From Shame to Game in One Hundred Years: An Economic Model of the Rise in Premarital Sex and its De-Stigmatization*

Jesús Fernández-Villaverde, Jeremy Greenwood, and Nezih Guner†

November 2009–Comments welcome

Abstract

Parents socialize their children about many things, including sex. Socialization is costly. It uses scarce resources, such as time and effort. Parents weigh the marginal gains from socialization against its costs. Those at the lower end of the social-economic scale indoctrinate their daughters less than others about the perils of premarital sex, because the latter will lose less from an out-of-wedlock birth. Modern contraceptives have profoundly affected the calculus for instilling sexual mores, leading to a de-stigmatization of sex. As the odds of becoming pregnant from premarital sex decline there is less need to inculcate sexual mores. Technology affects culture.

*This version of the paper will be presented at the Rogerson-Shimer-Wright NBER working group meeting on "Macro Perspectives on Labor Market," hosted by the Federal Reserve Bank of Minneapolis, on November 19th and 20th, 2009.

†*Affliations*: Fernández-Villaverde and Greenwood, University of Pennsylvania; Guner, ICREA, Universitat Autonoma de Barcelona, and Barcelona GSE; *Email*: nezih.guner@uab.es

1. Introduction

Shame is a disease of the last age; this seemeth to be cured of it. Marquis of Halifax (1633-1695)

The last one hundred years have witnessed a revolution in sexual behavior. In 1900, only 6% of U.S. women would have engaged in premarital sex by age 19–see Figure 1 (all data sources are discussed in the Appendix). Now, 75% have experienced this. Public acceptance of this practice reacted with delay. Only 15% of women in 1968 had a permissive attitude toward premarital sex. At the time, though, about 40% of 19 year-old females had experienced it. The number with a permissive attitude had jumped to 45% by 1983, a time when 73% of 19 year olds were sexually experienced. Thus, societal attitudes lagged practice. Beyond the evolution and acceptance of sexual behavior over time, there are relevant cross-sectional differences across females. In the U.S., the odds of a girl having premarital sex decline with family income. So, for instance, in the bottom decile 70% of girls between the ages of 15 and 19 have experienced it, versus 47% in the top one. Similarly, 68% of adolescent girls whose family income lies in the upper quartile would feel "very upset" if they got pregnant, versus 46% of those whose family income is in the lower quartile. The goal here is to present a model that can account for the rise in premarital sex, its lagged de-stigmatization, and the cross-sectional observations about sex and the attitudes towards it.

The idea is that young adults will act in their own best interest when deciding to engage in premarital sex. They will weigh the benefits from the joy of sex against its cost, the possibility of having an out-of-wedlock birth. An out-of-wedlock birth has many potential costs for a young women: it may reduce her educational and job opportunities; it may hurt her mating prospects on the marriage market; she may feel shame or stigma. Over time the odds of becoming pregnant (the failure rate) from premarital sex have declined, due to the facts that contraception has improved, and more teens are using some method–Figure 2. The cost of engaging in premarital sex have fallen, as a result. This leads to the paradoxical situation where, despite the fact that the efficacy of contraception has increased, so has the number of out-of-wedlock births.

The stigma that a young woman incurs from premarital sex may drop over time too. Suppose that parents inculcate a proscription on premarital sex into their daughters' moral fibers. As Coleman (1990, p. 295) nicely puts it: "the strategy is to change the self and let the new self decide what is right and what is wrong (for example, by imagining what one's mother would say about a particular action)." Parents do this because they want the best for their daughter. They know that an out-of-wedlock birth will hurt their daughter's welfare.

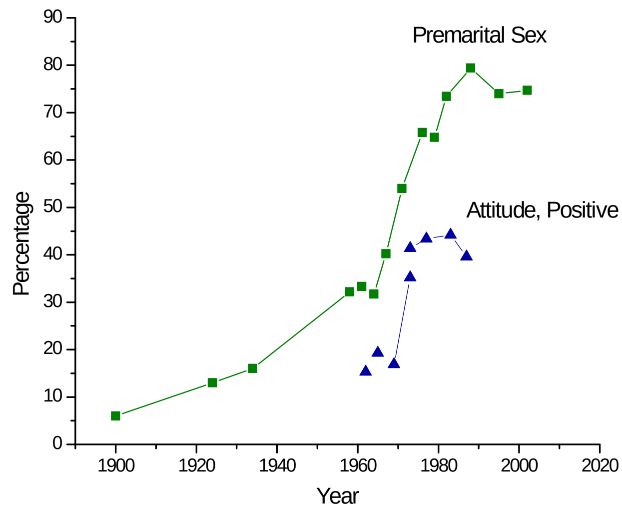

Figure 1: Premarital Sex, attitudes and practice

As contraception improves, the need for the proscription diminishes and with it the amount of parental indoctrination. If the stigma is transmitted over time, however, its reduction will lag the increase in sexual activities. The same shift in incentives may also change the moral proscriptions of institutions such as the church and state.

Differences in the costs of an out-of-wedlock birth also explain the cross-sectional observations. The desire to socialize will be smaller the less its impact is on a child's future well being. Therefore, there may be little incentive to socialize children at the bottom of the socioeconomic scale because they have no where to go in life anyway. Similarly, the payoff for a parent to changing his offspring's self is higher the closer and longer the parent's connections to the child are. Hence, in societies where parents lose contact with their offspring when they grow up, the incentives to socialize the latter may be attenuated.

These mechanisms will be examined here, both theoretically and quantitatively, by developing an overlapping generations model where parents invest effort into the socialization of their children. The concept of socializing children is operationalized by letting a parent influence his offspring's tastes about an out-of-wedlock birth. Doing so incurs a cost in terms of effort to the parent. In the model, for simplicity, there is no distinction between direct and oblique socialization; that is, between socialization within the family and outside the family–Cavalli-Sforza and Feldman (1981). This is not a serious drawback and it provides the needed analytical tractability. Think about a parent's effort as either being spent directly on educating his children about sexual mores, or indirectly in selecting and moving into a

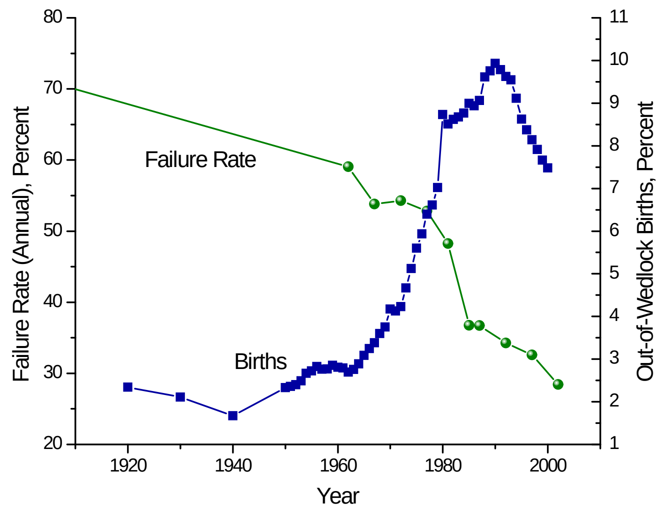

Figure 2: Effectiveness in contraception and out-of-wedlock births to teenage girls

neighborhood where the oblique socialization would go in the desired direction.[1] After socialization, some offspring will engage in sex, resulting in a percentage of out-of-wedlock births, and others will not. In the following period, there is a matching process in the marriage market. The presence of an out-of-wedlock child will diminish the attractiveness of a woman as a partner. After marriages occur, the new households will produce, consume, and raise and socialize their own kids (including any previous out-of-wedlock children). Some analytical results for the model are presented. Then, a steady state for the model is calibrated to match some stylized facts for today's U.S. economy. After this some transitional dynamics are computed for the situation where society faces a known time path of technological progress in its contraceptive technology. It is demonstrated that the model can replicate the observed rise in premarital sex and out-of-wedlock births. Last, illegitimacy is also costly for institutions such as the church and state, which have typically provided unwed mothers with some form of charity. A Ramsey-style problem is briefly considered where the church and state tries to influence attitudes in order to minimize the number of out-of-wedlock births net of the cost of socialization.

Before proceeding onto a more detailed exploration of the historical evidence, the inves-

[1]The previous argument should not be interpreted as a negation of the importance of peer group effects that the empirical literature has documented extensively, see Manski (2000). The emphasis here is the ability of parents to control, to some extent and at a cost, the peers of their children. Furthermore, there may "social multiplier" effects created by individual interaction that are ignored here; e.g., Glaeser *et al.* (2003) .

tigation should be framed within the literature on modelling the purposeful transmission of preferences, beliefs, and norms using economic models.[2] The modern analysis of how to affect a child's preferences through parental investments starts with Becker (1993), who was undoubtedly influenced by the work of Coleman (1990). He explored how parents may predispose childrens' preferences toward providing them with old age support. Becker and Mulligan (1997) focus on the manipulation of the child's rate of time preference. This idea is extended in Doepke and Zilibotti's (2008) work on the decline of the aristocracy that accompanied the British Industrial Revolution. They argue that parents, who thought that their children might enter the class of skilled workers, instilled in their offspring a patience that allowed their child to sacrifice today in order to acquire the human capital necessary so that they would earn more tomorrow. Bisin and Verdier (2001), and a number of following papers, approach the problem of preferences transmission from a different perspective: parents want children to behave like them [see Bisin and Verdier (2008) for a short summary of the existing knowledge]. Under this assumption, they analyze the evolution of the distribution of traits in the population and how the incentives of parents regarding the level of socialization invested in their children evolve depending on the aggregate distribution of traits.

The current work builds on the preference transmission literature by emphasizing how technological innovation induces changes in the socialization decisions of parents through shifts in incentives. Parents' decisions become an amplification mechanism of the original technological shocks. The paper can be read, in part, as an example of this type of amplification mechanism. Other examples are the shifts in investments that parents make in promoting the patience, self-discipline, religiosity, ethnic or national identification, or cultural appreciation when the economic environment changes. Furthermore, the analysis focuses on how endogenous socialization generates a lag between behavior and societal attitudes. In such a way, a mechanism is built that formalizes the insights of Ogburn (1964) regarding the existence of a lag between technology and cultural change. Greenwood and Guner (forth.) also study the impact that technological advance in contraception has had on social behavior and interaction. They build an equilibrium matching model where youths make decisions about which social groups (either abstinent or promiscuous ones) to circulate within. The group they mix with will depend both on the state of contraceptive technology and on what others are doing. They define social change simply as shifts in the relative sizes of these social groups, which reflect the aggregation of decentrialized decision making at the individual level.

[2] There is also a growing literature on evolutionary models of preferences transmission. [See Barkow *et al.* (1992) for an Evolutionary Psychology perspective, and Robson and Samuelson (forth) for a survey in Economics.] Similarly, Durham (1992) explores the coevolution of genetic traits with endogenous socialization. While those mechanisms are clearly relevant in the long run, the time frame of the sexual changes focused on here, around a century, excludes a large role for evolution in the observed variations of behavior.

The emphasis here is very different: the spotlight is on the role that parents, and institutions, play in shaping their children's sexual mores, and therefore their behavior, and on the lags between this behavior and societal acceptance.

Finally, there is a large empirical literature relating culture and economic behavior that is too wide to survey here. Guiso *et al.* (2006) provide a nice summary of many of the issues studied by economists over the last few years. Of particular interest is the evidence regarding the effect of "ethnic capital" as documented by Borjas (1992), Fernández and Fogli (2009), and Guiliano (2007). The current analysis can be used to interpret this evidence as the result of the persistence in parents' decisions induced by the role that socialization plays as state variable; i.e., the action of a youth today is influenced by the socialization she or he received from her or his parents, which in turn is affected by the socialization they experienced from their parents.

2. Historical Discussion

> Every lewd woman which have any bastard which may be chargeable to the parish, the justices of the peace shall commit such women to the house of correction, to be punished and set on work during the term of one whole year. Statute of 7 James, cap 4 (1610).[3]

Widespread participation in premarital sex is a recent phenomena in Western societies. In yesteryear only a small fraction of women must have entertained it.[4] This can be inferred from Figure 3, which plots the number of out-of-wedlock births for England and Wales from 1580 to 2004. The experience for other Western European countries is similar. Therborn (2004, p. 149) reports that the percentage of children born out of wedlock among live births around 1896-1900 was 6% in Australia, 8% in Belgium, 9% in Germany, 6% in Italy, 4% in New Zealand, 3% in the Netherlands, 2% in Ontario (Canada), 5% in Spain, and 5% in Switzerland. Furthermore, prenuptial conception (i.e., births happening less than 9 months after the wedding) was relatively low.

Given the primitive state of contraception, the small number of out-of-wedlock births is only consistent with a small fraction of the population engaging in premarital sex, especially because some women might have had more than one such birth and because a substantial fraction of those births came from long-lasting cohabitating couples that for some reason or another had not formalized their marriage. For instance, a typical reason for the large number

[3] As quoted by MacFarlane (1980, p. 73).

[4] The case for men might be different since prostitution was a rather common practice in Western societies– Therborn (2004).

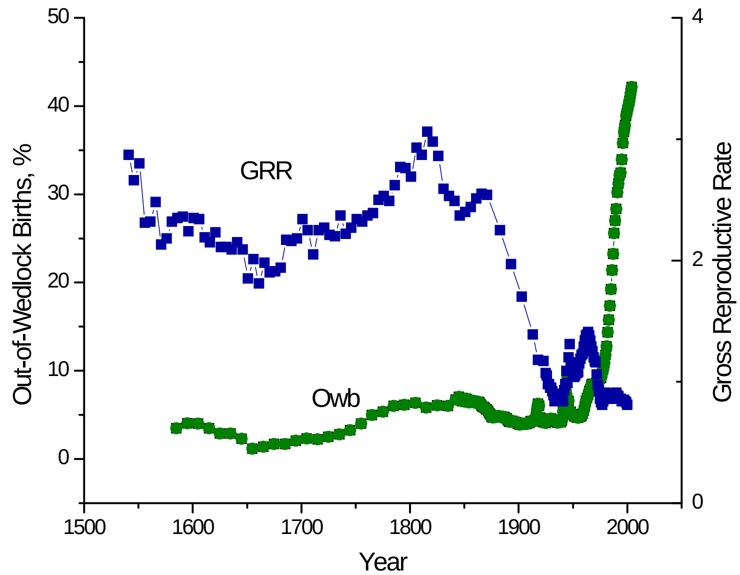

Figure 3: The percentage of all births that are out-of-wedlock from 1580-2004 and the gross reproductive rate 1540-2000, both for England and Wales

of cohabitating couples in the Paris of the 19th century was the legal costs of civil marriage (including a notarized parental consent), which could amount to more than one month's wage for a poor working couple–Fuchs (1992).[5] It is interesting to note that the recent rise in out-of-wedlock births occurred at a time when the gross reproductive rate (GRR) was declining. The small number of out-of-wedlock births is also surprising in light of the fact that for much of period women tended to marry late (around 26 years of age in the seventeenth century), with a significant fraction never marrying–see Voightlander and Voth (2009) for a discussion of the European marriage pattern. The trend in U.S. teenage out-of-wedlock births follows a very similar pattern–recall Figure 2. Why was this practice so limited in the past?

