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*

December 2008–*Preliminary and incomplete*, comments welcome

Abstract

Parents socialize their children about many things, including sex. Socialization is costly. It uses scare resources, such as time and effort. Parents weigh the marginal gains from socialization against its costs. Parents 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.

---

*Affiliations: University of Pennsylvania and Universidad Carlos III de Madrid; *Email*: nguner⊚eco.uc3m.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 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. By 1983, the number with a permissive attitude had jumped to 45%, a time when 73% of 19 year olds were sexually experienced. Thus, societal attitudes lagged practice. Beyond the evolution of sexual behavior over time, there are relevant cross-sectional differences in the data. In the U.S., the odds of a girl having premarital sex decline with family income. So, for instance, 70% of girls in the bottom decile 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-stigmization, 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. This reduces the cost of engaging in premarital sex, other things equal. This leads to the paradoxical situation where, despite the fact that the efficacy of contraception has increased,
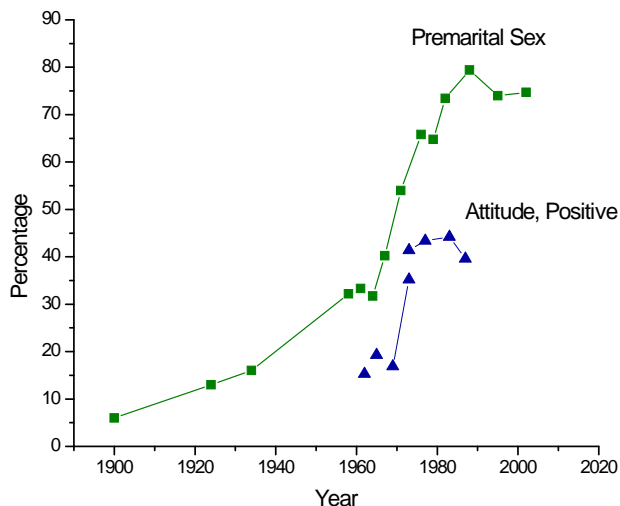
2

Figure 1: Premarital Sex, attitudes and practice

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. As contraception improves, the need for the proscription diminishes and with it the amount of parental indoctrination. As the stigma is transmitted over time, however, its reduction will lag the increase in sexual activities.

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 are analyzed here 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-
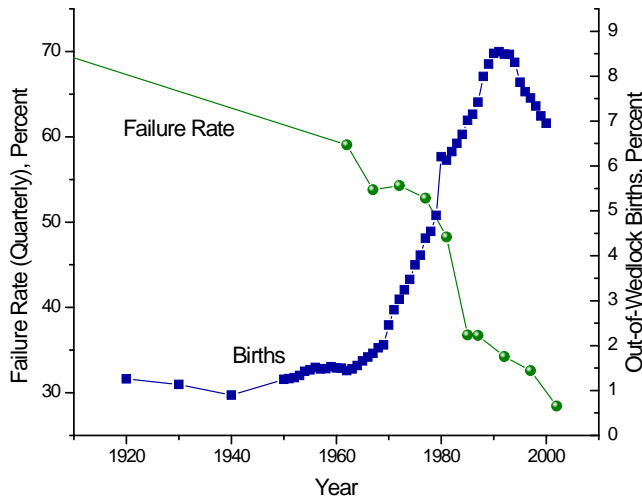
3

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

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 serious drawback. 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 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 some will not. In the following period, there will be 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 the U.S. economy. After this some transitional dynamics are computed for the situation where society faces a time path of technological progress in its contraceptive technology. The quantitative implications of the model are compared with the data, and some counterfactual experiments are conducted.

---

[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 (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 (Glaeser *et al.*, 2003) that are ignored here.

4

There is a large 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 and Mulligan (1997), who were undoubtedly influenced by the work of Coleman (1990). Becker and Mulligan focused on the manipulation of the child's rate of time preference. This idea is extended in Doepke and Zilibotti's (2005) 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 movements in relative prices. 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 (2008) 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. The emphasis here is on the role that parents play in influencing their children's sexual mores, and therefore their behavior, and on the lags between this behavior and societal acceptance.

---

[2]There is also a growing literature on evolutionary models of preferences transmission [Barkow *et al.* (1992), from 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.

