Birth Control and Female Empowerment:

An Equilibrium Analysis[1]

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Abstract

It has been widely argued that innovations in birth control technology during the last decades have affected not only women's fertility choices, but generally their position in families and society. We analyze, from a theoretical perspective, the impact of these innovations on the intrahousehold allocation of resources. We consider a model of frictionless matching on the marriage market in which men, as well as women, differ in their preferences for children; moreover, women may choose to have a child of their own, whereas men must marry to enjoy fatherhood. We show that an improvement in the birth control technology generally increases the 'power', hence the welfare, of all women, including those who are not interested in the new technology. However, this 'empowerment' effect crucially relies on the availability of the new technology to single women. Should the innovation be reserved to married women (as was initially the case for the pill), the conclusion may be reversed, resulting in a 'disempowerment' effect. Various extensions are discussed.

1 Introduction

The innovations in birth control during the last four decades have had a strong impact on modern societies. The direct effect on demography, and especially on birth rates in specific social groups, has been abundantly studied.[1] An additional, indirect effect operates through the reduction in uncertainty faced by couples and single women due to the increased ability to plan demographic phenomena. This fact has dramatically altered the context in which decisions regarding human capital accumulation were made. For instance, many authors have argued that the spectacular increase in women's education and participation to the labor market since the 60s was in part the consequence of these innovations.[2]

A third, and relatively less studied consequence goes through a different channel - namely, the impact of the changes on the 'balance of power' within the couple. After all, innovations in birth control technology, including the legalization of abortion, have a potentially huge effect on men's and women's respective decision rights within the household regarding such crucial issues as the number or timing of births. It is hard to believe that a shift of such magnitude would leave the balance of powers unaltered. This claim has

[1] See for instance Levine et al. (1999), Klerman (1999), Angrist and Evans (1996) and Oltmans Ananat, Gruber and Levine (2004).

[2] See Michael (2000) and Goldin and Katz (2002).

been put forth by a number of sociologists[3], but there is little in terms of an economic analysis of this phenomenon.

Oreffice (2007) has provided an empirical study of the 'empowerment' issue based on the collective approach to household behavior. The basic idea is to check whether the legalization of abortion has affected the labor supply of married females in their fertile age. If, as is often argued, legalization actually improves the wife's bargaining situation, then she should, everything equal, receive a larger share of household resources. By a standard income effect, the reform should thus decrease her labor supply and increase her husband's. As it turns out, the predictions of the model are well confirmed by the data. A significant effect is observed on both male and female labor supply for married couples when the wife is in her fertile age, but not for older couples nor for single males, while the effect for (young) single female is small.

Although the claim that abortion legalization influenced intrahousehold bargaining has received some empirical support, the mechanism by which this empowerment occurs still deserves some scrutiny. While it is not hard to convince oneself that *some* women will gain, whether *all* will is another matter. A strong objection is that women have heterogeneous preferences

[3] See for instance Héritier (2002).

for fertility (or different attitudes toward abortion); some, in particular, do not consider abortion as an option, either for religious and ethical reasons or because they do want children. Whether the legalization will benefit these women as well is not clear. From a general perspective, the new context will affect the matching process on the market for marriage, and in particular the way the surplus generated by marriage is shared between members. In principle, such 'general equilibrium' effects could annihilate or even reverse the direct impact of the reform, particularly for these women who are unlikely to derive much direct benefit from it.

The goal of the present paper is precisely to construct an explicit model of matching on the marriage market in which these phenomena can be formally analyzed. We use a barebone setting in which any woman who wants a child is biologically able to have one, but unwanted pregnancies are possible.[4] Children (whether wanted or not) are a public good, in the general sense that they affect both parent's utility, although the father derives utility from children only if married to their mother. This impact, however, is not uniform; both male and female populations are heterogeneous in their preferences towards children, and some individuals may even dislike the presence

[4] Our simple, static framework cannot address such dynamic issues as the timing of birth. In particular, we only model the decision to have a child (or not). Depending on the context, this can be interpreted as postponing the time of birth.

of children. In addition, motherhood decreases a woman's ability to earn income, which may discourage some women from becoming mothers unless they receive an adequate compensation. Marriage is modelled as the outcome of a frictionless matching process; utilities are assumed transferable, so that the impact of the matching process on individual utilities and intrahousehold transfers can readily be assessed. Finally, households are able to commit, at least partially, on the division of resources during marriage. It follows that the socioeconomic environment at the date of marriage, which determines the agreement reached between spouses when they marry, has potentially lasting effects on intrahousehold allocation. In particular, fertility decisions and the allocation of resources within the couple are closely related issues; in our setting, they are jointly determined at the equilibrium of the matching game.

A crucial ingredient of our approach is the legal and biological asymmetry between men and women regarding children. Namely, *women do not need to be married to become a mother, while men cannot enjoy paternity without being in a couple.*[5] Therefore, those men for whom children are a

[5] The anthropological literature has abundantly emphasized that an important feature of marriage is the transfer of custodial rights on children to the father; see for instance Bohannan 1949 (who distinguishes between between uxorial and genetricial rights), Bohannan and Middleton (1968), and Grossbard (1976). Similarly, the legal definition of marriage typically emphasizes the link it establishes between the husband and the children borne by the wife (see Posner 1994). For an economic analysis, see Grossbard-Schechtman

public good are potentially willing to compensate their wife for childbearing. Whether such a compensation actually takes place at equilibrium depends on the situation on the marriage market. If 'marriageable' men (defined, in our setting, as men with a positive taste for fatherhood) are in very short supply, in the sense that *all* married women would be willing to have a child even if they were single (a situation we call 'father shortage'), then the surplus generated by marriage is entirely appropriated by the husband. In the alternative situation, some married women would not elect to have a child if single; they must therefore be compensated for childbearing, via appropriate intrahousehold transfers. But then equilibrium conditions require that *all* women receive a share of the surplus generated in their couple. Both the nature of the equilibrium and the division of the surplus are generated endogenously at equilibrium, and respond to changes in the economic, demographic and technological environment.

In this framework, we consider the introduction of a new technology that allows women (or couples) to better control fertility at no cost. Note that our general setting can be applied not only to abortion, but to any technological innovation affecting birth control. A particularly interesting

(1993) and especially Edlund and Korn, who explicitly analyze marriage as a 'contract on children in which custodial rights are transferred from the mother to the father' (2002, p. 185).

example is provided by the pill, which first became available to married women only, and later to singles as well. Our main finding is that the legalization of abortion (and generally any improvement in birth control that is freely available to *all* women) never worsens women's well being (and never increase men's). In general, all women are strictly better off after the reform (the exception being a situation of father shortage before or after the reform). Even women who do not actually use the new technology benefit from its introduction, because at equilibrium they receive a larger share of household resources; in some cases, these women are actually those who gain the most. Correspondingly, men are strict losers from the reform. These conclusions remain essentially valid when individuals' access to the technology has a cost.

Our model thus predicts that a better birth control technology leads to an empowerment of all women in the economy. However, this 'empowerment effect' relies on a market adjustment mechanism in which single women play a key role. Indeed, the reform benefits married women with children *only insofar as the new technology is available to single women as well.* Paradoxically, should the new technology be exclusively reserved to married women (as was initially the case for the pill), then for most (married) women the impact of the reform in terms of intrahousehold allocation is either nil or even negative.

Finally, our framework generates interesting comparative statics results. A proportional increase in female income (both with and without children) decreases fertility; moreover, the gain for the wife typically exceed the additional income because of the intrahousehold redistribution triggered by the change. A decline in the supply of marriageable men decreases total fertility but tends to increase out-of-wedlock births; it typically harms women's well-being. The introduction of more generous benefits targeted to single mothers also increases out-of-wedlock fertility, but the impact on female welfare is more complex, since its consequences on the qualitative patterns of the stable match (and in particular on intrahousehold allocation of the surplus generated by marriage) must be taken into account. We argue that these features are broadly compatible with the main changes that took place in the US over the last decades.

