women about wife beating and FGM

Age group	Number of observations	Husband is justified in beating wife if she		Women who have undergone FGM
		burns food	goes out without telling	
20-29 yrs	5,445	63%	55%	79%
30-39 yrs	3,557	65%	57%	84%
40-49 yrs	2,656	67%	59%	86%

Source: http://www.measuredhs.com/pubs/pdf/FR118/03Chapter03.pdf

or non-docile. We find it reasonable to assume that at any given level of confinement, the marginal cost of confinement is relatively greater for parents of non-docile girls.[7]

Any feature of a society that helps parents to justify confinement as something for the future benefit of their daughters will reduce the psychic costs borne by the parents. For instance, parents will find it relatively easier to confine their daughters in a society where the prevailing beliefs already suggest that women should be subservient to their husbands.[8] More importantly, girls might 'internalize' such views.

Table 2 summarizes the results of a Demographic and Health Survey (DHS, 2001) conducted in Ethiopia. Among 5,445 respondents of age 20-29 yrs (i) 63% believe it is justified for a husband to beat his wife if she burns the food, (ii) 55% believe it is justified if the wife goes out of home without telling her husband, and (iii) 79% have undergone FGM.

A significant fraction of women in this sample seem to believe that it is the duty of a wife to serve and obey her husband. The beliefs of young unmarried girls would most likely be quite similar. The *psychic* costs of confining daughters will undeniably be quite low for parents in such an environment. It is not difficult to imagine societies where answers to the questions listed in Table 2 will be very different. We find these data suggesting that in societies where girls have greater *agency* – the ability to lead an independent life – it will be harder for parents to carry out confinement. Costs of confining a given type of girl to a given extent will be relatively greater in societies where *agency* of girls is higher.

III. The Model

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[7]This assumption follows the standard assumption in job-signaling models where the marginal cost of education is assumed to be relatively greater for agents with relatively lower ability.

[8]Passages from various religious texts could be potentially interpreted as suggesting this view. See, for example, Titus 2:5 in the King James Bible, Quran 4:34, I Ching 37, and the Laws of Manu 5.153-65 in Wilson (1995).

The decision making units will be referred to as 'parents of girls' on one side, and 'men' on the other side. Docile and non-docile girls will be denoted as type-d and type-n, respectively.[9] The common prior probability held by men that a girl is docile shall be denoted by $\mu_o \in [0,1]$. The impure signaling game unfolds through the following stages. (i) Nature determines the type of each girl which is private information for her family. (ii) Parents choose the level of confinement for their daughters. (iii) Men observe the confinement of each girl, update their beliefs regarding the type of each girl, and decide which girls to *consider* as a potential marriage partner. We now break this brief description into each of its component parts.

Confinement: Confinement will be denoted by the non-negative variable e. It is important to note that confinement is a process that usually takes place over time. The extent of confinement can be thought of as the observed history of a girl. An important question which is difficult to answer convincingly is how to measure confinement in its totality. Unfortunately, we are not aware of any existing data set that could help us do this. However, we hope that the intuitive meaning of confinement is quite clear.

Cost of confinement: Confinement of a girl can be costly for parents in several ways. We focus on psychic costs of justifying the confinement. The cost of confining a type-t girl to an extent e will be denoted by $c_t(e, \theta)$, where $t \in \{d, n\}$. The parameter θ refers to the agency of girls and is common to both types of girls *within* a society. In a given society with a fixed θ,

$$c_t(e, \theta) \;\geq\; 0, \quad \frac{\partial c_t}{\partial e} \;\geq\; 0, \quad \text{and} \quad \frac{\partial^2 c_t}{\partial e^2} \;>\; 0 \text{ for all } e \geq 0. \tag{1}$$

$$\frac{\frac{\partial c_n}{\partial e}}{\frac{\partial c_d}{\partial e}} \;\geq\; 1, \text{ at any common } e \geq 0. \tag{2}$$

These are standard properties of cost functions used in signaling models. The first property formalizes that the cost is non-negative and the marginal costs are positive and increasing in the level of confinement. The second property – single crossing – implies that if a docile and a non-docile girl have the same level of confinement, then increasing the confinement by an additional unit is costlier for parents of a non-docile girl.[10]

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[9]It is possible that the type of a girl is not exogenously fixed and is influenced by the confinement she undergoes. This does not pose any problems for our analysis as will become clear when we discuss the item *value of girls for men* later in this section.

[10]Following Lundberg et. al (2007) one could model the interaction between parents and daughters explicitly. However, given the focus of our paper we prefer to capture this indirectly via the specification of the cost functions.

Following the discussion in the previous section, we shall assume that the cost of confining girls of both types *within* any given society will be relatively higher if the *agency* of girls in the society is relatively higher. Relatively higher values of the parameter $\theta \geq 1$ represent societies with relatively higher agency. Thus

$$\frac{\partial c_t}{\partial \theta} \ > \ 0, \ \ \text{at any fixed } e, \ \ \text{for } t \in \{d, n\}. \tag{3}$$

The single crossing property of cost functions given in Equation (2) is the key to analyzing confinement patterns within a society. In order to be able to extend this analysis *across* societies we make the following additional assumption on the structure of the cost functions.

$$\frac{\partial}{\partial \theta} \Big[\frac{\frac{\partial c_n}{\partial e}}{\frac{\partial c_d}{\partial e}}\Big] \ > \ 0, \ \ \text{at any common } e \geq 0. \tag{4}$$

For any given level of confinement, the marginal cost of confining a non-docile girl relative to a docile girl is relatively higher in societies where girls have relatively greater agency. In a society where agency of girls is quite low (i.e., θ is close to one), the cost function is relatively insensitive to the type of a girl and there is relatively little difference in the costs of confining a docile and a non-docile girl to the same extent. However, in societies where girls have greater agency, the cost function is relatively more sensitive to the type of a girl.

Value of girls for men: The value of a type-t girl whose confinement is observed to be e is denoted by $v_t(e)$, where

$$v_t(0) \geq 0, \ \ \text{and} \ \ \frac{\partial v_t}{\partial e} \ \geq 0, \ \ \text{for all } e \geq 0, \ \ \text{for } t \in \{d, n\}. \tag{5}$$

The value men attach to the docility of a type-t girl is given by $v_t(0)$. The assumption that marginal value of confinement is non-negative reflects that men might value confinement in and of itself for a variety of reasons as discussed earlier. If marginal value of confinement is zero, then the model reduces to a 'pure' signaling model.

The non-negative marginal value of confinement can be interpreted in another way. Recall that in the standard job signaling model education serves only as a signal of productivity of a worker. It is possible that education also adds to the productivity of a worker. Similarly, it is possible that confinement adds to the docility of a girl. Although we do not have any particular reason to prefer either interpretation of the non-negative marginal value of confinement, we shall think of docility as exogenous.

We further assume that (i) men attach a higher value to an unconfined docile girl than to an unconfined non-docile girl, and (ii) a marginal increase in confinement adds (weakly) more to the value of a docile girl than to the value of a non-docile girl at any level of confinement. Formally

$$v_d(0) \;>\; v_n(0) \quad \text{and} \quad \frac{\partial v_d}{\partial e} \;\geq\; \frac{\partial v_n}{\partial e}, \quad \text{for all } e \geq 0. \tag{6}$$

Utility function of men: Each man in the society is characterized by his wealth $w \geq 0$. We assume that every man expects that a fraction $\lambda \in (0,1)$ of his wealth will be spent on the girl he will end up marrying. Without loss of any generality, we assume λ equals 0.5. The utility function of men is assumed to be additively separable in their wealth and the value they derive from marrying a girl, and is given by

$$u_m(t, e, w) \;=\; \begin{cases} v_d(e) + 0.5w & \text{if married to girl} - (d, e). \\ v_n(e) + 0.5w & \text{if married to girl} - (n, e). \\ w & \text{if unmarried.} \end{cases} \tag{7}$$

Decision making of men: Each man decides whether he would be willing to *consider* a girl as a potential partner after observing her extent of confinement.[11] The strategy of all men can be concisely represented by an indicator function– $d(e|w)$ – which takes the value 1 if the man with wealth w would be willing to consider the girl whose confinement is observed to be e, and takes the value 0 if he would not be willing to consider her.

