Chapter 5

Differential Fecundity: An Introduction

Women are fecund for a shorter period of their lives than men. Menopause occurs around age 50 in women and fecundability is very low for several preceding years. Compared with aging in the female partner, male reproductive senescence places few constraints on fertility. If older men cannot have children with women of the same age cohort, how will the desire of some of these men for children affect the marriage market and gender roles in general? It turns out that the assumption of differential fecundity have widespread implications for gender roles. We will study these different implications in the next chapters.

This chapter shows that differential fecundity and marital institutions can generate the following well known gender differences:

(1) Divorced women are less likely to remarry than divorced men.[1]

(2) There are proportionately less never married women than men.[2]

(3) The average age of first marriage is lower for women than men.[3]

In order to focus on the effects of differential fecundity on gender roles,

[1]Chamie and Nsuly (1981) showed that divorced men were more likely to remarry than divorced women in all forty seven countries that they had data for. Dupâquier, et al. (1981) has similar historical data from Europe.

[2]In 89 out of 138 countries, there are more never married 45-49 year old men than women (United Nations 1992). Haines (1996) showed similar results for 5 western countries since 1840.

[3]In 91 countries, the mean age at first marriage is higher for men than for women (Bergstrom and Bagnoli 1993).

we assume, counterfactually, that there is no other difference between men and women.

Differential fecundity, by itself, has no implication for gender roles. When older women are not fecund, older men who want to have children have to compete with younger men for young wives. Ceteris paribus, the return to marrying an older person is lower than that of marrying a younger person. Older men, due to their age, will be at a disadvantage in competing with younger men for young wives. If there is no other feature which distinguishes older men from younger men, young women will not choose to marry or have children with older men. In this case, young women will choose to marry young men. Since there is approximately the same number of men and women in each age cohort, there will be no young woman left for older men to marry even if some older men want to do so. Thus older men will not have any incentive to dissolve their existing marital relationships in order to marry non-available younger women. So one must introduce other factors into the marriage market for differential fecundity to make an impact on gender roles.

We consider two different factors. First, in addition to age, we can introduce differences across individuals within a gender. For example, let individuals have different levels of income which potential spouses value. Wealthier older men may use their wealth to try to compete with younger men in the marriage market. Second, we can introduce search frictions into the marriage market. If search frictions are large, a young womon who is matched with an older man may prefer to marry the older man rather than rejecting the match and reentering the marriage market.

We begin by considering a benchmark model where differential fecundity do not imply gender differences in behavior. Then we provide modifications to show how gender differences may emerge.

5.1 Gender Neutrality with Differential Fecundity

Consider a society with a constant population. Each individual lives for two periods as adults and one period as children. Women are fecund when they are young and infertile when they are old. Men are fecund over their entire lives. Individuals marry only to have children. So older single women will not want to marry. We normalize the per period return to being single to zero. Older married couples who cannot have any children will also receive a return of zero. Each fertile couple will have a boy and a girl per period. These children will become adults in the next period and make their own decisions. Each member of a fertile couple will receive a per period return of γ. Divorced individuals, widows or widowers suffer a disutility of $\beta < \gamma$. This model assumes that marriage is a public good and that there is no redistribution of resources within marriage. The discount rate is also set to zero.

Since there are equal numbers of young men and women entering the marriage market in each period, consider an equilibrium in which young men and young women marry each other. In this case, each young married adult will receive a payoff of γ for the period.

When the couple becomes old and remain married, each individual will receive a payoff of zero in the second period. Will the older husband like to divorce his wife and remarry a younger woman? His payoff from divorce and remarriage is $\gamma - \beta > 0$. Thus if he can find a younger woman to marry him, he will be willing to divorce his current wife and remarry. But will any young woman prefer not to marry a young man in order to marry him? If a young woman marries him, she will get a current utility of γ and a next period return of $-\beta$ when she becomes widowed. Since there is no discounting, her life time utility is:

$$\gamma - \beta$$

She cannot be worse off marrying a young man rather than an older man. If she marries a young man and he divorces her later, her life time utility is

$$\gamma - \beta$$

If her marriage to a young man lasts two periods, her life time utility will be

$$\gamma$$

She will be strictly better off marrying this young man rather than an older man. Since she cannot be worse off marrying a young man, we may assume that she will choose to marry a young man over an older man. In this case, all young women will be married to young men. If an older man choose to divorce his current wife and reenter the marriage market, he will suffer a disutility loss of β and not find any young woman being willing to marry him. Given this expected outcome from divorce, he will not choose to divorce his wife.

