Review of Economic Dynamics **5,** 815–855 (2002)
doi:10.1006/redy.2002.0190

Why Do Women Wait? Matching, Wage Inequality, and the Incentives for Fertility Delay[1]

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This paper explores the interaction between wage inequality and the marriage and fertility decisions of young women. We develop an equilibrium search model of marriage, divorce, and investment in children that allows for differential timing of fertility. We show how patterns of fertility timing in U.S. data can be explained by the incentives for fertility delay implied by marriage and labor markets. We find that these incentives help explain both the cross-sectional relationship between women's wages and fertility timing and the changes over the past 40 years in married women's fertility timing and labor supply. *Journal of Economic Literature* Classification Numbers: J12, J13.

Key Words: marriage; fertility; returns to experience.

[1] This paper previously circulated as "The Timing of Births: A Marriage Market Analysis." We also thank participants at the conference on Macroeconomic Perspectives on Families and Inequality organized by C. V. Starr Center and the Society for Economic Dynamics. We are grateful to Alessandra Fogli and José-Víctor Ríos-Rull, for detailed comments and suggestions, and to Joseph Hotz for comments on an earlier draft. The second author acknowledges financial support from the Social Sciences and Humanities Research Council of Canada.

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1094-2025/02 $35.00

1. INTRODUCTION

Two of the most remarkable trends in family life of the past 40 years have been the decline of marriage and the rise in labor force participation of young women. These phenomena underscore the strength of the interactions between marriage and labor markets. Becker's seminal work on marriage (Becker (1973, 1974)) suggested an approach to understanding such interactions: Becker argued that marriage and labor markets are definitively linked through the comparative advantages of spouses in market vs nonmarket labor, particularly in the production of children.

In a similar spirit, this paper analyzes marital and labor supply decisions jointly with the evolution over time of the wage distribution. Using panel data for U.S. women, we show that neither the cross-sectional nor the time-series patterns are due to variation in the time women spend in education. We believe that these patterns reveal the interaction of two distinct economic incentives for fertility delay, one arising from the nature of marriage markets, the other from returns to experience in the labor market. To explore these interactions theoretically, we develop a dynamic model of family formation that links marriage decisions and labor supply via the production of children.

Our basic hypothesis is that the cross-sectional relationships between household income and fertility and labor supply behavior are related to differences in the dynamic returns to fertility, and that these returns are determined by both the marital matching process and the dependence of women's wages on labor market experience. To the extent that having children consumes time, women may lower their future labor time, their future wages, and their marriage possibilities. When divorce probabilities are high and information about future matches uncertain, even married women must consider the effect of motherhood and labor supply on their prospects for a possible future outside the marriage.

The strength of the empirical linkages between labor markets and fertility delay can be seen in the results of our analysis of U.S. women in the Panel Study of Income Dynamics (PSID). We find that women with higher wages have fewer kids and have them later; women in the highest wage quintile have 64% of their children at age 27 or older, compared to 42% for women in the lowest wage quintile. Even after we control for years of education, measures of quality such as educational attainment and wages remain strongly associated with fertility delay. There has also been a significant change in both the level and the timing of births over time. Since the 1938 birth cohort of mothers, more recent cohorts have fewer kids and have them at later ages; the proportion of kids born to mothers age 27 or older has grown 44%. Simultaneously, the labor supply of married women ages 20–26 has increased by 71%, from 758 h per year for the

1938–1947 cohort to 1294 h per year for the 1958–1967 cohort. Our analysis shows that changes in the length of women's education over time can explain at most about 30% of this pattern of fertility delay.

Turning to our model, the three key margins in child production are quality, quantity, and timing of children. In contrast to the previous literature on fertility dynamics, we allow for endogenous marital decisions and solve for the equilibrium marital matching rules. Although this inevitably entails considerable sacrifice in terms of the structure of the labor market and of the life cycle, we feel that modeling the equilibrium is crucial for two reasons. First, the decisions in our model affect the evolution over time of the human capital distribution, which in turn affects the marital equilibrium. And second, changes in women's labor market conditions have direct implications for marital decisions, because they change the bargaining power of wives relative to their husbands. To allow for this latter channel, we assume that the decisions of married households solve a simple bargaining game between the spouses.

In this environment, women with high wage levels delay fertility more than women with lower wages because they are pickier than high-wage men about whom they marry. A woman with low wages is more likely to marry a high-wage man than vice versa, because the low-wage wife can compensate for her low wages by spending more time in raising children, an option which is not available for the low-wage husband, as we assume that men's time is not a substitute for women's time in child production.

To see the implications of our model for cross-sectional patterns of fertility timing, we parameterize the model to match calibration targets for the 1938–1947 cohort of women in the PSID. These targets are chosen to pin down the key margins in our model, such as labor supply and marriage behavior, without building in the pattern of fertility timing of the model. In addition to the proportion of children born to women over 27, these targets include the total fertility rate, the income distribution across marital states, the aggregate marriage rate, and the share of income invested in children. As a result of this procedure, our calibrated model generates a steady-state equilibrium which reproduces the most relevant features of the data.