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 (2007), 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 got 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. This can be inferred from Figure 3, which plots the number of out-of-wedlock births for England and Wales from 1844 to 2004 [Laslett and Oosterveen (1973) provide a complementary series for 1561 to 1960 with the same pattern]. 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 it, especially because some women might have had more than one such birth. It is interesting to note that the recent rise in out-of-wedlock births occurred at a time when the general fertility rate (GFR) was declining. The figure also illustrates that the trend in U.S. out-of-wedlock births follows a very similar pattern. 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. Beyond a nearly unbounded number of references from literature and religious authorities, some historical examples of how premarital sex was stigmatized will now be presented. In 1601, the Lancashire Quarter sessions condemned an unmarried father and mother of a child to be publicly whipped.[4] They then had to sit in the stocks still naked from the waist upwards. A placard on their heads read 'These persons are punished

---

[3]As quoted by MacFarlane (1980, p. 73).
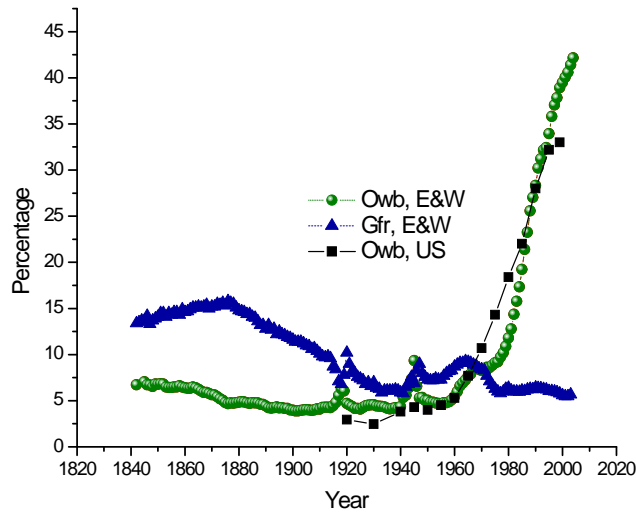[4]This case is taken from the classic book by Stone (1977, p. 637).

Figure 3: The percentage of births that are out-of-wedlock and the general fertility rate (per 100 women) for England and Wales, 1842-2004; the percentage of births that are out-of-wedlock for the US, 1920-1999

for fornication.' In early America, a New Haven court in 1648 fined a couple for having sex out of marriage.[5] 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. 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

---

[5]The discussion on premarital sex in early America derives from Godbeer (2002).

the punishment for the crime was hanging.[6]

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 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."

There are also plenty of historical examples of the relationship between the environment and promiscuity 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. Nineteenth century France, an anomaly compared with other Western European countries, provides an interesting illustration of how the environment can affect social behavior.[7] 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 women earned about half that of a man in a similar job. Her earnings barely covered her subsistence. In the 1860s, a working women 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

---

[6]See Klepp (1994, p. 74).

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

8

later is estimated at Fr300 a year). A working women 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.[8] 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." 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.

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. Furthermore, later in life, old adults realize utility from the level of consumption that their children enjoy. Children who experience out-of-wedlock births will have lower consumption levels. Since the likelihood of this situation depends on the level of socialization of the children, parents will invest resources in their socialization.

---

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

The model is constructed to capture two features. First, females and males have different attitudes towards premarital sex. In the model, more males would like to engage in premarital sex than women. This is an endogenous outcome in the framework that arises from the different cost/benefit calculation young females and males engage in. Second, out-of-wedlock births cause, through the matching process at adulthood, an externality. Women with out-of-wedlock children are less attractive partners. Since an aggregate matching constraint will hold (one man marries one woman with everyone finding a partner), an additional out-of-wedlock birth creates an extra bad partner that someone has to marry.

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. The distribution across $\mathcal{H}$ is independent across generations. 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. There will be no aggregate population growth. Births happen at the end of the youth period. 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. 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 as 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 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 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. 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 an female adult by $A^f(y', I')$, 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. A precise definition for A^f will also 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 $U(c) + \beta A^f(y', 0)$. 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 $U(c) + h + \pi \beta A^f(y', 0) + (1 - \pi)[\beta A^f(y', 1) - D(s)]$. She will pick the option that generates the highest level of expected lifetime utility. Her decision can be summarized as follows:

$$
\begin{array}{llll}
\text{ABSTINENCE} & \text{if} & \beta A^f(y', 0) \geq h + \pi \beta A^f(y', 0) + (1 - \pi)[\beta A^f(y', 1) - D(s)], \\
\text{PREMARITAL SEX} & \text{if} & \beta A^f(y', 0) < h + \pi \beta A^f(y', 0) + (1 - \pi)[\beta A^f(y', 1) - D(s)].
\end{array}
\tag{1}
$$