The equilibrium outcome in this society is that all young adults will marry each other and remained married for two periods. Both men and women will receive life time utilities of γ. In this benchmark model, there is no gender difference in behavior or welfare even though older men get a strictly positive payoff from remarriage whereas older women do not. As discussed in the introduction, the gender neutrality results come from the fact that older men are less attractive spouses than younger men and there is no compensating factor. We will consider modifications in the next section to obtain gender differences in behavior and welfare.

5.2 Random Matching in the Marriage Market

Consider a society with the same structure as in the benchmark model. The only modification we will introduce is to have random matching in the marriage market. There will be at most one match between an eligible man and an eligible woman per period. If a match occurs and the couple decides not to marry, they cannot find another match in the same period. They may return to the marriage market in the next period if they wish. Single older women will not be interested in participating in the marriage market because they will have not gain from participating. Single young women who are randomly matched with older men will be willing to marry them to obtain a life time payoff of $\gamma - \beta > 0$. This life time payoff is larger than not marrying because there is no return to reentering the marriage market when old. Single young women may prefer to marry young men but may be unable to match with them due to the random matching assumption.

We will show in this society that there is a stationary equilibrium in which young women will marry both young and old men. Young men who are unsuccessful in meeting a young woman will reenter the marriage market. Young couples who marry will divorce in the second period. Divorced men will reenter the marriage market. Some divorced men will remarry.

Let n be the number of young men and women who enter the marriage market in period t. Let o be the number of older men who are also in the marriage market in period t. Then the total number of men in the marriage market is $n + o$. Since there are more men than women in the marriage market, we will assume that all eligible women will meet a man. Due to our random matching assumption, an eligible man will meet an eligible woman with probability

$$\frac{n}{n+o}$$

The number of young men who will successfully meet a woman and marry her is

$$(\frac{n}{n+o})n = \frac{n^2}{n+o}$$

The number of young men who will remain single and reenter the marriage market in period $t+1$ is

$$(1 - \frac{n}{n+o})n = \frac{no}{n+o}$$

Consider the behavior of older men who married when young. Their payoff from divorce in reentering the marriage market is

$$d = -\beta + \frac{n\gamma}{n+o} \tag{5.1}$$

If this payoff is greater than zero, they will divorce their wife and reenter the marriage market. Let us assume for the time being that $d > 0$. Then the number of divorce men who will reenter the marriage market at period $t+1$ is

$$\frac{n^2}{n+o}$$

The total number of older men in the marriage market will consists of never married older men and divorced men:

$$\begin{aligned} o &= \frac{no}{n+o} + \frac{n^2}{n+o} \\ &= n \end{aligned}$$

Using $o = n$ and (5.1), $d > 0$ as long as:

$$-\beta + \frac{n\gamma}{n+n} > 0$$

which reduces to:

$$\gamma > 2\beta \tag{5.2}$$

When (5.2) holds, there is an equilibrium in which young women will marry both young men and older men. $\frac{1}{2}$ of the young women will marry young men and be divorced when old. $\frac{1}{4}$ of the young women will marry never married older men. $\frac{1}{4}$ of the young women will marry divorced older men. These divorced men who remarry will have two wives over their lifetime. $\frac{1}{4}$ of the men will never marry. The life time utility of a young woman is independent of her marriage partner and is:

$$\gamma - \beta \tag{5.3}$$

$\frac{1}{4}$ of men never marry and receive a life time utility of 0. $\frac{1}{4}$ of men will marry once when old and receive a utility of γ. $\frac{1}{4}$ of men will marry once when young and receive a life time utility of $\gamma - \beta$. $\frac{1}{4}$ of men will marry twice and receive a life time utility of $2\gamma - \beta$. The expected utility of a young man who marries is:

$$\begin{aligned} \frac{\gamma - \beta}{2} + \frac{2\gamma - \beta}{2} &= \frac{3\gamma}{2} - \beta \\ &> \gamma \end{aligned}$$