Let $\mu_d(e) \in [0,1]$ denote the common updated probability that the girl is docile after her extent of confinement is observed to be e. We assume that men would be willing to consider all those girls as potential marriage partners who leave them at least as well off as in the unmarried state. Thus a girl whose confinement is observed to be e would be considered by all men having wealth w such that

$$\mu_d(e)(v_d(e) + 0.5w) + (1 - \mu_d(e))(v_n(e) + 0.5w) \;\geq\; w. \tag{8}$$

$$\Rightarrow \;\; w \;\leq\; 2\mu_d(e)v_d(e) \;=\; \overline{w}(e), \tag{9}$$

where $\overline{w}(e)$ denotes the wealth of the *critical suitor*– the richest man willing to consider the girl whose confinement is observed to be e.

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[11]Note that we are not interested in identifying which girl will be matched with which suitor. Sub-section 3A clarifies this further.

Decision making of parents: Relatively higher confinement makes relatively richer men consider a girl, but the associated cost of confinement is also higher. Parents are assumed to optimally choose the level of confinement for their daughters under these two opposing pulls. Formally, parents choose the extent of confinement for their daughters to maximize

$$u(t, e, \overline{w}) \;=\; \overline{w} - c_t(e). \tag{10}$$

A. Remarks

The results would be qualitatively similar if we assume girls, instead of parents, to be the decision makers. Note that the utility function of parents given in Equation 10 can be taken as the utility function of girls. Controlling for other factors, it would be reasonable to assume that the utility of a girl is positively related with the wealth of richest suitors she attracts, and that a docile girl would suffer lower psychic costs of confining herself relative to a non-docile girl.

We are not interested in identifying who will ultimately get married to whom. Imagine the approach graduate schools might take to deal with a large number of applications for the position of an assistant professor. In the first stage, the hiring committee might invoke some useful criterion (for e.g., whether the applicant has a publication) to decide which applications to 'consider' in detail. Only in the second stage the committee might look in detail at the strengths and weaknesses of the candidates selected in the first stage. In fact, Moffat (1989) finds strong evidence that male students classify girls into dichotomous categories of 'good' and 'bad' based on their sexual behavior and attitudes with the intention of sexually experimenting with the bad ones before finding a good one for a long term relationship.

We explore the first stage of the marriage market where each man only decides which girls he would be willing to consider using the extent of premarital confinement as the useful selection criterion. Various other factors, which have been extensively discussed in the matching literature, will indeed play a role in the second stage and determine the precise pairings that would be formed.

We will identify the unique *undefeated equilibrium* (Mailath et al., 1993) of the impure signaling game described above. The focus shall be on understanding (i) what combination of parameter values lead to a pooling/separating equilibrium, (ii) what determines the equilibrium level of confinement, and (iii) how the nature of equilibrium and the associated equilibrium confinement level varies with changes in the parameter values.

It could be argued that at least the parameter denoting the agency of girls (θ) should be endogenized. However, an attempt to endogenize any of the four parameters will require us to consider issues related to growth, development, and technological change

Table 3: PARAMETERS OF A SOCIETY

Parameter	Notation
Valuation of docility of girls by men	$\alpha > 0$
Marginal valuation of confinement of girls by men	$\beta \geq 0$
Agency of girls of both types within a society	$\theta \geq 1$
Prior belief of men regarding the probability of a girl being docile	$\mu_o \in [0,1]$

and may not provide a substantial marginal addition to our understanding of the issue under consideration.[12]

IV. Equilibrium Analysis

We shall use specific functional forms for cost and value functions in the following analysis since it helps convey the intuition behind the results clearly and allows us to obtain clear cut comparative statics. A simple specification of cost functions satisfying the assumptions listed in Equations 1-4 is provided below.

$$c_d(e, \theta) = \sqrt{\theta} e^2 \quad \text{and} \quad c_n(e, \theta) = \theta e^2, \quad \text{where } \theta \geq 1. \tag{11}$$

The valuation of girls by men will be assumed to be

$$v_d(e) = \alpha + \sqrt{\beta} e \quad \text{and} \quad v_n(e) = 0, \quad \text{where } \alpha > 0, \ \beta \geq 0. \tag{12}$$

These value functions satisfy the assumptions listed in Equations 5 and 6. The utility function of men and the utility function of parents is provided in Equations 7 and 10.

Once we choose the specific functional forms, each society in our model will be characterized by four parameters – the valuation of docility by men (α), the marginal valuation of confinement by men (β), the agency of girls (θ), and the prior belief of men (μ_o). Note that this is the most parsimonious impure signaling model that could be used. The only additional parameter in our model compared to a pure signaling model is β (which is, by definition, unavoidable in an impure signaling model). Table 3 summarizes the notation and interpretation of parameters.

The indifference curves of parents of docile and non-docile girls in the $(e, \overline{w})$-space are illustrated in Figure 1A. The solid (broken) upward sloping curves are the indifference

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[12]The interested reader may refer to Doepke and Tertilt (Forthcoming) for an analysis along these lines.

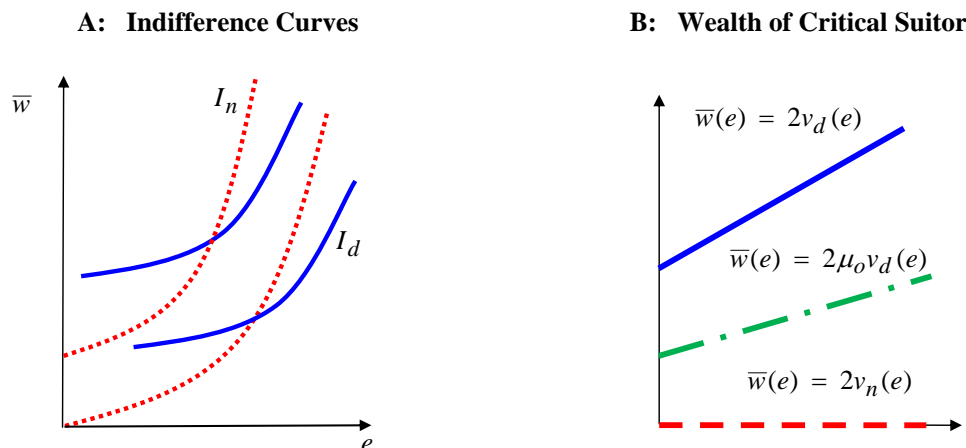**A: Indifference Curves**   **B: Wealth of Critical Suitor**

Figure 1: INDIFFERENCE CURVES OF PARENTS AND WEALTH OF CRITICAL SUITOR

curves of parents of docile (non-docile) girls and are labeled I_d (I_n). Indifference curves associated with relatively higher utility levels lie towards the north-west in Figure 1A.

The utility of parents is defined over *values* of $\overline{w}$ and e. Equation Y suggests that the wealth of the critical suitor for a girl depends on the updated belief regarding the type of the girl and her observed confinement level. The critical suitor wealth function - $\overline{w}(e)$ - is denoted in Figure 1B for three different cases. The top (bottom) most line represents how the wealth of the critical suitor varies according to the observed level of confinement of a girl who is believed to be docile (non-docile). The middle line represents how the wealth of the critical suitor varies according to the observed level of confinement of a girl who is believed to be docile with the prior probability of μ_o.

