The economic value of virtue

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Abstract

Virtue is modeled as an asset that women can use in the marriage market: since men value virginity in prospective mates, preserving her virtue increases a woman's chances of marrying a high-status husband, and therefore allows for upward social mobility. Consistent with some historical and anthropological evidence, we find that the prevalence (and the value) of virginity, across societies and over time, can be influenced by socio-economic factors such as male income inequality, gender differences, social status and stratification, and overall economic development.

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1 Introduction

Since Becker (1973), economic analysis has tried to explain various aspects of human mating, spouse selection and family formation, the basic question being: "who marries whom and why?" Therefore, we have now models that can help us to understand a range of issues, from assortative matching of partners (in terms of human capital, etc.), to inter-sex differences in the age at marriage (Bergstrom and Bagnoli, 1993), the existence of marriage transaction like dowries (Botticini and Siow, 2003), and even the so-called mystery of monogamy (Gould et al., 2008). All these

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contributions highlight the role played by economic factors in determining, at least partially, the historical evolution and cross-cultural differentiation of marriage and family patterns.

In this paper we want to show that a simple model of marriage can also explain how the value of virtue varies across societies, and responds to changing economic conditions inside a given society. Throughout the paper, we will use a narrow definition of virtue, as "female virginity at marriage" (premarital chastity). In a wider sense, however, it might be also defined as "sexual exclusiveness" (without necessarily implying premarital chastity), or sexual morality. Whatever the case, virtue can be regarded as an important factor influencing spouse selection.

The idea of explaining the prevalence of virginity and its social value with economic factors is, to the best of our knowledge, new. The importance attached to chastity and the way it can affect human mating has usually been regarded as a cultural, ethical, and religious phenomenon, neglecting possible interactions with economic variables.[1] The only existing economic model of the evolution of sexual mores (Greenwood and Guner, 2008) explains the increased prevalence of premarital sex mainly by a dramatic improvement in contraceptive techniques. In that paper, the economic consequences of premarital sex are not related to the loss of virginity itself, but rather to the possibility of undesired pregnancy and out-of-wedlock births. However, its almost exclusive focus on technology implies that it cannot explain, for instance, the variability in the value and prevalence of virginity before the introduction and diffusion of modern contraception (symbolized by the birth control pill) in the 20th century, or across traditional societies, many of which are characterized by highly ineffective contraceptive methods. If, instead, we look at the contributions of the socio-anthropological and historical literature, we find a deep awareness that economic factors may play an important role in defining the value put by different societies on (female) virginity.

For instance, in a comparative study of traditional societies, Goethals (1971) observes that virginity is highly valued when women are looked upon as the property of their husbands: in these circumstances, virginity attains market value and parents try to preserve their daughters' virginity as a means of protecting their own pocketbooks. Broude (1975) shows that class stratification is correlated with premarital sexual norms: if a society is characterized by fluid class structure as a result of achievable status, parents are expected to prohibit premarital sex to protect the social standing of their daughter. Goody (1976) sees restrictiveness as a way of avoiding inappropriate marriages: by controlling a girl's sexuality, her family can better control her marriage choice, for the loss of virginity may "diminish a girl's honour and reduce her marriage chances" (p. 14). In

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[1]See Scott (1998) for a cross-national study on the evolution of attitudes towards premarital sex.

a more recent paper, Schlegel (1991) claims that the cultural value put on the virginity of girls is, in large part, a function of the form of marriage transactions. Using data on traditional societies, she provides some evidence that virginity is relatively more valued when marriage implies transfers of wealth between the families of the bride and the groom ("when no property accompanies the marriage, virginity is of little interest", p. 725). Moreover, Anderson (2007) reports that the ancient brideprice was often considered a direct payment for a bride's virginity.

This view of virtue as an asset that can be used in the marriage market need not apply only to traditional societies. In a sociological study, Berger and Wenger (1973) defend the idea that virginity serves the interest of women, helping them to secure a better marriage, if they have little economic power; it is not a "given", but depends on the economic role of women. In a study of contemporary China, Zhou (1989) puts forward that virginity is regarded as a marketable asset, often the only one future wives hold. Ortner (1978) stresses that, in many (modern) societies, being a "good" girl increases the potential for personal status mobility: in this respect, virginity plays the same role as a dowry, enhancing the girl's value for a higher-status spouse. Finally, Gonzalez-Lopez (2004), after interviewing Mexican fathers living in Los Angeles, reports that, for them, "protecting their daughters from a sexually dangerous society and improving their socioeconomic future is of greater concern than preserving virginity *per se*" (p. 1118).

Most importantly, in a well-known study of the historical evolution of the family in Britain, Stone (1990, pp. 401-402) claims that, in the 18th century, " ... the value attached to chastity is directly related to the degree of social hierarchy and the degree of property ownership. Premarital chastity is a bargaining chip in the marriage game, to be set off against male property and status right". The female then has "a powerful lever to obtain marriage". As a consequence, Stone argues: (i) "the most sexually inhibited class in the population is likely to be the lower-middle class of small property owners"; (ii) "the rise of a class of landless rural labourers and urban workers without property or status meant the rise of a class to whom virginity was not important, and foresight, prudence and planning were irrelevant to their dismal economic future"; (iii) "the developments of the 18th century, with the progress of enclosures, the amalgamations of farms, the development of cottage industries and the growth of towns, were causing a considerable increase in the size of such a class." Stone then suggests that "the principal cause of the rise of illegitimacy in England in the late 18th century was (...) a rise of the proportion of the propertyless with no economic stake in the value of their virginity". The change in attitudes towards premarital sex could thus have been dictated by a change in economic circumstances.