Engaging in premarital sex was, until recently, a risky venture. First, it was illegal and viewed as being morally reprehensible. Second, an out-of-wedlock birth placed a female in a perilous economic state. Some historical examples of how premarital sex was stigmatized will now be presented. In 1601, the Lancashire Quarter sessions condemned an unmarried

[5] Out-of-wedlock births were higher, though, among some social groups, like landless agricultural workers, poor workers in bigger cities, in peripheric mountainous regions, and in some European areas of settlement like the Appalachians, suggesting a higher degree of participation in premarital sex. The higher prevalence of premarital sex among the working classes is discussed later.

father and mother of a child to be publicly whipped.[6] They then had to sit in the stocks still naked from the waist upwards. A placard on their heads read 'These persons are punished for fornication.' In early America, a New Haven court in 1648 fined a couple for having sex out of marriage.[7] The magistrate ordered that the couple "be brought forth to the place of correction that they may be shamed." He said that premarital sex was "a sin which lays them open to shame and punishment in this court. It is that which the Holy Ghost brands with the name of folly, it is wherein men show their brutishness, therefore as a whip is for the horse and asse, so a rod is for the fool's back." These were not isolated cases. The prosecution of single men or women either for "fornication", or of married couples who had a child before wedlock, accounted for 53% of all criminal cases in Essex country, Massachusetts, between 1700 and 1785. Likewise, 69% of all criminal cases in New Haven between 1710 and 1750 were for premarital sex. In the Chesapeake Bay, when an unmarried woman gave birth to a child, she was levied a large fine or, in case she could not pay, publicly whipped–see Fisher(1989). The otherwise moderate and pacific Quakers found that the English Crown decided in 1700 to suspend their Pennsylvania Law Code of 1683 against fornication because it was unreasonably harsh, a revealing judgement since the English crown was not particularly progressive in its views about crime and punishment.

It is also telling that in colonial America, abortion was punished when it was intended to cover adultery or fornication; however, it was overlooked when it was used as a device to control fertility within a marriage. In Pennsylvania, the law was taken even one step further. If a bastard child was found dead, the mother was presumed to be guilty unless she could prove otherwise, overriding the general English law principle of presumption of innocence. This change in the principle of the law was particularly harsh, as the punishment for the crime was hanging.[8]

The stigma attached to premarital sex, and other forms of illicit sex, is reflected by the language used to describe such acts. Words such as debauched, lascivious, lewd, loose, incontinent, vain, and wanton were used to reflect a lack of self control; others such as base, defiling, polluting, unclean, and vile described the desecration of the body associated with illicit sex; yet others such as adultery, disorderly, indolation, misdirection, rebellion, uncivil, unlawful, conjured up the notion of civil or religious disobedience and affected even those in situations of social prestige and power. So, for example, the son and namesake of the renowned minister John Cotton was excommunicated in 1664 by the First Church of Boston "for lascivious unclean practices with three women."

---

[6] This case is taken from the classic book by Stone (1977, p. 637).
[7] The discussion on premarital sex in early America derives from Godbeer (2002).
[8] See Klepp (1994, p. 74).

There are also plenty of historical examples of the relationship between the environment and promiscuity, which will now be discussed. The economic consequences for an unwed mother and her child could be dire. Churches, courts and parents tried to make the father and mother of an unwed child marry. The next best option was to ensure that the father paid child support. Sometimes neither of these two options worked. The outlook for the mother and child could then be bleak. Note that statute cited at the beginning of this section only seemed to apply to women that needed support. Now, nineteenth century France, an anomaly compared with other Western European countries, provides an interesting illustration of how the environment can affect social behavior.[9] The French Civil Code of 1804 prohibited questioning by the authorities about the paternity of a child. As a consequence, males could evade the responsibility for bringing up their illegitimate offspring. Roughly at the same time, all French hospitals were instructed to receive abandoned children. These laws may have drastically changed the cost and benefit calculations of engaging in premarital sex, and encouraged illegitimacy and abandonment on a grand scale. In 1816 about 40% of births in Paris were out of wedlock, and 55% of these children were abandoned. In 1820 a staggering 78% of these kids would have died. (Many of these out-of-wedlock births were undoubtedly from young women who lived outside of Paris and move to the anonymity of the capital after getting pregnant.) Why would an unwed mother abandon her child?

The decision to abandon a child was most likely dictated by the economic circumstance. A woman was paid about half that of a man in a similar job. Her earnings barely covered her subsistence. In the 1860s, a working woman could earn somewhere between Fr250-600 a year, taking into account seasonal unemployment. It cost approximately Fr300 a year for rent, clothing, laundry, heat, and light. Even at the maximum salary this didn't leave much for food–less than a franc a day–never mind the costs of clothing and wet nursing a baby (the later is estimated at Fr300 a year). A working woman could certainly not afford to raise a child alone. Furthermore, there is evidence, especially for the early part of the century, that abandonments were correlated with the price of bread.

Illegitimacy disproportionately affected the ranks of the working class. In 1883 the Registry General for Scotland tabulated that only 0.5% of illegitimate births were to the daughters of professional men.[10] The middle and upper classes had to worry about how illegitimacy would disrupt the transfer of property through the lineage. English author Samuel Johnson expressed this concern well: "Consider of what importance to society the chastity of women is. Upon that all the property in the world depends. We hang a thief for stealing a sheep, but the unchastity of a woman transfers sheep, and farm, and all from the right owner."

[9] The material on France is drawn exclusively from Fuchs (1984).

[10] The source for Scotland is Smout (1980).

Illegitimacy was connected to the structure of the environment that the working class lived in. In nineteenth century Scotland, the Lowlands had a much higher rate of illegitimacy than the Highlands. This has been tied to economy of the two places, and how it impacted on the relationship between parents and their children. In the Lowlands labor was mobile. Young and old laborers independently travelled from farm to farm, district to district, taking work where available. As a consequence, young males and females freely mixed in the residences of farms (the chaumer system). A young man could easily evade his responsibility to a pregnant woman. His parents would suffer little stigma, or be forced to lend to financial support, either. In the more stable Highlands disappearing was more difficult. Additionally, in the Lowlands it was easy for unwed mothers to find jobs milking cows or tending to turnips. Furthermore, in some places a ploughman had to provide an able-bodied female to work along side (the bondager system). Since the work unit was often then the family some feel that this meant that partners had to prove their fertility before marriage.

Other areas of Western Europe with high illegitimacy ratios, like Alpine Austria or northern Portugal, had land property structures that prevented a large number of men and women from participating in a marriage market (thus eliminating a powerful incentive for avoiding out-of-wedlock children) and experienced large outmigration.

3. The Economic Environment

Imagine a world comprised by overlapping generations of females and males. Children are socialized by their parents. This socialization is important when youths decide whether or not to engage in premarital sex. A high level of socialization by one's parents will induce a high level of shame if an out-of-wedlock birth occurs. But, why should parents socialize their offspring? Altruism is the mechanism here. In particular, later in life, old parents realize utility from the socioeconomic status of the household that their adult daughter lives in. Daughters who experience out-of-wedlock births are more likely to be in households of low socioeconomic status than those who don't. Since the likelihood of this situation depends on the level of socialization given to young daughters, young parents will invest resources in it. In the analysis socialization is a costly activity, so parents undertake it judiciously.

Agents live for three periods: youth, adulthood, and old age. People are born with three characteristics: their gender, $g \in \{f, m\}$, either female or male; their productivity $y_g \in \mathcal{Y}^g \equiv \{y_{g,1}, \cdots, y_{g,n}\}$; their libido $h \in \mathcal{H} = [0, 1]$ which represents the utility they realize from sex. Exactly half of newborns are females. The distributions over $\mathcal{Y}^g$ and $\mathcal{H}$ are given by P^y and P^h. The distributions are equal across males and females (in a sense for P^y that is made clear below). The distribution function P^h is strictly concave in $h \in \mathcal{H}$ and is presumed to be independent across generations. Note that females have the same biological desire for sex as males. Therefore, any predisposition for premarital sex by males over females will have to derive from the economics of the model. The distribution over $\mathcal{Y}^g$ is conditional on the mother's type; i.e., there is some transfer of ability across generations. In particular, $P^y(y'|y)$ is increasing in y, in the sense of stochastic dominance and $P^y(y'_{f,j}|y_{f,i}) = P^y(y'_{m,j}|y_{m,i})$. Denote the stationary distribution associated with $P^y(y'|y)$ by $\overline{P}^y$. Assume that a suitable law of large numbers holds in this economy and that, consequently, individual probabilities equal aggregate shares of realizations of random variables.

4. Youth

Youths live with their parents. Assume each female will always give birth to just one set of twins, a male and a female. This keeps the birth rate for each type of female fixed, so there is no need to keep track of potential shifts in P^y over time due to cross-sectional differences in births rates. Thus, there will be no aggregate population growth. Births happen at the beginning of adult life. The birth of the twins may occur in or out of wedlock. Children are socialized by their parents at the beginning of their youth. Represent the level of socialization by s. This denotes some level of investment that parents make in influencing a child's views on premarital sex. The word investment is used deliberately. Noncognitive skills, such as the sense to avoid risky activities such as drinking, doing drugs or engaging in premarital sex, are important for building a child's human capital. They complement the formal schooling stressed by economists–eg Restuccia and Urritia (2004). Both the boy and girl in the household are socialized at the same level, say, for example, because of indivisibilities in education practices. After this socialization occurs, youths decide whether or not to engage in premarital sex. This is the only decision youths make. If they do so, they receive a utility h, but the female partner risks a pregnancy with probability $1 - \pi$. Think about π as representing the quality of the contraception technology, including more drastic measures, specifically abortion and infanticide. For example, it may be reasonable to view the 1973 decision by the U.S. Supreme Court that legalized abortion as a drop in $1 - \pi$. An out-of-wedlock birth will generate a present-value disgrace of $D(s)$. The function $D(\cdot)$ is increasing and strictly concave in s. If youths do not engage in premarital sex, they get utility normalized to zero.

To engage in premarital sex, a youth needs to find a partner of the opposite gender. If the proportion of males searching for a female partner is given by σ_m and the proportion of females searching for a male partner is σ_f, the total number of premarital matches is given by $\min(\sigma_m, \sigma_f)$. Assume that the outcome of this search for premarital sex is random. Hence, the probability of obtaining premarital sex will be either 1, if the agent belongs to a gender g where $\sigma_g \leq \sigma_{\sim g}$, or $\sigma = \sigma_{\sim g}/\sigma_g$ when $\sigma_g > \sigma_{\sim g}$. It will be established in Section 7 that there are more males seeking premarital sex than females; i.e., $\sigma_f \leq \sigma_m$. Hence, a female youth desiring premarital sex will match with probability one, while a male will find a partner with probability $\sigma = \sigma_f/\sigma_m$.

Beyond sex, youths obtain utility, $U(c)$, from family consumption, c. Consumption is a public good within household. The determination of family consumption is described in Section 5. A female will enter adulthood next period with a known level of productivity, y', and perhaps an out-of-wedlock child. Represent the value function for a female adult next period by $A^{f\prime}(y', I')$, where I' is an indicator for having a pair of out-of-wedlock children. In particular, $I' \in \{0, 1\}$ will return a value of one when an out-of-wedlock birth occurs. Here a prime is attached to a variable to denote its value in the next period. Likewise, a prime is attached to a function to signify that the implied relation changes as time progresses. A precise definition for A^f will be provided in Section 5.

4.1. Premarital Sex

Direct attention now to a female youth's decision about whether or not to engage in premarital sex. On the one hand, if a female youth is abstinent then she will realize an expected lifetime utility level of $U(c) + \beta A^{f\prime}(y', 0)$. On the other hand, if she engages in premarital sex she will realize the enjoyment h, but will become pregnant with probability $1 - \pi$. Her expected lifetime utility level will be $U(c) + h + \pi\beta A^{f\prime}(y', 0) + (1 - \pi)[\beta A^{f\prime}(y', 1) - D(s)]$. She will pick the option that generates the highest level of expected lifetime utility. Her decision can be summarized as follows:

$$\begin{array}{lll} \textsc{Abstinence} & \textit{if} & \beta A^{f\prime}(y', 0) \geq h + \pi\beta A^{f\prime}(y', 0) + (1 - \pi)[\beta A^{f\prime}(y', 1) - D(s)], \\ \textsc{Premarital sex} & \textit{if} & \beta A^{f\prime}(y', 0) < h + \pi\beta A^{f\prime}(y', 0) + (1 - \pi)[\beta A^{f\prime}(y', 1) - D(s)]. \end{array} \tag{1}$$

Pick a row in (1) and fix y' and s. Observe that the right-hand side is increasing in h while the left-hand side is constant. Thus, there is a threshold for utility from sex for females, h^{f*}, such that

$$\beta A^{f\prime}(y', 0) = h^{f*} + \pi\beta A^{f\prime}(y', 0) + (1 - \pi)[\beta A^{f\prime}(y', 1) - D(s)],$$

or

$$h^{f*} = H^f(y', s) \equiv (1 - \pi)\{D(s) + \beta[A^{f\prime}(y', 0) - A^{f\prime}(y', 1)]\}. \tag{2}$$