A. Complete Information

We begin by analyzing the benchmark *complete information* setting where docile girls will be believed by men to be docile with probability one, and non-docile girls will be believed to be docile with probability zero. The optimal confinement choice by parents of the two types of girls would be

$$e_d^c = argmax_e \left[2v_d(e) - c_d(e)\right] \quad \text{and} \quad e_n^c = argmax_e \left[2v_n(e) - c_n(e)\right]. \tag{13}$$

$$\Rightarrow \quad e_d^c(\beta, \theta) = \sqrt{\frac{\beta}{\theta}} \quad \text{and} \quad e_n^c = 0. \tag{14}$$

The equilibrium confinement level of docile girls in the complete information setting increases in the marginal valuation of confinement by men (β), but decreases with an increase
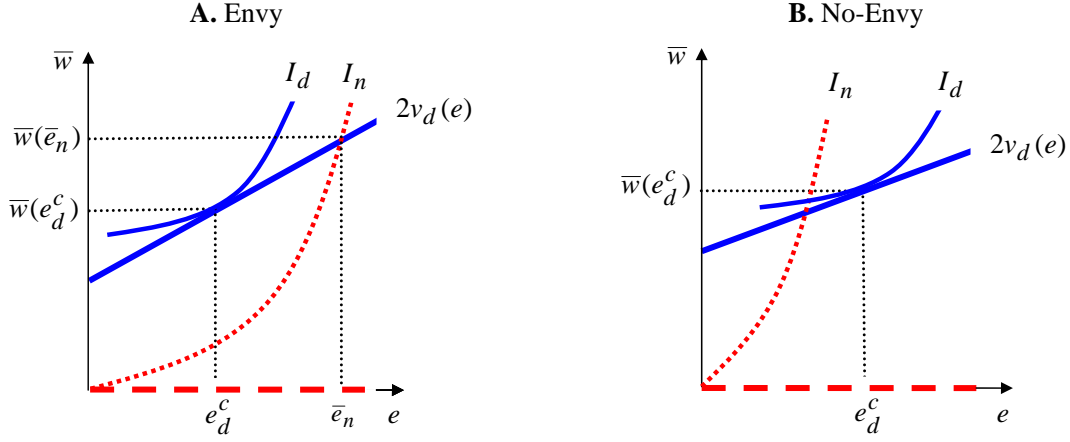
Figure 2: COMPLETE INFORMATION EQUILIBRIUM.

in agency of girls (θ). The zero confinement of non-docile girls is a consequence of our simplifying assumption that men attach a value of zero to non-docile girls (recall, $v_n(e)$ was normalized to zero in Equation 12). The wealth of the critical suitors corresponding to the two types of girls will be

$$\overline{w}(e_d^c) = 2v_d(e_d^c) \quad \text{and} \quad \overline{w}(e_n^c) = 2v_n(e_n^c). \tag{15}$$

$$\Rightarrow \quad \overline{w}(e_d^c) = 2(\alpha + \frac{\beta}{\sqrt{\theta}}) \quad \text{and} \quad \overline{w}(e_n^c) = 0. \tag{16}$$

The resulting utilities of parents of docile and non-docile girls are

$$u(d, e_d^c, \overline{w}(e_d^c)) = (2\alpha + \frac{\beta}{\sqrt{\theta}}) \quad \text{and} \quad u(n, e_n^c, \overline{w}(e_n^c)) = 0. \tag{17}$$

B. Asymmetric Information

It is customary to divide the analysis of the asymmetric information setting into two subcases: the *no-envy* case, and the *envy* case (Figure 2). In envious societies parents of non-docile girls have a strict incentive to mimic the (complete information) confinement choice by parents of docile girls. And this could easily happen since the cost of increasing confinement (from 0 to e_d^c) for parents of non-docile girls can be outweighed by the benefit from the corresponding increase in the wealth of the critical suitor (from 0 to $\overline{w}(e_d^c)$). Formally, envious societies are those where

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$$u(n, e_d^c, \overline{w}(e_d^c)) \;=\; \overline{w}(e_d^c) - c_n(e_d^c, \theta) \;>\; u(n, e_n^c, \overline{w}(e_n^c)) \;=\; 0. \tag{18}$$

$$\Rightarrow \quad 2\alpha + \frac{2\beta}{\sqrt{\theta}} - \beta \;>\; 0. \tag{19}$$

Signaling, by its very nature, is meaningful only in envious societies since the situation in non-envious societies is identical to that in the complete information setting. Any society whose parameters satisfy the above inequality will be envious. Societies with relatively high valuation of docility (α), and relatively low agency of girls (θ) are likely to be envious. A partial increase in α increases the reward of posing one's non-docile daughter as a docile girl, while a partial decrease in θ decreases the cost of doing so. A partial increase in the marginal valuation of confinement (β) increases the wealth of the critical suitor for docile girls because the equilibrium confinement is higher. The incentive for parents of non-docile girls to mimic this increased confinement level depends on the differential benefit of a wealthier critical suitor compared to the differential cost of increasing confinement in order to attract the wealthier suitor.

All societies with a sufficiently low agency of girls ($\theta < 4$) will be envious, irrespective of the values of the other parameters in the society. Similarly, all societies with a sufficiently low valuation of confinement relative to the valuation of docility ($\frac{\beta}{\alpha} < 2$) will be envious, irrespective of the values of the other parameters in the society (see Figure 4 below).

C. Best-Separating Equilibrium

A separating equilibrium involves the choice of a strictly higher confinement of docile girls than that of non-docile girls. In envious societies parents of docile girls will not be able to distinguish their daughters by choosing e_d^c. The minimum confinement that helps parents of docile girls distinguish their daughters equals the maximum confinement parents of non-docile girls would be willing to choose for their daughters. This level of confinement, $\overline{e}_n$, makes parents of non-docile girls indifferent between (i) revealing their daughters as non-docile girls by choosing e_n^c ($= 0$), and (ii) choosing $\overline{e}_n$ to pose their daughters as docile girls (see Figure 2A). Thus, $\overline{e}_n$ is given by

$$u(n, \overline{e}_n, \overline{w}(\overline{e}_n)) \;=\; u(n, e_n^c, \overline{w}(e_n^c)). \tag{20}$$

$$\Rightarrow \quad \overline{e}_n(\alpha, \beta, \theta) \;=\; \frac{\sqrt{\beta} + \sqrt{\beta + 2\alpha\theta}}{\theta}, \tag{21}$$

such that $\frac{\partial \overline{e}_n}{\partial \alpha} > 0$, $\frac{\partial \overline{e}_n}{\partial \beta} > 0$, and $\frac{\partial \overline{e}_n}{\partial \theta} < 0$.

Proposition 1. *Among all possible separating equilibria in the envy case, the one which provides parents of docile girls maximum utility is as follows.*[13]

(i) *The strategy of the parents of girls is:* $(e_d^*, e_n^*) = (\bar{e}_n, 0)$;

(ii) *The belief of men is*:

$$\mu_d^*(e) = \begin{cases} 1 & \text{if } e \geq \bar{e}_n. \\ 0 & \text{otherwise.} \end{cases} \tag{22}$$

(iii) *The strategy of men is*:

$$d^*(e|w) = \begin{cases} 1 & \text{if } e \geq \bar{e}_n \text{ and } w \leq 2v_d(e). \\ 0 & \text{otherwise.} \end{cases} \tag{23}$$

This separating equilibrium shall be referred to as the *best*-separating equilibrium. On the *equilibrium path* in this equilibrium (i) the confinement of docile girls is the minimum confinement that helps distinguish them from non-docile girls, (ii) men believe a girl to be docile if her confinement is $\bar{e}_n$, and non-docile if she is not confined, and (iii) all men with wealth $w \leq 2v_d(\bar{e}_n)$ would be willing to consider all the confined docile girls as potential partners. No man would be willing to consider the unconfined non-docile girls. The *off-equilibrium* beliefs of men are such that any girl who is confined at least to the extent $\bar{e}_n$ is believed to be docile with certainty, while if the confinement of a girl is below this level then she is believed to be non-docile with certainty. The utilities of parents in the best-separating equilibrium will be

$$u_d^{sep} = 2(\frac{\sqrt{\theta} - 1}{\sqrt{\theta}})(\alpha + \beta + \sqrt{\beta^2 + 2\alpha\beta\theta}) \quad \text{and} \quad u_n^{sep} = 0. \tag{24}$$