In his study of bastardy in Bavaria, Lee (1977) tries to find an explanation for the sexual

revolution that, according to him, took place in Southern Germany between 1750 and 1850. After dismissing a number of sociological and religious factors (such as the reintroduction of restrictive marriage legislation, secularization, and educational reform), he concludes that the increasingly promiscuous social mores ("A virgin! *Rara avis*") were probably due to higher (real) wages, which made out-of-wedlock births more affordable. Lee also claims (p. 422) that "a further social factor affecting the propensity towards high illegitimacy rates was that lower-class illegitimacy did not constitute such a problem as similar rates among higher social groups would have done", thus suggesting differences in sexual behavior across social classes. Moreover, he mentions the possibility that social isolation and class stratification increased during the period: this would imply a negative correlation between the value of chastity and social segregation.

Finally, if we look at contemporary Western societies, we can see that, in the years prior to the onset of the sexual revolution, which took place in the 1960s and 1970s, and led to the (almost) complete destigmatization of premarital sex, the rising incidence of premarital sex was correlated to some major socio-economic changes, such as increased female labor force participation, and an overall reduction in income inequality.[2]

In this paper, we develop a theoretical model to explain how the value and prevalence of virginity may depend on economic factors, such as overall economic development, social status, income distribution, inequality between the sexes, social segregation, and strategic interaction between the social classes.

Central to our model is the marriage market. Potential partners belong to two different social classes: the rich and the poor. Income is split between spouses after marriage. Women value prospective husbands only in terms of income, while men also value virginity in potential wives. Mating is, to some extent, random: a rich man can fall in love with a woman of lower status (although this is less likely than falling in love with a rich woman). Therefore, a poor woman can aspire to upward social mobility, if she is lucky enough to be matched (by love) with a well-off husband. However, virginity also matters; if she is no longer a virgin, love may not be enough to secure a low-status woman's marriage to a rich man: he may in fact prefer to marry an upper class virgin (who he would not have chosen on the basis of love). This defines the economic value of virtue as the increase in income after marriage, which can be expected by a girl who makes the choice to remain a virgin. Investing in chastity affects the outcomes of the marriage market

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[2]Evidence on the historical evolution of premarital sex behavior and attitudes towards premarital sex in the U.S. in the 20th century is provided by Greenwood and Guner (2008, Figures 1 and 2). Data on the labor force participation of married women can be found in Goldin (1990, Table 5.1). Lindert (2000) reports some evidence on changes in income inequality.

and strategic behavior arises, since the virginity decisions of rich and poor girls are mutually dependent. All our results derive from this mechanism: in particular, any factor lowering the relative returns to a "good" marriage (such as a decrease in male inequality, or a narrower gender gap) may reduce the value of virginity, thus inducing a larger number of women to engage in premarital sex. Social segregation also plays an important role: in general, a more fluid class structure, implying a higher probability of upward social mobility through marriage, strengthens – all other things being equal – the incentive for women to preserve their virginity and use it as an asset in the marriage market.

By suggesting several socio-economic determinants of the economic value of virtue, our model contributes to explaining both differences across societies and variations over time. However, this is not to say that other kinds of factors (culture, religious beliefs, technology, etc.) do not also play an important role in shaping individual behavior and attitudes towards virginity.

The paper is organized as follows. After this Introduction, Section 2 describes the structure of the basic model. Section 3 solves for the equilibrium, showing how virginity choices depend on economic variables. Finally, a few concluding remarks are presented in Section 4.

2   The model

In line with some existing literature (Hamilton and Siow, 2007; Nosaka, 2007; Peters and Siow, 2002; Engineer and Welling, 1999), we assume that the marriage market is based on a matching process.

2.1   Population, preferences and individual characteristics

In the model economy, the population is equally divided between males and females, and between rich and poor. This means that there are four groups (rich women, rich men, poor women, poor men) of equal size, which we normalize to one. The income, or earning capacity, of each individual is denoted by $w_{g,y}$, where $g = F, M$ and $y = R, P$.

For the sake of simplicity, we assume that everybody ends up married and polygamy is forbidden. Inside every newly formed family, income is equally split between husband and wife, so that, once married, the income of each spouse is given by $(w_M + w_F)/2$.[3] If women do not work

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[3]This is the most parsimonious way to introduce a form of resource sharing inside the family. Of course, in many societies the bargaining power of women is still much lower than that of men, but assuming a different exogenous bargaining rule would not affect the results of the model. However, it should be noticed that the distribution of

on the market, we may think that the individual income of a potential bride ($w_{F,y}$) derives from the wealth of her family of origin.[4]

Like Bergstrom and Bagnoli (1993) and Gould et al. (2008), we introduce the stark simplification that males and females look for different qualities in their prospective mates. The quality of potential husbands coincides essentially with their income: women prefer to marry rich men. This can be especially true in traditional societies. On the other hand, men (indexed by i) value potential wives on the basis of three characteristics – love, virtue and money – which combine to define the utility level U_i they obtain from a given match:

$$U_i = \alpha L + \beta_i V + \gamma Y, \tag{1}$$

where $\alpha, \gamma > 0$ and $\beta_i \in (0, \alpha)$.

The variable L stands for "love". It can take only the two values 0 and 1, and is assumed to be random: a male can fall in love with a female regardless of her income and whether or not she is a virgin. This reproduces the kind of hypothesis employed by Engineer and Welling (1999): on the basis of "true love", each person is randomly matched with a member of the opposite sex. In fact, of course, mating is influenced by factors such as physical attraction, personal affinity, chance, etc., which are, to some extent, independent of income and virtue.

V stands for virginity (which can be generalized to "virtue"): it too can take only the values 0 and 1. Men's innate preference for virginity and/or sexual exclusiveness is well documented. According to Buss (1994), men characterized by a preference for female virginity enjoyed an evolutionary advantage, since premarital female chastity provided a cue to the future certainty of paternity, thus ensuring successful gene transmission.[5] Stone (1990) puts it in a more straightforward way: men value virginity in potential mates for it guarantees that they are "purchasing new and not second-hand goods" in the marriage market, and because they value exclusiveness in the good they buy. Moreover, it makes sense to assume that virtue is not equally important

power within a household might rather be endogenous, depending for instance on the relative earning position of the husband and the wife (as in de la Croix and Vander Donckt, 2010).