Since the expected utility from marriage is larger than γ, a young man will never voluntarily choose not to marry. A young man who enters the marriage market does not know what his marital outcomes will be. So his life time expected utility is:

$$\frac{1}{4}0 + \frac{1}{4}(\gamma - \beta) + \frac{1}{4}(2\gamma - \beta) + \frac{1}{4}\gamma = \gamma - \frac{\beta}{2} \tag{5.4}$$

Comparing (5.4) with (5.3), men are better off than women in this society. However they are both worse off than in a society without divorce and remarriage where all young adults marry each other. Women are worse off because they have to incur divorce cost and the cost of widowhood. Men are worse off because for every man who successfully remarries, some other man will never marry. Thus the benefits of remarriage for men is simply a redistribution of utility among men. But some men in this society incur divorce costs which is a social cost. Differential fecundity and random matching lead to all individuals, acting in their own self interest, to be worse off. The drop in social welfare comes from the fact that when a married young man thinks about whether he should divorce his wife when old, he see a private benefit from divorcing his wife. His divorce creates a negative externality for his wife and other men in the marriage market which he does not take into account.

The predicted gender difference in welfare is specific to this model. In particular, this model does not allow redistribution of resources between men and women even though fecund women are scarce in the marriage market.

From a positive or predictive point of view, this model is substantially better than the benchmark gender neutral model. There are three predictions about gender roles which are consistent with the evidence across many societies. First, the average age of marriage for women is lower than that for men. Second, there are more never married men than women. Third, the remarriage rate of divorced men is higher than that for women.

Finally, if there is a social norm against divorce such that nobody divorces, there will be no divorced men in the marriage market. In this case, there will a equal number of youg men and young women in the marriage market and all young adults will marry. There will also be no divorce. All individuals will attain a life time utility of γ which is larger than the society without a divorce taboo. Marital insitutions affect social welfare.

5.3 Heterogenous Individuals and Transferable Utility

A problem with the previous model is the assumption of random matching. Since the age of an individual is readily observed, it is unlikely that young women will randomly meet with old men to the exclusion of meeting young men. Thus there is room to consider models of differential fecundity and gender differences without the random matching assumption.

We will now consider a completely opposite model, one without random matching and with transferable utilities.

Consider a society with the same demographic structure as the benchmark society. We introduce heterogeneity into the society by assuming that some old adults will have different skills from other adults. Let all young adults have the same initial skill L. With probability $p < \frac{1}{2}$, an old adult will have skill $H > L$. An individual with skill s in a particular period will derive a utility from labor income of s. Labor income is not shared. For the rest of this section, we ignore the individuals' payoffs from labor market earnings.

Individuals may derive more utility from the marriage market. The utility from participating in the marriage market is in addition to the utility from labor income. As discussed earlier, older single women will receive no additional utility from marriage and therefore be willing to remain single. Older eligible men will prefer to marry if they can find a young spouse. All young women will marry. Since all young women are identical, let the first period marital output with a husband of skill S be $m(S)$. $m(S)$ does not include labor earnings of the husband. $m(S)$ is divided between the couple. The output from marriage is zero in the second period even if the marriage persists. We assume that $m(S)$ is increasing in S. The rationale for this assumption is to obtain the result that high income men will be willing to pay more for marriage, that children is a normal good. The marriage may also end in divorce and both parties will suffer a divorce cost of $\beta < m(L)$. The marriage may also end if the young woman married an older man and becomes a widow in the second period. She will also suffer a cost of β in the second period.