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

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

or

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

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

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

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, $A^m(y')$, 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

$$\text{ABSTINENCE} \quad if \quad \begin{aligned} \beta A^m(y') &\geq (1 - \sigma)\beta A^m(y') \\ &+ \sigma\{h + \pi\beta A^m(y') + (1 - \pi)[\beta A^m(y') - D(s)]\}, \end{aligned}$$

$$\text{PREMARITAL SEX} \quad if \quad \begin{aligned} \beta A^m(y') &< (1 - \sigma)\beta A^m(y') \\ &+ \sigma\{h + \pi\beta A^m(y') + (1 - \pi)[\beta A^m(y') - D(s)]\}. \end{aligned}$$

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

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

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

12

engaging in sex is $\sigma[1 - P^h(h^{m*})]$, and the probability of having an out-of-wedlock birth is

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

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, a socialization level, s_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.

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 $T(y_f, 0) = 0$, $0 \leq T(y_f, 1) \leq 1$, and $[1 - T(\tilde{y}_f, 1)]\tilde{y}_f \geq [1 - T(y_f, 1)]y_f$ if $\tilde{y}_f \geq y_f$. 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

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

An old couple also derives joy from the current living standards of their daughter's family. Let (y'_f, y'_m, I') represent the characteristics of their daughter's household. The daughter's family's living standards will then be $C^a(y'_f, y'_m, I')$, which generates $G(C^a(y'_f, y'_m, I'))$ in utility for her parents, where G is an increasing function. This level of utility will depend upon whether or not the daughter had an out–of-wedlock birth. An out-of-wedlock birth for the daughter will reduce consumption per person in her family, ceteris paribus. It may also affect the quality of the husband, y'_m, that she draws on the marriage market, through the matching function $P^f(y'_m|y'_f, I')$. This is the reason why parent's socialize their daughters. 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

13

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 $1 - \omega - s$. Therefore, $-V((1 + \iota I) s)$ can be thought of as representing the mother's utility function for leisure.

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) will read

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

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

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

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 will read

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

5.1. Positive Assortative Matching

Suppose that there is perfect assortative mating by the contribution that each party will bring to 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 matched 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 $R^l_m(y_{m,k})$ be the amount of remaining type-$y_{m,k}$ males that can be allocated at the l-th position on the list. Similarly, let $R^l_f(y_{f,j}, I)$ be the number of available type-$(y_{f,j}, I)$ females. The number of matches is given by $\min\{R^l_m(y_{m,k}), R^l_f(y_{f,j}, I)\}$. Thus, the odds of a match are $\Pr(y_{m,k}|y_{f,j}, I) = \min\{R^l_m(y_{m,k}), R^l_f(y_{f,j}, I)\}/\#(y_{f,j}, I)$. The matching process is then summarized by

Ranking	Lifetime Utility	Odds
1	$L(y_{f,n}, y_{m,n}, 0)$	$\Pr(y_{m,n}|y_{f,n}, I = 0) = 1$
$\vdots$	$\vdots$	$\vdots$
l	$L(y_{f,j}, y_{m,k}, I)$	$\Pr(y_{m,k}|y_{f,j}, I) = \frac{\min\{R^l_m(y_{m,k}), R^l_f(y_{f,j}, I)\}}{\#(y_{f,j}, I)}$
$\vdots$	$\vdots$	$\vdots$
$2n^2$	$L(y_{f,1}, y_{m,1}, 1)$	$\Pr(y_{m,1}|y_{f,1}, I = 1) = 1,$