Related literature Our work is related to two lines of research. From a theoretical perspective, modeling marriage markets as matching equilibria is a standard approach, used in several contributions.[6] Related, although different, approaches rely on search models, in which initial matching is

[6] Following Becker's (1973, 1974, 1993) seminal work, one can mention, among others, Mortensen (1988), Roth and Sotomayor (1990), Iyigun and Walsh (2004), Choo and Siow (2005), and Chiappori, Iyigun and Weiss (2006).

generally random, but agents may decide to accept the current match or continue searching;[7] matching equilibria can be seen as limit cases of search models when frictions become negligible (so that repeated sampling is costless). In both frameworks, the environment at the date of marriage is a driving factor in the determination of intrahousehold allocation; as such, they both assume that some minimum level of commitment is achievable within couples.[8]

Our work is also related to the contribution of Akerlof, Yellen and Katz (1996, from now on AYK) on out-of-wedlock child bearing in the United States. The relationship between their approach and ours is discussed in more detail at the end of this paper. At this stage, we may just emphasize two crucial differences. First, while we allow for the existence of unwanted pregnancies, we assume that at least a fraction of births are the outcome of a deliberate decision made by a couple whose members derive utility from children; in AYK, on the contrary, no woman (and no man) wants children, even with marriage, and fertility is essentially an unwanted consequence of sex. Secondly, the level of welfare reached by individuals within each couple is taken as *exogenously* given in AYK, whereas it is fully *endogenous* in our

[7] Examples include Burdett and Coles (1997, 1999), Aiyagari, Greenwood and Guner (2000), Shimer and Smith (2000) and Chiappori and Weiss (2003, 2005).

[8] An alternative view is based on intrahousehold bargaining in a no-commitment context; see for instance Lundberg and Pollak (1996) for a survey.

context. Our goal is precisely to analyze how equilibrium conditions on the marriage market influence intrahousehold allocation of welfare.

Our approach is closer to that proposed by Neal (2004). In Neal's model, as in ours, marriage is modeled within a matching equilibrium framework. Neal discusses how the conjunction of specific social policies (especially single mother benefits) and the situation on the labor market (particularly the 'quality' of the pool of potential husbands) may explain the raise in out-of-wedlock childbearing among less educated minority women during the last decades. Neal's framework, however, is quite different from ours, reflecting the difference in purpose between the two approaches. In Neal's model, women have identical preferences; the only source of heterogeneity between males is in income. Our emphasis, unlike Neal's, is on intrahousehold allocation, which, in a quasi-linear world, is not affected by male (or female) income; income heterogeneity is thus irrelevant from our perspective. While Neal concentrates on income heterogeneity, differences in taste for children (and their consequences on fertility choices and intrahousehold allocations) are the driving force in our framework. These aspects are crucial to explain how birth control innovations affect marriage and fertility patterns. Finally, Neal does not discuss the impact of abortion; in his model, in particular, all married women elect to have children. Our approach can therefore be viewed as complementary to Neal's work.

The paper is organized as follows: Section 2 describes the model; Section 3 provides the equilibrium analysis and some comparative statics; Section 4 studies the effects of the technological innovation on the equilibrium outputs, presents some extensions and discusses the links with the existing literature; Section 5 concludes the paper.

2 The model

Preferences and budget constraints In the economy we consider, there exists a continuum of men and women who derive utility from one private composite good a and from children. For the sake of expositional simplicity, we only consider the choice between having children or not, although the generalization to different numbers of children is straightforward. Let the dummy variable k denote the presence ($k = 1$) or the absence ($k = 0$) of children in the household; alternatively, k can be interpreted as the additional child that men and women may have at any given moment.

Men have quasi-linear preferences over consumption and children. To sharpen our analysis, we assume that the utility of single men only depends on their consumption; i.e., men cannot derive utility from (and do not share the costs of) out-of-wedlock children, due to the fact that they do not live in the same household.[9] On the other hand, married men differ in their preferences toward children. Specifically, their utility is of the form $U_M(a_M, k) = a_M + v.k$, where a_M denotes male consumption of the private good; the individual-specific preference parameter v is distributed over some support included in the interval $[-V, V]$, according to the atomless distribution g. Note, in particular, that the utility of a married man does not depend on the identity of the person he marries, but only on the joint fertility decision and on the share of composite good he receives.[10] Some males may derive a negative utility from the presence of children; we shall assume, however, that $v > 0$ for a positive mass of males. The total number of males is $M = \int_{-V}^{V} g(t)\, dt$, and we define the cumulative function G by $G(t) = \int_{-V}^{t} g(t)\, dt$, so that $G(V) = M$.

Similarly, female utility functions take the quasi-linear form $U(a_W, k) = a_W + u.k$. Each woman is characterized by a preference parameter u, which is distributed over some support included in some interval $[-U, U]$ according to the atomless density f; let F denote the corresponding cumulative distribution function, and let the total mass of women be normalized to 1.[11]

[9] Our assumptions could be modified to allow for single men sharing some costs of and deriving some utility from children who are not living with them; the qualitative conclusions remain unchanged.

[10] Following Chiappori and Weiss (2002), one could include an additional, match-specific non-monetary benefit θ_i received by both spouses from the companionship in marriage.

[11] The support of the distribution may be strictly included within the interval $[-U, U]$.

Note, in particular, that utility is transferable in this model.

We assume that taste parameters are publicly observable; when dating a woman, a man acquires a reasonably good understanding of her attitude toward children (and conversely). Any woman (single or married) who wants a child can have one. However, should she plan not to have children, unwanted births may occur with some probability p, which depends on the technology available.[12]

Throughout the paper, the price of the private composite good is normalized to 1. Male income is denoted Y. Women initially receive an income y; however, if a woman has children, her income drops to z, with $z < y$, reflecting both the loss in her earning capacity due to childbearing and the cost of raising the child. Hence a single woman without children consumes her income y; if she decides to have a child (or if an unwanted pregnancy occurs), she also consumes her income (which has dropped to z) and receives moreover the utility u from her child.

It may be the case, for instance, that all women derive positive utility from children. In general, we do *not* make assumptions on the respective values of males' and females' preferences for children (i.e., technically, on the distributions of u and v). Our model allows for all women caring more for children than any man, or any alternative assumption.

[12]Introducing uncertainty about the ability of having children would not change our qualitative results. Indeed, women in general do not know whether they are biologically able to have children until they try to have one; hence, there would be no hidden information or selection into marriage in this respect, and in our risk neutral world all payoffs can always be interpreted as expected values. Also, our results are robust to the introduction of different unwanted birth probabilities between married and single women.

In our framework, the couple's decision to have a child or not will depend on both spouses' preferences. Therefore the spouses must agree on two issues. One is the fertility decision; i.e., they must decide whether to have kids or not, a decision driven by their respective preferences towards children. The other decision relates to the distribution of resources within the household (i.e., the allocation of total income between male and female consumption of the composite good).[13] Both decision will be ultimately determined by the equilibrium on the market for marriage.

As indicated above, our main focus is the impact of innovations in the birth control technology. We model the legalization of abortion (and generally the availability of some birth control technology) as an exogenous decrease in the probability p of experiencing an unwanted pregnancy.[14]

Marriage market We assume that the marriage market is frictionless; i.e., we model marriage as a matching process, for which we will characterize the 'stable' matches, defined by the property that no married person would rather be single and there cannot be a man and a woman who would

[13] Note that should the couple decide not to have children, each member's consumption may also be state-contingent, i.e. depend on whether a child is (unvoluntarily) born or not. In our world, individuals are risk-neutral, and the payoffs can always be interpreted as expected values.