[4]If a dowry system is in place, $w_{F,y}$ can be interpreted as the dowry a girl from social class y is endowed with (i.e. the straight economic value of the bride). If instead a brideprice custom exists, $(w_M - w_F)/2$ might be regarded as the price paid by the groom to the bride (or to her family). Sometimes, the same culture may simultaneously practice both brideprice and dowry: for instance, the Code of Hammurabi established that, if a wife died without sons, her father was entitled to the return of her dowry, minus the value of the bride price (i.e. $(3w_F - w_M)/2$ in our model).

[5]To corroborate his argument, Buss also cites contemporary studies showing that the single best predictor of extramarital sex is premarital sexual permissiveness. Like the anthropologists, sociologists and historians cited in the Introduction, he firmly believes that the cultural variability in the preference for virginity is heavily affected by economic factors, particularly the economic independence of women.

in defining the desirability of men as potential marriage partners, for the simple reason that it cannot be assessed in males as easily as in females.

Money (relative income $Y = w_F/w_M$) refers to the fact that some of the utility that accrues to the husband depends on the division of resources inside the family. Equation (1) can be thus rewritten as:

$$U_i = \alpha L + \beta_i V + \gamma \frac{w_F}{w_M}. \tag{2}$$

Y can, in principle, take any positive value, but it would not be unrealistic to assume that $0 < Y < 1$, thus implying that the earning capacity of women is less than that of men.

Notice that we have introduced heterogeneous preferences among male agents: since the focus of this paper is on virtue, we make the hypothesis that all males have the same preferences with respect to love and income, while each male attaches a different degree of importance to virginity. To keep things simple, assume that β_i is uniformly distributed among rich men, over the interval $(0, \alpha)$. Assume also that $\alpha > \gamma$: when choosing a mate for life, love is more important than virtue *or* money alone, although it may not be enough if the potential bride lacks *both* virtue and money.

It is worth noticing that Buss (1989) has gathered some evidence on sex differences in human mating preferences. In his study, people in 37 cultures (33 countries) are asked to value the desirability of some characteristics (income, physical attractiveness, chastity, etc.) of potential partners, on a 0-3 scale. In 33 of the 37 cultures, men value chastity in potential mates more than women do, this difference being statistically significant in 23 cases; in the 4 countries where women attach more importance than men to this characteristic, the difference is not significant. The same study shows that, in mate selection, women value good financial prospect (earning potential and ambition/industriousness) more than men do in 36 of the 37 samples, while physical attractiveness (good looks) is more important to men in all 37 cultures. Simple computations on these data show that, on average, the importance of chastity is 1.08 for men and 0.55 for women. Physical attractiveness is valued at 2.00 and 1.55 by men and women respectively, while men attach much less importance to income than women do (1.51 against 2.28). Overall, these results provide some justification for our simplifying assumption that men and women look for different characteristics in their prospective mates, and support the idea that α is larger than β or γ.

U_i is the total value of a female, as a potential bride, from the point of view of the *i*-th male. It is important to stress that, unlike L and Y, V can be assessed, in general, only after marriage (or after two potential mates have engaged in a relationship). However, for the sake of simplicity, let us assume that as soon as a woman enters the marriage market, all the information about her

quality as a prospective bride (*L*, *Y* and *V*) is revealed simultaneously, and this information is correct. This can be justified saying that, for instance, women cannot lie – or decide not to lie – about their virginity, because this might lead to repudiation immediately after marriage (as has happened, and still happens in some societies). In Appendix A, we will show that our results do not change if this assumption is removed.

Male and females enter the marriage market as soon as their earning capacity is revealed, which we assume to take place at the same time for both sexes.[6] At that point, all the relevant variables that determine the value of a potential wife – love, income and virtue – are perfectly observable.

However, unlike income and love, virtue is not exogenous in our model. Before entering the marriage market, girls can decide whether to stay a virgin or not. Premarital chastity has a (utility) cost $c_{y,j}$, which we assume to be heterogeneous (individual-specific) and uniformly distributed over $(0, C_y)$. However, preserving her virginity increases the value of a female on the marriage market. A woman will therefore decide to remain chaste only if, in her particular situation, the value of virtue exceeds the cost of virginity.

2.2 Mating

Our model confers an advantage on high-status males, who are free to select their mates: a marriage proposal made by a rich man will never be rejected since, by assumption, women value potential husbands exclusively on the basis of their income. This may not be too unrealistic, especially in less developed countries and traditional societies. For ease of presentation, the mating process will be described from the point of view of rich males.

As already pointed out, in our model love strikes randomly. This means that there is an exogenous probability π that a rich man falls in love with a lower-status woman; with a probability $(1 - \pi)$ he will instead be attracted by a woman from a well-to-do family. It seems sensible to assume $0 < \pi < 1/2$: since males and females from different social classes have fewer opportunities to meet each other, different tastes and different levels of education, they are less likely to feel an affinity and reciprocally fall in love.[7] The parameter π can be interpreted as a measure of the level of stratification that characterizes a given society: the lower π, the stronger the social

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[6]In traditional societies, where women only engage in housekeeping activities and their resources are provided by the family, the bride is typically much younger than the groom. See also Bergstrom and Bagnoli (1993), whose model explains why women, in general, marry older men.

[7]For example, even if rich and poor women have the same chance of being graced with beauty, rich women have more occasions to meet a rich man who can be impressed by their beauty.

segregation.

Therefore, on the basis of pure love, there would be π marriages involving a rich man and a poor woman, and $1 - \pi$ marriages in which both spouses come from the upper class. Symmetrically, π low-income men should end up married to rich women, while $1 - \pi$ poor-poor marriages would take place.