This expression equates the utility of sex, given by h^{f*}, with its expected cost, the difference in future expected utilities induced by an out-of-wedlock birth plus the disgrace associated with this event, multiplied by the probability of pregnancy. Hence, a threshold rule of the form $h^{f*} = H^f(y', s)$ obtains such that for $h > H^f(y', s)$ the female agent will seek sex, and will not otherwise. The odds of a type-y' female youth, with a socialization level of s, engaging in premarital sex are given by

$$\Sigma(s, y') \equiv 1 - P^h\left(H^f(y', s)\right), \tag{3}$$

while the probability of becoming pregnant is

$$(1-\pi)\Sigma(s, y').$$

The decision making for a male youth is analogous. The value function for a young male adult, $A^{m\prime}(y')$, does not depend on whether or not he had any out-of-wedlock children. This assumption embodies the idea that historically fathers could walk away from their children outside marriage. Recall that a male youth will only find a female partner with probability σ. Therefore, a male will choose

$$\begin{array}{lll} \textsc{Abstinence} & \textit{if} & \begin{array}{c} \beta A^{m\prime}(y') \geq (1-\sigma)\beta A^{m\prime}(y') \\ +\sigma\{h + \pi\beta A^{m\prime}(y') + (1-\pi)\left[\beta A^{m\prime}(y') - D(s)\right]\}, \end{array} \\ \textsc{Premarital sex} & \textit{if} & \begin{array}{c} \beta A^{m\prime}(y') < (1-\sigma)\beta A^{m\prime}(y') \\ +\sigma\{h + \pi\beta A^{m\prime}(y') + (1-\pi)\left[\beta A^{m\prime}(y') - D(s)\right]\}. \end{array} \end{array}$$

The threshold libido level for males, h^{m*}, will be defined by

$$\beta A^{m\prime}(y') = (1-\sigma)\beta A^{m\prime}(y') + \sigma\{h + \pi\beta A^{m\prime}(y') + (1-\pi)\left[\beta A^{m\prime}(y') - D(s)\right]\},$$

or

$$h^{m*} = H^m(s) \equiv (1-\pi)D(s). \tag{4}$$

Note that for males the cost of premarital sex is equal to the disgrace cost times the probability of a pregnancy, because they can simply walk away from out-of-wedlock children. Therefore, the lifetime utility for an adult male is orthogonal to the decision of having premarital sex or not. This decision rule defines a simple invertible mapping between s and h^{m*}. Given P^h, the probability of a young male searching for sex is just $1 - P^h(h^{m*})$, the probability of engaging in sex is $\sigma[1 - P^h(h^{m*})]$, and the probability of having an out-of-wedlock birth is

$$\sigma(1-\pi)\left[1 - P^h(h^{m*})\right].$$

5. Adulthood

At the start of adulthood, females and males match for the rest of their lives. Now, a female will enter a marriage with productivity level, y_f, and possibly some out-of-wedlock children, I. All adult females and males are matched, according to some rule that may be a function of (y_f, y_m, I). Suppose that the conditional odds of a type-(y_f, I) female drawing a type-y_m male on the marriage market are described by the distribution function $P^f(y_m|y_f, I)$. The precise form of this conditional distribution will depend upon the assumed matching process; this is discussed in Section 5.1. The utility that a married couple derives from consumption, leisure and children is a public good enjoyed jointly by husband and wife.

An adult has one unit of time, which is split between market and nonmarket activity. Denote the productivity on the market for an efficiency unit of labor by χ. A male devotes the fraction ω of his time to working in the market. A male earns on the market $\chi\omega y_m$. An out-of-wedlock birth is assumed to reduce a female's productivity. For instance, it may prevent her from attaining an education or on-the-job training. Suppose that the presence of an out-of-wedlock birth taxes a female's productivity at the rate $T(y_f, I)$, with $T(y_f, 0) = 0$, $0 \leq T(y_f, 1) \leq 1$, $T_1(y_f, 1) \geq 0$, and $[1 - T(\widetilde{y}_f, 1)]\widetilde{y}_f \geq [1 - T(y_f, 1)]y_f$ if $\widetilde{y}_f \geq y_f$. Therefore, a household with a female of type (y_f, I) and a male of type y_m can produce consumption when young and old in the amounts

$$c = C^a(y_f, y_m, I) = \chi\omega\{[1 - T(y_f, I)]y_f + y_m\},$$

and

$$c' = C^o(y_f, y_m, I) = \chi'\omega\{[1 - T(y_f, I)]y_f + y_m\}.$$

The utility from consumption when young and old will be $U(c)$ and $U(c')$. The children living with a young couple will also realize the utility level $U(c)$ from household consumption.

An old couple also derives joy from their daughter's family. Let (y'_f, y'_m, I') represent the characteristics of their adult daughter's household. This describes the socioeconomic status of the daughter's family. It generates $G(y'_f, y'_m, I')$ in utility for her old parents. The function G is increasing in y'_f and y'_m, and decreasing in I'. The old couple's utility rises in y'_f and y'_m because higher types make more in income and hence the daughter's family will enjoy a higher living standard. Social status may be increasing in type too. Parental utility declines in I' because an out-of-wedlock birth for the daughter will reduce consumption per person in her family, ceteris paribus. It may also incur stigma. As an example, one could simply imagine that G is increasing in the young household's consumption, $C^a\left(y'_f, y'_m, I'\right)$, so that one could write $G(C^a\left(y'_f, y'_m, I'\right))$.

So, an out-of-wedlock birth directly reduces the utility that old parents will realize from their adult daughter through the influence of I' in the function G. The presence of an out-of-wedlock birth may also affect the quality of the husband, y'_m, that the daughter will draw on the marriage market, through the matching function $P^{f\prime}\left(y'_m|y'_f, I\right)$. These two reasons explain why young parent's socialize their young daughters in the model. In societies where parent's lose contact with their children, the marginal influence of G in determining total utility will be small. Therefore, one might think in such societies that parents will socialize their children less.

Define $V((1+\iota I)\, s)$ as the disutility that each parent gets from socializing a pair of twins to level s. Think about this as representing the cost in terms of effort of inculcating the child with a certain set of values. This function is increasing and convex in s. Note that disutility from socializing the twins is higher for an out-of-wedlock birth (when $\iota > 0$); perhaps the father is less engaged in their upbringing so that the mother must expend more effort to attain a given level of socialization. A mother's leisure is given by $1-\omega-(1+\iota I)\, s$. Therefore, $-V((1+\iota I)\, s)$ can be thought of as representing the mother's utility function for leisure. The male's leisure is constant at $1-\omega$, and hence the utility the couple derives from this can be disregarded.

Remember that for a female youth the probability of having out-of-wedlock children is

$$(1-\pi)\,\Sigma\left(s, y'_f\right).$$

Therefore, the expected level of utility for a young adult couple in a marriage of type (y_f, y_m, I, y'_f), who arbitrarily socialize their children to level s, will read

$$\begin{aligned} M\left(y_f, y_m, I, y'_f, s\right) \;=\;& U(C^a\left(y_f, y_m, I\right)) + \beta U(C^o\left(y_f, y_m, I\right)) - V((1+\iota I)\, s) \\ & +\beta[1-\Sigma\left(s, y'_f\right)] \int G(y'_f, y'_m, 0) dP^{f\prime}\left(y'_m|y'_f, 0\right) \\ & +\beta\pi\Sigma\left(s, y'_f\right) \int G(y'_f, y'_m, 0) dP^{f\prime}\left(y'_m|y'_f, 0\right) \\ & +\beta(1-\pi)\Sigma\left(s, y'_f\right) \int G(y'_f, y'_m, 1) dP^{f\prime}\left(y'_m|y'_f, 1\right). \end{aligned} \tag{5}$$

The young adult couple will choose s to maximize their lifetime utility. Hence, s solves

$$M^*\left(y_f, y_m, I, y'_f\right) \equiv \max_s [M\left(y_f, y_m, s, I, y'_f\right)]. \qquad \text{P(1)}$$

The function $M^*(y_f, y_m, I, y'_f)$ gives the expected value for a type-(y_f, I) young adult female marrying a type-y_m young adult male, who together have type y'_f daughters, and vice versa.

Recall that a male youth simply walks away from the responsibility of any out-of-wedlock births. Therefore, the family's income will not be a function of his own out-of-wedlock children. Consequently, it is irrelevant whether or not parent's care about the living standards of their sons. This will merely be some constant that is independent of s. Then, the value function for a young adult female just prior to marriage will read

$$A^f\left(y_f, I\right) \equiv \int \int M^*\left(y_f, y_m, I, y_f'\right) dP^f\left(y_m | y_f, I\right) dP^y(y_f'|y_f). \tag{6}$$

5.1. Positive Assortative Matching

Recall that the expected lifetime utility in marriage accruing from consumption and other factors is a public good, enjoyed in equal fashion by husband and wife. Suppose that there is perfect assortative mating based on what each party will contribute to this expected lifetime utility, as measured by $L(y_f, y_m, I)$. The lifetime utility realized for a type-(y_f, y_m, I) household will be

$$L(y_f, y_m, I) \equiv \int M^*\left(y_f, y_m, I, y_f'\right) dP^y(y_f'|y_f), \tag{7}$$

where $M^*\left(y_f, y_m, I, y_f'\right)$ is defined by P(1). There will be $2n^2$ possible pairings in L. Let F represent the joint distribution for females over (y_j, I). Then, the number of females of type $(y_{f,j}, I)$ will be given by $\#(y_{f,j}, I) = F(y_{f,j}, I) - F(y_{f,j-1}, I)$. Similarly, $\#(y_{m,k})$ denotes the number of type-y_k males.

To characterize the implied matching process simply make a list of lifetime utilities from pairings, starting from the top and going down to the bottom. The best females will be matched with best males. Now, suppose that there are more of these males than females. Then, some of the males will have to match with the next best females on the list. The matching process continues down this list in this fashion. At each stage the remaining best males are matched with the remaining best females. If there is an excess supply of one of the sexes, the overflow of this sex must find a match on the next line(s) of the list.

Now, suppose that the l-th position on the list is represented by a match of type $(y_{f,j}, y_{m,k}, I)$. Some type-$y_{m,k}$ males may have already been allocated to females that are higher on the list; i.e., to women that have a better combination of y_f and I. Let $R_m^l(y_{m,k})$ be the amount of remaining type-$y_{m,k}$ males that can be allocated at the l-th position on the list. Similarly, let $R_f^l(y_{f,j}, I)$ be the number of available type-$(y_{f,j}, I)$ females. The number of matches is given by $\min\{R_m^l(y_{m,k}), R_f^l(y_{f,j}, I)\}$. Thus, the odds of a match are $\Pr(y_{m,k}|y_{f,j}, I) = \min\{R_m^l(y_{m,k}), R_f^l(y_{f,j}, I)\}/\#(y_{f,j}, I)$. The matching process is then summarized by

$$
\begin{array}{llll}
\text{Ranking} & \text{Lifetime Utility} & \text{Odds} \\
1 & L(y_{f,n}, y_{m,n}, 0) & \Pr(y_{m,n}|y_{f,n}, I=0) = 1 \\
\vdots & \vdots & \vdots \\
l & L(y_{f,j}, y_{m,k}, I) & \Pr(y_{m,k}|y_{f,j}, I) = \frac{\min\{R_m^l(y_{m,k}), R_f^l(y_{f,j}, I)\}}{\#(y_{f,j}, I)} \\
\vdots & \vdots & \vdots \\
2n^2 & L(y_{f,1}, y_{m,1}, 1) & \Pr(y_{m,1}|y_{f,1}, I=1) = 1,
\end{array}
\tag{8}
$$

where $R_m^{l+1}(y_{m,k}) = R_m^l(y_{m,k}) - \min\{R_m^l(y_{m,k}), R_f^l(y_{f,j}, I)\}$, with $R_m^1(y_{m,k}) = \#(y_{m,k})$, and $R_f^{l+1}(y_{m,j}, I) = R_f^l(y_{f,j}) - \min\{R_m^l(y_{m,k}), R_f^l(y_{f,j}, I)\}$, with $R_f^1(y_{f,j}, I) = \#(y_{f,j}, I)$.
It is easy to see $P^f(y_m|y_f, I) = \Pr(y \leq y_m|y_f, I) = \sum_{j=1}^m \Pr(y = y_j|y_f, I)$. Now, the distribution function $P^f(y_m|y_f, 0)$ will stochastically dominate the one represented by $P^f(y_m|y_f, 1)$, because having an out-of-wedlock birth will not increase the chances of a female drawing a male with an income greater than some specified level.

Any degree of assortative matching in the economy can be obtained by assuming that some fraction μ of each type mates in the above fashion while the remaining fraction, $1-\mu$, matches randomly. With random matching $\Pr(y_m|y_f, I) = \#(y_m)$, so that $P^f(y_m|y_f, I) = \sum_{j=1}^m \#(y_{m,j})$.

The matching process follows the Gale and Shapley (1962) algorithm–see Del Boca and Flinn (2006) for a recent marriage application. The cue for randomness in matching comes from Fernández and Rogerson (2001). Since all consumption for the couple is a public good, there are no opportunities for transfers between the husband and wife here. Also, there are no complementarities between the husband and wife's types in the production of household income. If these assumptions were relaxed, then a matching process along the lines of Becker (1981) could be used–see Chiappori, Iyigun and Weiss (2009) or Choo and Siow (2009) for recent work using this approach.

5.2. Solution for Socialization

The solution to problem P(1) can now be characterized. Maximizing with respect to s yields the first-order condition

$$
\begin{aligned}
-\beta(1-\pi)\Sigma_1(s, y_f')\,[\int G(y_f', y_m', 0)dP^{f\prime}(y_m'|y_f', 0) - \int G(y_f', y_m', 1)dP^{f\prime}(y_m'|y_f', 1)] \\
= (1+\iota I)\,V_1((1+\iota I)\,s).
\end{aligned}
\tag{9}
$$

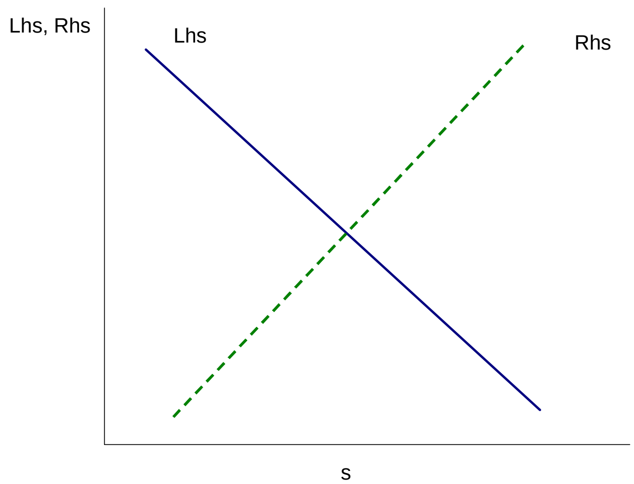

Figure 4: The determination of s

Now, from the above efficiency condition it is apparent that the level of socialization for a daughter, s, will be a function of her type, y'_f, and whether there are any out-of-wedlock births in the family, I, so that $s = S(y'_f, I)$.