$$\tag{8}$$

where $R^{l+1}_m(y_{m,k}) = R^l_m(y_{m,k}) - \min\{R^l_m(y_{m,k}), R^l_f(y_{f,j}, I)\}$, with $R^1_m(y_{m,k}) = \#(y_{m,k})$, and $R^{l+1}_f(y_{m,j}, I) = R^l_f(y_{f,j}) - \min\{R^l_m(y_{m,k}), R^l_f(y_{f,j}, I)\}$, with $R^1_f(y_{f,j}, I) = \#(y_{f,j}, I)$.
It is easy to see $P^f(y_m|y_f, I) = \Pr(y \le y_m|y_f, I) = \sum_{j=1}^m \Pr(y = y_j|y_f, I)$. Now, the distribution function $P^f(y_m|y_f, 0)$ will stochastically dominate the one represented by $P^f(y_m|y_f, 1)$,
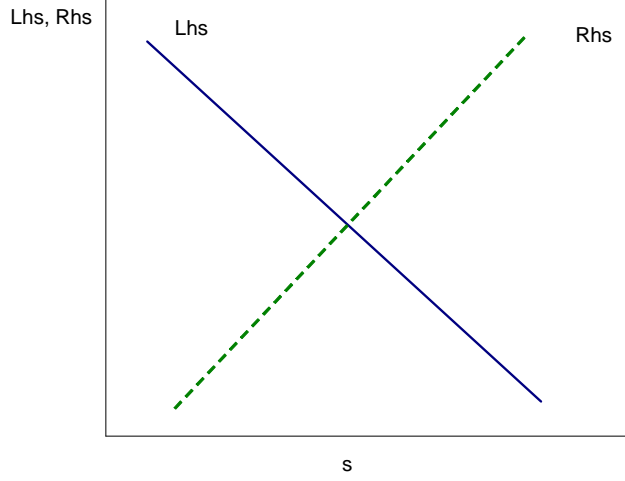
Figure 4: The determination of s

because having an out-of-wedlock birth will not increase the chances of a female drawing a male with some specified income 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 $P^f(y_m | y_f, I) = \sum_{j=1}^{m} \#(y_{m,j})$.

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

$$-\beta (1 - \pi) \Sigma_1 \left(s, y'_f \right) \left[\int G(C^a(y'_f, y'_m, 0)) dP^f \left(y'_m | y'_f, 0 \right) - \int G(C^a(y'_f, y'_m, 1)) dP^f \left(y'_m | y'_f, 1 \right) \right]$$
$$= (1 + \iota I) V_1((1 + \iota I) s). \tag{9}$$

The right-hand side of this equation is increasing in s, because V is convex.

The slope of the left-hand side of (9) will now be examined. Using (2) and (3) it is easy to see that

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

16

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). Now, from (9) it is apparent that the level of socialization for a daughter will be a function of her type, y_f', and whether there are any out-of-wedlock births in the family, so that $s = S(y_f', I)$.

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

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

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. Their presence will affect her future matching possibilities, and it could prove more costly to socialize them if her future husband distant from them. Therefore, one would expect that males will engage more in pre-martial 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. *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 $A^f(y_f, 0) - A^f(y_f, 1) > 0$, where female and male youths' productivity levels are now denoted by y_f and y_m (instead of y'_f and y'_m). The fact that $A^f(y_f, 0) - A^f(y_f, 1) > 0$ follows from the properties that: (i) $M^*(y_f, y_m, 0, y'_f) - M^*(y_f, y_m, 1, y'_f) > 0$; (ii) $\Pr(y \leq y_m | y_f, 0) \leq \Pr(y \leq y_m | y_f, 1)$; (iii) $M^*(y_f, y_m, s, 0, y'_f)$ 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 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 differential for both parents and grandparents between having and not having an out-of-wedlock birth in the family, as the lemma below makes clear.

Lemma 3. *Suppose that U and G are isoelastic functions. 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 $U(C^a(y'_f, y'_m, 0)) - U(C^a(y'_f, y'_m, 1))$ and $G(C^a(y'_f, y'_m, 0)) - G(C^a(y'_f, y'_m, 1))$ 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, $A^f(y'_f, 0) - A^f(y'_f, 1)$, 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 $A^f(y'_f, 0) - A^f(y'_f, 1)$ 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 $A^f(y'_f, 0) - A^f(y'_f, 1)$ 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. 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. *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. ∎

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 $A^f\left(y'_f, 0\right) - A^f\left(y'_f, 1\right)$ 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 my 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.

Lemma 5. *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. ∎

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 number of daughters who are promiscuous, boosting the benefit from socialization. An assumption on the elasticity of the density for P^h is required to ensure that the first effect dominates.