[14] In particular, we disregard here the other benefits derived from the improved birth control technology (e.g., increased ability to plan and control human capital accumulation, or easier access to sexual activity before marriage).

both prefer being married together than their current situation. In particular, any individual gets married as long as the utility (s)he can get from marriage is larger than or equal to the utility (s)he gets from remaining unmarried. Note that our analysis is consistent with a collective model of household behavior in which spouses interact and take Pareto-efficient decisions, possibly transferring resources to each other. From this perspective, a contribution of this paper, following several others[15], is to endogeneize the 'sharing rule' that characterizes intrahousehold allocation.

3 Equilibrium on the marriage market

We now characterize the main features of the equilibrium (or stable assignment) reached on the marriage market.

3.1 Fertility and marriage decisions

Fertility We first consider fertility decisions, starting with single individuals. Single men consume their income, and get a utility equal to Y. Single women, on the other hand, will decide to have children if and only if the benefit compensates the income loss, i.e. if $u \geq y - z$, leading to a util-

[15] See for instance Browning, Chiappori and Weiss (2005), Iyigun and Walsh (2004), and Chiappori, Iyigun and Weiss (2005).

ity equal to $z + u$. In the alternative case when $u < y - z$, single women of type u choose not to have a child; any pregnancy will be involuntary and occur with probability p. Their expected utility will thus be equal to $(1 - p)\, y + p\,(z + u)$. In what follows, the threshold $y - z$ is denoted $\bar{u}$. We call women whose parameter is larger than or equal to $\bar{u}$ '*unconditional mothers*', since they want a child irrespective of their marital status. Other women, however, will choose to have a child only if they are married and their husband is willing to bear some of the costs; these women, whom we call '*conditional mothers*', are characterized by $u < \bar{u}$. We assume in what follows that $0 < F(\bar{u}) < 1$ - i.e., there exists both conditional and unconditional mothers in the population.

Regarding couples, note, first, that in a transferable utility context the stable match must maximize total surplus. The total benefit to a couple of having a child is $v + u$, whereas the cost is $\bar{u} = y - z$. It follows that a married couple will plan to have a child if $u + v \geq \bar{u}$, and will decide not to have children otherwise (although unwanted pregnancies are always possible).

The *surplus* generated by marriage can therefore be expressed as the difference between this marital utility and the spouses' welfare if single:

$$S(u,v) = \max((1-p)y + p(z+u+v), z+v+u) - \max(y(1-p) + p(z+u), z+u) \tag{1}$$

In particular, when $u+v < \bar{u}$ and $u < \bar{u}$, neither the couple nor the wife as single want a child, and $S(u,v) = pv$. If $u+v \geq \bar{u}$ while $u < \bar{u}$, the couple has a child while the wife as single would not, and $S(u,v) = v - (1-p)(\bar{u} - u)$. Finally if $u \geq \bar{u}$, both the couple and the wife, as single, would want a child, and $S(u,v) = v$.[16]

Marriage Marriage cannot take place unless the surplus generated is non negative. A first property is that the sign of the surplus depends only on the man's taste parameter; specifically, $S(u,v) \geq 0$ if and only if $v \geq 0$, as can readily be seen from equation (1). This reflects the fundamental difference between men and women in our model (and, arguably, to a large extent in real life), namely that, as stated earlier, *women do not need to be married to become a mother, while men cannot enjoy paternity without being in a couple*. Therefore, for any man who valuates children positively, marriage is Pareto improving, because a birth (wanted or not) would increase his utility

[16] We do not consider the case $u+v < \bar{u}$ while $u \geq \bar{u}$. Indeed, this requires $v < 0$; but then $S(u,v) < 0$ and marriage does not take place (see below).

by v at no cost for the wife; he would actually be willing to pay for this opportunity of accessing paternity. On the contrary, men who dislike children ($v < 0$) will tend, everything equal, to remain single (although they may sometimes be bribed into marriage), because singlehood is a simple way of guaranteeing the absence of a child. Women, on the other hand, cannot lose from marriage, even if they dislike children: in our model, the probability of unwanted pregnancies is the same for married and single women. They are at worst indifferent; moreover, they may in some cases strictly gain from marriage, because of the compensation they may receive from their husband. Therefore, any woman is a potential wife, while not all men are potential husbands.

This basic difference has crucial consequences for the marriage market. Indeed, the supply of potential wives is equal to the total female population, irrespective of the distribution of the taste parameter. On the contrary, in most cases only male with a positive preference for children will consider getting married.[17] This creates a systematic asymmetry on the marriage market, whereby women tend to be in excess supply even when population sizes are similar.

[17] Note, however, that in some cases men with a 'low enough' distaste for children can choose to marry because they are compensated by the wife. This situation is discussed in Subsection 4.2.

3.2 Stable matches

Characterization In our transferable utility world, a match is stable if and only if it maximizes total surplus; therefore the existence of a stable match is guaranteed by standard results (see for instance Chiappori and al 2007). Moreover, a crucial property of the surplus function is the following:

Proposition 1 *The surplus function is supermodular: if $u' > u, v' > v$, then*

$$S\left(u', v'\right) + S\left(u, v\right) \geq S\left(u, v'\right) + S\left(u', v\right) \tag{2}$$

Proof. *See Appendix* ■

A well known consequence is:

Corollary 2 *There exists a stable match which is* assortative *on taste for children.*

Since the surplus function is not strictly supermodular (i.e., one can find $u' > u, v' > v$ such that (2) is satisfied as an equality), the stable match is not unique in general. Indeed, if a stable match is such that u marries v, u' marries v' and $S(u', v') + S(u, v) = S(u, v') + S(u', v)$, then switching the couples to (u, v') and (u', v) maintains stability.

Our main interest is in how the spouses share the surplus generated by marriage, and how this allocation is affected by an exogenous change in birth prevention technology. As always with matching models, the qualitative properties of the stable match and of the resulting allocation of surplus crucially depends on which side is in excess supply, although the notion of 'excess supply' has a specific meaning in our context: as discussed above, one should compare the total female population with the mass of men with a positive preference for children. Formally, the marriage market is characterized by an excess supply of women if:

$$\int_0^V g(t)\,dt = M - G(0) < 1$$

As argued before, if the male and female populations are of similar sizes, and if a non negligible fraction of the male population dislike children, women will be in excess supply, a case we consider as the benchmark situation in our analysis.

We may further characterize the stable matches in this benchmark case. First, in any stable match, all men with a positive taste for children v are married, and all men with a negative v are single. Also, we may define u_M

by:

$$\int_{u_M}^{U} f(s)\,ds = M - G(0) = \int_{0}^{V} g(t)\,dt$$

In words, u_M is such that the number of women with a taste parameter larger than u_M is equal to the number of men with a positive taste for children.

Then two cases can be distinguished.

Proposition 3 ('Traditional fertility') *Assume that $u_M < \bar{u} = y - z$. Then:*

1. *There exists a Strictly Assortative Stable Match (SASM) such that (i) a woman with taste u is married (necessarily with a man with a non negative taste parameter) if and only if $u \geq u_M$, (ii) if (u, v) and (u', v') are two married couples and $u' \geq u$ then $v' \geq v$ (strictly assortative matching), (iii) there exists a* pivotal married couple (u_P, v_P), *with $u_P > u_M$ and $u_P + v_P = \bar{u}$, such that a married couple (u, v) elects to have a child if and only if $u \geq u_P$.*

2. *For any stable match, no single woman wants children, and some married couples do not want children. Moreover, if a couple (u, v) is married and elects to have children in the SASM, then for* any *stable match both u and v are married (although not necessarily together) and have*

children.