The right-hand side of equation (9) is increasing in s, because V is convex. The slope of the left-hand side of the equation will now be examined. Using (2) and (3) it is easy to see that

$$-\Sigma_1\left(s, y'_f\right) = P_1^h(h^{f*})\,(1-\pi)\,D_1\,(s)\,. \tag{10}$$

This will be decreasing if both D and P^h are concave functions. Note that $P_1^h\left(h^{f*}\,(s)\right)$ is decreasing in s, a fact evident from (2). Therefore, the left-hand side of (9) declines with s. To summarize, the situation is portrayed by Figure 4.

6. Steady-State Equilibrium

Suppose that the economy is in a steady state. Recall that F represents the joint distribution for females over (y_f, I). In a steady state this distribution will be given by

$$\begin{aligned} F(y'_f, 1) &= (1-\pi)\int\int^{y'_f} \Sigma\left(S(\widetilde{y}'_f, 0), \widetilde{y}'_f\right) dP(\widetilde{y}'_f|y_f)dF(y_f, 0) \\ &\quad +(1-\pi)\int\int^{y'_f} \Sigma\left(S(\widetilde{y}'_f, 1), \widetilde{y}'_f\right) dP(\widetilde{y}'_f|y_f)dF(y_f, 1), \end{aligned} \tag{11}$$

with

$$F(y'_f, 0) = \overline{P}^y(y'_f) - F(y'_f, 1).$$

The first term in (11) gives the number of young girls with a productivity level less than y'_f, who came from a family without out-of-wedlock births, that will in turn experience an out-of-wedlock birth. The second term gives the number of young girls with a productivity level less than y'_f, and who were born in a family with out-of-wedlock births, that will experience an out-of-wedlock birth.

Definition. *A steady-state equilibrium consists of a threshold libido rule for female youths, $h^{f*} = H^f\left(y'_f, s\right)$, a rule for how young parents socialize their daughters, $s = S(y'_f, I)$, the matching probability for an unmarried female, $P^m\left(y'_m|y'_f, I'\right)$, and the stationary distribution for unmarried females, $F(y'_f, I')$, such that:*

1. *The threshold rule for a female youth maximizes her utility, as specified by (2).*
2. *The parents' socialization rule maximize their utility in line with P(1).*
3. *The matching probability is determined in line with the process described by (8).*
4. *The stationary distribution for unmarried females is given by (11).*

7. Results

Since a male youth can simply walk away from an out-of-wedlock birth, all he will suffer is the momentary disgrace associated with his dalliance. By contrast, the impact of an out-of-wedlock birth is more severe for a female. First, it will lower the income she will make. Second, their presence will affect her future matching possibilities. Third, it could prove more costly to socialize her kids if her future husband feels distant from them. Therefore, one would expect that males will engage more in premarital sex than are females. If so, females will be in short supply on the market for premarital sex so that all males will not be able to find a willing partner.

Lemma 1. *(Lustful males) Male youths have a lower libido threshold than do female youths so that $h^{m*} < h^{f*}$.*

Proof. This fact follows from the threshold rules (2) and (4) while noting that $A^{f\prime}\left(y_f', 0\right) - A^{f\prime}\left(y_f', 1\right) > 0$, where female and male youths' productivity levels are now denoted by y_f' and y_m'. The fact that $A^{f\prime}\left(y_f', 0\right) - A^{f\prime}\left(y_f', 1\right) > 0$ follows from the properties that: (i) $M^*\left(y_f', y_m', 0, y_f''\right) - M^*\left(y_f', y_m', 1, y_f''\right) > 0$; (ii) $\Pr(y' \leq y_m'|y_f', 0) \leq \Pr(y' \leq y_m'|y_f', 1)$; (iii) $M^*\left(y_f', y_m', s, 0, y_f''\right)$ is increasing in y_m'. ■

Corollary 2. *More male youths desire to engage in premarital sex than females, $\sigma_f < \sigma_m$ so that $\sigma = \sigma_f/\sigma_m$.*

It is interesting to ask how an increase in the general standard of living that will face a teenage girl when she becomes a young adult, as indexed by χ', will affect the level of socialization that she will receive from her parents, s. This depends on how it impacts on the utility differentials between having and not having an out-of-wedlock birth in the family, for both the girl and her parents, as the lemma below makes clear. The shape of the utility function for consumption, U, plays an important role in determining how a young girl's future income will influence her decision about whether or not to engage in premarital sex. Likewise, the form of the altruism function, G, which governs how parents care about their offspring, will effect how the child's future income will influence her parents' socialization decision. Specialize G to have the form $G(y_f', y_m', I') = G(C^a\left(y_f', y_m', I'\right))$ in the next lemma.

Lemma 3. *(The impact of growth on socialization) Suppose that U and G are isoelastic functions of consumption. Then, the level of socialization, s, is related to productivity, χ', in the following manner:*
(i) If U and G are logarithmic (as will be the case in the simulations) an increase in χ' has no effect on s;
(ii) If U is logarithmic, G is more (less) concave than logarithmic, and matching is random, an increase in χ', holding fixed the future levels of efficiencies, $\chi'', \chi''', \cdots$, reduces (increases) s;
(iii) If G is logarithmic, U is more (less) concave than logarithmic, and matching is random, an increase in χ', holding fixed the future levels of efficiencies, $\chi'', \chi''', \cdots$, increases (decreases) s.

Proof. It is easy to see that both $U(C^{a\prime}\left(y_f', y_m', 0\right)) - U(C^{a\prime}\left(y_f', y_m', 1\right))$ and $G(C^{a\prime}\left(y_f', y_m', 0\right)) - G(C^{a\prime}\left(y_f', y_m', 1\right))$ are increasing or decreasing in χ' depending on whether the functions U and G are less or more concave than logarithmic. When they are logarithmic these two differences are not a function of χ'. Given this, the first result follows almost immediately from the first-order condition (9), as can be deduced from a guess-and-verify procedure. Suppose that $s, s', s'', \cdots$ are unaffected by χ'. Then, there is no impact on the matching probabilities, $P^f(y_m'|y_f', I')$'s, because a shift in χ' does not change the ranking or mass of each type of female. The difference in expected lifetime utilities, $A^{f\prime}(y_f', 0) - A^{f\prime}(y_f', 1)$, is not affected by χ'. This implies that $-\Sigma_1\left(s, y_f'\right)$ will remain constant from (2) and (10). Condition (9) will still hold. Next, turn attention to part (ii). An increase in χ' will cause the term in brackets on the left-hand side of (9) to fall when G is more concave than logarithmic. But, $-\Sigma_1\left(s, y_f'\right)$ will remain constant (for given values of s and y_f') because $A^{f\prime}(y_f', 0) - A^{f\prime}(y_f', 1)$ will not change. The latter point obtains because U is logarithmic, $\chi'', \chi''', \cdots$ are being held fixed, and matching is random. The result follows–again, see (2) and (10). Last, direct attention to (iii). Now, the term in brackets on the left-hand side of (9) will not change when χ' increases. It is easy to deduce that $-\Sigma_1\left(s, y_f'\right)$ will rise when U is more concave than logarithmic. This transpires because $A^{f\prime}(y_f', 0) - A^{f\prime}(y_f', 1)$ falls when χ' rises under random matching, holding fixed $\chi'', \chi''', \cdots$. ■

The above results make intuitive sense. When G is more concave than logarithmic an increase in χ' narrows the difference in parents's utilities between the situations where their daughter has and does not have an out-of-wedlock birth, ceteris paribus.[11] Therefore, they spend less time socializing her. Likewise, if U is more concave than logarithmic then the difference in lifetime utilities that a young girl receives across these two situations contracts, other things equal. Therefore, her threshold libido level rises. Parents counteracts this by socializing her more. In general it appears that a rise in χ' can have any effect on s.

Corollary 4. *(The impact of a girl's ability on her socialization) When matching is random and the draw for a female's productivity is independent across generations, the level of socialization for a young female, s, is increasing or decreasing in her own level of productivity, y_f', depending on whether U is less or more concave than logarithmic.*

Proof. The proof is similar to Case (iii) in the Lemma. ■

[11] On another note, rewrite the function G as $G(C^{a\prime}(y_f', y_m', I)) = \phi\widetilde{G}(C^{a\prime}(y_f', y_m', I))$, where $\widetilde{G}$ is an increasing function. Now, reduce the parents' connection with their daughter by lowering the value of ϕ (while holding fixed their daughter's connection with her progeny). Then, it is immediate from (9) that s will fall. This suggests that in societies when parents lose connection with their children there may be less incentive to socialize. A complete proof would have to take into account that a shift in ϕ across *all* generations would affect Σ_1 through $A^{f\prime}$.

When matching is assortative, it may transpire that a rise in productivity improves a female's match when she has an out-of-wedlock birth by so much that $A^{f\prime}\left(y'_f,0\right)-A^{f\prime}\left(y'_f,1\right)$ actually narrows even when U is less concave than logarithmic.

A young mother with an out-of-wedlock birth may have to spend more effort to socialize her children, because her husband may be less attached to them. If so, out-of-wedlock children will be socialized less about the perils of premarital sex than those born in wedlock. These kids in turn will be more likely to experience an out-of-wedlock birth.

Lemma 5. *(Shameful mother, shameful daughter) The level of socialization, s, will be lower in families with out-of-wedlock children, $I=1$ (when $\iota>0$).*

Proof. The right-hand side of (9) shifts up with I, leading to a fall in s. ■

Autocorrelation in either income or libido is likely to generate this phenomena too. Establishing theoretically when this will transpire for these situations would be a more difficult task.

Consider a temporary improvement in the efficacy of contraception. That is, imagine that π increases while holding fixed $\pi',\pi'',\cdots$. One might think that as contraception becomes more effective, the marginal benefit from inculcating the current generation of children about the perils of premarital sex will fall since parents' daughters are less likely to become pregnant. This isn't necessarily the case; because, an increase in the efficacy of contraception will raise the likelihood that a daughter will be promiscuous, boosting the benefit from socialization. From the parents' first-order condition (9), it is apparent that the marginal benefit of socialization is proportional to $-\left(1-\pi\right)\Sigma_1\left(s,y'_f\right)$. Now, $-\left(1-\pi\right)\Sigma_1\left(s,y'_f\right)=\left(1-\pi\right)^2P^h_1(h^{f*})D_1\left(s\right)$, by (10). Therefore, a rise in π will reduce the marginal benefit of socialization, s, holding fixed h^{f*}. But, ceteris paribus, an increase in π reduces the threshold level of libido, h^{f*}–see (2). This operates to increase $P^h_1(h^{f*})$, when P^h is strictly concave. Therefore, an assumption on the elasticity of the density for P^h is required to ensure that the first effect dominates.

Assumption 6. *(Elasticity restriction on the libido distribution, P^h) Suppose that $(1-\pi)^2P^h_1((1-\pi)x)$ is decreasing in π for all $x>0$; i.e., the elasticity of $P^h_1((1-\pi)x)$ with respect to $1-\pi$ is smaller than 2 (in absolute value).*

Lemma 7. *(Concavity restriction on P^h) Suppose that $P^h((1-\pi)x)$ is strictly convex in $\ln(1-\pi)$. Then, the above assumption holds.*

Proof. Write $P^h((1-\pi)x)$ as $P^h(xe^{\ln(1-\pi)})$. The first derivative with respect to $\ln(1-\pi)$ is

$$xe^{\ln(1-\pi)}P^h_1(xe^{\ln(1-\pi)}).$$

The second derivative is then

$$x(1-\pi)P_1^h((1-\pi)x)+x^2(1-\pi)^2P_{11}^h((1-\pi)x).$$

Strict convexity will imply that

$$P_1^h((1-\pi)x)+(1-\pi)xP_{11}^h((1-\pi)x)>0.$$

This is the same thing as saying $(1-\pi)P_1^h((1-\pi)x)$ is decreasing in π. If $(1-\pi)P_1^h((1-\pi)x)$ is decreasing in π then so is $(1-\pi)(1-\pi)P_1^h((1-\pi)x)=(1-\pi)^2P_1^h((1-\pi)x)$. ■

The assumption in the lemma limits the amount of permissable concavity in P^h, so to speak. In particular, any P^y function that is convex will satisfy it. Only some that are concave will, though.

Lemma 8. *(The de-stigmatization of sex) Assume Assumption (6) holds and that matching is random. An increase in the current level of the efficiency of contraception, π, holding fixed the future levels of efficiencies, $\pi', \pi'', \cdots$, will reduce the current level of socialization, s.*

Proof. The left-hand side of (9) is decreasing in π, because $-(1-\pi)\Sigma_1\left(s, y_f'\right)$ is decreasing in π, when s is held fixed. This follows from (10) and the above assumption. Using Figure 4 it is easy to see that this will lead to a drop in s. ■

It is of interest to calculate the impact that an improvement in contraception has on the number of out-of-wedlock births. A naive view is that an improvement in contraception will lead to decline in the number of out-of-wedlock births. Figures 2 and 3 quickly dispel the empirical veracity of this notion. They suggest young females became more promiscuous as a result of technological innovation in contraception. Thus, there is a tug of war between two opposing effects. Now, suppose that initially, when contraception is rudimentary, only some small number of girls engage in premarital sex. One would expect that the number of out-of-wedlock births will rise from this small number with an incremental improvement in contraception as more girls are encouraged to engage in sex with little change in the failure rate. As technological progress continues to improve at some point the number of out-of-wedlock births must decline because contraception will eventually become perfect.

This conjecture holds under some simplifying assumptions. Assume that female productivity is independently distributed across generations. Also, suppose that the level of socialization that a child receives does not depend on I. This occurs when the cost of socialization does not depend upon the presence of an out-of-wedlock birth ($\iota = 0$). Then, it is easy to deduce that the steady-state number of out-of-wedlock births, b, is given by

$$b = (1-\pi) \int \Sigma \left(S(y_f'), y_f' \right) dP^y. \tag{12}$$

Assumption 9. *Let*

$$P^h(h) = h^\eta, \text{ for } h \in [0,1] \text{ and } 0 < \eta < 1. \tag{13}$$

Note that the above distribution satisfies Assumption (6).