Assumption 6. *Suppose that $(1-\pi)^2 P_1^h((1-\pi)x)$ is decreasing in π for all $x > 0$; i.e., the elasticity of $P_1^h((1-\pi)x)$ with respect to $1-\pi$ is smaller than 2 (in absolute value).*

Lemma 7. *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

$$xe^{\ln(1-\pi)}P_1^h(xe^{\ln(1-\pi)}).$$

The second derivative is then

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

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 $(1-\pi)(1-\pi)P_1^h((1-\pi)x) = (1-\pi)^2 P_1^h((1-\pi)x)$. ∎

Lemma 8. *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 improves 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 will occur 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 number of out-of-wedlock births, b, will be 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. *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 $1 - \max P^h(h^*_f) < \eta/(1 + \eta)$] 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

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

When doing the above calculation note that $A^f(y', 0) - A^f(y', 1)$ 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

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

Now, suppose $\pi \simeq 0$. Note that if $1 - \max P^h(h_f^*) < \eta/(1+\eta)$ 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, since showing something can obtain qualitatively is not the same thing as demonstrating that it can happen quantitatively. Simulating the model requires choosing functions 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 parent's realize from having children with a living standard of living in the amount k, $G(k)$, the disgrace a daughter will suffer from an out-of-wedlock birth, $D(s)$, and the disutility that a parent incurs from socialization, $V(s(1 + \iota I))$, as follows:

$$
U(c) = \ln(c), G(k) = \phi \ln(k), D(s) = \gamma \frac{s^{1-\delta}}{1-\delta}, V(s(1 + \iota I)) = \theta \ln(t - s(1 + \iota I)),
$$

where t represents the mother's time endowment of nonmarket time.

Next, let there be three levels of productivity for females and males. For recent years these levels of productivity will be taken to correspond with three levels of educational attainment; viz, less than high school, <HS, high school and some college, HS, and college and post-college, C. This is in line with Guner, Kaygusuz, and Ventura (2008). The parameterization adopted for the stationary distribution, $\overline{P}^y$, is shown in Table I. Give the conditional distribution for

22

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

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

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 $\rho = 0.7$. Finally, the correlation between a husband's and wife's education in the U.S. is around 0.6–see Fernández, Guner and Knowles (2005). On this account, let 40% of matches be random dictating that $\mu = 0.6$.

<div align="center">

TABLE I: PROD. DIST.

	y_f	y_m	$\overline{P}^y$
$< HS$	0.5050	0.709	0.136
$\geq HS, <C$	0.738	1.014	0.595
$\geq C$	1.147	1.572	0.269

</div>

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

$$T(y_{f,i},1) = \{[\sum_{j=1}^{i} \lambda(\frac{y_{f,j}}{y_{f,3}})^\alpha (y_{f,j} - y_{f,j-1})] + \tau - \lambda(\frac{y_{f,1}}{y_{f,3}})^\alpha (y_{f,1} - y_{f,0})\}/y_{f,i}, \text{ for } i = 1, 2, 3,$$

where $y_{f,0} \equiv 0$. 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, $y_{f,i}$.

Last, the libido distribution will be taken to be characterized by (13). The annual failure rate for contraception in 2000 was 28%, so that the odds of safe sex are 72%–see Greenwood and Guner (2008). An average teenager does not engage in premarital sex all the time. On average, females have about 3 partners by age 19.[9] Furthermore, teenage relations tend to be short, about 13 months.[10] 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 $\pi = 1 - 0.28/2 = 0.86$.

---

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

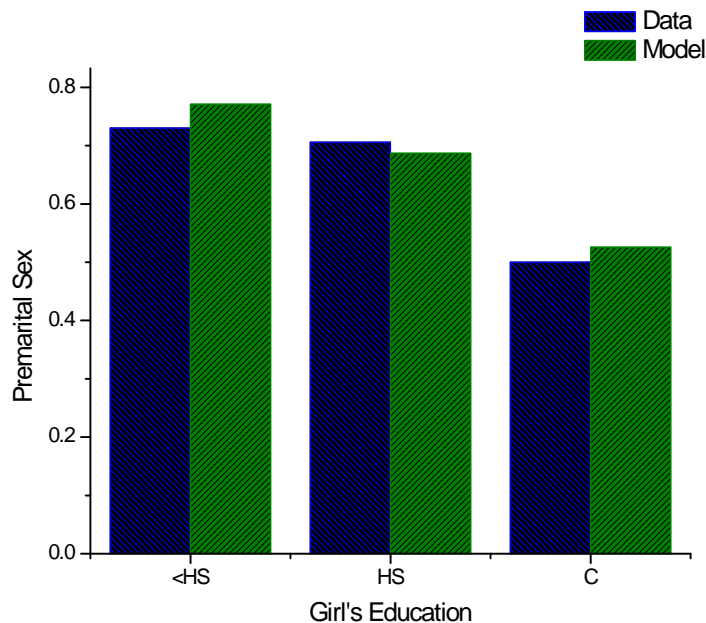[10]Sources: Ryan, Manlove, and Franzetta (2003) and Udry and Bearman (1998).