Proof. *See Appendix* ■

In words, the condition $u_M < \bar{u} = y - z$ implies that the 'last married' wife u_M is a conditional mother, who would not elect to have children unless compensated by her husband. In the SASM, only women above the threshold u_M get married. Moreover, u_M women marry men unwilling to compensate them for having a child, and these couples do not want children. The pivotal couple (u_P, v_P) is indifferent to the presence of a child; any couple whose taste for children is higher than the pivotal chooses to have a child. Finally, single women are conditional mothers, therefore they elect not to have a child; out-of-wedlock fertility is exclusively involuntary. The picture is therefore one of *traditional fertility*, in which no single woman (and not all couples) are voluntarily fecund.

The SASM is not the only stable match, because S is not always strictly supermodular. Specifically, take two couples (u, v) and (u', v') such that $u' > u, v' > v$. If both couples want children (i.e., $u+v \geq \bar{u}$), then $S(u', v') + S(u, v) = S(u, v') + S(u', v)$, and there exists a stable match in which u marries v' and v marries u'. The same holds true if $u' + v' < \bar{u}$ (that is, both couples decide not to have children). Therefore, among couples who decide to have children, the identity of the spouses is indeterminate, and the same is true among couples who do not want children. Moreover, women who marry but do not want children are indifferent with remaining single; therefore the set of married women also varies across stable matches. However, the set of women who want children once married is constant across stable matches.

The alternative situation is described in the next result:

Proposition 4 ('Father shortage') *Assume, conversely, that $u_M > \bar{u}$. Then for any stable match, all married couples want a child; moreover, some single women also decide to have a child. Also, there exists a Strictly Assortative Stable Match such that (i) women with a taste parameter equal to u_M marry men with a taste parameter equal to 0, (ii) all women with a taste parameter larger than u_M are married with men with a taste parameter larger than 0, and (iii) all women with a taste parameter smaller than u_M are single.*

Proof. *See Appendix* ■

In this alternative, '*father shortage*' situation, the number of men willing to marry and have a child is so small that the last married woman is an unconditional mother, who wants a child even without any compensation from her husband. Then all married couples want children. Moreover, some unconditional mothers remain single, and choose to have a child as well, resulting in *voluntary* out-of-wetlock births. Again, the identity of the married women is not determined at equilibrium, because all unconditional mothers are equivalent from a male's perspective.

Finally, it is crucial to note that *the utility level of any individual is the same in all stable matches.* Since our main interest is in assessing changes in individual welfare, we can, without loss of generality, concentrate on one particular stable match for our analysis. It is natural to choose the SASM, which we do throughout the paper. For any married couple (u, v), the mass of men with a taste parameter $v' > v$ is then equal to the mass of women with a taste parameter $u' > u$:

$$1 - F(u) = M - G(v)$$

It follows that the mapping ψ which associates to any married man v the taste parameter u of his spouse is given by $u = \psi(v) = F^{-1}(1 - M + G(v))$. Equivalently, we can define $\phi = \psi^{-1}$ by $v = \phi(u) = G^{-1}(M - 1 + F(u))$. Both ϕ and ψ are increasing. In particular, for any stable match, the total surplus generated by children, $u + v$, is increasing in u.

Surplus distribution In our continuous framework, the allocation of surplus between household members is exactly pinned down by the stability condition: competition on the marriage market imposes a specific distribution of welfare between spouses. This allocation is described in the following Proposition. Not surprisingly, the two cases described in propositions 3 and 4 lead to qualitatively different allocations:

Proposition 5 *1. In the 'father shortage' situation* $u_M > \bar{u}$*, all the surplus is received by the husband; each married woman has the same utility as when single.*

2. In the alternative, 'traditional fertility' situation $u_M \leq \bar{u}$*: in sub-pivotal couples* ($u + v < \bar{u}$)*, who do not want children, all the surplus* $S = pv$ *goes to the husband, and the wife is indifferent between marrying and remaining single; in super-pivotal couples* ($u + v \geq \bar{u}$)*, who have children, the husband receives* $S_M = v - (1-p)(\bar{u} - u_P)$*, and the wife receives* $S_W = (1-p)(\min(u, \bar{u}) - u_P)$*.*

Proof. *See Appendix* ■

The intuition for these results is clear. Consider father shortage. The last married woman is an unconditional mother, who needs (and receives) no compensation for deciding to have a child. Competition between women requires that all husbands be in the same situation, namely having a child at no cost, thus pocketing all the surplus generated by fertility.

The alternative, 'traditional fertility' case is slightly more complex. Consider first the 'pivotal' couples, for which $u + v = \bar{u}$. Pivotal women need to be compensated to have a child; specifically, the compensation, in that case, equals both the minimum the wife would require and the maximum the husband is willing to pay to have a child. Couples with preferences for children smaller than pivotal choose not to have a child; the wife is not compensated, and the husband enjoys the benefits of involuntary births for free. In super-pivotal couples, on the other hand, the wife's compensation is pinned down by competition, giving the patterns described. In practice, *all super-pivotal husbands transfer a fixed amount to their wife*, equal to the compensation required by the pivotal woman, namely $(1-p)(\bar{u} - u_P)$.

Each spouse's total utility follows. The 'father shortage' case is straightforward: each husband consumes his income Y and receives the benefit v derived from the child, while the wife's utility is as if she was single. In the alternative case, in sub-pivotal couples ($u + v < \bar{u}$), who do not want children, the husband's utility is $Y + pv$, and the wife receives her utility as single, namely $y(1-p) + p(z+u)$; in super-pivotal couples ($u + v \geq \bar{u}$), who all have children, the husband's utility is $Y + v - (1-p)(\bar{u} - u_P)$, and the wife's is $U_W = z + u + (1-p)(\bar{u} - u_P)$.[18]

[18] If men with a positive utility from children outnumber the female population, then all women are married and stability requires that each married man be indifferent with

3.3 Comparative statics

Simple as it may be, our model still offers interesting insights on the role of several key parameters. We simply describe the main conclusions; the reader is referred to Chiappori and Oreffice (2006) for a detailed discussion, including the proofs.

Incomes Consider, first, the impact of income changes on fertility and allocations. In our quasi linear world, changes in male income has little impact beyond increasing men's utility. On the other hand, female utility always increases with both y (her income without a child) and z (her income with a child). Assume, now, that y and z are inflated by the same *factor*, so that the difference $\bar{u} = y - z$ increases proportionally; one may think of a general increase in female income. Then the 'pivotal' parameter u_P is increased, although by a smaller amount.[19] The number of super-pivotal couples is thus reduced. Within such couples, the transfer received by the wife is increased; intuitively, the compensation has to be raised because of the larger opportunity cost incurred when having a child; the precise amount depends on the distribution of taste parameters in the population. We conclude that (i)

remaining single. Therefore, the utility men derive from having children is captured by women under the form of additional consumption

[19]Indeed, $0 < \frac{\partial u_P}{\partial \bar{u}} = \frac{1}{1+\phi'(u_P)} < 1$.

total fertility is reduced, (ii) in non fertile couples, the wife's utility grows by exactly her gain in income, and (iii) in voluntarily fertile couples, her gain is larger than the additional income, since the compensation paid by the husband increases as well; the raise in income is thus *compounded* by intrahousehold effects.

Single parent benefits So far, we have assumed that the income of a woman with a child is z whatever her marital status. We now allow for single parent benefits, say b, and assume for simplicity that all single women are eligible. The income of a woman with a child is thus still z when she is married, but becomes $b+z$ when single. This fact has various consequences. First, out of wedlock fertility generally increases; indeed, the parameter threshold for single motherhood drops to $\bar{u}-b$. Fertility decisions within marriage are not affected. Secondly, marriage is discouraged; specifically, the pool of potential husband is decreased because men will not marry unless their taste parameter v is at least b (so that, from a collective viewpoint, the gain in husband's welfare more than compensates the loss in income resulting from marriage). Therefore, the 'father shortage' situation is more likely to occur than before. Then married women are exactly compensated for their income loss - i.e., they receive a transfer equal to b, and the husband's surplus is $v - b$. Finally, in the alternative, 'traditional fertility' case, sub-pivotal women receive a transfer equal to pb, compensating them for the expected loss in income. Super-pivotal women have a child and receive a transfer equal to $(1 - p)(\bar{u} - u_P) + pb$.