Lemma 10. *(A rise and fall in out-of-wedlock births) Assume that Assumption (9) holds and that matching is random. Hold fixed the efficacy of contraception in the future, or $\pi', \pi'', \cdots$. Now, suppose that a small number of young women [in the sense that $1 - \min_{h_f^*} P^h(h_f^*) < \eta/(1+\eta)$] are engaged in premarital sex when $\pi = 0$. Then, $db/d\pi > 0$ when $\pi = 0$, and $db/d\pi < 0$ when $\pi = 1$, assuming that $ds/d\pi < 0$.*

Proof. It is easy to calculate from (12), using (2) and (3), that

$$\begin{aligned} db/d\pi &= -\int \Sigma dP^y + (1-\pi) \int P_1^h(h_f^*)\{D + \beta[A^{f\prime}(y',0) - A^{f\prime}(y',1)]\}dP^y \\ &\quad -(1-\pi)^2 \int P_1^h(h_f^*) D_1(s)(ds/d\pi)dP^y. \end{aligned}$$

When doing the above calculation note that $A^{f\prime}(y',0) - A^{f\prime}(y',1)$ does not change, because $\pi'', \pi''', \cdots$ are being held fixed, and matching is random. The functional form assumption for $P^h(h)$, in conjunction with (2) and (3), allow this to be rewritten as

$$\begin{aligned} db/d\pi &= -\int \Sigma dP^y + \eta \int P^h(h_f^*)dP^y - (1-\pi)^2 \int P_1^h(h_f^*) D_1(s)(ds/d\pi)dP^y \\ &= -1 + (1+\eta) \int P^h(h_f^*)dP^y \\ &\quad -\eta(1-\pi) \int \frac{P^h(h_f^*)D_1(s)}{\{D(s) + \beta[A^{f\prime}(y',0) - A^{f\prime}(y',1)]\}} \frac{ds}{d\pi} dP^y. \end{aligned}$$

Now, suppose $\pi \simeq 0$. Note that if $1 - \min P^h(h_f^*) < \eta/(1+\eta)$ then $(1+\eta) \int P^h(h_f^*)dP^y > 1$. Therefore, $db/d\pi > 0$ since $ds/d\pi < 0$. Likewise, when $\pi \simeq 1$ it follows that the expression will be negative, since $P^h(h_f^*) \simeq 0$ because $h_f^* \simeq 0$. ■

8. Simulation

It would be difficult to uncover much more about the model by using pencil and paper techniques alone. So, the model will now be simulated to see if it can explain the rise in premarital sex and the increase in out-of-wedlock births over the last century. Surely, this is no less general than imposing simplifications on the model's structure so that the analysis can proceed along theoretical lines. It also imposes discipline on the analysis, because showing that something can be obtained qualitatively is not the same thing as demonstrating that it can happen quantitatively. Simulating the model requires choosing functional forms and picking parameter values. The model will be calibrated to match the data available for the modern era, say 2000.

To begin with, parameterize the utility functions for consumption, $U(c)$, the joy old parent's realize from having an adult daughter in a type-(y'_f, y'_m, I') marriage, $G(y'_f, y'_m, I')$, the disgrace an unmarried girl will suffer from an out-of-wedlock birth, $D(s)$, and the disutility that parents incur from socialization, $V(s(1+\iota I))$, as follows:

$$U(c) = \ln(c), G(y'_f, y'_m, I') = \phi \ln(C^{a\prime}(y'_f, y'_m, I')) + \phi \ln(\zeta T(y'_m, I')),$$
$$D(s) = \gamma \frac{s^{1-\delta}}{1-\delta}, V(s(1+\iota I)) = \theta \ln(1 - \omega - s(1+\iota I)).$$

Note that G is assumed to be separable between the utility that parents get from their daughter's consumption and the stigma they feel if their daughter has an out-of-wedlock birth. The latter is assumed to be a function of the productivity loss associated with an out-of-wedlock birth.

The analysis will focus on several stylized facts categorized with respect to a female's educational background. There will be three groups for educational attainment: viz, less than high school, <HS; high school and some college, HS; college and post-college, C. The productivity distributions for females and males need to be specified for each category of education. An educational group is divided into six productivity levels corresponding to the average wage rate for those individuals lying within the following ranges for percentiles: 0 to 10, 10 to 25, 25 to 50, 50 to 75, 75 to 90, and 90 to 100. Thus, there are 18 productivity levels in all for each sex. The ranking of income levels does not map monotonically into education groups. For example, women in the upper end of the high school pay scale earn more than those at the lower end of the college one. This procedure is a variation on the one employed in Guner, Kaygusuz, and Ventura (2008). The parameterization adopted for the stationary distribution, $\overline{P}^y$, is summarized in Table I, which shows the mean level of productivity for each education group. The figures have been normalized by the mean wage rate for the entire

sample.

TABLE I: PROD. DIST.

	y_f	y_m	$\overline{P}^y$
<HS	0.49	0.72	0.129
HS	0.72	0.98	0.596
C	1.14	1.43	0.275
(Means, tabulated from 2000 CPS)			

Give the conditional distribution for productivity, $P^y\left(y'_f|y_f\right)$, the following simple representation:

$$\begin{aligned} y'_{f,i} &= y_{f,i}, && \text{with probability } \rho + (1-\rho)\Pr(y_{f,i}), \\ y'_{f,i} &= y_{f,j} \text{ (for } i \neq j), && \text{with probability } (1-\rho)\Pr(y_{f,j}), \end{aligned}$$

where $\Pr(y_{f,j})$ represents the odds of drawing $y_{f,j}$ from the stationary distribution. With this structure, ρ determines the autocorrelation across types over time within a family. Following Knowles (1999) set the intergenerational persistence across generations at 0.70, so that $\rho = 0.7$.

The implicit tax schedule on an out-of-wedlock birth, $T(y_{f,i}, 1)$, is parameterized as follows:

$$T(y_{f,i},1) = \{[\sum_{j=1}^{i} \lambda(\frac{y_{f,j}}{y_{f,N}})^{\alpha}(y_{f,j} - y_{f,j-1})] + \tau - \lambda(\frac{y_{f,1}}{y_{f,N}})^{\alpha}(y_{f,1} - y_{f,0})\}/y_{f,i}, \text{ for } i = 1, 2, \cdots, N,$$

where $N = 16$ and $y_{f,0} \equiv 0$. With this formulation, the tax function is determined by the three parameters τ, λ, and α. The tax rate starts at τ and then rises in a progressive fashion (when $\lambda > 0$ and $\alpha > 1$) with income, $y_{f,i}$.

The annual failure rate for contraception in 2000 was 28%, so that the odds of safe sex are 72%–see Greenwood and Guner (forth.). An average teenager does not engage in premarital sex all the time. On average, females have about 3 partners by age 19.[12] Furthermore, teenage relationships tend to be short, about 13 months.[13] Taking ages 14 to 19, inclusive, as the window for teenagers to have premarital sex, on average teenage females are exposed about half of this time to risk. So, for the modern era $\pi = 1 - 0.28/2 = 0.86$; i.e., the odds of a sexually active teenager not becoming pregnant are taken to be 86%. Last, the libido distribution will be taken to be characterized by (13).

There are 13 parameter values to determine, $\{\beta, \phi, \zeta, \gamma, \delta, \theta, \iota, \omega, \mu, \alpha, \tau, \lambda, \eta\}$. Around 2000, the median age at first premarital sex was about 17.6, while the median age at first

[12]The source is Abma et al. (2004, Table 13, p. 26)

[13]Sources: Ryan, Manlove, and Franzetta (2003) and Udry and Bearman (1998).

marriage was about 25 for females.[14] Taking 0.96 as a standard value for yearly discount factor, let $\beta = 0.96^7$, reflecting the fact that there is about a 7 year gap between the time of first premarital sex and the time of first marriage. A male is assumed spend 1/3 of his time endowment working so set $\omega = 1/3$. Given the form of preferences the level of productivity aggregate productivity, χ, will not matter–recall Lemma 3. So let $\chi\omega = 1$. The remaining parameters are picked to match three sets of targets discussed below. The parameter values for the model are listed in Table II.

1. The first target is the cross-sectional relationship between a girl's education and the likelihood that she will have premarital sex. The odds of premarital sex decrease with education, as can be seen from Figure 5. Both in the data and in the model, about 66% of girls have premarital sex. The calibrated model matches this cross-sectional feature of the data reasonably well, as can also be seen from Figure 5.

2. The next target is the amount of time that a mother spends with her child, as a function of the mother's educational background. Time increases with education, as Figure 6 illustrates. The model is good at mimicking this feature of the data too, as can be seen from the figure.

3. The last target is the correlation between a husband's and wife's education in the U.S., for women with and without out-of-wedlock births. The match between the data and model is shown in Table III. The model has little trouble reproducing the facts. The presence of an out–of-wedlock birth reduces the degree of assortative mating.

[14] The median age at first premarital sex is taken from Finer (2007), and is for the period 1994-2003. The median age at first marriage for 2000 is taken from the Census Bureau web page, http://www.census.gov/population/socdemo/hh-fam/ms2.pdf

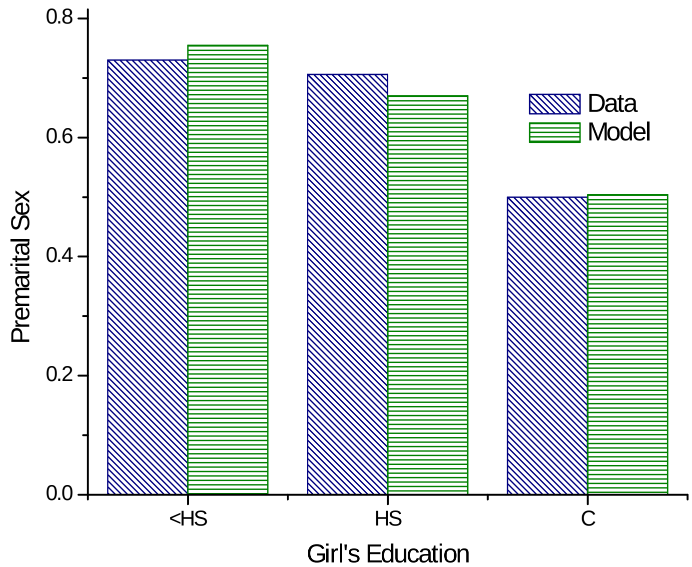

Figure 5: Cross-sectional relationship between the odds of a girl engaging in premarital sex and her educational background, data and model

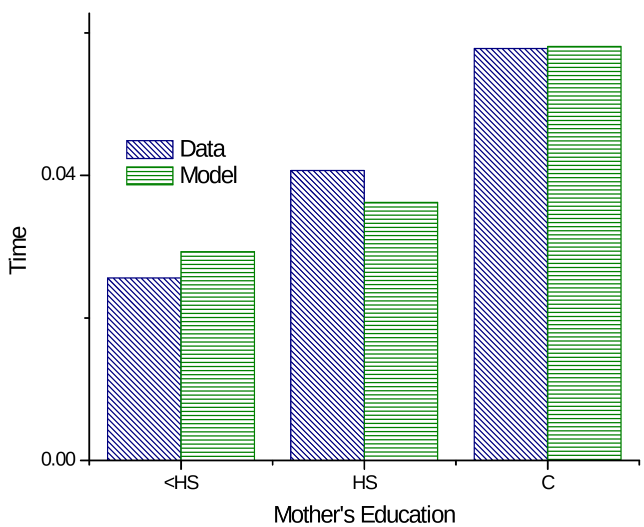

Figure 6: Cross-sectional relationship between the time spent with a daughter and the mother's educational background, data and model

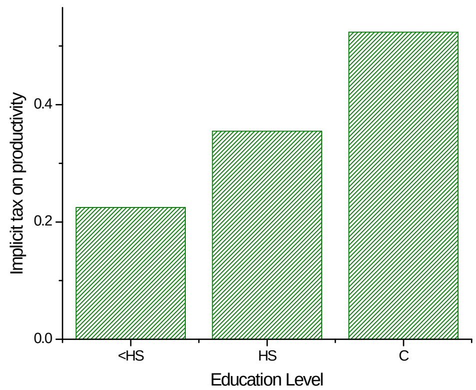

Figure 7: Implicit tax on an out-of-wedlock birth by education level, model

TABLE II: PARAMETER VALUES

Parameter Value	*Comment*
Tastes	
$\beta = (0.96)^7$	Standard
$\phi = 2.41$, $\zeta = 0.16$, $\gamma = 5.74$, $\delta = 0.45$	Calibrated
$\theta = 0.21$, $\iota = 0.08$	Calibrated
Productivity	
y_i's–see Table I for average values.	U.S. data
$\chi = 1/\omega$	Normalization
$\rho = 0.70$	Knowles (1999)
$\omega = 1/3$	Standard
Matching	
$\mu = 0.82$	Calibrated
Tax Schedule	
$\alpha = 5000$, $\lambda = 5.1$, $\tau = 0.03$	Calibrated
Libido	
$\eta = 0.76$	Calibrated
Contraception	
$\pi_{2000} = 0.86$	Greenwood and Guner (forth.)

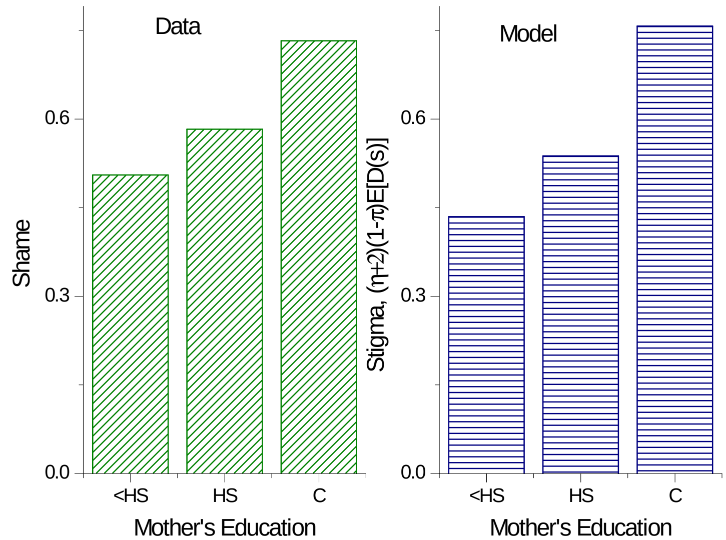

Figure 8: Left panel, Cross-sectional relationship between the daughter's shame from an out-of-wedlock birth and her mother's educational background, data; Right panel, Cross-sectional relationship between the daughter's expected stigma from engaging in premarital sex and her mother's educational background, model

TABLE III: CORRELATIONS–MATCHING BY EDUC.