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

There are 10 parameter values to determine, $\{\beta, \phi, \gamma, \delta, \theta, \eta, \iota, \tau, \lambda, \alpha\}$. Around 2000, the median age at first premarital sex was about 17.6, while the median age at first marriage was about 25 for females.[11] Taking 0.96 as a standard value for yearly discount factor, let $\beta = 0.96^7$, reflecting the fact that there is about 7 year gap between the first premarital sex and the first marriage. These remaining parameters are picked to match two sets of targets. 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 second 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 calibrated model matches these two cross-sectional features of the data reasonably well, as can also be seen from Figures 5 and 6. 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.

---

[11] 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
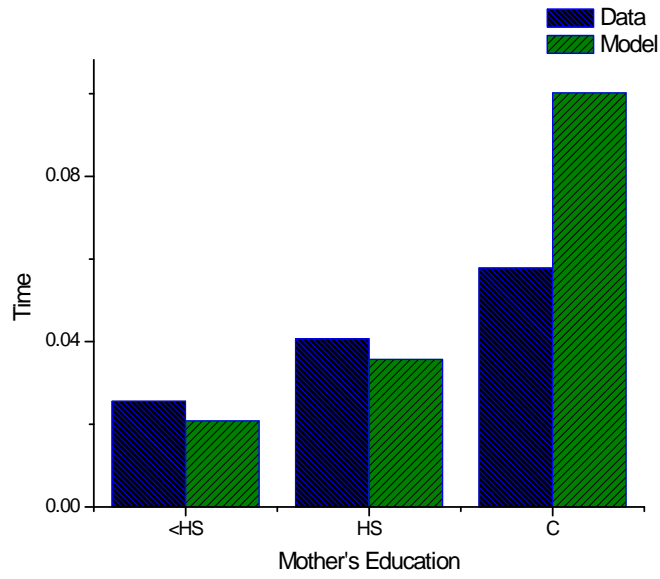
Figure 6: Cross-sectional relationship between the time spent with a daughter and the mother's educational background, data and model
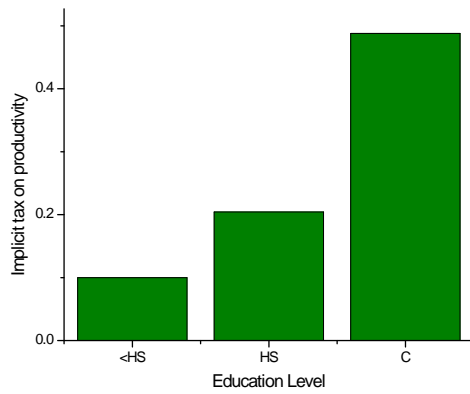

Figure 7: Implicit tax on an out-of-wedlock birth by education level, model

Parameter Value	Comment
Tastes	
$\beta = (0.96)^7$	Standard
$\delta = 0.4$, $\phi = 9$, $\gamma = 5$, $\theta = 0.17$	Calibrated
$\iota = 0.1$	Calibrated
Productivity	
y_i's–see Table I.	Guner et al (2008)
$\rho = 0.70$	Knowles (1999)
Matching	
$\mu = 0.60$	Fernández et al (2005)
Tax Schedule	
$\alpha = 2$, $\lambda = 1.5$, $\tau = 0.1$	Calibrated
Libido	
$\eta = 0.65$	Calibrated
Contraception	
$\pi_{2000} = 0.86$	Greenwood and Guner (2008)

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.