In summary, the introduction of single parent benefits will in general profit all married women. There is however an exception to this statement. If the resulting equilibrium switches from traditional fertility to father shortage, the increase in married women's reservation utility due to single parent benefits is partly or totally offset by the loss of the surplus they previously received. Then the impact on female welfare is ambiguous and depends on the particular distributions.

Smaller male population Let us now study the impact of a reduction in the number of males with a positive taste for children. Assume that the distribution G is replaced with some G' such that $G'(U) - G'(t) \leq G(U) - G(t)$ for all t. The mapping ϕ is then replaced with some ϕ' such that $\phi'(u) < \phi(u)$ for all u; i.e., each woman is matched with a man with lower taste for children. The marriage threshold u_M is increased; in particular, a situation of father shortage is more likely to occur. If the equilibrium switches from traditional fertility to father shortage, total fertility decreases, but (voluntary and involuntary) out-of wedlock fertility increases significantly (some single women now want children); all married women suffer since their share of the surplus is reduced to zero, while married men all gain. If, on the contrary, the equilibrium remains within the 'traditional fertility' class, women's share of surplus is still reduced. Namely, the new pivotal couple $(u'_P, v'_P = \phi(u'_P))$ is such that $u'_P > u_P$ and $v'_P < v_P$; the number of sub-pivotal women, who receive no surplus, is increased. Within super-pivotal couples, the transfer to the wife is reduced to $(1-p)(\bar{u} - u'_P)$. Total fertility decreases (less couples want to have children), but (involuntary) out-of-wedlock fertility increases.

In practice, these predictions seem to fit fairly well the main stylized facts characterizing the marriage market in the US. The raise in female income over the last decades has coincided with a reduction in fertility. Moreover, the idea of an amplification of these gains through intrahousehold transfers may explain the stronger demand for college education among women, as argued by Chiappori, Iyigun and Weiss (2006). Also, an overwhelming phenomenon that took place during the last decades is the dramatic raise of incarceration rates for young, low-skilled black males.[20] If we accept that

[20] According to Western and Pettit (2000), the percentage of young, high-school dropouts black males in prison or jail reached 36% in 1996, up from 15% in 1982; as a comparison, the rate for young, high-school dropouts *white* males went only from 4% to 7% over the same period. Similar effects can be observed on employment data. Among black high-

the marriage market is largely assortative by race and education, the 'sub-market' of black, low-skilled individuals has experienced a dramatic decline in male supply. According to our analysis, such a brutal change should induce a drop in marriage but a sharp rise in non marital fertility. Indeed, while the overall fertility rate of black, high-school dropout women aged 25 to 29 has slightly declined over the period (from 102.5 per mil in 1980 to 99.5 per mil in 2000[21]), the fraction of women never married with children has raised from 3% in 1960 to 35% in 1990, as compared to 6% for both white high-school dropouts and black women with college education in the same age range.[22] Our results, on this point, are in line with earlier intuitions proposed by Neal (2004). Also, an implication of our model is that the welfare of unskilled black women may have significantly *decreased* over the period.

school dropouts aged 26-36, the percentage of individuals who worked at least 26 weeks during the poll year dropped from 80% in 1960 to 44% in 1990. For high school graduates, the drop is from 86% to 67% (Neal, 2004, table 2). See also Wilson (1987).

[21] Computation made by the authors using National Vital Statistics Report, 50-5, 2002, Table 4, p.30; Monthly Vital Statistics Report, 31-8, 1982, Table 19, p. 30; National Vital Statistics Report, 50-5, 2002, Table 21, p. 51; "Educational Attainment, US Census Bureau, Historical Tables, Table A-2, p. A-4.

[22] The effect may initially have been further boosted by the increased generosity of single parent benefits over the 60s and the early 70s. Note, however, that this latter trend has been largely reverted since then (Moffit 1992), while the increase in birth outside marriage has persisted, suggesting that the marriage market factor may have been dominant.

4 Changes in the birth control technology

We now come to the main implications of our model, namely the impact of a technological change in birth control.

4.1 Legalizing abortion

We first consider the impact of innovations in birth control technology that reduce the probability of unwanted pregnancies, assuming that all women (including single) are given free access to the technology; a natural example could be the legalization of abortion that took place in the 70s. In our model, we consider the impact of a reduction in the probability of unwanted pregnancies from p to some $p' < p$.

The model generates the following conclusions:

- Not surprisingly, single women who do not want a child benefit from the technology, precisely because unwanted pregnancies become less likely. The gain for a single woman of taste $u < \bar{u}$ is thus $(p - p')(\bar{u} - u)$.
- Regarding married women, the outcome depends on the type of equilibria. In the extreme case of father shortage, the distribution of the surplus generated by marriage remains unbalanced in favor of the husband; each wife receives her utility as single. Since married women are

all unconditional mothers that would not use the birth control technology, the legalization of abortion has no impact on married couples.

- The alternative, traditional fertility case is much more interesting. Consider, first, subpivotal couples. Because better birth control is now available, the total surplus generated by marriage is reduced. The wife still receives her utility as single, which has however been increased by $(p - p') \bar{u}$ by the new technology. Meanwhile, the father's expected utility is reduced by the same amount, since the windfall gain from unwanted pregnancies has become less likely. We conclude that subpivotal couples experience a decline in fertility; moreover, the wife gains, and the husband loses, from the new technology.

- Consider, now, superpivotal couples. Their fertility decision is not affected by the new technology; these couples want children and will not resort to abortion. This, however, does not mean that the reform has no impact on these couples, because the intrahousehold allocation of the surplus is significantly altered. Husband-to-wife transfers increase by $(p - p') (\bar{u} - u_P)$; since behavior is unaffected, her utility is boosted (and his declines) by the same amount.

The intuition for the last result is that the intrahousehold distribution of resources is driven by the marginal woman. Except for the extreme case of father shortage, she is indifferent between getting married and remaining single *without (wanted) children*. Her reservation utility is thus improved by the new technology. The nature of a matching game implies that any improvement of the marginal agent's situation must be transmitted to all agents above the marginal one. All in all, the new technology reduces fertility of some couples (then the wife grabs all the benefits); moreover, in those couples whose fertility does not change (and who do not use the new technology), the reform results in a net transfer from the husband to the wife. In particular, it is the case that *all men lose* from the new technology.

We thus conclude that in our model an improvement in the birth control technology, such as the legalization of abortion, generally increases the welfare of *all* women, including those who want a child and are not interested in the new technology. Note, however, that the mechanism generating this gain is largely indirect. The reason why even married women willing to have a child benefit from the birth control technology is that the latter, by raising the reservation utility of single women, raises the 'price' of all women on the matching market. Moreover, this logic fails to apply in situations of severe shortage of marriageable men. As argued above, empirical evidence suggests that specific submarkets (e.g., low skill minority women) may exhibit the typical features of a father shortage. Our analysis suggests that married women belonging to such social groups may have derived little benefits from the legalization of abortion.

4.2 The power shift of the pill

The previous argument shows clearly that an important channel through which the new technology benefits all women - what could be called 'female empowerment' - is the raise in their reservation utility. In turn, the source of this change lies in the fact that single women can access the new technology. Consider, now, a situation in which a new technology of this type is introduced but exclusively available to married women. A typical illustration is provided by the pill, which became available first (in 1960) to married women only, and later (by the end of the 1960s) to single women as well (Goldin and Katz 2002).