Instead of random matching, we will assume that the marriage market clears by transfers between market participants such that any individual can marry if the individual is willing to pay the transfer required to do so. We will assume that individuals can agree to pre-nuptial (state contingent) contracts in marriage. In other words, they will agree in the first period what transfers will occur if the couple divorces in the second period.

Since all young women are alike, let R be the expected lifetime utility that a young woman gets from the marriage market. This lifetime utility is in addition to what she can get from her expected discounted labor earnings. Then, any man who wants to marry must offer a young woman at least R. Consider an eligible older man of skill S. His gain in marriage is:

$$V(S) = m(S) - \beta - R \tag{5.5}$$

The marriage produces $m(S)$. He has to pay her β in anticipation of her being a widow. R is her net gain from marriage. He will only marry if

$V(S) > 0$. $V_S > 0$. So if an older eligible man of skill L marries, an older eligible man of skill H will also marry.

Will an older man of skill S in a current marriage divorce his wife to remarry? Since we allow marital contracts to specify transfers contingent on divorce, he will do so only if he can afford to pay for the divorce costs of him and his wife:

$$\begin{aligned} D(S) &= V(S) - 2\beta \\ &= m(S) - 3\beta - R > 0 \end{aligned} \tag{5.6}$$

If $D(S) < 0$, he will choose not to divorce his wife. $D_S > 0$. If husband of skill S is willing to divorce his wife and remarry, then a single older man with the same skill will also marry. Put another way, if a single older man of skill S chooses not to marry, a husband of the same skill will not divorce his current wife to remarry.

In order to have gender differences in this society, we need to have some older husbands being willing to divorce their wives and remarry. Otherwise all young men will marry, there will be no divorce and the society will be gender neutral. On the other hand, it also cannot be the case that all older husbands want to divorce their wives and remarry. There will not be enough young women in the marriage market to marry all the men. Since high skill men have a higher return from divorce than low skill men, we will study an equilibrium in which high skill husbands want to divorce their wives but low skill men do not.

The return to marriage for a young man is then:

$$\begin{aligned} U &= m(L) - R + pD(H) + (1-p)0 \\ &= m(L) - R + pD(H) \end{aligned} \tag{5.7}$$

$m(L) - R$ is the first period return from marriage. $pD(H) + (1-p)0$ is the expected second period payoff from being married in the first period.

Consider an equilibrium in which some young men remain single. The return to being single is:

$$Y = 0 + pV(H) + (1-p)\max(V(L), 0) \tag{5.8}$$

0 is his first period return from being single in the marriage market. We ignore utility from labor income. $pV(H)+(1-p)\max(V(L),0)$ is his expected

second period return. We will now argue that $V(L) \leq 0$ in equilibrium. If $V(L) > 0$, all older single men will marry. In this case, young men who marry plus older single men from the previous period will marry all the young women. There will be no extra women for the divorced high skill men to remarry. Thus in an equilibrium with remarriage, some older single men must choose not to marry. Since $V_S > 0$, if the equilibrium exists, it must be the case that older single low skill men do not marry. Assuming that $V(L) \leq 0$ (to be verified later), (5.8) reduces to:

$$\begin{aligned} Y &= pV(H) \\ &= p(m(H) - \beta - R) \end{aligned} \tag{5.9}$$

For young men to be indifferent between marriage or not, the return to marriage for a young man must be zero. That is, $U = Y$, which implies

$$\begin{aligned} R &= m(L) + p[D(H) - V(H)] \\ &= m(L) - 2p\beta \end{aligned} \tag{5.10}$$

For high skill husbands to be willing to divorce their wives and remarry, (5.6) and (5.10) implies:

$$D(H) = m(H) - 3\beta - R > 0 \tag{5.11}$$
$$m(H) - 3\beta - (m(L) - 2p\beta) > 0$$
$$m(H) - m(L) > \beta(3 - 2p) \tag{5.12}$$

(5.12) is a necessary condition for high skill husbands to be willing to divorce their wives and remarry. This condition also means that children is a normal good. This assumption is important to point out because it is in general not true that wealthier individuals have more children.[4]

For single low skill older men to choose not to marry, $V(L) \leq 0$ and (5.10) imply:

$$V(L) = m(L) - \beta - R \leq 0 \tag{5.13}$$
$$m(L) - \beta - (m(L) - 2p\beta)) \leq 0$$
$$-\beta(1 - 2p) \leq 0$$

[4]The standard explanation given for this fact is that wealthier individuals also have higher wages which increases the time cost of having their children. See Willis (1973).