	Data	*Model*
Female's history		
Without out-of-wedlock birth	0.49	0.47
With out-of-wedlock birth	0.29	0.32

The implicit tax schedule on an out-of-wedlock birth is shown in Figure 7. It weighs high on a young women at the upper end of the (potential) education scale. It is interesting to note that the likelihood a teenage girl will feel "very upset" if she gets pregnant increases with her mother's education background, as the left panel of Figure 8 makes clear. The right panel plots for the model a measure of the expected stigma associated with premarital sex.[15]

[15] The average expected level of stigma in the model is given by $(1-\pi)[\int\int D\left(S(\widetilde{y}'_f,0)\right)dP(\widetilde{y}'_f|y_f)dF(y_f,0)$ $+\int\int D\left(S(\widetilde{y}'_f,1)\right)dP(\widetilde{y}'_f|y_f)dF(y_f,1)]$. Normalize this by the expected level of libido, which is $1/(\eta+2)$.

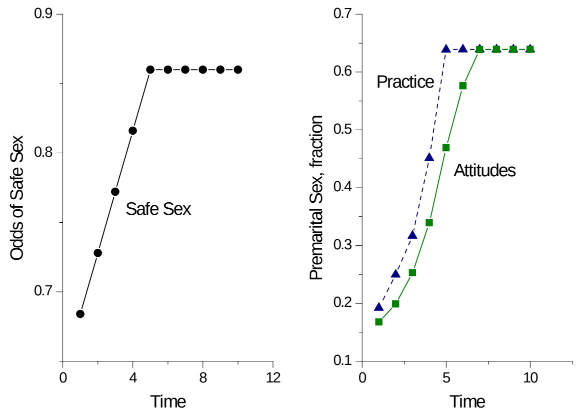

Figure 9: Sexual revolution

8.1. The Computational Experiment

Imagine starting the world off in a situation where premarital sex is risky. Specifically, assume in the initial situation that the annual failure rate for contraception is 72%; this is Greenwood and Guner's (forth) estimate for 1900. This implies that the odds of safe sex are 1-0.72/2=64%. Let the failure rate decline smoothly over time from 36 to 14%–the number picked earlier for 2000. The inputted time profile for the odds of safe sex is displayed in the left panel of Figure 9. So, what will happen in the economy under study?

The increase in the efficacy of contraception induces a sexual revolution in the model, which is displayed in the right panel of Figure 9. The number of women practicing premarital sex rises from 16% to 64%. It is reasonable to postulate that the number of women engaging in premarital sex translates directly into a measure of that generation that has a favorable attitude toward it. At any point of time, in the real world society is made up of many generations of women, each of which had a different sexual experience. Averaging across all generations gives a measure of society's attitude toward premarital sex. Do this for the three generations in the model. As can be seen, attitudes lag current sexual practice.[16] Additionally, as contraception becomes more effective, parents socialize their daughters less–Figure 10. Interestingly, the number of out-of-wedlock births rise.

[16]See footnote 20 for an illustration of how stigma may be transmitted over time. This leads to persistence in parents' socialization decisions.

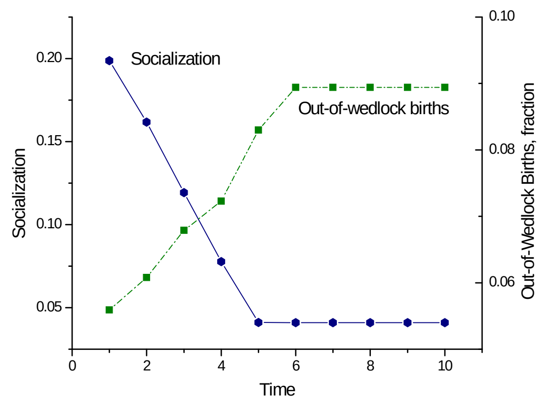

Figure 10: The decline in socialization and the rise in out-of-wedlock births

8.2. The Importance of Socialization: Some Counterfactual Experiments

One can ask how important in the model is socialization for curtailing premarital sex. To gauge the significance of this, three counterfactual experiments are run. First, one could ask what would happen if parents did not socialize their children at all ($s = 0$). The results of this experiment are shown in the upper right quadrant of Figure 11. As can be seen, promiscuity would run rampant in the model. Even in the old steady state 73% of girls would engage in premarital sex. A large fraction of these girls would become pregnant, given the poor state of contraception. This compares with just 16% in the baseline model.[17] Second, one could ask what would happen if parents maintained their old steady-state levels of socialization even in face of technological improvement in contraception. As can be seen from the lower left quadrant, the vast majority of girls would remain abstinent. These two experiments suggest that socialization plays an important role in the model. Third, the lower right quadrant plots the transitional dynamics for model in the situation where parents always follow the new steady-state pattern of socialization. Here 35% of girls would engage in premarital sex in the initial period (again compared with 16% in the baseline model). Note that the transitional dynamics to the new steady state are faster than in the baseline model.

To cast further light on the importance of socialization, imagine that a teenage girl grows up in a nation (the old country) with a primitive state of contraception ($\pi = 0.64$). Her parents socialize her according to the environment there. Now, suppose that around 15

[17] In a similar vein, one could ask how important is assortative matching in the model. This can be gauged by setting $\mu = 0$, so that all matches are random. In the old steady state the number of girls experiencing premarital sex would rise from 16 to 19%, while in the new steady state they would increase from 64 to 70%.

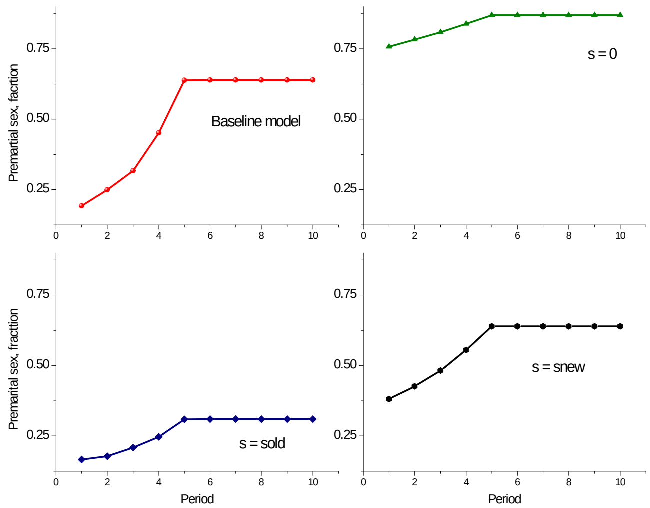

Figure 11: The impact of socialization on premarital sex, some counterfactual experiments

years of age the girl and her family immigrate to another nation (the new country) with a more advanced state of contraception ($\pi = 0.86$). In the new country the teenager will decide whether or not to engage in premarital sex. She will do this so as maximize her lifetime utility, taking into account the odds of becoming pregnant, how a pregnancy will effect her new-country socioeconomic status, and how becoming pregnant will relate to her old-country set of values. Figure 12 illustrates the upshot of this thought experiment. The young teenager's odds of engaging in premarital decrease as a function of mother's education. In general a girl whose mother is educated has more to lose from engaging in this risky activity than one whose isn't. Note that an immigrant is much less likely to engage in premarital sex than a native is, at all education levels. Native girls received less socialization about the perils of premarital sex than the immigrant did. Their parents are more liberal about this, because the risk of becoming pregnant is much less in the new country versus the old country. Overall, 31% of immigrant girls will engage in premarital sex as opposed to 64% of native ones. Culture affects decisions but the economic environment also affects culture.

Even though socialization plays an important role in the current model it may be possible to match the rise in premarital sex without including it. The goal of the analysis here is to develop a framework to show that parents may play an important role in inculcating social norms into their children and that the cost/benefit calculus governing this will be affected by

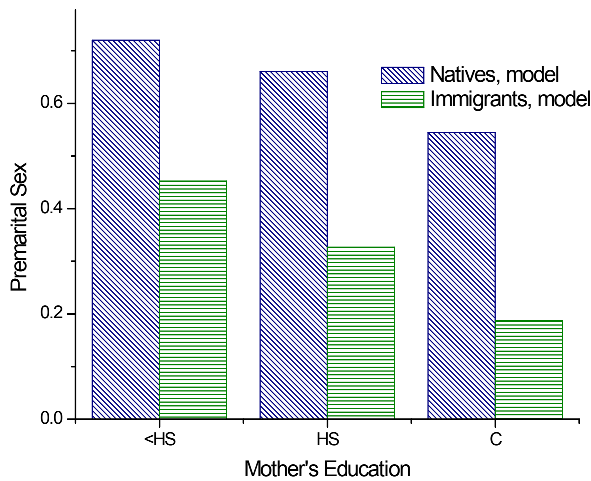

Figure 12: The cross-sectional odds of premarital sex in the immigration thought experiment

the state of society's technology. Deciphering exactly how important a role socialization plays in affecting teenagers sexual behavior would require a more exacting quantitative analysis where the parameters of the model could identified with precision.

9. The Church and State: An Extension

Illegitimacy imposes a financial burden on state and church. Different European states organized and funded orphanages and conservatories that took care of abandoned children, mostly illegitimate ones–see McCants (1997), Safley (1997), Sherwood (1989) and Terpstra (2005) for historical background. Churches, as long as they underwrote charity work, faced a similar burden.

To avoid these financial costs, both churches and states have used over history extensive instruments to reduce premarital sex and illegitimacy. Section 2 discussed how states employed criminal procedures to punish premarital sex. But other tools were available. One particularly powerful one was the legal concept of illegitimacy. Both in Civil law and Common law countries, a child was illegitimate if it was born to parents who were not legally married to one another at the time of birth, even if they later married. Illegitimate children were subject to a large number of discriminatory measures, from merely symbolic (as stating in the child's birth certificate his or her condition as illegitimate) to reduced inheritance rights–

see Beckert (2007) and Witte (2009).[18] The most harsh of those was the English Common law idea of *filius nullius* (child of nobody): having no right to inherit from either father or mother, no right to the surname of either parent, and no claim on them for support or education. Interestingly enough, these legal mandates were explicitly justified as a way to prevent premarital sex. As the Earl of Selborne states in *Clarke v. Carfin Co. (1891), A.C. 412, 427*, this policy was designed for "the encouragement of marriage and the discouragement of illicit intercourse." Policies directed at generating shame rather than explicit punishment were also widespread. For instance, in colonial Virginia, women engaged in premarital sex were required to offer a public apology in front of the congregated parish dressed in a white sheet and carrying a white wand–Brown (1996). Finally, there were more informal instruments in the form of some socially sanctioned activities such as supervised courtship rituals or the spread of the charivari as a ritual prosecution–Muir (2005). A particularly interesting strategy was the New England's practice of "bundling." A courting couple were allowed to lie together but separated by a bundling board with, often, the woman's legs bound together by a bundling stocking–Fisher (1989). This institution allowed intimacy for the young couple without sexual contact.

There is little doubt that illegitimacy taxed the resources of church and state. A fine, call leyrwite, was levied on the bondwomen of medivial English manors. The name describes its purpose and is based on two AngloSaxon elements: 'leger' to lie down and 'wite' a fine. This tax on fornication (6d versus a daily wage of 3/4d) levied by the Lord and Lady of the manor was aimed at discouraging bastardy, which placed great financial strain on the manorial community–see Bennett (2003). (The Church punished fornicators more ruthlessly.) A related fine was childwite, which was levied on out-of-wedlock births. Stone (1977) relates how parish authorities in England frequently worked to ensure that bastards were birthed outside of their local jurisdictions, so that they would not have to absorb a financial liability. Hayden (1942-43) discusses a similar situation in eighteenth century Ireland. Churchwardens often employed a 'parish nurse.' This person was commonly known as a 'lifter.' Her task was to round up secretly abandoned foundlings and deposit them in a nearby parish. Sometimes she sedated the baby with a narcotic, diacodium, to muffle any crying. One woman, Elizabeth Hayland in the Parish of St. John's, lifted 27 babies in a year. Seven died in her care. A baby that she dropped off in the Parish of St. Paul's was promptly returned by their lifter–the churchwarden then told her not to deposit babies at same place too often. Her salary

[18] A simple way to keep the stigma of illegitimacy public existed in Spain. By tradition, children use in daily life both the family name of the father and the mother. Women do not take the family name of their husband when they marry. Consequently, any person that used exclusively his mother's family name was immediately identified as illegitimate.

for lifting was £3 a year. Another nurse, Joan Newenham, started out getting paid 4s 9d for every baby she lifted. This was subsequently switched to an annual salary of £4 10s. Illegitimacy placed a great strain on the church's or state's resources. They may be called upon to provide poor relief to an unwed mother who kept her illegitimate children. They had to support the foundling hospitals and workhouses that received the abandoned babies, and provide the children with the necessary food, clothing, wetnursing, etc. And, then there was the cost of foster parents, orphanages, and workhouses for the lucky children who survived.

Suppose that today's church or state officials desire to minimize the current number of out-of-wedlock births. To do this, assume that they embark on a program to encourage parents to socialize their children about the perils of premarital sex. Specifically, let an old couple feel opprobrium in the amount $O(\mathbf{r}) = \kappa \mathbf{r}^{1-\xi}/(1-\xi)$, with $0 < \xi < 1$, should their daughter experience an out-of-wedlock birth, where $\mathbf{r}$ is the level of activity undertaken by the state or church to generate this stigma. Suppose that the church or state faces the cost function $\nu \mathbf{r}^{\upsilon+1}/(\upsilon+1)$, with ν, $\upsilon > 1$. Clearly, the church and state may pursue other ideals, such as the well-being of society. The virtue of the specific objective adopted here is its simplicity.