However, when deciding who to marry, rich men will also take money and virtue into account. For instance, if a rich man falls in love with a lower-class woman who is no longer a virgin (denoted by $L\overline{VY}$), he might consider marrying a rich woman he does not love, provided that: (i) she is virgin ($\overline{L}VY$), and (ii) he has a strong preference for virginity, i.e. if $\beta_i + \gamma(w_{F,R}/w_{M,R}) > \alpha + \gamma(w_{F,P}/w_{M,R})$. If instead he loves an upper-class woman who turns out to be a non-virgin ($L\overline{V}Y$), he would nevertheless marry her because he cannot find a better match: given men's preferences, namely $\alpha > \beta_i$, she will be preferred to a $\overline{L}VY$-type wife.

Therefore, all well-off women who are lucky enough to win the love of a rich man will end up married to him, while only low-status women who are also virgins ($LV\overline{Y}$) can secure a good marriage. Poor women who are not matched (by love) with a higher-status man have no chance of upward social mobility, while rich women in the same situation still have a chance of getting a rich husband, provided they have preserved their virginity.

The role of virtue as an instrument for (upward) social mobility is then clear: in the marriage market, virginity is an asset whose value can be defined in expected terms and depends, for instance, on male preferences and the behavior of other women in the market. Let us see how.

2.3 The value of virtue

For the time being, let us consider the proportion of virgins among poor and rich women (v_P and v_R, respectively) as given. Let us also define $w_{M,R} \equiv w$ and assume that $w_{F,P} = \rho w$, $w_{F,R} = \mu w$ and $w_{M,P} = \lambda w$, with $0 \leq \rho, \mu, \lambda \leq 1$, $\rho < \lambda$ and $\rho < \mu$. These restrictions on the parameters mean simply that $w_{F,y} < w_{M,y}$, $\forall y$ (as far as premarital income is concerned, men are always richer than women from the same social class), and $w_{g,P} < w_{g,R}$, $\forall g$ (high-status agents are richer than low-status individuals of the same sex). However, we do not impose any restriction on the relation between $w_{F,R}$ and $w_{M,P}$, so that well-off women may have a higher premarital income than poor men.

2.3.1 The poor

Consider now the point of view of the π low-status females, who happen to be matched, on the basis of love, with rich males. Among these women, the less virtuous ones (i.e. $(1 - v_P)\pi\, L\overline{VY}$-type females) can *potentially* be ranked lower, as marriage partners, than $\overline{L}VY$-type females. How many of them will *actually* suffer this fate depends on male preferences. In fact, as we have seen above, a rich man can decide to marry a woman whom he does not love, but is both wealthy and virgin ($\overline{L}VY$), instead of the one he loves, who lacks both status and virtue ($L\overline{VY}$), if and only if $\beta_i > \alpha + \gamma(\rho - \mu)$.

In particular, there will be a "threshold" male individual, characterized by $\beta_i = \hat{\beta} = \alpha - \gamma(\mu - \rho)$, who is indifferent between $L\overline{VY}$ and $\overline{L}VY$. Men with $\beta_i < \hat{\beta}$ would prefer to marry the lower-class woman they love, regardless of her virtue, while those characterized by $\beta_i > \hat{\beta}$ would prefer a $\overline{L}VY$-type wife.[8]

Since β_i is uniformly distributed over the interval $(0, \alpha)$, this means that the number of $L\overline{VY}$-type females exposed to the risk of missing an advantageous marriage is given by:

$$(1 - v_P)\frac{\gamma(\mu - \rho)}{\alpha}\pi. \tag{3}$$

The number of them who will be actually "replaced" by rich, yet unloved, virgins depends on the availability of this kind of marriage partner. For instance, if $v_R \geq (1 - v_P)\gamma(\mu - \rho)/\alpha$, all of them will be replaced. Taking this into account, the probability of a poor, non-virgin woman marrying a rich man, is given by:

$$\pi\left\{\left(1 - \frac{\gamma(\mu - \rho)}{\alpha}\right) + \frac{\gamma(\mu - \rho)}{\alpha}\left(1 - \min\left[1, \frac{\alpha v_R}{\gamma(\mu - \rho)(1 - v_P)}\right]\right)\right\}, \tag{4}$$

while the probability that she ends up married to a low-status husband is:

$$(1 - \pi) + \pi\left\{\frac{\gamma(\mu - \rho)}{\alpha}\min\left[1, \frac{\alpha v_R}{\gamma(\mu - \rho)(1 - v_P)}\right]\right\}. \tag{5}$$

Losing her virginity exposes a poor woman, who has been matched by love to a high-status man, to a double risk. First, that man might be willing to search for a better marriage partner if he cares enough about virginity. Second, her place may be actually taken by a $\overline{L}VY$-type female, if there are enough potential mates of this kind in the marriage market.

Let us now look at the expected income of a poor woman.

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[8]If $\beta_i < \hat{\beta}$, love is stronger than everything, being able to compensate for the lack of both money and virtue.

If she is a virgin, her expected income, which depends on the random variable π, is given by:

$$\pi \left(\frac{w_{M,R} + w_{F,P}}{2} \right) + (1 - \pi) \left(\frac{w_{M,P} + w_{F,P}}{2} \right), \tag{6}$$

that is:

$$[(\lambda + \rho) + \pi(1 - \lambda)] \frac{w}{2}. \tag{7}$$

This expression means that, with probability π, a low-status female who manages to preserve her virtue is able to increase her income (as a wife) by $(1 - \lambda)w/2$, with respect to a "benchmark" marriage to a poor husband.