Since $p < \frac{1}{2}$, (5.13) is automatically satisfied.
(5.10) and (5.9) imply:

$$\begin{aligned} Y &= p(m(H) - \beta - m(L) + 2p\beta) \\ &= p(m(H) - m(L) - \beta(1 - 2p)) \end{aligned} \tag{5.14}$$

Comparing the welfare of men and women,

$$\begin{aligned} R - Y &= m(L) - 2p\beta - p(m(H) - m(L) - \beta(1 - 2p)) \\ &= m(L) - p(m(H) - m(L) - \beta(1 + 2p)) \end{aligned}$$

The sign of $R - Y$ is indeterminate. Consider the case where $\beta = 0$. In this case, we have:

$$\begin{aligned} R &= m(L) \\ Y &= p(m(H) - m(L)) \end{aligned}$$

Here it is easy to see that women obtain all the rents from marriage from the man who is indifferent between marriage and being single. The marginal man is the low skilled man and he gives away all the gains from marriage, $m(L)$. Put another way, the high skilled man only has to bid $R = m(L)$ to be sure that he will attract a spouse. So the gains to marriage to men is $m(H) - m(L)$, what a high skilled man obtains. And a young man will obtain it with probability p. So if $p(m(H) - m(L)) > m(L)$, men are better off than women in the marriage market even though women are relatively scarce.

Returning to the general case, the expected lifetime gains to entering the marriage market for a man and a woman together is:

$$\begin{aligned} R + Y &= m(L) - 2p\beta + p(m(H) - m(L) - \beta(1 - 2p)) \\ &= m(L) + p(m(H) - m(L) - \beta(3 - 2p)) \end{aligned}$$

Consider an alternative society in which divorce is forbidden. There are two potential marriage patterns. First, men may decide to marry only when they are old. The total expected gains to marriage per couple is:

$$pm(H) + (1 - p)m(L) - 2\beta < R + Y$$

Second, all individuals marry when they are young and each couple will gain $m(L) < R+Y$. Thus in either case, social welfare is higher in the society with divorce and remarriage. In the model with transfers considered here, divorce is welfare improving unlike the model with search friction discussed in the previous section. The welfare gain obtained here is due to (1) an increase in the number of high output marriages (high skilled old men and young women), and (2) the transfers between men and women correctly price the relative scarcity of fecund women in the marriage market.

Let the number of young men who marry be k. $n-k$ young men will not marry. pk husbands will divorce their wives and remarry. $p(n-k)$ single older men will also marry for the first time. The total number of young women marrying in a period must be equal to the total number of men marrying:

$$\begin{aligned} n &= k + pk + p(n-k) \\ k &= n(1-p) \end{aligned}$$

Summarizing, if (5.12) holds, there is an equilibrium in which all young women marry. $n(1-p)$ young men will marry. $p(1-p)n$ husbands will divorce their wives and remarry. p^2n older men will marry for the first time. $p(1-p)n$ men will never marry.

In terms of gender differences, the average age of first marriage for women is lower than that for men. There are more never married men than never married women. Divorced men are more likely to remarry than divorced women. Husbands who obtain unanticipated higher earnings have a higher divorce rate than wives who obtain unanticipated higher earnings. Men with higher labor earnings are more likely to be married than men with lower labor earnings. The marriage rate of women is uncorrelated with their labor income.

In this simple model, labor earnings do not play an active role in the marriage market. High skilled older men do not marry or remarry because their labor earnings are higher. They marry or remarry because their gains from marriage is higher. That is $m_S > 0$.