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 63%. This implies that the odds of safe sex are 1-0.63/2=68%. Let the failure rate decline smoothly over time from 31.5 to 14.0%. 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 2.8% to 65.5%. 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 the society is made up of many generations of women, each of which had a different sexual experience. Averaging across all
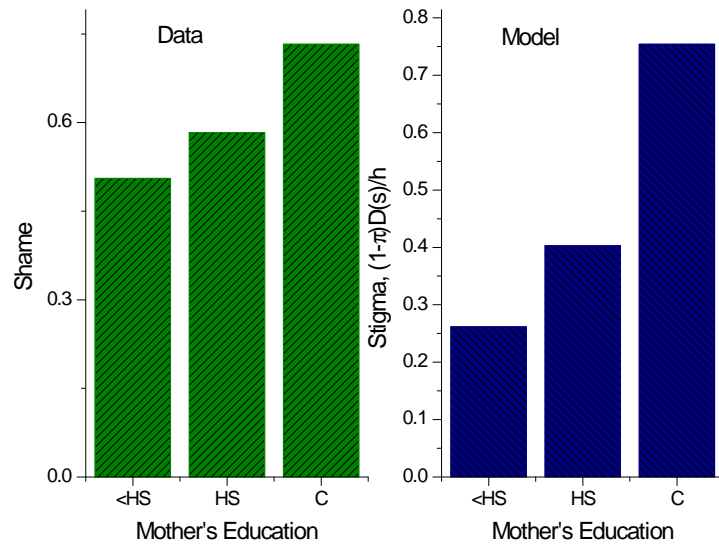
Figure 8: Left panel, Cross-sectional relationship between the daughter's shame from an out-of-wedlock birth and her mother's educational background, data; Right panel, Cross-sectional relationship between the daughter's expected stigma from engaging in premarital sex and her mother's educational background, model
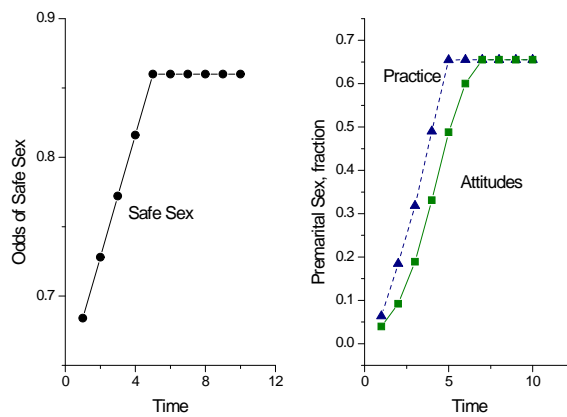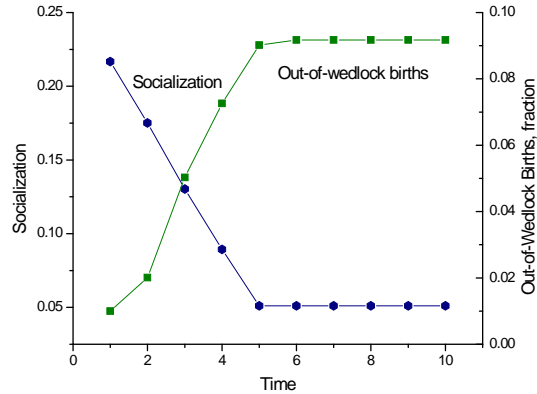

Figure 9: Sexual revolution

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

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. Additionally, as contraception becomes more effective, parents socialize their daughters less–Figure 10. Interestingly, the number of out-of-wedlock births rise.

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 86% of girls would engage in premarital sex. The vast majority of these girls would become pregnant, given the poor state of contraception. This compares with just 0.6% in the baseline model. 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 41% of girls would engage in premarital sex in the initial period (again compared with 0.6% in the baseline). Note that the transitional dynamics to the new steady state are faster than in the baseline model.
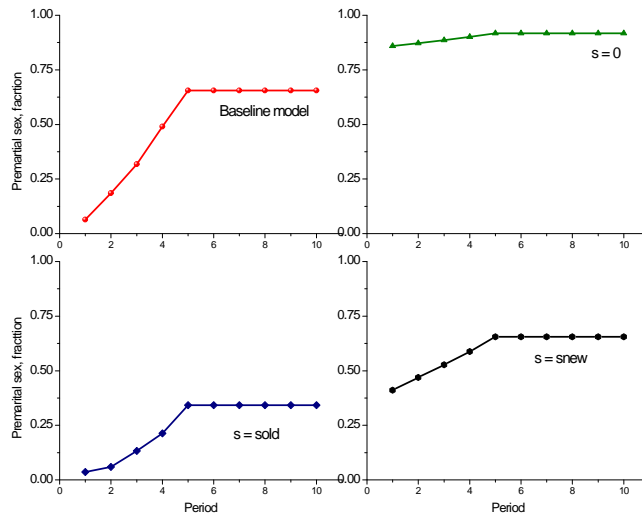
28

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

9. 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 social economic scale would have less incentive to engage in such practice. With the passage of time contraception become more efficient. 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, which would also spur promiscuity. This is an example of culture following technology 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] 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.