D. Best-Pooling Equilibrium

In a pooling equilibrium both types of girls are confined to the same level and confinement looses it's signal value. The updated beliefs of men regarding the fraction of docile girls in the society will be the same as their prior belief μ_o. In our set up pooling is possible at several levels of confinement for any $\mu_o \in (0, 1)$. The pooling equilibrium which provides parents of docile girls the highest utility (see Figure 3A) among all the possible pooling equilibria for a given $\mu_o \in (0, 1)$ involves

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[13] Among all possible separating equilibria in the *no-envy* case, the one which provides parents of docile girls maximum utility is identical to the equilibrium in the complete information setting (see Figure 2B).
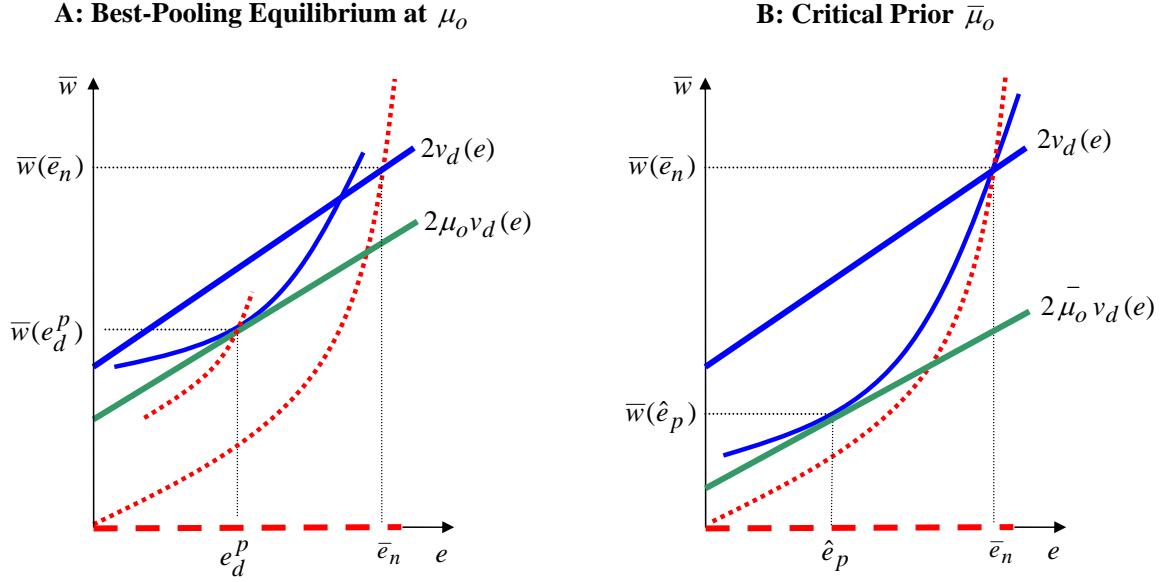
A: Best-Pooling Equilibrium at μ_o

B: Critical Prior $\overline{\mu}_o$

Figure 3: POOLING EQUILIBRIA.

$$e_d^p(\beta, \theta, \mu_o) \;=\; argmax_e \, [2\mu_o v_d(e) - c_d(e)] \;=\; \mu_o\sqrt{\frac{\beta}{\theta}}, \tag{25}$$

such that $\frac{\partial e_d^p}{\partial \alpha} = 0$, $\frac{\partial e_d^p}{\partial \beta} > 0$, $\frac{\partial e_d^p}{\partial \theta} < 0$, $\frac{\partial e_d^p}{\partial \mu_o} > 0$.

Proposition 2. *For a given* $\mu_o \in (0,1)$, *among all possible pooling equilibria in the envy case, the one which provides parents of docile girls maximum utility is as follows.*

(i) *The strategy of the parents of girls is:* $(e_d^*, e_n^*) = (e_d^p, e_d^p)$;

(ii) *The belief of men is*:

$$\mu_d^*(e) = \begin{cases} \mu_o & \text{if } e \geq e_d^p. \\ 0 & \text{otherwise.} \end{cases} \tag{26}$$

(iii) *The strategy of men is*:

$$d^*(e|w) = \begin{cases} 1 & \text{if } e \geq e_d^p \text{ and } w \leq 2\mu_o v_d(e). \\ 0 & \text{otherwise.} \end{cases} \tag{27}$$

We shall refer to this pooling equilibrium as the *best*-pooling equilibrium. On the *equilibrium path* in this equilibrium (i) all girls are confined to the same level of e_d^p, (ii)

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men believe each girl is docile with (the prior) probability μ_o, and (iii) all men with wealth $w \leq 2\mu_o v_d(e_d^p)$ would be willing to consider all girls in the society as potential marriage partners. The *off-equilibrium* beliefs involve men believing that even if a girl is confined more than the equilibrium level she is a docile girl with the prior probability of μ_o. However, if a girl is confined less than the equilibrium level, then she is believed to be non-docile with certainty. The utilities of parents in the best-pooling equilibrium are

$$u_d^{pool} = 2\mu_o\alpha + \frac{\mu_o^2\beta}{\sqrt{\theta}} \qquad \text{and} \qquad u_n^{pool} = 2\mu_o\alpha - (\frac{\theta-1}{\sqrt{\theta}})\frac{\mu_o^2\beta}{\sqrt{\theta}}. \tag{28}$$

E. The Critical Prior

In envious societies there exists a $\overline{\mu_o} \in (0,1)$ such that some of the feasible pooling equilibria for any $\mu_o > \overline{\mu_o}$ provide parents of docile girls strictly higher utility than the best-separating equilibrium mentioned in Proposition 1. The value of $\overline{\mu_o}$ for a given society is such that parents of docile girls are indifferent between (i) pooling at $e_p^d(\beta, \theta, \overline{\mu_o})$, and (ii) separating by choosing $\overline{e}_n$. Let $\hat{e}_p$ denote $e_p^d(\beta, \theta, \overline{\mu_o})$ as in Figure 3B. Thus, the critical prior can be obtained using the following equality.

$$u(d, \hat{e}_p, \overline{w}(\hat{e}_p)) = u(d, \overline{e}_n, \overline{w}(\overline{e}_n)). \tag{29}$$

$$\Rightarrow \quad \overline{\mu_o} = \overline{\mu_o}(\frac{\beta}{\alpha}, \theta), \tag{30}$$

where

$$\frac{\partial \overline{\mu_o}}{\partial \alpha} \leq 0, \quad \frac{\partial \overline{\mu_o}}{\partial \beta} \geq 0, \quad \frac{\partial \overline{\mu_o}}{\partial (\frac{\beta}{\alpha})} \geq 0, \quad \frac{\partial \overline{\mu_o}}{\partial \theta} \geq 0. \tag{31}$$

All societies below the dark-dashed curve in the north-east corner of Figure 4 are envious, while those above it are non-envious (see Equation 19).[14] This dark-dashed curve is the contour of $\overline{\mu_o} = 1$. The contour of $\overline{\mu_o} = 0$ is $\theta = 1$. The two downward sloping dark solid curves in Figure 4 are the contours of the critical prior for some $\overline{\mu_o}^1, \overline{\mu_o}^2 \in (0,1)$. The contour associated with a higher value of the critical prior lies completely above the contour for any comparatively lower critical prior. The critical prior is (weakly) increasing in β, $\frac{\beta}{\alpha}$ and θ, but (weakly) decreasing in α.

Before proceeding it is helpful to consider any point in Figure 4. For instance, the point labeled C represents a *set* of societies all of which have the same agency of girls (θ)

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[14]Figure 4 is a faithfully modified version of the output from Mathematica 6.0 which is provided in the Appendix. The derivation of $\overline{\mu_o}$ and its properties are also described.
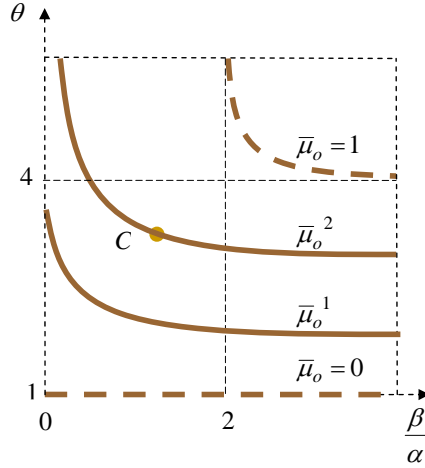
Figure 4: CONTOURS OF THE CRITICAL PRIOR.

and marginal valuation of confinement relative to the valuation of docility ($\frac{\beta}{\alpha}$). They will have the same critical prior since the critical prior depends only on θ and $\frac{\beta}{\alpha}$. However, the societies represented by point C may differ in the values of α and β. More importantly, the societies represented by point C may differ in the value of the actual prior μ_o.