5.4 Conclusion

The previous two sections provide two different environments in which gender roles may arise. In both environments, divorces are feasible. In the random matching model, differential fecundity creates a negative externality and lowers the welfare of individuals in the society. In the society with marital transfers and heterogeneity across individuals, differential fecundity increases the welfare of individuals in the society. The marital transfers internalize the social costs of differential fecundity. If divorce is not feasible, no gender difference arise in either society. Thus marital institutions affect gender roles and social welfare.

In terms of observed gender roles, these simple models already generate some well know stylized facts. The average age of first marriage for women is lower than that for men. There are more never married men than never married women. Divorced men are more likely to remarry than divorced women. Married men have higher income than never married men.

The second model also makes the prediction that that husbands who obtain unanticipated higher earnings have a higher divorce rate than wives who obtain unanticipated higher earnings. This prediction is not supported by the evidence in Weiss and Willis 1997. Their paper showed that unanticipated decrease in husband's earnings increased the probability of divorce whereas unanticipated increase in husband's earnings decreased the probability of divorce. They also showed that unanticipated increase in wife's earnings increased the probability of divorce whereas unanticipated decrease in wife's earnings decreased the probability of divorce. This empirical evidence suggests that the second model is too simple.

5.5 Bibilographic notes

The effect differential fecundity on gender roles was first pointed out in a classic paper by a biologist, Robert Trivers 1972. Anthropologists and evolutionary psychologists were the first to apply his ideas to the study of human behavior. For a survey of this literature, see Betzig 1997; and Blaffer Hrdy 1999. Our contribution here is to formalize ideas from this literature. Economists have contributed few new ideas to this literature. However, given the controversy and confusion about how gender roles are determined, there is a large return to being analytically precise about models of gender roles.

5.6 Problems

(1) Consider the bivariate distribution of the gains to marriage in 1970, Π, plotted in the previous chapter. What characteristics of that distribution do you think the models in this chapter can explain?

(2) Consider the model in Section 5.2 with random matching and without transferable utilities. We introduce heterogeneity into the society as in the model in the next section. Let all young adults have the same initial skill L. With probability $p < \frac{1}{2}$, an old adult will have skill $H > L$. An individual with skill s in a particular period will derive a utility from labor income of s. As discussed earlier, older single women will receive no additional utility from marriage and therefore be willing to remain single. Older eligible men will prefer to marry if they can find a young spouse. All young women will marry. Since all young women are identical, let the first period marital output with a husband of skill S be $m(S)$. $m(S)$ does not include labor earnings of the husband. $m(S)$ is divided equally between the couple. The output from marriage is zero in the second period even if the marriage persists. We assume that $m(S)$ is increasing in S.

Assume that divorce cost, β, is zero. With the random matching environment as in Section 5.2, find the equilibrium number of young men who marries, the equilibrium number of old men who divorces their wives and remarries.

Will men and women have different views on divorce in this society?

Is divorce welfare enhancing in this society? If there is no divorce, will men want to first enter the marriage market when young or when they are old?

(3) Consider a society in which adults live two periods. n young men and n young women enter the marriage market in each period. Men are always fecund. Women are fecund with probability β. Fecund women can have children when they are young and old. If a woman is not fecund, she cannot have children. A woman's fecundity status is unknown when she enters the marriage market. If she marries in the first period, her status is known to everyone after the first period depending on whether she had a child or not. There is no cost to bringing up a child. Every marriage lasts one period. So if an adult wants to be married his or her entire life, the adult will have to marry twice. The value of being single is 0. The value of children in a one period marriage is Π which is divided between the husband and the wife. Childless marriages generate 0 utility. Individuals are risk neutral

and maximize expected lifetime utility. Assume a discount rate of zero (no discounting).

(a) What is the market clearing transfer for young women in marriage?

(b) What is the market clearing transfer for older women in marriage?

(c) Is the market clearing transfer higher for young or older wives? Why?

(4) In modern industry societies, most married couples have two or less children. Since these couples do not want so many children, differential fecundity should be a less important influence on gender roles in these societies. Discuss.