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

[5] 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.

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

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

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

[9] Doepke, Matthias and Zilibotti, Fabrizio. "Social Class and the Spirit of Capitalism," *Journal of the European Economic Association*, 3, 2-3 (April/May 2005): 516-524.

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

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

[12] Fernández, Raquel and Alessandra Fogli (2007). "Culture: An Empirical Investigation of Beliefs, Work and Fertility." Mimeo, University of Minnesota.

[13] Fernández, Raquel, Guner, Nezih, and Knowles, John A. "Love and Money: A Theoretical and Empirical Analysis of Household Sorting and Inequality," *Quarterly Journal of Economics*, 120, 1 (February 2005): 273-344.

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

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

[16] 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.

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

[18] Greenwood, Jeremy and Guner, Nezih, "Social Change," Economie d'Avant Garde Research Paper No. 9, 2008.

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

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

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

[22] 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.

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

[24] 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.

[25] 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.

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

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

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

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

[30] 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.

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

[32] 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.

10. Appendix

10.1. Data Sources

- *Figures 1 and 2*. See Greenwood and Guner (2008) for information about the data.

- *Figure 3*. Source, Ermisch (2006, Figure 1).

- *Figure 5*. The data on premarital sex is calculated from the 2002 National Survey of Family Growth, as the fraction of women between ages 20 and 44 who have 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*. Based on calculations using data from the 2002 National Survey of Family Growth.

- *Figure 10*. The data on pregnancies is from Greenwood and Guner (2008).

10.2. 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.

10.3. 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^f_t, L_t, F_t, and s_t from period $2, ..., T$. Represent this by $\overrightarrow{A}^f_1$, $\overrightarrow{F}_1$ and $\overrightarrow{s}_1$. For period T use the steady-state values for A^f_T, L_T, F_T and s_T. Note that F_1 is an initial condition.

2. Enter iteration j with the guess $\overrightarrow{A}^f_j$, $\overrightarrow{F}_j$, $\overrightarrow{L}_j$ and $\overrightarrow{s}_j$. Now, solve for A^f_t, P^f_t, 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^f_{t+1}. To do this, use the guesses for L_{t+1} and F_{t+1} contained in $\overrightarrow{L}^f_j$ and $\overrightarrow{F}_j$. Next, compute s_t using (9). To do this, use the guess for A^f_{t+1} contained in $\overrightarrow{A}^f_j$. This is used in the $\Sigma_{1,t}$ term. The solution for P^f_{t+1} just obtained is also used.

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

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

33

with

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

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 $\overrightarrow{A}^f_{j+1}$, $\overrightarrow{L}_{j+1}$, $\overrightarrow{F}_{j+1}$ and $\overrightarrow{s}_{j+1}$. Check the distance between $(\overrightarrow{A}^f_j, \overrightarrow{F}_j, \overrightarrow{s}_j)$. and $(\overrightarrow{A}^f_{j+1}, \overrightarrow{F}_{j+1}, \overrightarrow{s}_{j+1})$.

   1. If it is below some prescribed tolerance level, then stop.

   2. If not, then go back to Step 2.

10.4. Steady State Distribution when 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

$$b = \frac{(1 - \pi) \int \Sigma \left(S(y'_f, 0), y'_f \right) d\overline{P}^y}{1 + (1 - \pi) \int \Sigma \left(S(y'_f, 0), y'_f \right) d\overline{P}^y - (1 - \pi) \int \Sigma \left(S(y'_f, 1), y'_f \right) d\overline{P}^y}. \tag{14}$$

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

$$F(y'_f, 1) = (1 - \pi)(1 - b) \int^{y'_f} \Sigma \left(S(y_f, 0), y_f \right) d\overline{P}^y + (1 - \pi)b \int^{y'_f} \Sigma \left(S(y_f, 1), y_f \right) d\overline{P}^y, \tag{15}$$

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.

10.5. 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. 637)

- Scotland, Smout in Laslett et al (1980, p. 200, p. 202, p. 204, pp. 214-216)