The mathematical transliteration of the church's goal is

$$\min_{\mathbf{r}}\{\int (1-\pi)\Sigma(s, y_f')dP^y(y_f'|y_f)dF(y_f, 0) + \int (1-\pi)\Sigma(s, y_f')dP^y(y_f'|y_f)dF(y_f, 1) + \nu \mathbf{r}^{\upsilon+1}/(\upsilon+1)\}, \quad \text{P(2)}$$

subject to

$$\begin{aligned} -\beta(1-\pi)\Sigma_1(s, y_f')[\int G(y_f', y_m', 0)dP^{f\prime}(y_m'|y_f', 0) \\ - \int G(y_f', y_m', 1)dP^{f\prime}(y_m'|y_f', 1) + O(\mathbf{r})] \\ = (1+\iota I)V_1((1+\iota I)s), \text{ for all } I \text{ and } y_f', \end{aligned} \tag{14}$$

taking as given $P^{f\prime}(y_m'|y_f', 0)$ and $\mathbf{r}'$. The constraint is the first-order condition that parents solve this period to determine s. Note the presence of the opprobrium that they will feel if their daughter has an out-of-wedlock birth. For simplicity, in this formulation the church neglects the secondary impact that its actions may have on the marriage market through the matching function $P^{f\prime}(y_m'|y_f', I)$ and the church's level of activity tomorrow, $\mathbf{r}'$. These channels are complicated to analyze. Essentially, the church would have to take into account how its current activity will influence the whole time path of the economy from today on.[19]

[19] To understand the problem note that church's actions today will affect tomorrow's type distributions

So, view the extension here as an illustrative example of how the church or state might be incorporated into the analysis.

Minimizing gives the first-order condition

$$-(1-\pi)\{\int\{\Sigma_1(s,y_f')\frac{ds}{d\mathbf{r}}dP^y(y_f'|y_f)dF(y_f,0)-\int\{\Sigma_1(s,y_f')\frac{ds}{d\mathbf{r}}dP^y(y_f'|y_f)dF(y_f,1)\} \\ =\nu\mathbf{r}^{\upsilon},$$

where

$$\frac{ds}{d\mathbf{r}}=\frac{\beta\,(1-\pi)\,\Sigma_1\left(s,y_f'\right)O_1(\mathbf{r})}{\Delta}>0, \tag{15}$$

with

$$\Delta(y_f',I,\mathbf{r})\equiv-\beta\,(1-\pi)\,\Sigma_{11}(s,y_f')[\int G(y_f',y_m',0)dP^{f\prime}\left(y_m'|y_f',0\right) \\ -\int G(y_f',y_m',1)dP^{f\prime}\left(y_m'|y_f',1\right)+O(\mathbf{r})]-(1+\iota I)^2\,V_{11}((1+\iota I)\,s)<0.$$

Note that church internalizes the impact that its action, $\mathbf{r}$, has on parental decision making s, as (15) makes clear. By pressuring parents it can increase the amount of socialization that they will undertake. The church or state is solving a static Ramsey-style problem.

The experiment conducted for the baseline model is now rerun while incorporating the Ramsey problem solved by the church. To do this, the selection for the parameters values governing the opprobrium function is $\kappa=0.2$ and $\xi=0.4$. Next, for the cost function set $\nu=7.0$ and $\upsilon=1.0$. Last, the odds of safe sex are presumed to increase to 95%, which is higher than assumed before. Figure 13 shows the upshot. Overtime socialization by both the church and parents decline as premarital sex becomes safer. Note that a hump-shaped pattern in out-of-wedlock births emerges when the failure rate for contraception becomes low enough. This is in accord with Lemma 10. The downturn in births now occurs because after some date the negative impact that technological progress has on out-of-wedlock births

---

$F'(y_f',0)$ and $F'(y_f',1)$, as equations (16) and (17) in the Appendix make clear. This will have an impact on the functions $P^{f\prime}\left(y_m'|y_f',0\right)$ and $P^{f\prime}\left(y_m'|y_f',1\right)$ through the matching process described by (8). Characterizing the impact of F' on $P^{f\prime}$ involves perturbing a function with respect to a *function*. The church's constraint (14) may be effected. Also, there will be an impact on what the church will do tomorrow, as is immediate by updating the church's problem P(2). Additionally, in P(2) observe that $\Sigma(s,y_f')=1-P^h\left(h^{f*}\right)$, where $h^{f*}=(1-\pi)\left\{D\left(s\right)+\beta[A^{f\prime}\left(y_f',0\right)-A^{f\prime}\left(y_f',1\right)]\right\}$. The church's action tomorrow, $\mathbf{r}'$, influences $A^{f\prime}\left(y_f',0\right)$ and $A^{f\prime}\left(y_f',1\right)$ through $O(\mathbf{r}')$. The matching functions, $P^{f\prime}\left(y_m'|y_f',1\right)$ and $P^{f\prime}\left(y_m'|y_f',1\right)$, also have an impact on $A^{f\prime}\left(y_f',0\right)$ and $A^{f\prime}\left(y_f',1\right)$. Last, the churches action's tomorrow will cause a shift in $F''(y_f'',0)$ and $F''(y_f'',1)$. And so, the problem rolls out recursively into the future.

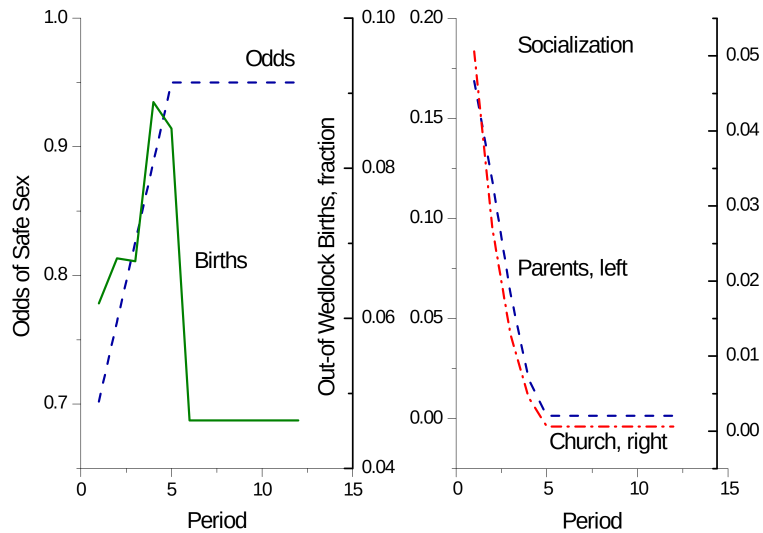

Figure 13: Socialization by church and parents

begins to exceed the positive effect resulting from the fact that more people are engaging in premarital sex.[20]

The historical record supports the idea of lower activity in modern times by the state and churches to reduce premarital sex. Most of the legal restrictions on illegitimate children started to be erased in the 1960s. The U.S. Supreme Court, in *Levy v. Louisiana, 391 U.S. 68* (1968), stated that the rights of a child to sue on a deceased parent's behalf may not be denied merely because a person is the illegitimate child of the deceased. The Supreme Court understood that such limitation would violate the Equal Protection Clause of the Fourteenth Amendment. Moreover, the decision established that states were not permitted to classify

[20]Consider the following alternative extension that injects cultural dynamics into the analysis. Let $\mathbf{r}$ evolve according to

$$\mathbf{r} = (1-\nu)\mathbf{s} + \nu\mathbf{r}_{-1},$$

where the average level of socialization, $\mathbf{s}$, is given by

$$\mathbf{s} = \int S(y_f', 0)dP^y(y_f'|y_f)dF(y_f, 0) + \int S(y_f', 1)dP^y(y_f'|y_f)dF(y_f, 1).$$

Here the opprobrium, $O(\mathbf{r})$, that parents feel when their child has an out-of-wedlock birth will adjust slowly over time to any new economic circumstances. Social attitudes will have a capital aspect to them. In this spirit, Fernández, Fogli and Olivetti (2004) develop a model where men's preferences toward female labor-force participation change slowly over time in response to an increase in the fraction of working mothers in the population (promoting further participation). In their work there are no interested parties, such as churches, states or parents, trying to influence this evolution.

in a way that constitutes "invidious discrimination against a particular class." This idea of "invidious discrimination" was developed in a number of subsequent decisions that eliminated nearly all legal consequences of illegitimacy in the U.S. (although a few survive, mostly related with immigration status). Similar legal changes equalizing the legal rights of legitimate and illegitimate children spread quickly in Western European countries, including England (1969 and 1989), France (1972 and 2001), Germany (1969 and 1997), Italy (1975), and Spain (1981). In 2005, France went as far as removing the very same concept of illegitimacy from its civil code.

Churches, particularly mainline protestant ones, also de-emphasized the existing strict provisions against premarital sex. In a famous example, the Episcopal Bishop of Newark, John Shelby Strong (a best-seller author of Christian books), called in 1987 for the recognition and blessing of non-marital relations. In Europe, the movement was even stronger. For instance, the German Protestant Church published in 1971 a *Memorandum on Questions of Sexual Ethics* that implied that couples who intended to marry could decide for themselves whether premarital sex was acceptable–Herzog (2007).

10. Conclusions

Engaging in a premarital conjugal relationship in yesteryear was a perilous activity for a young woman. The odds of becoming pregnant were high, given the primitive state of contraception. The economic consequences of an out-of-wedlock birth were dire for a young woman. Being born in or out of wedlock could be the difference between life or death for a child. Just like today young adults would have weighed the cost and benefit of engaging in premarital sex. The cost would have been lower for women stuck at the bottom of the social economic scale, so they would have been more inclined to participate. To tip the scale against premarital sex, parents, churches, etc. socialized children to possess a set of sexual mores aimed at stigmatizing sex. Parents at the lower end of the social economic scale would have less incentive to engage in such practice. With the passage of time contraception become more efficient and the costs of premarital sex consequently declined. This changed the cost and benefit calculation for young adults so that they would be more likely to participate in sexual activity. It also reduced the need for socialization by parents, or the church and state, which would also spur promiscuity. This is an example of culture following technological progress.

References

[1] Abma, Joyce C., Martinez, G. M., Mosher, William D., and Dawson, B. S. "Teenagers in the United States: Sexual Activity, Contraceptive Use, and Childbearing, 2002," Vital and Health Statistics, Series 23, No. 24. Hyattsville, Maryland, National Center for Health Statistics, 2004.

[2] Aguiar, Mark and Hurst, Erick. "Measuring Trends in Leisure: The Allocation of Time Over Five Decades," *Quarterly Journal of Economics*, 122, 3 (August 2007): 969-1006.

[3] Bachu, Amara. *Trends in Premarital Childbearing: 1930-1994* . Current Population Reports P23-197. U.S. Census Bureau, Washington D.C. 1999.

[4] Barkow, Jerome H., Cosmides Leeda, and Tooby, John. *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*. Oxford, U.K., Oxford University Press, 1992.

[5] Becker, Gary S. *A Treatise on the Family*. Cambridge, MA, Harvard University Press, 1981.

[6] Becker, Gary S. "The Economic Way of Looking at Behavior," *Journal of Political Economy*, 101, 3 (June 1993): 385-409.

[7] Becker, Gary S. and Mulligan, Casey B. "The Endogenous Determination of Time Preference," *Quarterly Journal of Economics*, 113, 3 (August 1997): 729-758.

[8] Beckert, Jens. *Inherited Wealth*. Princeton, Princeton University Press, 2007.

[9] Bennett, Judith M. "Writing Fornication: Medieval Leyrwite and its Historians," *Transactions of the Royal Historical Society*, Sixth Series Volume 13, (2003): 131-162.

[10] Bisin, Alberto and Verdier, Thierry. "The Economics of Cultural Transmission and the Evolution of Preferences," *Journal of Economic Theory*, 97, 2 (April 2001): 298-319.

[11] Bisin, Alberto and Verdier, Thierry. "Cultural Transmission." In Steven N. Durlauf and Lawrence E. Blume, Eds, *The New Palgrave Dictionary of Economics*. New York, N.Y., Palgrave Macmillan, 2nd Edition, v2, 2008: 329-333.

[12] Borjas, George. "Ethnic Capital and Intergenerational Mobility," *Quarterly Journal of Economics*, 107, 1 (February 1992): 123-50.

[13] Brown, Kathleen M. *Good Wives, Nasty Wenches, and Anxious Patriarchs. Gender, Race, and Power in Colonial Virgina*. Chapel Hill, University of North Carolina Press, 1996.

[14] Cavalli-Sforza, Luigi L. and Marcus Feldman. *Cultural Transmission and Evolution.* Princeton, Princeton University Press, 1981.

[15] Chiappori, Pierre-Andre, Iyigun, Murat and Weiss, Yoram. "Investment in Schooling and the Marriage Market," *American Economic Review*, 99, 5 (December 2009): 1689-1713.

[16] Choo, Eugene and Siow, Aloysius. "Who Marries Whom and Why," *Journal of Political Economy*, 114, 1 (February 2006): 175-210.

[17] Coleman, James S. *Foundations of Social Theory.* Cambridge, The Belknap Press of Harvard University Press, 1990.

[18] Del Boca, Daniela and Flinn, Christopher J. "Household Time Allocation and Modes of Behavior: A Theory of Sorts." Working Paper, NYU, 2006.

[19] Doepke, Matthias and Zilibotti, Fabrizio. "Occupational Choice and the Spirit of Capitalism," *Quarterly Journal of Economics*, 123, 2 (May 2008): 747-793.

[20] Durham, William. *Coevolution: Genes, Culture, and Human Diversity.* Palo Alto, CA, Stanford University Press, 1992.

[21] Ermisch, John. "An Economic History of Bastardy in England and Wales." ISER Working Paper 2006-15, University of Essex, 2006.

[22] Fernández, Raquel and Rogerson, Richard, 2001. "Sorting and Long-Run Inequality," *The Quarterly Journal of Economics*, 116, 4 (November 2001): 1305-1341.

[23] Fernández, Raquel, Fogli, Alessandra and Olivetti, Claudia (2004). "Mothers and Sons: Preference Transmission and Female Labor Force Dynamics," *The Quarterly Journal of Economics*, 119, 4 (November 2004): 1249-1299.

[24] Fernández, Raquel and Fogli, Alessandra. "Culture: An Empirical Investigation of Beliefs, Work and Fertility," *American Economic Journal: Macroeconomics*, 1, 1 (January 2009): 146-177.

[25] Finer, Lawrence B. "Trends in Premarital Sex in the United States, 1954-2003," *Public Health Reports*, 122, 1 (January/February 2007): 73-78.

[26] Fisher, David H. *Albion's Seed: Four British Folkways in America.* New York, Oxford University Press, 1989.

[27] Fuchs, Rachel. *Abandoned Children: Foundlings and Child Welfare in Nineteenth-Century France.* Albany, State University of New York Press, 1984.

[28] Fuchs, Rachel. *Poor and Pregnant in Paris.* New Brunswick, Rutgers University Press, 1992.

[29] Gale, David and Shapley, Lloyd S. "College Admissions and Stability of Marriage," *American Mathematical Monthly* 69, 1 (January 1962): 9-15.