In case she is not a virgin, her expected income is affected by the possibility of missing a rich husband because of her premarital sexual behavior, and can be written as:

$$\left\{ (1 - \pi) + \pi \frac{\gamma(\mu - \rho)}{\alpha} \min \left[1, \frac{\alpha v_R}{\gamma(\mu - \rho)(1 - v_P)} \right] \right\} \left(\frac{w_{M,P} + w_{F,P}}{2} \right) +$$
$$+ \pi \left\{ 1 - \frac{\gamma(\mu - \rho)}{\alpha} \min \left[1, \frac{\alpha v_R}{\gamma(\mu - \rho)(1 - v_P)} \right] \right\} \left(\frac{w_{M,R} + w_{F,P}}{2} \right), \tag{8}$$

which, after substituting, becomes:

$$\left\{ (\lambda + \rho) + \pi(1 - \lambda) \left(1 - \frac{\gamma(\mu - \rho)}{\alpha} \min \left[1, \frac{\alpha v_R}{\gamma(\mu - \rho)(1 - v_P)} \right] \right) \right\} \frac{w}{2}. \tag{9}$$

Therefore, the "value of virginity" (for a poor woman) can be defined as the difference between (7) and (9), which is the expected income gain associated with preserving her virginity:

$$\Omega_P \equiv \pi \frac{\gamma(\mu - \rho)(1 - \lambda)}{\alpha} \min \left[1, \frac{\alpha v_R}{\gamma(\mu - \rho)(1 - v_P)} \right] \frac{w}{2}. \tag{10}$$

Notice that the economic value of virtue for the poor increases with π (it is higher if there is less social segregation and thus a higher – *ceteris paribus* – chance of social mobility) and w (the absolute level of income). It is also decreasing in λ: the higher the relative income of poor men, the smaller the cost associated with missing a high-status husband. Moreover, if $v_R \geq (1 - v_P)\gamma(\mu - \rho)/\alpha$, the economic value of virginity depends positively on γ and $(\mu - \rho)$: both these factors (defining men's preferences for income and the income differential between rich and poor women), reduce the likelihood of non-virgin poor women being selected as marriage partners by rich men, thus increasing the cost of losing their virginity; Ω_P is also a non-increasing function of α: if men attach great importance to love, virginity is less likely to play a decisive role in mate selection. Finally, if $v_R < (1 - v_P)\gamma(\mu - \rho)/\alpha$, Ω_P depends positively on the prevalence of virginity among poor and rich females (v_P and v_R, respectively): a relatively large number of

virgins, in both social classes, increases the likelihood that poor, non-virgin women actually miss the opportunity of a good marriage, thus increasing the returns to virginity. From the point of view of low-status girls, preserving their virtue can be seen as a kind of "defensive" investment, which is a strategic complement to the virginity choice of other girls in the marriage market.

2.3.2 The rich

We can now follow the same procedure to determine Ω_R, the value of virginity for rich women.

If she stays chaste, a rich woman can secure a good marriage with probability $(1 - \pi)$ (the probability that a rich man falls in love with her); moreover, she also gets a chance to marry a rich man who does not love her, taking the place of a $L\overline{VY}$-type female. Therefore, the expected after-marriage income for a rich virgin can be written as:

$$(1 - \pi) \left(\frac{w_{M,R} + w_{F,R}}{2} \right) + \pi \min \left[1, \frac{\gamma(\mu - \rho)(1 - v_P)}{\alpha v_R} \right] \left(\frac{w_{M,R} + w_{F,R}}{2} \right) +$$
$$+ \pi \left(1 - \min \left[1, \frac{\gamma(\mu - \rho)(1 - v_P)}{\alpha v_R} \right] \right) \left(\frac{w_{M,P} + w_{F,R}}{2} \right); \qquad (11)$$

this expression, once we use $w_{M,R} \equiv w$, $w_{F,P} = \rho w$, $w_{F,R} = \mu w$ and $w_{M,P} = \lambda w$, becomes:

$$\left[(1 + \mu) - \pi(1 - \lambda) \left(1 - \min \left[1, \frac{\gamma(\mu - \rho)(1 - v_P)}{\alpha v_R} \right] \right) \right] \frac{w}{2}. \qquad (12)$$

If, however, a rich woman has lost her virginity, there is no way she can be ranked higher than a $L\overline{VY}$-type female by rich men, so that her expected income is:

$$(1 - \pi) \left(\frac{w_{M,R} + w_{F,R}}{2} \right) + \pi \left(\frac{w_{M,P} + w_{F,R}}{2} \right), \qquad (13)$$

which can be easily simplified to:

$$[(1 + \mu) - \pi(1 - \lambda)] \frac{w}{2}. \qquad (14)$$

This expression means that, with probability π, a high-status female who is no longer a virgin would see her income decrease by $(1 - \lambda)w/2$, with respect to a marriage to a male from the same social class.

The difference between (12) and (14) defines the value of virginity for women from well-to-do families:

$$\Omega_R \equiv \pi(1 - \lambda) \min \left[1, \frac{\gamma(\mu - \rho)(1 - v_P)}{\alpha v_R} \right] \frac{w}{2}. \qquad (15)$$

It should be noticed that, if $v_R > (1 - v_P)\gamma(\mu - \rho)/\alpha$, Ω_R is a negative function of both v_P and v_R: with relatively higher aggregate "virginity rates", there will be less opportunities for rich,

yet unloved women to end up married to well-off husbands. As a consequence, their expected rewards for preserving their virtue would be less. Not surprisingly, the value of virginity for the rich also depends on the opportunity cost of a good marriage: for instance a higher λ, meaning a smaller income difference between a low- and a high-status husband, implies lower relative returns to chastity.

3 Equilibrium

We have just seen that the economic value of virtue, from the female point of view, depends on the behavior of other women competing in the marriage market. Therefore, premarital (virginity) choices are strategic in nature.