The actual prior in some of the societies represented by point C may be strictly less than the critical prior of $\overline{\mu_o}^2$, and the actual prior may be (weakly) greater than the critical prior in other societies. We will now state the main proposition which will help us predict the unique equilibrium for any society characterized by a given α, β, θ, and μ_o.

F. The unique prediction

In Proposition 1 (2) we identified the separating (pooling) equilibrium which provides parents of docile girls the maximum utility among all separating (pooling) equilibria that are possible for that society. The following proposition tells us that the unique prediction for any society in our model is that equilibrium which provides parents of docile girls the highest utility among all equilibria that are possible in that society.

Proposition 3(i). *If the society is non-envious, then the unique undefeated equilibrium is the separating equilibrium at* $(e_d^*, e_n^*) = (e_d^c, 0)$.

Proposition 3(ii). *If the society is envious, then the unique undefeated equilibrium is*

- *the best-pooling equilibrium at* $(e_d^*, e_n^*) = (e_d^p, e_d^p)$ *if* $\mu_o \geq \overline{\mu_o}(\frac{\beta}{\alpha}, \theta)$.

- *the best-separating equilibrium at* $(e_d^*, e_n^*) = (\bar{e}_n, 0)$ *if* $\mu_o < \overline{\mu_o}(\frac{\beta}{\alpha}, \theta)$.[15]

The identical confinement of all girls in the pooling equilibrium can be interpreted as reflecting a *society-wide norm*. The conditions prevailing in a society (as captured by the four parameters $\alpha, \beta, \theta, \mu_o$) that lead to the pooling equilibrium being the unique prediction provide parents of docile girls no incentive to distinguish their daughters as being docile, while parents of non-docile girls have all the incentive not to let their daughters be identified as non-docile. Parents of both types of girls are better off in the best-pooling equilibrium than they would be in any separating equilibrium that could arise in such a society. Moreover, for the best-pooling equilibrium to be the unique prediction for a society it must be the case that the utility of parents of non-docile girls is strictly positive since they can ensure zero utility by separating.

V. Pooling Equilibrium as a norm

Confinement does not have any signal value in a society that exhibits a pooling equilibrium as both docile and non-docile girls are confined to the same level. However, this does not mean that confinement becomes meaningless for members of such a society. On the contrary, since the conditions prevailing in the society make it feasible for all girls to be confined to the same level, it can easily come to be perceived as a norm/tradition/custom. It is the defining feature of traditions that a common pattern of behavior is observed despite heterogeneities in individual characteristics. The natural question that arises is what combination of parameter values are likely to make the pooling equilibrium the unique prediction for a society.

We have identified the nature of the equilibrium and the associated level of confinement for the whole range of plausible values of each of the four parameters. Thus, Proposition 3 provides us the unique prediction for all societies permitted in our model. However, it is quite likely that some/all of the four parameters that characterize a society in our model (i.e., $\alpha, \beta, \theta, \mu_o$) are correlated. The possible correlation among the parameters renders a question like – what would be the change in the level of confinement *within* a society in response to a partial increase in one of the parameters – meaningless. But, we can answer whether a society that differs from another society in only one of the parameters (i) will have a relatively higher or lower confinement, and (ii) is it more likely to exhibit a pooling/separating equilibrium. This is why the partial effect of parameters on the

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[15]When the actual prior in a society equals the critical prior for the society, then parents of docile girls will be indifferent between the best-pooling equilibrium and the best-separating equilibrium. We assume that parents of docile girls choose the lower level of confinement corresponding to the best-pooling equilibrium in such a case.

feasibility of pooling equilibrium and on the level of confinement should be interpreted as predictions *across* societies.

A. Feasibility of a society-wide norm

Proposition 3 tells us that if the actual prior in a given society is greater than the critical prior for the society, then the society will exhibit a pooling equilibrium. Consider any two societies that differ with respect to only α, or only β, or only θ. The two societies will have different critical priors (say, $\overline{\mu_o}^1 > \overline{\mu_o}^2$) but the same actual prior (say, μ_o). For any $\mu_o \in (0, 1)$:

(i) if the first society exhibits a pooling equilibrium, then so will the second society (because if $\mu_o > \overline{\mu_o}^1$, then $\mu_o > \overline{\mu_o}^2$).
(ii) if the first society exhibits a separating equilibrium, then the second society may still exhibit a pooling equilibrium (because it is possible that $\overline{\mu_o}^1 > \mu_o > \overline{\mu_o}^2$).
(iii) if the second society exhibits a separating equilibrium, then the first society will also exhibit a separating equilibrium (because if $\overline{\mu_o}^2 > \mu_o$, then $\overline{\mu_o}^1 > \mu_o$).

These observations suggest a general rule. Any partial parameter difference across societies that leads one society to have a relatively lower critical prior, makes it more likely for this society to exhibit the pooling equilibrium. Equation (31) tells us that higher valuation of docility (α), lower valuation of confinement (β), lower valuation of confinement relative to docility ($\frac{\beta}{\alpha}$), and lower agency (θ) increase the feasibility of a societal norm of confinement.

A comparison of the utilities of parents of non-docile girls in the best-separating and best-pooling equilibria provides the intuition. Equations 24 and 28 give us

$$ u_n^{sep} = 0 \quad \text{and} \quad u_n^{pool} = 2\mu_o\alpha - (\frac{\theta - 1}{\sqrt{\theta}})\frac{\mu_o^2\beta}{\sqrt{\theta}} \tag{32} $$

The parents of non-docile girls obtain zero utility in the best-separating equilibrium corresponding to any set of parameter values characterizing a society. Thus, a necessary (but not sufficient) condition for the best-pooling equilibrium to be the unique prediction for a society is that the utility of parents of non-docile girls in the best-pooling equilibrium must be strictly positive. An increase in the valuation of docility leads to an unambiguous increase in the utility of parents of non-docile girls corresponding to the best-pooling equilibrium (because the total cost of confinement does not rise since the extent of confinement in the pooling equilibrium is independent of the valuation of docility by men).

Equation 32 also suggests that a partial increase in the marginal valuation of docility leads to an unambiguous decrease in the utility of parents of non-docile girls corresponding

to the best pooling equilibrium. Thus, a partial increase in the valuation of confinement by men will tend to decrease the feasibility of a societal norm of confinement. However, this result should be interpreted with caution.

There are two components to mens' valuation of girls: α and β. The critical prior is increasing in $\frac{\beta}{\alpha}$. Thus, the feasibility of a societal norm of confinement increases with decreasing values of $\frac{\beta}{\alpha}$. This in turn implies that a societal norm of confinement can arise even if valuation of confinement is very high if the valuation of docility is sufficiently high (so that $\frac{\beta}{\alpha}$ is quite low). Intuitively, an increase in the marginal valuation of confinement puts parents of non-docile girls at a disadvantage. They have to incur greater costs since they need to increase the level of confinement of their daughters if pooling has to be sustained. On the other hand, a substantial increase in valuation of docility leads to an increase in the benefits to parents of non-docile girls without adding to their costs corresponding to the pooling equilibrium. The relative impact of these two changes is such that if the marginal valuation of confinement relative to the valuation of docility decreases, the feasibility of a societal norm of confinement increases.

A partial increase in the agency of girls has an unambiguously negative impact on the feasibility of a societal norm of confinement. This is so because an increase in agency increases costs of confinement for parents of both types of girls, but relatively more so for parents of non-docile girls. We summarize the main insights from this discussion in the form of the following observation.