We therefore consider a situation in which only married women can access a technology that reduces the probability of unwanted pregnancies from p to some $p' < p$. The analysis is qualitatively different from the previous case. We do not provide here an exhaustive characterization; the reader is referred to Chiappori and Oreffice (2007) for precise statements and proofs. Let us simply indicate the main qualitative patterns of the stable match in this context. First, the surplus function is still (weakly) supermodular. As a consequence, matching is still positive assortative: *among married couples*, women with a larger taste for children marry men with a larger taste for children. Secondly, the set of potential husbands is increased. Indeed, the surplus $S(u,v)$ can now be positive for negative taste parameters v, provided that the wife's parameter u is below $\bar{u}$. The intuition is that women who do not care for children are now willing to 'purchase' the technology through marriage, and are willing to pay the husband for the reduction in unwanted pregnancies. This compensation attracts new possible mates. Finally, the set of married women qualitatively differs from the previous case; it now consists (in general) of two disjoints intervals. As before, women with a high preference for children marry and have kids. At the other end of the spectrum, women with a minimum taste (or maximum distaste) for children also marry, precisely because they want access to the technology. In between is an interval of women with 'intermediate' taste parameters; they are the ones who remain single. Without the innovation, some of them would have married and had children: the innovation thus reduces both wanted and unwanted fertility.

In terms of welfare, women who do not want children and marry to access the new technology gain from the innovation, although part of the gain is repaid to their husband. Some women are single with or without the new technology, and are therefore indifferent. All other women strictly lose from the innovation. Some are now single, while they used to be married and receive a fraction of the surplus generated by marriage. Others would marry irrespective of the innovation; however, their share of the surplus is decreased by the innovation. In particular, one can show that the benefits of a larger pool of potential husbands cannot offset the loss due to the increased competition from low taste women that generates it. Finally, *all men benefit from the innovation.*

In other words, making the new technology available to married women *only* has the major, and somewhat counter intuitive consequence of *reversing* the empowerment effect, for two reasons. First, the previous conclusions that all women benefit from the new technology rely on a crucial insight of matching models - namely, that the welfare of the marginal ('last single') woman drives the equilibrium allocation. If the new technology is exclusively reserved to married women, this effect disappears, and with it the redistribution generated by the innovation. In addition, the availability for marriage of women with a low taste for children, who are willing to compensate their husband for getting married and gaining access to the new technology, toughens competition for husbands. Therefore, women with a higher taste for children lose from the introduction of the new technology. Only women with a very low taste parameter gain from the innovation.

The discussion above emphasizes the complex and partly paradoxical welfare impact of a new technology. On the one hand, its effects can go well beyond the individuals who actually use it, or even consider using it. Our model suggests that a major effect of legalizing abortion may have been a shift in the intrahousehold balance of powers and in the resulting allocation of resources, even (and perhaps especially) in couples who were not considering abortion as an option. On the other hand, the new technology benefits all married women only because it is available to singles. A technological improvement which is reserved to married women will have an impact on their fertility, partly because it changes the mechanisms governing selection into marriage. But its impact on women's welfare is either nil or negative, except for a small fraction of women who choose marriage as an access to the new technology.

Obviously, this analysis is only partial, in that it omits other benefits of the pill (such as women's increased ability to plan their fertility and to achieve higher levels of education). These aspects, which have been intensively discussed in the literature, clearly favored all women, including married one. Still, the strong message of this analysis is that reserving the technology to married women makes an important difference, and, more surprisingly, that most married women are likely to *lose* from this exclusivity. Our analysis thus suggests that as far as the intrahousehold balance of power is concerned, the introduction of the pill in 1960 (when it was available to married women only) may have had a *disempowerment* effect on most women. The true empowerment revolution came later; it was caused by the generalization of its availability for single women during the late 60s, and strengthened by the legalization of abortion in the 70s. In particular, the true empowerment effect of Roe vs. Wade may have come less from the innovation itself than from its availability to all women, including singles.

4.3 Some extensions

We briefly discuss possible extensions of our results.

Costly access to the new technology As a first extension, consider the case in which the new technology, while available to all women, is 'costly'. The cost, here, should be understood in a general way; it includes financial costs, but also the moral or ethical discomfort some women may experience with the new technology. We assume for the moment that the cost is identical for all women. Since, however, preferences for children differ, a uniform cost generates different responses over the population. Specifically, single women will use the technology only if the net cost of the child (i.e. the income loss minus the benefit u) is large enough to compensate for the abortion cost. Therefore, some single women who do not want children will nevertheless decline to use the new technology; only those with a small enough preference for children will. Similarly, among subpivotal couples, some (and possibly all) will be unwilling to pay the cost. The resulting equilibrium is therefore in-between the initial, pre-legalization benchmark and the free technology case. In particular, in terms of welfare, all women are weakly better off than before the technology became available, although some of them may actually be indifferent; but all women are either indifferent or worse off than if the technology was available at zero cost

A clear policy implication is that *any legislative change that increases the cost of the technology reduces in general welfare of all women, including those who would not use (or even consider using) the technology.* For instance, in the first few years after the national legalization in 1973, abortion was eligible for Medicaid public funding; this provision was ruled out in 1976 by the Hyde Amendment that generated many similar provisions at the state level. According to our analysis, these fluctuations in public funding[23] not only modify women's actual use of abortion, but affect the gains generated

[23] Other examples include the provisions of mandatory counseling and of parental consent for abortion on minors.

by the legalization *for all women* - including those who are willing to bear the costs and those who are not interested in abortion in any case.

Heterogenous costs In practice, different women face different costs. The psychological distress clearly varies between women; and even though the financial cost is more uniform, its relative impact on individual consumption and welfare is as heterogenous as individual incomes, a feature that our simplified model does not consider. To capture the idea of heterogenous costs, one can make the simple assumption that some women pay the full cost c discussed above, while for others the cost is nil. Also, we assume that the distribution of this cost among women is not correlated with marital status.[24] To further sharpen the discussion, consider the extreme case of an infinite cost. Hence, among women with identical preferences some are willing to adopt the new technology while the others do not (or cannot); and the respective proportion of the two classes is independent of the taste parameter u.

In this new context, women who do not accept the new technology are in a weaker position on the market, because their reservation utility as single is lower. A first consequence is that these women are, everything equal, more

[24] Under the opposite extreme assumption where abortion is costly for single women only, we are back to the case, studied above, of a technology exclusively available to married women.

likely to marry. Regarding the equilibrium structure, different cases should be considered. In a 'father shortage' situation, first, nothing is changed, since the marginal married woman wants children anyway. In the alternative, 'balanced fertility' case, things are more complex. Clearly, women who would not use the technology are more attractive to men who value children, because of the possibility of involuntary pregnancies. This fact may have different consequences depending on the parameters. For instance, there may exist two marginal married women, one who accepts the technology while the other does not; the taste parameter is larger for the former. Alternatively, it may be the case that all women who reject the technology are married, while some abortion-prone women remain single. From a welfare point of view, it should however be noted that no woman can possibly lose from the introduction of the new technology, even when some (possibly many) women reject its use. It is in general the case that all women gain from the introduction, including those who reject it (the exception being the 'father shortage' case). Conversely, if one takes as a benchmark the situation in which all women can access the technology, the introduction of costs that preclude its use by some women harms all women in general.

4.4 Shotgun marriages

In the discussion of the consequences of *Roe vs. Wade*, the issue of 'shotgun marriages' has attracted considerable attention. In an influential paper, Akerlof, Yellen and Katz (1996) have argued that abortion led to the disappearance of shotgun marriages, since women could avoid unwanted pregnancies, a fact that was known to (and potentially used by) men. They conclude that legalizing abortion may actually have harmed some women.