3.1 Virginity choices

Let us now recall that there is also a cost associated to virtue (the utility loss implied by giving up premarital sex). This cost is individual specific; for the sake of simplicity, it is assumed to be uniformly distributed over the intervals $[0, C_y]$, where $y = R, P$. These distributions are known to female agents. A woman will decide to preserve her virginity if the value of virtue (Ω_y) exceeds its cost ($c_{y,j}$). In other words, we can identify threshold costs $c_y^* = \Omega_y$ such that only women with $c_{y,j} < c_y^*$ decide to opt for chastity. Accordingly, we can determine the endogenous proportion of virgins in each income class, as $v_y = \Omega_y / C_y$.

3.2 Aggregate behavior

Let us assume that $C_R = \phi C_P$ and $C_P \equiv A$, with $\phi, A \geq 0$.[9]

Since Ω_P and Ω_R both depend on v_P and v_R, the virginity choices of rich and poor women are mutually dependent: every woman decides on her premarital behavior taking into account how many virgins she thinks there are among women from the two social classes. We can therefore write the following aggregate best-response functions:

$$v_P = \frac{\pi w \gamma (1 - \lambda)(\mu - \rho)}{2 \alpha A} \min \left[1, \frac{\alpha v_R}{\gamma (\mu - \rho)(1 - v_P)} \right], \tag{16}$$

and

$$v_R = \frac{\pi w (1 - \lambda)}{2 \phi A} \min \left[1, \frac{\gamma (\mu - \rho)(1 - v_P)}{\alpha v_R} \right]. \tag{17}$$

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[9]We do not restrict ϕ to be larger or smaller than 1, since we do not have elements to think that the utility cost of abstinence is related to income or social status. Of course, the social stigma attached to premarital sex may vary across classes, and is probably itself related to potential outcomes of the marriage market.

Alternatively, the aggregate reaction function for poor women ($v_P \equiv v_P(v_R)$) can be expressed as:

$$v_P(v_R) = \begin{cases} (1/2)(1 \pm \sqrt{[A - 2\pi w(1-\lambda)v_R]/A}) & \text{if } v_R < \gamma(\mu - \rho)(1 - v_P)/\alpha \\ \pi w \gamma(1-\lambda)(\mu - \rho)/(2\alpha A) & \text{if } v_R \geq \gamma(\mu - \rho)(1 - v_P)/\alpha \end{cases}, \tag{18}$$

while the behavior of rich women is summarized by:

$$v_R(v_P) = \begin{cases} \pi w(1-\lambda)/(2\phi A) & \text{if } v_R \leq \gamma(\mu - \rho)(1 - v_P)/\alpha \\ \sqrt{\pi w \gamma(1-\lambda)(\mu - \rho)(1 - v_P)/(2\phi\alpha A)} & \text{if } v_R > \gamma(\mu - \rho)(1 - v_P)/\alpha \end{cases}. \tag{19}$$

3.3 Equilibrium solutions

In this framework, an equilibrium can be defined as a pair $(v_R^*; v_P^*)$, such that (i) the underlying threshold values (c_R^* and c_P^*) ensure that subjective optimality is realized, and (ii) women's beliefs are mutually consistent. Graphically, any intersection between (18) and (19) in the (v_R, v_P) space is an equilibrium.

Depending on the parameters, we may have two different cases. Let us define

$$\hat{\pi} \equiv \frac{2\gamma\phi\alpha A(\mu - \rho)}{w(1-\lambda)[\alpha^2 + \phi\gamma^2(\mu - \rho)^2]}, \tag{20}$$

and focus only on interior solutions.

If $\pi < \hat{\pi}$ (case (a): high degree of social segregation), the equilibrium solution is given by:

$$(v_R^{*a}; v_P^{*a}) = \left(\frac{\pi w(1-\lambda)}{2\phi A}; \frac{1}{2} \left[1 - \sqrt{1 - \frac{\pi^2 w^2(1-\lambda)^2}{\phi A^2}} \right] \right), \tag{21}$$

and corner solutions are automatically ruled out since $\hat{\pi} < 2\phi A/[w(1-\lambda)]$.

If instead $\pi > \hat{\pi}$ (case (b): weaker segregation), we have:

$$(v_R^{*b}; v_P^{*b}) = \left(\frac{1}{2\alpha A} \sqrt{\frac{\pi w \gamma(1-\lambda)(\mu - \rho)[2\alpha A - \pi w \gamma(1-\lambda)(\mu - \rho)]}{\phi}}; \frac{\pi w \gamma(1-\lambda)(\mu - \rho)}{2\alpha A} \right). \tag{22}$$

The situation is depicted in Figure 1, where the two curves RR and PP represent the aggregate best-response functions of the rich and the poor, respectively, and the downward sloping dashed line is $v_P = 1 - \alpha v_R/[\gamma(\mu - \rho)]$. For $\pi < \hat{\pi}$ ($\pi > \hat{\pi}$), RR and PP intersect below (above) $v_P = 1 - \alpha v_R/[\gamma(\mu - \rho)]$. It is important to underline that, as it will be shown in Appendix B

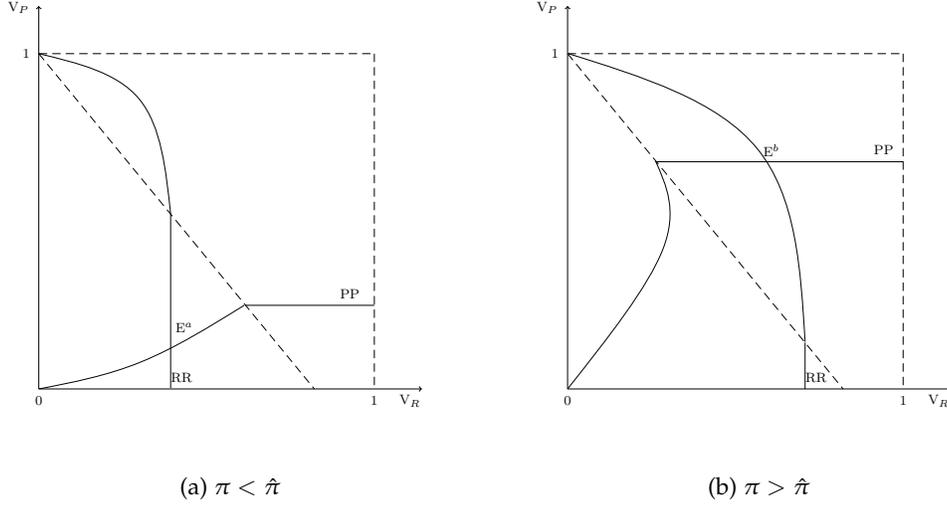(a) $\pi < \hat{\pi}$ (b) $\pi > \hat{\pi}$