Observation 1. *The feasibility of a societal norm of confinement increases with a partial decrease in the agency of girls, a partial increase in the valuation of docility, and a partial decrease in the marginal valuation of confinement. Moreover, the feasibility of the norm increases with a decrease in the marginal valuation of confinement relative to the valuation of docility.*

B. Level of confinement

Societies may exhibit either the pooling or the separating equilibrium depending upon the parameter values that characterize them. Neglecting the discontinuities due to change in the nature of the equilibrium, the partial effect of each parameter on the equilibrium level of confinement can be easily identified. Recall that the equilibrium confinement of both types of girls in the best-pooling equilibrium, and that of docile girls in the best-separating equilibrium is

$$e_d^p \;=\; \mu_o\sqrt{\frac{\beta}{\theta}} \qquad \text{and} \qquad e_d^{sep} \;=\; \bar{e}_n \;=\; \frac{\sqrt{\beta} + \sqrt{\beta + 2\alpha\theta}}{\theta}. \tag{33}$$

The marginal valuation of confinement and the agency of girls affect the level of confinement in both types of equilibria, but the valuation of docility affects the level of confinement corresponding to the separating equilibrium. An increase in agency lowers the equilibrium confinement level in both types of equilibria by making it costlier for parents to carry out confinement.

The two components of mens' valuation of girls – valuation of docility and marginal valuation of confinement – have distinct effects. Societies with relatively higher valuation of docility are more likely to exhibit a society-wide norm of confinement as reflected by the pooling equilibrium. But, a higher valuation of docility has no impact on the equilibrium level of confinement in the pooling regime. On the other hand, although higher marginal valuation of confinement leads to an increase in the level of confinement, it decreases the feasibility of the pooling equilibrium. Moreover, a societal norm involving strictly positive levels of confinement for girls necessarily requires men to value confinement in and of itself.

C. The importance of agency

We have shown that a higher α, a lower β, and a lower θ make pooling more likely. Let us first consider societies that differ only with respect to α. Although societies with relatively greater valuation of docility are more likely to exhibit the pooling equilibrium, pooling may not occur even if the valuation of docility tends to its upper bound of infinity. This is because

$$lim_{\alpha \to \infty} \ [\overline{\mu_o}(\frac{\beta}{\alpha}, \theta)] \ = \ 1 - \frac{1}{\sqrt{\theta}}. \tag{34}$$

If agency of girls in the society is sufficiently high, then it is possible that the actual prior in the society is lower than the critical prior of $1 - \frac{1}{\sqrt{\theta}}$. Consequently, a society with extremely high valuation of docility need not necessarily exhibit the pooling equilibrium. Similarly, pooling may not be observed in a society where the marginal valuation of confinement approaches its lower bound of zero because

$$lim_{\beta \to 0} \ [\overline{\mu_o}(\frac{\beta}{\alpha}, \theta)] \ = \ 1 - \frac{1}{\sqrt{\theta}}. \tag{35}$$

On the other hand, when the agency of girls in a society approaches its lower limit of unity, then the critical prior for the society approaches zero. Or,

$$lim_{\theta \to 1} \ [\overline{\mu_o}(\frac{\beta}{\alpha}, \theta)] \ = \ 0. \tag{36}$$

The actual prior in any imaginable society in our model will be at least zero, and thus (weakly) greater than the critical prior when agency approaches its lower limit of unity. We know from Proposition 3 that if the actual prior is (weakly) greater than the critical prior, then the society will exhibit a pooling equilibrium. Thus, if the agency of girls in a society is sufficiently low, then the pooling equilibrium can arise *irrespective* of the values of the other parameters. Moreover, the lower the agency, the higher is the equilibrium level of confinement.

Intuitively, with a decrease in the agency of girls the *absolute* cost of confining both types of girls to any given extent decreases, and the cost of confining a non-docile girl *relative* to a docile girl to any given extent also decreases. Consequently, as agency decreases, a society-wide norm involving high level of confinement becomes increasingly feasible.

VI. Discussion and concluding remarks

A. Emergence versus persistence

The actual reasons for the emergence of footbinding and FGM are not known with certainty. They might have been initially thought of as aesthetically pleasing, an ethnic marker, or a symbol of social status. References to footbinding in China are found from the period of the Shang dynasty around twelfth century B.C. Written records indicate that it was only during the reign of the Song dynasty (960-1279 AD) that it diffused 'from the palace dancer to the upper classes and finally down to the masses' (Levy 1992, pp.41). Similarly, there are references suggesting that Egyptians, Phoenicians, and Hittites, practiced FGM as far back as 500 BC (Sanderson, 1981).

The present paper should be thought of as an attempt to understand what ensures the persistence of such practices. Controlling the sexual behavior of women may not have been the reason why these practices arose in the very first place. But, they do seem have acquired this function at some point in time. One among many references supporting this view listed by Levy (1992) is the following quotation from the time of the Yuan dynasty (1271-1368 AD) in China.

"Why must the foot be bound? To prevent barbarous running around!"

B. Anthropological evidence

The correlation between the socio-economic organization of societies and the extent of confinement of unmarried girls has been empirically examined by anthropologists. Although causal inferences are hard to make, the model presented in the paper can help organize these findings.

In a society with low population density and high marginal product of unskilled labor, a woman's fertility may become paramount since greater number of children add to the labor force of the family. Fertility may override the concern with fidelity, making premarital confinement less valuable to men (i.e., β will be low). Accordingly, controlling for other factors, the model would predict relatively low levels of confinement in societies where the marginal product of unskilled labor is relatively high.

Patrilineal descent rules make fidelity a relatively more important concern for men as compared to matrilineal descent rules. The mechanism described in the paper would predict relatively high levels of premarital confinement of girls in patrilineal societies since the valuation of docility (α), and/or the marginal value of confinement for men (β) would be relatively higher in patrilineal societies. This prediction is confirmed by several empirical studies (for example, Eckhardt, 1971).

Substantial contribution by women in the production process in a society translates into greater agency (θ) for girls according to our interpretation. The model predicts low levels of confinement in such societies. The findings of Sanderson et. al. (2005) and Whyte (1978) provide the supporting empirical evidence. In fact, one of the more robust findings is that intensive plow agriculture is strongly associated with lower status of women in a society. In general, if the primary production technology in a society relegates women to the domestic sphere, then it usually leads to relatively lower status of women (Boserup, 1970). For instance, it is believed that an important reason for the relatively better status of women in rice cultivating communities compared to wheat cultivating communities in India is that it is relatively easier for women to be directly engaged in rice cultivation (Guha, 2007).[16]

C. Direction of marriage transactions

It seems plausible that the direction of transactions associated with marriage would be a good predictor of confinement of girls across societies. Seduction of a daughter would reduce her 'price' in societies where parents receive bride-price, and thus they would have an incentive to confine their daughters. Goody (1999) has shown that although prohibitions on premarital sex are observed in societies where parents of girls receive bride-price, they are no less prominent in societies where parents pay dowry to marry off their daughters. In addition, prohibitions are found even in those societies where there are no individual property rights, no transactions associated with marriage, and no particular rules of inheritance (see Table 1, pp. 121 in Goody, 1999).

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[16]The interested reader may refer to Anderson and Eswaran (Forthcoming) and the references therein for a discussion of factors that influence autonomy of women in household decision-making. It can be expected that the socio-economic factors that enhance the autonomy of women also increase the agency of young girls in the society and lead to lower levels of confinement.

Goody's findings imply that why and where we would observe premarital confinement can not be adequately explained by focusing on the direction of transactions associated with marriage. For example, in several communities in contemporary India dowry and and premarital confinement of girls go hand in hand; while in several contemporary African communities bride-price and FGM are simultaneously observed. Moreover, such an approach raises the additional question regarding what socio-economic factors determine the direction of transactions associated with marriage (the interested reader may refer to Anderson (2007) for a detailed analysis of this question). In contrast, the model presented in the present paper is based on fundamental and universal considerations, viz., the preference of men for faithful wives, and parental concern for well-being of their daughters.