'There is no such thing as a free marriage' A first difference between AYK's model and ours reflects the emphasis we put on the intrahousehold allocation of resources as the *endogenous* outcome of equilibrium formation on the marriage market. In our model, a women being 'shotgun married' is not necessarily better off than a woman remaining single, especially if the latter can use the new technology. The intuition is simply that if 'marriageable' men are in short supply, the surplus generated by marriage will be partly or fully appropriated by the husband; the woman will thus 'pay' for marriage by a low share of household consumption. While this extreme conclusion is clearly linked to our simple setting (e.g., the absence of frictions, hence of post-marital bargaining), we still believe that it stresses an important issue - namely, that shotgun marriage may not come for free. Whether forced marriages closely following an unwanted pregnancy really benefited women is at least debatable; after all, the resulting allocation of household resources was unlikely to favor women, and it is at least conceivable that the new wife's situation within such 'shotgun couples' was no better than what it would have been had she been single.[25]

Still, an important insight of AYK can readily be incorporated into our discussion. Specifically, assume, following AYK, that in the absence of the birth control technology, social norms impose an implicit commitment from the male part, whereby sexual activity leading to pregnancy must end up in marriage, even against the male's initial intention. Assume, moreover, that the availability of abortion results in the disappearance of the social norm, in the sense that the father of an unwanted child no longer feels committed by the mother's decision to keep the child. Under such circumstances, the new

[25] The issue is difficult to assess empirically, if only because modifications of social norms are hard to document (let alone measure). Note, however, that a complete investigation *must* involve estimates of intrahousehold inequality. An analysis that neglects the changes in intrahousehold allocations resulting from the new technology misses a key issue, and may therefore lead to erroneous conclusions. To take but one example, the idea of a 'feminization of poverty' taking place in the 70s should probably be considered with some caution. Insofar as available empirical evidence mostly relies on comparison between individuals and couples while failing to address the crucial issue of the allocation of individual well-being within couples, it may be largely misleading. Standard answers to this problem, based on equivalence scales, are inadequate. Relating the income of a single mother to half (or, for that matter, any fixed fraction) of the couple's income amounts to assuming that income is split within the couple according to some *exogenously given* rule. Our paper points precisely to the opposite direction: economic theory in general, and equilibrium considerations in particular, tells us that the split is endogenous, driven by the environment, and responsive to the technological changes as well as to market conditions in general. Should these effects be taken into account, the conclusions may be reversed.

technology may change the distribution of taste for children in the male population. Specifically, men may accept (involuntary) fatherhood as an indissoluble aspect of sexual activity. Once the link has been broken, male preference for children can be expected to decline, at least for a fraction of the male population. As discussed above, such a decline will typically harm women, and may partly (or even totally) offset the benefits of the new technology. Additionally, the reduction in shotgun marriage could provide an explanation for the increase in out-of-wedlock fertility, since pregnancies no longer result in marriage once abortion has been legalized.

The distinction between our model and the variant just sketched involves deep social and ethical issues. In a sense, one approach views children mostly as the intended consequence of a well-informed decision (which can be thought of as investment in human capital), whereas the other emphasizes fertility as an involuntary by-product of sex. Still, empirical considerations may also be invoked in this debate. One of the best empirical discussion of the 'shotgun' analysis is provided by Neal (2004). Neal makes two main points. First, we expect social norms to influence most or all members of a given society. If one believes that the decline in shotgun marriages is the primary explanation for the rise in never-married motherhood, one has to explain why its impact in terms of out-of-wedlock births appears to be concentrated among a very specific fraction of the population, principally less educated black women. Secondly, if most of these additional births are unwanted, as implied in the AYK version, one would expect a sharp increase in the number of adoptions per non marital birth over this period: even if many women are unwilling to terminate unwanted pregnancies through abortions, whether for ethical, religious or financial reasons, relinquishing the child to adoptive parents remains an option. Neal shows, however, that this prediction is counterfactual: the adoption rate has, if anything, declined over the period.[26]

Finally, the ‘impoverishment of women’ effect described by AYK must operate through a particular channel; namely, a significant fraction of the male population decides to remain single, while they would have chosen (or be forced) to get married before legalization. One way to empirically analyze this issue, hence, is to see whether legalization has significantly increased the probability of singlehood in the male population. Casual observation does not support this prediction. The proportion of single men in the male population does not seem to respond to legalization.[27] Actually, when regressing

[26] Note that our model provides simple answers for both phenomena. We relate the raise in out-of-wedlock fertility to the sharp decline in men’s supply, a phenomenon specific to the population of black males with lower education. Moreover, in our model the babies born out-of-wedlock were *wanted*, which explains the feeble rate of adoptions.

[27] Whites or blacks, various age ranges, evidence from the annual March Census Current Population Reports "Marital status and living arrangements", 1968 to 1979. See Chiappori and Oreffice (2006) for detailed figures.

a male singlehood dummy on age, education, race and fixed effect by year and state, as well as an abortion dummy,[28] on the male population aged 15-50 in the CPS March supplements 1968-1980, we find that the abortion dummy is not significant, and its point estimate is actually negative.

5 Final comments

The model proposed in this paper provides a simplified view of the phenomena at stake. Many issues remain open. Marriage markets are characterized by multidimensional heterogeneity (tastes, but also incomes, ...). Frictions are paramount, which implies that intrahousehold bargaining could profitably be taken into account.[29] Dynamic issues are crucial, not only because divorce and remarriage are important features of the market, but also because such factors as the average age at marriage or the age difference between the spouses are known to matter for equilibrium. A single, unified market for marriage probably does not exist; the relevant concept is more a multiplicity of markets by age, localization, race and religion. Our model applies to each of these submarkets, with possibly different conclusions in

[28] The abortion dummy variable takes a value of unity in 1970 and on for observations located in any of the five states that fully legalized abortion in that year (California, New York, Washington, Alaska, Hawaii) and for all observations after January 1973 following the Supreme Court's ruling on Roe vs. Wade; it is zero otherwise.

[29] This view is explored by Chiappori and Weiss (2003, 2005) and Chiappori, Iyigun and Weiss (2005).

the various situations. For instance, the decrease in the supply of men may be a more stringent phenomenon in some contexts (say, younger population in impoverished urban neighborhoods) than in others - and this fact may explain considerable differences in marriage or out-of-wedlock fertility across the population. The empirical definition of these submarkets and the measure of their interconnections will raise delicate problems for future research.

Despite these simplifications, we believe that our approach puts forth important insights regarding the impact of birth control technologies. Our main message is that issues related to intrahousehold allocation are of crucial importance, and that the distribution of resources and welfare within couples must be understood as an *endogenous* phenomenon which responds to changes in the economic and technological environment. An important consequence is that the introduction of new technologies (or new benefits, for that matter) may have a major impact on individual welfare *even within couples who do not directly benefit from it.* This intuition has been frequently mentioned by sociologists (the idea of 'female empowerment' resulting from the legalization is an old theme of feminist studies), but it may have been somehow disregarded by economists, at least as far as explicit modeling is concerned.[30]

Economic analysis provides new and interesting insights on the 'female empowerment' issue. For instance, the impact of a given reform deeply varies with such exterior determinants as female wages, the generosity of benefit systems or the situation on the market for marriage. These interactions are complex. For instance, our model suggests that there is no simple relationship between the extent to which an innovation is used and the magnitude of its impact on intrahousehold inequality.[31] Studies analyzing the fertility consequences of the innovation, although important, are no substitutes for an investigation of intrahousehold allocation issues. This is a task for which specific models must be devised. A final contribution of our model is precisely to show how the 'collective' analysis, which has been largely developed at the household level, can easily be incorporated into a market-wide analysis to provide a model of the type required. In a sense, the link is very natural. The 'sharing rule', a crucial ingredient of the collective approach,

[30] An interesting and early exception is the analysis of guaranteed employment programs in India proposed by Haddad and Kanbur (1990). See also Grossbard-Schechtman (1993) and Edlund and Korn (2002).