Figure 1: Equilibrium

(together with the derivation of $\hat{\pi}$), the possibility of multiple equilibria can easily be ruled out, while $(v_R^{*a}; v_P^{*a})$ and $(v_R^{*b}; v_P^{*b})$ coincide if $\pi = \hat{\pi}$.

Notice that $v_P^{*a} < v_R^{*a}$ if $\pi < \overline{\pi}^a$, where $\overline{\pi}^a \equiv 2\phi A/[w(1-\lambda)(1+\phi)]$. This condition is always verified if, for instance, we make the parsimonious assumption that $\phi < \alpha/[\gamma(\mu - \rho)]$, since in this case $\hat{\pi} < \overline{\pi}^a$. Therefore, if π is relatively low, and the utility cost of chastity is not too much higher for rich women, virtue is positively correlated with social status, as historical evidence seems to suggest (Stone, 1990). Moreover, $v_P^{*b} < v_R^{*b}$ if $\pi < \overline{\pi}^b$, where $\overline{\pi}^b \equiv 2\alpha A/[w\gamma(1-\lambda)(\mu - \rho)(1+\phi)]$. Since we cannot exclude that $\pi > \overline{\pi}^b$ (if $\overline{\pi}^b < 1/2$, of course), it is possible that, with low levels of social segregation, virginity is more widespread in the lower social class.

Let us now see how the equilibrium values of v_P and v_R are affected by the main parameters of the model.

In case (a), it can easily be checked that, for $y = P, R$: $\partial v_y^{*a}/\partial \pi > 0$, $\partial v_y^{*a}/\partial w > 0$, $\partial v_y^{*a}/\partial \lambda < 0$, $\partial v_y^{*a}/\partial \phi < 0$ and $\partial v_y^{*a}/\partial A < 0$.

In case (b), provided that $\pi < \tilde{\pi}$, where $\tilde{\pi} = \alpha A/[w\gamma(1-\lambda)(\mu - \rho)]$, we have: $\partial v_y^{*b}/\partial \pi > 0$, $\partial v_y^{*b}/\partial w > 0$, $\partial v_y^{*b}/\partial \gamma > 0$, $\partial v_y^{*b}/\partial \lambda < 0$, $\partial v_y^{*b}/\partial \mu > 0$, $\partial v_y^{*b}/\partial \rho < 0$, $\partial v_y^{*b}/\partial \alpha < 0$ and $\partial v_y^{*b}/\partial A < 0$. Moreover $\partial v_R^{*b}/\partial \phi < 0$.

Therefore, the prevalence of virginity is in general positively linked to π, meaning that with a less fluid class structure, which implies a smaller chance of upward social mobility through

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marriage, there is less incentive for women to preserve their virginity and use it as an asset in the marriage market. In addition, virginity rates decrease with ρ and λ: both a narrower gender gap and less male inequality imply a lower value of virginity (because of the lower relative value of a high-status husband), thus reducing the incentive to stay a virgin; in absence of inequality, the preference of men for virgin brides would not affect female behavior. Finally, all other things being equal, overall economic development (w) induces more chastity, since it increases the absolute value of a good marriage.[10] All these results are consistent with the historical and cross-cultural evidence discussed in the Introduction.

In our model, male preferences (α and γ) also affect women's choices, but only if π is sufficiently large ($\pi > \hat{\pi}$), i.e. if social segregation is rather weak. In particular, if men have very strong preferences for "love" (or beauty) when selecting potential brides, and/or do not attach great importance to "money", poor women who lost their virtue face a relatively low risk of missing a good marriage. This in turn leads to low virginity rates. The effect of female preferences (A and ϕ) is trivial: a higher utility cost of virtue implies lower virginity rates, among both rich and poor women.[11]

It should be noticed, however, that if $\tilde{\pi} < 1/2$, the effect of some parameters on the behavior of high-status women would be different. In fact, for $\pi > \tilde{\pi}$ we would have, for instance: $\partial v_R^{*b}/\partial \pi < 0$, $\partial v_R^{*b}/\partial w < 0$, $\partial v_R^{*b}/\partial \lambda > 0$ and $\partial v_R^{*b}/\partial \rho > 0$. This means that there might be a non-monotonic relationship between v_R^{*b} and π: as long as $0 < \pi < \tilde{\pi}$, the prevalence of virginity among high-status females depends positively on π, but for high values of π ($\pi > \tilde{\pi}$, i.e. very weak social segregation), further increases in π cause a reduction in the number of rich women who opt for premarital chastity (and v_R^{*b} eventually becomes lower than v_P^{*b}, as soon as $\pi > \overline{\pi}^b$).[12] Unlike case (a), in case (b) an upward shift of both PP and RR in Figure 1 (induced by a higher π) can determine a new equilibrium characterized by a higher v_P^* and a lower v_R^*. This might happen because, with a very fluid class structure (i.e. for high values of π), the incentive to preserve their virginity is very strong for low-status women; consequently, v_P is very large, rich virgins have few chances of replacing a $L\overline{VY}$-type woman, and v_R (as a function of v_P) decreases steeply.

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[10]Economic development is not independent, however, of female labor force participation, inequality, etc.