D. The liberal-traditional dichotomy

In the popular jargon it is not uncommon to distinguish societies as liberal or traditional depending upon the restrictions faced by women. Low confinement of women is the hallmark of liberal societies in this terminology. Could the pattern of confinement in a very liberal society be thought of as pooling at low levels of confinement? Our answer is no.

Liberal societies are invariably characterized by high agency of girls which in turn makes the pooling equilibrium quite unlikely. Since the agency of girls is very high, the confinement of even the docile girls will be negligible, making the separating equilibrium almost similar to a pooling equilibrium involving zero confinement.

In contrast, traditional societies are usually characterized by low agency of girls and are thus likely to exhibit a pooling equilibrium. Since agency of girls is very low the associated level of confinement for all girls in the pooling equilibrium will be quite high. We believe that practices like footbinding and FGM signify a strict society-wide norm of confinement, rendered feasible primarily by the extremely low agency of girls.

E. Gender empowerment and development

We briefly discuss the association between the level of development of a country and the confinement of women in general. For the purpose of this discussion we shall use the Human Development Index (HDI) as the measure of development of a country. The HDI of a country accounts for life expectancy, literacy, and GDP per capita (in PPP US$).

A satisfactory measure of confinement is difficult to find. A crude measure of confinement can be constructed by using the Gender Empowerment Measure (GEM) of a country which is an index of political participation and decision making power, economic participation and command over resources by women relative to men. The GEM of a country
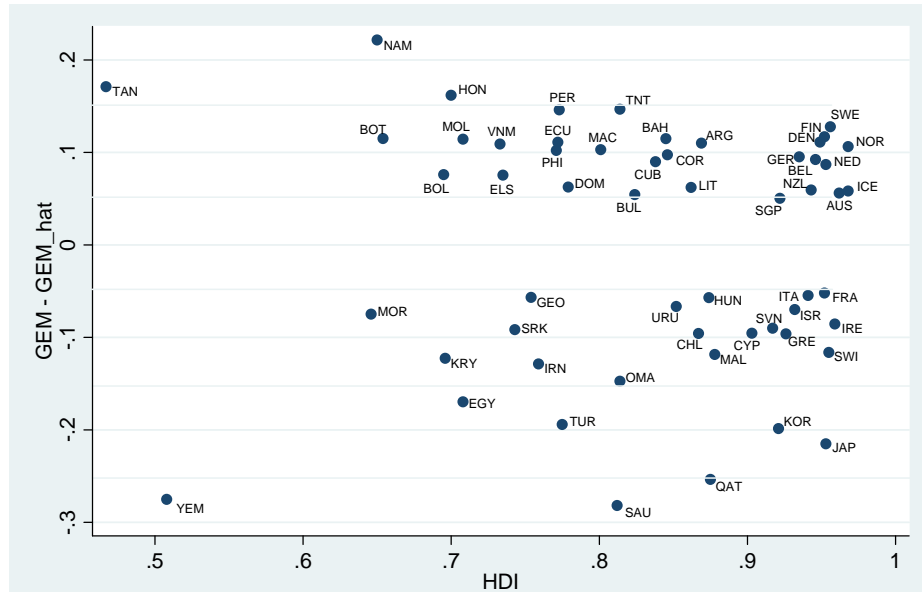
Figure 5: Development and Gender Empowerment

lies between zero and one.[17] Confinement could be thought of as the inverse of gender empowerment.

The results of the linear regression of GEM on HDI with the highest adjusted-R^2 are reported below using data on 93 countries.[18]

$$\widehat{GEM} \; = \; 1.34 \; - \; 3.25 \, (HDI) \; + \; 2.79 \, (HDI)^2$$

$$N = 93, \;\; \bar{R}^2 = 0.61, \;\; \text{St. Dev. of Residuals} \; = \; 0.1$$

The residuals $(GEM - \widehat{GEM})$ from the above regression are plotted as a function of the HDI in Figure 5 for those 57 countries that have residuals greater than +0.05 or less than -0.05 (where, 0.05 is half the standard deviation of the residuals). Countries with a positive (negative) residual reflect greater (lower) empowerment of women, and thus lower (higher) confinement, than would be predicted by the gender-neutral HDI.

The residuals of Qatar and Argentina (-0.25 vs. 0.11) are very different although the HDI for these countries is about 0.87. Similarly, Japan and Sweden have almost the same value of HDI (0.95), but the residuals are very different (-0.21 vs. 0.13). Clearly, not all

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[17]HDI also ranges from zero to one. Details regarding the exact calculations underlying the GEM and HDI are available at: http://hdr.undp.org/en/media/HDR_20072008_Tech_Note_1.pdf.

[18]The *p*-value corresponding to each coefficient is less than 0.001. The data used in the regressions are taken from the Human Development Report (2007-08) which is available at: http://hdr.undp.org/en/media/HDR_20072008_Tables.pdf.

the variation in GEM across countries can be explained using measures of development. The cultural and historical particularities of a society influence gender empowerment over and above the level of development reflected by gender-neutral measures like the HDI.

E. Concluding remarks

In this paper we have focused on pre-marital confinement of girls and tried to explain it using an impure signaling model. Why a signaling approach is best suited to model pre-marital confinement can also be motivated by examining the reasons for post-marital confinement of women. The main reason behind post-marital confinement of women is to assure certainty of paternity of children (Posner, 1992).[19] If post-marital confinement is an attempt to ensure fidelity of women, then it is reasonable to expect that societies will exhibit mechanisms whereby parents try to signal their daughter's likelihood to remain fidel in various ways.

Agency of girls in a society plays a key role in our model. Low agency of girls not only increases the feasibility of a society wide norm of confinement, it also leads to high levels of confinement. This is in line with Doepke and Tertilt (Forthcoming) who have argued that technological changes that increase the importance of human capital in a society lead to greater empowerment of women. The importance of greater investments in human capital of women in less developed countries can hardly be exaggerated. Lagerlöf (2003) has shown that policies designed to reducing human capital differentials between men and women have positive impact on the growth rate of an economy.

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Appendix I: Proofs

Let e_d, e_n, and $d(e|w)$ denote the strategy of parents of docile girls, parents of non-docile girls, and men, respectively; and, $\mu_d(e)$ denote the updated probability of men that a girl whose confinement is observed to be e is of type-d. A Perfect Bayesian Equilibrium is a collection of strategies and beliefs $(E^* = e_d^*, e_n^*, d^*(e|w), \mu_d^*(e))$ that satisfy the following three requirements: (i) strategies are mutual best responses given the beliefs, (ii) beliefs *on* the equilibrium path are updated according to Bayes rule, and (iii) beliefs *off* the equilibrium path may be arbitrary. It can be easily verified that the equilibria presented in Propositions 1 and 2 satisfy these three conditions mentioned above.

Proof of Proposition 3. The Sequential equilibria of the game are the same as the Perfect Bayesian Equilibria of the game (Fudenberg and Tirole, 1991). We follow Mailath et al. (1993) in the exposition of the proof. Let E^* be a proposed equilibrium, and E^{**} be an alternative equilibria. Suppose, the confinement choice of e^{**} is sent *on* the equilibrium

path in E^{**} by some $t \in \{d, n\}$, but not in E^*. Or, e^{**} is an *off* the equilibrium path message by type-t with respect to E^*. Further suppose that the type(s) that chooses e^{**} strictly prefers the equilibrium E^{**} over E^*. If the belief of men in E^* at the off equilibrium message e^{**} are inconsistent with their belief at e^{**} in the E^{**} equilibrium, then the alternative equilibrium defeats the proposed equilibrium. An equilibrium which can not be defeated by any other equilibrium in this manner is referred to as an *undefeated equilibrium.*

We shall prove the two parts of the proposition for the envy scenario. The proof of the no-envy scenario is identical to the proof of the envy scenario for $\mu_o < \overline{\mu_o}$. So, first let us consider the envy scenario with $\mu_o < \overline{\mu_o}$. Let the separating equilibrium in Proposition 1 be the proposed equilibrium. (i) Any separating equilibrium with $e_d^{**} > \overline{e}_n$ does not even qualify as an *alternative* equilibrium since neither type of parents would strictly prefer it over the separating equilibrium at $(e_d^*, e_n^*) = (\overline{e}_n, 0)$. (ii) There does not exist any envy-separating equilibrium involving an $e_d^{**} < \overline{e}_n$. (iii) Let any pooling equilibrium, say, the one in Proposition 2 be the alternative equilibrium. This alternative equilibrium is preferred only by type-n parents over the proposed separating equilibrium. Moreover, the proposed separating equilibrium involves men assigning any choice of $e \leq \overline{e}_n$ to type-n. Hence, the beliefs in the proposed equilibrium are consistent with the beliefs in the alternative equilibrium. We can thus conclude that the proposed envy-separating equilibrium is not defeated by any other equilibrium. Proceeding in a similar manner one can easily show that it defeats any other proposed equilibrium. Therefore, the envy separating equilibrium in Proposition 1 is the unique undefeated equilibrium if $\mu_o < \overline{\mu_o}$.