[31] Assume a given innovation (say, abortion legalization) is simultaneously introduced in two different 'submarkets', one experiencing a father shortage while the other is in a situation of balanced fertility (in the sense defined in the paper). The consequences on fertility will be much larger in the first submarket (all 'conditional mothers', being single, will use the technology), whereas the consequences on intrahousehold allocation is nil. In the second submarket, fewer women use the technology, but the allocative impact is maximum.

has a direct translation in the context of a matching model; specifically, it defines the payoffs that stabilize a given match. Because our approach is based on matching, it seems well adapted to analyze the impact of the reform on couples formed *after* the reform has been implemented; it thus complements alternative works based on bargaining models.[32] Our contribution should be seen in the perspective of a general line of research which is currently pursued.

[32] See for instance Chiappori and Donni (2005)

APPENDIX

A Proof of Proposition 1

Define

$$D = S\left(u', v'\right) + S\left(u, v\right) - \left(S\left(u, v'\right) + S\left(u', v\right)\right) \geq 0$$

where $u' > u$ and $v' > v$. Equivalently,

$$D = \Gamma(u\prime, v\prime) + \Gamma(u, v) - (\Gamma(u, v\prime) + \Gamma(u\prime, v)) \geq 0$$

where $\Gamma(u, v)$ represents the aggregate utility of the couple (u, v).

We know that if (u, v) have children so do $(u', v), (u, v')$ and (u', v'); and that if (u', v') do not have children neither do $(u', v), (u, v')$ and (u, v). We therefore consider several cases.

1. All couples have children, or none of the couples have children: then $D = 0$

2. (u', v') have children, but none of the others; then

$$\begin{aligned} \Gamma\left(u', v'\right) &= z + Y + v' + u' \geq y + Y + p\left(v' + u' + z - y\right) \\ \Gamma\left(u, v'\right) &= y + Y + p\left(v' + u + z - y\right) \geq z + Y + v' + u \\ \Gamma\left(u', v\right) &= y + Y + p\left(v + u' + z - y\right) \geq z + Y + v + u' \\ \Gamma\left(u, v\right) &= y + Y + p\left(v + u + z - y\right) \geq z + Y + v + u \end{aligned}$$

hence

$$D = -\left(1 - p\right)\left(y - \left(z + v' + u'\right)\right) \geq 0$$

since $u' + v' \geq y - z = \bar{u}$ by assumption.

3. (u', v') and (u, v') have children, but none of the others

$$\begin{aligned} \Gamma\left(u', v'\right) &= z + Y + v' + u' \geq y + Y + p\left(v' + u' + z - y\right) \\ \Gamma\left(u, v'\right) &= z + Y + v' + u \geq y + Y + p\left(v' + u + z - y\right) \\ \Gamma\left(u', v\right) &= y + Y + p\left(v + u' + z - y\right) \geq z + Y + v + u' \\ \Gamma\left(u, v\right) &= y + Y + p\left(v + u + z - y\right) \geq z + Y + v + u \end{aligned}$$

hence

$$D = \left(1 - p\right)\left(u' - u\right) > 0$$

4. (u', v') and (u', v) have children, but none of the others: same argument as 3.

5. All have children except (u, v)

$$\begin{aligned}
\Gamma\left(u', v'\right) &= z + Y + v' + u' \geq y + Y + p\left(v' + u' + z - y\right) \\
\Gamma\left(u, v'\right) &= z + Y + v' + u \geq y + Y + p\left(v' + u + z - y\right) \\
\Gamma\left(u', v\right) &= z + Y + v + u' \geq y + Y + p\left(v + u' + z - y\right) \\
\Gamma\left(u, v\right) &= y + Y + p\left(v + u + z - y\right) \geq z + Y + v + u
\end{aligned}$$

$$D = (1 - p)\left(y - (v + u + z)\right) \geq 0$$

since $u + v \leq y - z = \bar{u}$ by assumption.

B Proof of Proposition 3

The existence of a strictly assortative match follows from supermodularity. In such a match, all married women are above the threshold u_M such that the number of such women equals the number of 'marriageable' men (i.e., men with a positive taste for children); in particular, u_M women are married with men with a zero taste for children, and since $u_M + 0 = u_M < \bar{u}$ these couples do not want children. Since the two distributions of male and female are atomless, the sum $u+v$ is continuous and strictly increasing over married couples. Some couples will have children (since some mothers are unconditional), while others (like $(u_M, 0)$) will not, hence by continuity the existence of a pivotal couple.

Consider, now, an arbitrary stable match. Assume that a single woman wants a child, hence belongs to the unconditional mother category. Since all men with positive taste are married, some must be married with conditional women, while they could receive a higher surplus by marrying the unconditional single, a contradiction.

Finally, assume that a couple (u', v') is married and elects to have children in the SASM (so that $u' \geq u_P$), and there exists a stable match in which u' is single. In that match, some married man are married with a wife $u < u_P$ and do not want children, while they could generate a higher surplus marrying u', a contradiction. By the same token, v' must be married for any stable match. Assume, alternatively, that there exists a stable match in which u' is married (say, to v) but does not want children; necessarily $v < \bar{u} - u' \leq v'$. If v' is married to some u and does not want children, then $u < \bar{u} - v' \leq u'$, and by condition 2 of the previous proof stability conditions are violated. If v' is married to some u and elect to have children, then by condition 3 of the previous proof stability conditions are violated.

C Proof of Proposition 4

Again, the existence of a strictly assortative match follows from supermodularity. In such a match, all married women are above the threshold u_M such that the number of such women equals the number of 'marriageable' men (i.e., men with a positive taste for children); in particular, u_M women, who are unconditional mothers, are married with men with a zero taste for children and want children. Consider, now, an arbitrary stable match. Some unconditional mothers must be single. Assume that a married couple does not want children; the husband could generate a higher surplus by marrying an unconditional single mother, a contradiction.

D Proof of Proposition 5

In a married couple (u', v'), where $v' = \phi(u')$, let $S_W(u')$ denote the part of surplus going to the wife, and $S_M(v') = S(u', v') - S_W(u')$ the husband's share. Note, first, that stability requires that for any v

$$S\left(u', v\right) \leq S_W\left(u'\right) + S_M(v)$$

with an equality for $v = v'$. Therefore

$$S_W\left(u'\right) = \max_v \left(S\left(u', v\right) - S_M\left(v\right)\right)$$

and by the envelope theorem:

$$S_W'\left(u'\right) = \frac{\partial S\left(u', \phi\left(u'\right)\right)}{\partial u'}$$

We start with the case of father shortage. For all married couples, $S(u,v) = v$, hence $\partial S/\partial u = 0$ and $S_W(u)$ is constant. Since it is zero for the marginal wife u_M, it is zero for all women.

Consider, now, the alternative case of balanced fertility. For subpivotal couples ($u < u_P$), $S(u,v) = pv$, hence $\partial S/\partial u = 0$. Again, $S_W(u)$ is constant, and zero for the marginal wife u_M; we conclude that $S_W(u) = 0$ for $u \leq u_P$. If $u > u_P$ but $u \leq \bar{u}$, then

$$S(u,v) = v - (1-p)(\bar{u} - u)$$

hence $\partial S/\partial u = S_W'(u) = (1-p)$. Since $S_W(u_P) = 0$ we have $S_W(u) = (1-p)(u - u_P)$. Finally, if $u > \bar{u}$ then $S(u,v) = v$, hence $\partial S/\partial u = 0$ and $S_W(u)$ is constant. Since $S_W(\bar{u}) = (1-p)(\bar{u} - u_P)$ we have $S_W(u) =$

$(1-p)(\bar{u}-u_P)$ for all $u>\bar{u}$.

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