[30] Glaeser, Edward L., Sacerdote, Bruce I., and Scheinkman, Jose A. "The Social Multiplier," *Journal of the European Economic Association*, 1, 2-3 (April/May 2003): 345-353.

[31] Godbear, Richard. *Sexual Revolution in Early America.* Baltimore, The Johns Hopkins University Press, 2002.

[32] Greenwood, Jeremy and Guner, Nezih, "Social Change: The Sexual Revolution," *International Economic Review*, forthcoming.

[33] Guiliano, Paola. "Living Arrangements in Western Europe: Does Cultural Origin Matter?" *Journal of the European Economic Association*, 5, 5 (September 2007): 927-952.

[34] Guiso, Luigi, Sapienza Paola, and Zingales, Luigi. "Does Culture Affect Economic Outcomes?" *Journal of Economic Perspectives* 20, 2 (Spring 2006): 23–48.

[35] Guner, Nezih, Kaygusuz, Remzi, and Ventura, Gustavo. "Taxation, Aggregates and the Household," IZA Discussion Paper 3318, January 2008.

[36] Harding, David J., and Jencks, Christopher. "Changing Attitudes Toward Premarital Sex: Cohort, Period, and Aging Effects," *Public Opinion Quarterly* 67, 2 (Summer 2003): 211–226.

[37] Hayden, Mary. "Charity Children in Eighteenth-Century Dublin," *Dublin Historical Record*, 5 (1942-43).

[38] Herzog, Dagmar. *Sex after Fascism: Memory and Morality in Twentieth-Century Germany.* Princeton, Princeton University Press, 2007.

[39] Heuser, Robert L. *Fertility Tables for Birth Cohorts by Color: United States, 1973-1973.* DHEW Publication No.(HRA) 76-1152, 1976.

[40] Klepp, Susan. "Lost, Hidden, Obstructed, and Repressed: Contraceptive and Abortive Technology in the Early Delaware Valley," In Judith A. McGaw, Ed, *Early American Technology.* Chappel Hill, University of North Carolina Press, 1994.

[41] Knowles, John A. "Parental Decisions and Equilibrium Inequality." Ph.D. Dissertation, University of Rochester, 1999.

[42] Laslett, Peter and Oosterveen, Karla. "Long-term Trends in Bastardy in England: A Study of Illegitimacy Figures in the Parish Registers and in the Reports of the Registrar General: 1561-1960," *Population Studies*, 27, 2 (July 1973): 255-286.

[43] Macfarlane, Alan. "Illegitimacy and Illegitimates in English History." In Peter Laslett, Karla Oosterveen and Richard M. Smith, Eds, *Bastardy and its Comparative History.* London, Edward Arnold, 1980: 71-85.

[44] Manski, Charles F. "Economic Analysis of Social Interactions," *Journal of Economic Perspectives* 14, 3, (Summer 2000): 115-136.

[45] McCants, Anne E.C.. *Civic Charity in a Golden Age: Orphan Care in Early Modern Amsterdam.* Urbana, University of Illinois Press, 1997.

[46] Muir, Edward. *Ritual in Early Modern Europe.* New York, Cambridge University Press, 2005.

[47] Ogburn, William, F. *On Culture and Social Change.* Chicago, The University of Chicago Press, 1964.

[48] Restuccia, Diego and Urrutia, Carlos. "Intergenerational Persistence of Earnings: The Role of Early and College Education," *American Economic Review*, 94, 4 (December 2004): 1354-1378.

[49] Robson, Arthur and Samuelson, Larry. "The Evolutionary Foundations of Preferences." In Jess Benhabib, Alberto Bisin, and Matthew Jackson, Eds, *Social Economics Handbook.* Amsterdam, The Netherlands, Elsevier Press, forthcoming.

[50] Ryan, Suzanne, Manlove, Jennifer, and Kerry, Franzetta. "The First Time: Characteristics of Teens' First Sexual Relationships," Child Trends Research Brief, Washington, D.C., Child Trends, 2003.

[51] Safley, Thomas M. *Charity and Economy in the Orphanages of Early Modern Augsburg.* Atlantic Highlands, NJ, Humanities Press, 1997.

[52] Sherwood, Joan M. *Poverty in Eighteenth-Century Spain: The Women and Children of the Inclusa.* Toronto, University of Toronto Press, 1989.

[53] Smout, Christopher. "Aspects of Sexual Behavior in Nineteenth-century Scotland." In Peter Laslett, Karla Oosterveen and Richard M. Smith, Eds, *Bastardy and its Comparative History.* London, Edward Arnold, 1980: 192- 216.

[54] Stone, Lawrence. *The Family, Sex and Marriage in England 1500-1800.* London, Weidenfeld and Nicolson, 1977.

[55] Terpstra, Nicholas. *Abandoned Children of the Italian Renaissance: Orphan Care in Florence and Bologna.* Baltimore, Johns Hopkins University Press, 2005.

[56] Therborn, Göran. *Between Sex and Power: Family in the World 1900-2000.* New York, Routledge, 2004.

[57] Udry, J. Richard and Bearman, Peter S. "New Methods for New Research on Adolescent Sexual Behavior." In Richard Jessor, Ed, *New Perspectives on Adolescent Risk Behavior.* Cambridge, U.K., Cambridge University Press, 1998: 241-269.

[58] Ventura, Stephanie J., Mathews, T. J. and Hamilton, Brady E. "Births to Teenagers in the United States, 1940-2000," National Vital Statistics Reports, Vol. 49, no 10 (Hyattsville, Maryland: National Center for Health Statistics, 2001).

[59] Voightlander, Nico and Voth, Hans-Joachim. "How the West Invested Fertility Restriction." Unpublished paper, Department of Economics, Universitat Pompeau Fabra, 2009.

[60] Witte, John Jr. *The Sins of the Fathers: The Law and Theology of Illegitimacy Reconsidered.* Cambridge, UK, Cambridge University Press, 2009.

[61] Edward A. Wrigley, Davies, R. S., Oeppen, James. E. and Schofield, Roger. S.. *English Population History From Family Reconstruction 1580-1837.* Cambridge, U.K., Cambridge University Press, 1997.

[62] Edward A. Wrigley and Schofield, Roger S. *The Population History of England 1541-1871.* Cambridge, MA, Harvard University Press, 1981.

11. Appendix

11.1. Proofs

11.2. Data Sources

- *Figure 1.* The data on attitudes by women toward premarital sex are displayed in Figure 2 in Harding and Jencks (2003) and was kindly supplied by the authors. The numbers on the fraction of teenage girls who have experienced premarital sex by age 19 are taken from Greenwood and Guner (forth.), which contains information about the source.

- *Figure 2.* See Greenwood and Guner (forth.) for information on how the failure rates are constructed. The data on out-of-wedlock births for teenage girls is derived as follows. The data for 1960-2000 is taken from Greenwood and Guner (forth.). For the 1972-2000 period it sums births to unmarried teenagers, all abortions to teenagers, and miscarriages (calculated as 20% of births plus 10% of abortions). For the 1960-1971 period it estimates the total number pregnancies by simply assuming that the (abortions + miscarriages)/(out-of-wedlock births) ratio took the same value as it did in 1972. For 1920, 1930, 1940 and 1950-1960 the series from Greenwood and Guner (forth.) is extended using the same procedure. The data on out-of-wedlock births for 1940 and 1950-1960 is from Ventura, Mathews and Hamilton (2001). For 1920 and 1930, using Bachu's (1999) estimates for 1930-1934, out-of-wedlock births are calculated as 14.5% of total births to teenagers. Total births to teenagers is from Heuser (1976).

- *Figure 3.* For the period 1580-1837 the data on out-of-wedlock births for all women is taken from Wrigley et al (1997, p. 224). For the period 1842-2005 the source is Ermisch (2006, Figure 1). Wrigley and Schofield (1981, p 230) provide data on the gross reproduction rate for 1541-1871. The data for 1876-2000 came from UK National Statistics.

- *Figure 5.* The data on premarital sex is calculated from the 2002 National Survey of Family Growth (Division of Vital Statistics, National Center for Health Statistics) as the fraction of women between ages 20 and 44 who had premarital sex before age 19.

- *Figure 6.* The underlying time-use data is taken from Aguiar and Hurst (2007). The figure plots the sum of educational and recreational childcare, normalized by 112 (total non-sleeping time per week).

- *Figure 8 (and the facts on attitudes cited in the Introduction).* Source: National Survey of Family Growth.

11.3. Outline of an algorithm to compute a steady-state solution for the model

1. Make a guess for $A^f(y', I')$, $L(y'_f, y'_m, I')$, and the joint distribution for females over (y'_f, I') denoted by F.

2. With the guess for F and L, solve the matching process (8) to obtain $P^f(y'_m|y'_f, I')$. Then, compute a solution for s of the form $s = S(y', I)$ using A^f and P^f–see (9). The distribution F can then be updated using (11).

3. Next, calculate $M^*(y_f, y_m, I, y'_f)$, using (5) and A^f, P^f, and S. From this a revised solution for A^f can be obtained–see (6). A similar computation can be done for L–see (7). The new solutions for A^f and L will depend upon the assumed process for matching, since one needs to know the conditional distribution P^f for the integration.

4. Continue until A^f and F converge.

11.4. Outline of an algorithm to compute the transitional dynamics for the model

Denote the initial time period by 1 and suppose that the model converges to the new steady state by period T.

1. Make an initial guess for the time path of A_t^f, L_t, F_t, and s_t from period $2, ..., T$. Represent this by $\overrightarrow{A}_1^f$, $\overrightarrow{F}_1$ and $\overrightarrow{s}_1$. For period T use the steady-state values for A_T^f, L_T, F_T and s_T. Note that F_1 is an initial condition.

2. Enter iteration j with the guess $\overrightarrow{A}_j^f$, $\overrightarrow{F}_j$, $\overrightarrow{L}_j$ and $\overrightarrow{s}_j$. Now, solve for A_t^f, P_t^f, F_t, and s_t starting at period 1 and moving down the path to period $T-1$ in the following manner:

    1. For each period t solve the matching process (8) to obtain P_{t+1}^f. To do this, use the guesses for L_{t+1} and F_{t+1} contained in $\overrightarrow{L}_j^f$ and $\overrightarrow{F}_j$. Next, compute s_t using (9). To do this, use the guess for A_{t+1}^f contained in $\overrightarrow{A}_j^f$. This is used in the $\Sigma_{1,t}$ term. The solution for P_{t+1}^f just obtained is also used.

    2. Once s_t has been computed for period t then calculate the implied solutions for A_t^f, L_t and F_t. The solution for A_t^f will involve P_{t+1}^f, which has already been computed. The formula for F_{t+1} is

$$\begin{aligned} F_{t+1}(y'_f, 1) &= (1-\pi_t) \int^{y'_f} \int \Sigma_t \left(S_t(y_f, 0), y_f \right) dP(y_f | y_{f,-1}) dF_t(y_{f,-1}, 0) \quad (16) \\ &\quad + (1-\pi_t) \int^{y'_f} \int \Sigma_t \left(S_t(y_f, 1), y_f \right) dP(y_f | y_{f,-1}) dF_t(y_{f,-1}, 1), \end{aligned}$$

    with

$$F_{t+1}(y'_f, 0) = \overline{P}^y(y'_f) - F_{t+1}(y'_f, 1). \quad (17)$$

3. Use the new computed values for A_t^f , L_t, F_t, and s_t for $t = 2, ..., T-1$ to revise the guess for the time path of these variables denoted by $\overrightarrow{A}_{j+1}^f$, $\overrightarrow{L}_{j+1}$, $\overrightarrow{F}_{j+1}$ and $\overrightarrow{s}_{j+1}$. Check the distance between $(\overrightarrow{A}_j^f, \overrightarrow{F}_j, \overrightarrow{s}_j)$. and $(\overrightarrow{A}_{j+1}^f , \overrightarrow{F}_{j+1}, \overrightarrow{s}_{j+1})$.

    1. If it is below some prescribed tolerance level, then stop.
    2. If not, then go back to Step 2.

11.5. Steady-State Distribution when $\mathbf{y}_f$ is Independent over Generations

The goal is to derive equation (12). Suppose that the economy is in a steady state. Let b represent the fraction of girls that are born out of wedlock. Then, $b\overline{P}^y(y_f')$ is the number of young girls that are born out of wedlock with a productivity level less than or equal to y_f'. In a steady state the number of out-of-wedlock births, b, will satisfy

$$b = (1-\pi)(1-b)\int \Sigma\left(S(y_f',0),y_f'\right)d\overline{P}^y + (1-\pi)b\int \Sigma\left(S(y_f',1),y_f'\right)d\overline{P}^y.$$

This formula takes into account that parents with out-of-wedlock children will socialize their children differently than ones with them. The first term gives the number of unmarried girls experiencing a pregnancy arising from families without out-of-wedlock children, while the second term gives the number from families with them. Solving for b yields

$$b = \frac{(1-\pi)\int \Sigma\left(S(y_f',0),y_f'\right)d\overline{P}^y}{1+(1-\pi)\int \Sigma\left(S(y_f',0),y_f'\right)d\overline{P}^y - (1-\pi)\int \Sigma\left(S(y_f',1),y_f'\right)d\overline{P}^y}. \tag{18}$$

This formula simplifies to (12) when S is not a function of I.

Recall that F represents the joint distribution for females over (y_f, I). In a steady state this distribution will be given by

$$F(y_f',1) = (1-\pi)(1-b)\int^{y_f'} \Sigma\left(S(y_f,0),y_f\right)d\overline{P}^y + (1-\pi)b\int^{y_f'} \Sigma\left(S(y_f,1),y_f\right)d\overline{P}^y, \tag{19}$$

with

$$F(y_f',0) = \overline{P}^y(y_f') - F(y_f',1).$$

The first term in (11) gives the number of young girls with a productivity level less than y_f', who came from a family without out-of-wedlock births, that will in turn experience an out-of-wedlock birth. The second term gives the number of young girls with a productivity level less than y_f', and who were born in a family with out-of-wedlock births, that will experience an out-of-wedlock birth.

11.6. Sources for Literature Cited

- *Random House Webster's Quotationary*, (1999, p. 784)
- France, Fuchs (1984, p.p. 17-22, p. 100, Table 3.3a, Table 3.11)
- America, Godbeer (2002, p. 35, p. 87, p. 98, p. 230)

- England, MacFarlane in Laslett et al (1980, p. 73) and Stone (1977, p. 635, p. 637)
- Scotland, Smout in Laslett et al (1980, p. 200, p. 202, p. 204, pp. 214-216)