Now let us consider the envy scenario for $\mu_o > \overline{\mu_o}$. Let the separating equilibrium in proposition 1 be the proposed equilibrium. Let the pooling equilibrium in Proposition 2 be the alternative equilibrium. This alternative equilibrium is strictly preferred by parents of both types compared to the proposed equilibrium. But, in the proposed equilibrium a choice of e_d^p is assigned to type-n parents only. This inconsistency implies that the pooling equilibrium in Proposition 2 defeats the separating equilibrium in Proposition 1 if $\mu_o > \overline{\mu_o}$.

Now let the pooling equilibrium in Proposition 2 be the proposed equilibrium. (i) Any separating equilibrium with $e_d \geq \overline{e}_n$, or any pooling equilibrium at an $e > e_d^p$ does not even qualify as an alternative equilibrium as it is not strictly preferred by either type of parents. (ii) Let a pooling equilibrium at an $e < e_d^p$ be the alternative equilibrium. This alternative pooling equilibrium is preferred only by type-n parents. The belief of men in the proposed pooling equilibrium are consistent with this. Hence, the proposed pooling equilibrium at e_d^p is not defeated by any other equilibrium.

Finally, (i) let the pooling equilibrium at an $e^p > e_d^p$ be the proposed equilibrium and the pooling equilibrium at e_d^p be the alternative equilibrium. The alternative equilibrium is preferred by both types of parents. The proposed pooling equilibrium assigns the choice

of e_d^p to only type-n parents, and is therefore inconsistent. (ii) Let the pooling equilibrium at an $e^p < e_d^p$ be the proposed equilibrium and the pooling equilibrium at e_d^p be the alternative equilibrium. The alternative equilibrium is not preferred by type-n parents. The proposed equilibrium, however, assigns the choice of e_p^d to type-n parents with strictly positive probability, and is therefore inconsistent. Since the pooling equilibrium at e_d^p defeats every other equilibrium but is not defeated by any other equilibrium, it is the unique undefeated equilibrium in the envy case when $\mu_o > \overline{\mu_o}$.

Appendix II: The critical prior

Equation (29) can be rewritten as

$$\overline{w}(\hat{e}_p) \ - \ \sqrt{\theta}(\hat{e}_p)^2 \ = \ \overline{w}(\overline{e}_n) \ - \ \sqrt{\theta}(\overline{e}_n)^2 \tag{37}$$

$$\Rightarrow \quad \alpha \cdot [(\frac{\gamma}{\sqrt{\theta}}) \cdot \overline{\mu_o}^2 \ + \ 2 \cdot \overline{\mu_o} \ + \ (\frac{r^2}{\theta\sqrt{\theta}} - 2(1 + \frac{\sqrt{\gamma}r}{\theta}))] \ = \ 0 \tag{38}$$

where $r = (\sqrt{\gamma} + \sqrt{\gamma + 2\theta})$ and $\gamma = \frac{\beta}{\alpha}$. If γ is zero, then $\overline{\mu_o} = 1 - \frac{1}{\sqrt{\theta}}$. When γ is strictly positive, the positive root of the above given quadratic equation is

$$\overline{\mu_o} \ = \ \frac{-\theta^{\frac{3}{2}} + \sqrt{\theta^3 + 2\gamma\theta(\sqrt{\theta} - 1)(\gamma + \theta + \sqrt{\gamma(\gamma + 2\theta)})}}{\gamma\theta}, \tag{39}$$

$$\text{with} \quad lim_{\theta \to 1} [\overline{\mu_o}] \ = \ 0, \quad \text{and} \quad lim_{\gamma \to \infty} [\overline{\mu_o}] \ = \ 2\sqrt{\frac{\sqrt{\theta} - 1}{\theta}}. \tag{40}$$

The contour plot of $\overline{\mu_o}(\gamma, \theta)$ as generated in Mathematica 6.0 is shown in Figure 6. The commands used to generate this figure were:

1. $\overline{\mu_o} \ = \ \dfrac{-\theta^{\frac{3}{2}} + \sqrt{\theta^3 + 2\gamma\theta(\sqrt{\theta} - 1)(\gamma + \theta + \sqrt{\gamma(\gamma + 2\theta)})}}{\gamma\theta}.$

2. ContourPlot$[\overline{\mu_o}, \{\gamma, 0.01, 5\}, \{\theta, 1, 5\}$, Contours $\to \{0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 0.95\}$, ContourLabels $\to$ *Automatic*].
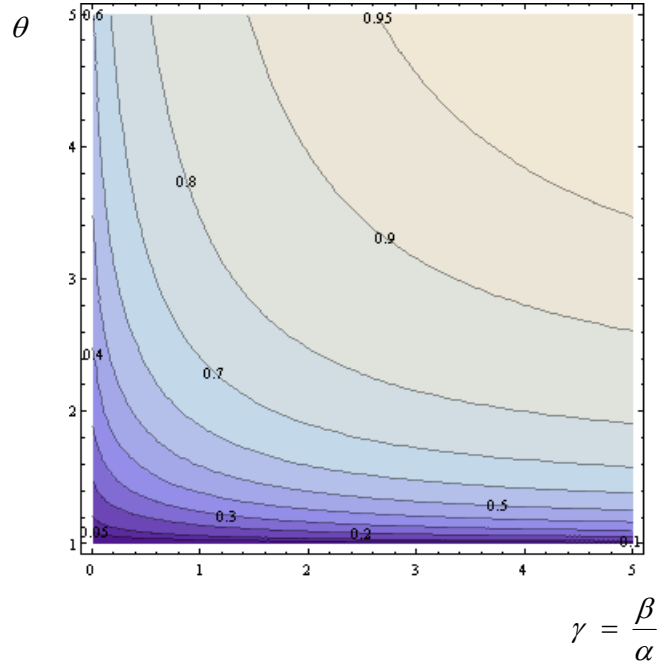
$$\gamma = \frac{\beta}{\alpha}$$

Figure 6: CONTOURS OF THE CRITICAL PRIOR.

Appendix III: Partial effect of parameters on the critical prior

In Equation (31) we have listed the partial effect of parameters on the critical prior. First note that Equation (19) gives us the condition that the parameters must satisfy for a society to be envious. In order to show that $\frac{\partial \overline{\mu_o}}{\partial \theta} \geq 0$, we first calculate the derivative of $\overline{\mu_o}$ with respect to θ. We then show that the minimum value of this derivative over the relevant range of parameters that characterize envious societies is weakly greater than zero. The commands used in Mathematica 6.0 to obtain this result are listed below.

1. $D[\overline{\mu_o}, \theta]$

2. NMinimize$[\{D[\overline{\mu_o}, \theta], \frac{2}{\gamma} + \frac{2}{\sqrt{\theta}} > 1, \theta \geq 1, \gamma \geq 10^{-3}\}, \{\theta, \gamma\}$,
Method $\rightarrow$ {"RandomSearch", "SearchPoints" $\rightarrow$ 500}]

The signs of the remaining derivatives listed in Equation (31) are obtained using a similar set of commands. When we have to show that a certain derivative is non-positive, then "NMinimize" is replaced by "NMaximize", and the maximum value of the derivative is shown to weakly less than zero.