[11]In this regard, notice that the cost of virginity might be affected, for instance, by the effectiveness of contraception. If the perceived risk of an undesired pregnancy decreases, the relative cost of chastity becomes larger. Therefore, as suggested by Greenwood and Guner (2008), technological improvements in contraception, increasing A, encourage promiscuity.

[12]Provided that $\overline{\pi}^b > \tilde{\pi}$. If, instead, $\tilde{\pi} > \overline{\pi}^b$ (which occurs for $\phi > 1$), v_R^{*b} becomes lower than v_P^{*b} before it starts decreasing.

Finally, it can be conjectured that the prevalence of virginity also depends on the distribution of power within a household. In our model, an (exogenous) increase of the relative bargaining power of the wife would increase, *ceteris paribus*, the value of virtue, thus leading to higher virginity rates.[13] However, the empowerment of women may also be associated with more sexual freedom, if the bargaining power is endogenous and depends, for instance, on the relative earning position of men and women.

4   Conclusions

In this paper we have shown how, inside a society, the prevalence of female virginity can be affected by economic variables. Using a very parsimonious mating model, where preserving her virtue helps a woman to improve her chances of marrying a husband of higher social status, we have obtained results that are fairly consistent with cross-cultural and historical evidence. In particular, economic development, increased female labor force participation, lower male inequality, stronger social stratification and higher social status may all weaken the incentive for women to preserve their virtue, thus explaining a lower prevalence of virginity. This is a further example of how the incentives to adhere to cultural and moral values can be shaped by economic factors.

Appendices

A   Alternative timing

In Section 2 we made the simplifying assumption that virginity (V or $\overline{V}$), like every other characteristic of prospective brides, can be observed before marriage or, which comes to the same thing, as soon as a woman enters the marriage market. In this Appendix we want to show that an alternative, more complicated but more realistic timing of events is also compatible with our model. Everything is based on the hypothesis that, unlike income Y and other factors susceptible of affecting L (beauty, for instance), virtue is not immediately observable, and can only be assessed after two potential spouses have started a relationship.

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[13]Suppose that, instead of $1/2$, the woman receives a fraction $1/n$ of the after-marriage income of the couple: a smaller n would account for a higher bargaining power of the wife. Doepke and Tertilt (2009) provide some examples of significant improvements of *married* women's economic rights which took place in 19th century America, when the legal treatment of men and married women in the labor market was still highly unequal and female labor force participation still very low, as also reported by Goldin (1990, Figure 5.1). Interestingly enough, in that period the American society was also characterized by a trend toward sexual repressiveness.

Since $\alpha > \gamma$ and V is unobservable, as soon as the marriage market opens, rich men will start dating their potential best choices, i.e. the women they are in love with, regardless of their income. Among these "lucky" females, consider first the poor ones. If they turn out to be virgin ($LV\overline{Y}$ type), they will be able to secure a marriage with their higher-status mate, because he cannot find a better match (recall that $\alpha > \gamma$, by assumption). If, however, they are not virgins and their potential husbands attach great importance to virginity ($\beta_i > \hat{\beta} = \alpha - \gamma(\mu - \rho)$), the men will start looking for a better match among rich women (a $\overline{L}VY$-type female). Therefore, some (or all) $L\overline{VY}$-type females will be replaced with $\overline{L}VY$-type females, depending on the relative size of these two groups. A rich woman who is loved by a rich man, even if she is not a virgin ($L\overline{V}Y$), is not exposed to the same risk, because her prospective husband could not find a better mate (given men's preferences, namely $\alpha > \beta$, she will still be preferred to a $\overline{L}VY$ female). Once all the rich men have found their best possible wives, the remaining women will marry poor men.

It is thus clear that exactly the same results arise as we obtained in Section 2: premarital chastity is still an instrument for upward social mobility.

B   Ruling out multiple equilibria

Let us start by showing how $\hat{\pi}$ is determined. In the model developed in Section 2 and 3, an equilibrium $(v_R^*; v_R^*)$ can be found as an intersection between the linear part of (18) and the non-linear part of (19), if $v_R > \gamma(\mu - \rho)(1 - v_P)/\alpha$, or between the linear part of (19) and the non-linear part of (18), if $v_R < \gamma(\mu - \rho)(1 - v_P)/\alpha$. If, instead, $v_R = \gamma(\mu - \rho)(1 - v_P)/\alpha$, the equilibrium pair $(v_R^*; v_R^*)$ corresponds to the intersection between $v_P = \pi w \gamma(1 - \lambda)(\mu - \rho)/(2\alpha A)$ and $v_R = \pi w(1 - \lambda)/(2\phi A)$. However, it can be easily checked that this intersection lies on the line $v_P = 1 - \alpha v_R/[\gamma(\mu - \rho)]$ if and only if:

$$\pi = \frac{2\gamma\phi\alpha A(\mu - \rho)}{w(1 - \lambda)[\alpha^2 + \phi\gamma^2(\mu - \rho)^2]},$$

which is $\hat{\pi}$.

In principle, our model might produce multiple equilibria. However, for indeterminacy to occur, the two intersections between $v_P = (1/2)(1 \pm \sqrt{[A - 2\pi w(1 - \lambda)v_R]/A})$ and $v_R = \pi w(1 - \lambda)/(2\phi A)$ should both lie below the horizontal line $v_P = \pi w \gamma(1 - \lambda)(\mu - \rho)/(2\alpha A)$ or, equivalently, below $v_P = 1 - \alpha v_R/[\gamma(\mu - \rho)]$ (which is the dashed line in Figure 1), since we are in case (a), characterized by $\pi < \hat{\pi}$. Given that one of the two possible crossing points is characterized by $v_P^* = 1/2[1 + \sqrt{1 - \pi^2 w^2(1 - \lambda)^2/(\phi A^2)}]$, which is always larger than $\pi w \gamma(1 -$

$\lambda)(\mu - \rho)/(2\alpha A)$ if $\pi < \hat{\pi}$, we can conclude that multiplicity of equilibria never arises.

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