The calibrated model also allows us to run computational experiments aimed at understanding the changes in fertility and labor supply observed in the United States over the past few decades. We report the results of two such experiments. In the first, we raise the value of being married relative to staying single, to clarify the importance of including marriage in our model. In the second, we introduce a positive rate of return to labor market experience for women, in the spirit of Blau and Khan (1997) and Olivetti (2001), who found significant increases in women's returns to experience since the 1970s.

The main results of the paper are as follows: (1) high-productivity women in our calibrated model choose fewer kids and delay fertility even in the absence of returns to experience in the labor market, (2) increasing the gains from marriage results in further postponement of fertility, and (3) an increase in returns to labor market experience for women also results in more fertility postponement, as well as a reduction in wage inequality among women. The first two results taken together indicate the importance of the incentives for fertility delay that arise from the marital matching process; higher wage women are pickier about whom they marry because delay is more likely to get them a better match than is the case for low-wage women. Since the third set of results mirror those observed in U.S. data, this suggests that the same forces are at work in both cases: higher wage growth for women who work more increases the incentives for fertility delay. Overall, we infer from our results that while marriage–market returns are the principal force behind fertility timing, a significant part of the recent changes in both labor supply and fertility timing could be due to an increase in returns to labor experience for women.

Our basic hypothesis, that the timing of fertility is strongly linked to human capital accumulation, is also supported by previous empirical research. The time a mother spends on child care and the number of young children she has substantially reduce her labor force participation, according to studies by Hotz and Miller (1988) and Eckstein and Wolpin (1989). Lower and interrupted participation rates lead to lower human capital accumulation and lower wages for females, according to Altug and Miller (1998) and Gunderson (1989). Waldfogel (1998) found that in 1994, mean wages for women with no children were 81.3% of mean wages for men, while mean wages for married mothers were only 76.5% of mean wages for men. Finally, the spread in childbearing ages across education groups has been increasing; Rindfuss *et al.* (1996) reported that over the period 1963–1989 it was women with college degrees who shifted their childbearing the most toward later ages, confirming a trend noticed earlier by Mare (1995) and Lewis and Ventura (1990).

The assumption that household decisions are the Pareto-optimal outcome of a simple bargaining game also plays an important role in the model, as it ensures that the utility of each spouse increases when their welfare as singles increases. Empirical research suggests that the household decisions of married couples do in fact depend on the outside options of the spouses in this way, and that the option values depend in turn on the states of the marriage and labor markets (see, for example, Chiappori *et al.* (2002) and Rubalcava and Thomas (2000)).

Our research is most closely related to that of Conesa (1999) and Mullin and Wang (2001), who constructed general equilibrium models of the timing of fertility and human capital accumulation. However, these papers abstracted from the dynamics of the marital matching process, which is the main force driving fertility delay, according to our paper. Other equilibrium family-structure models related to ours include Aiyagari *et al.* (2000) who model the interaction between the income distribution and parental decisions regarding marriage and divorce, and Greenwood *et al.* (in press), and Regalia and Ríos-Rull (1999), where income distribution interacts with marital decisions, fertility, and parental investment in children's human capital. None of the above papers considered the problem of fertility timing, however. Our results are also complementary to those of Olivetti (2001), who modeled the labor supply responses of women to shifts in the wage gap and returns to experience, taking demographics such as marital status and number of children as given. She finds that a shift in women's wage levels cannot account for the increase in labor supply of young married women, while an increase in the response of wage growth to women's experience can, a finding analogous to our own regarding marriage and fertility timing.

In the next section, we present our empirical analysis. In the following section, we develop our model. We discuss calibration of the model in Section 4. Our computational experiments are reported in Section 5, and conclusions are listed in the final section.

2. EMPIRICAL ANALYSIS

In this section we present an empirical description of labor supply and family decisions by income, education level, and birth cohort of the parents, based on a simple analysis of the PSID from 1968 to 1999. The goal of the analysis is to show how fertility and timing of births are related to wages, education, and birth cohort of the mother.

Empirically, two basic facts suggest the hypothesis that the timing channel plays an important role in the recent changes in labor market behavior and marital status. First, we know that women in low-income households tend to have children earlier than women in higher income households. Second, there has been a significant change in the timing of births, especially since the 1970s. Women are now having children later than was the case 30 years ago. For white women, according to Hotz *et al.* (1997), the probability of a first birth at age 20 has fallen from 17% in 1960 to 7% in the late 1980s. Rindfuss *et al.* (1996) showed that between 1973 and 1988, the age-specific fertility rates declined by 7% for women between ages 20 and 24, while increasing about 33% for those between ages 30 and 34. Indeed, Morgan (1996) pointed out that delayed childbearing is becoming a more visible feature of the modern American fertility pattern.

Before proceeding to the main analysis, we first give a simple view of what we mean by the timing of births. We construct a representative sample of births, which we call the "childbirth sample," by taking all the births and adoptions from the PSID childbirth and adoption history file. This file is

TABLE I
Fraction of Children Born to Mother Age 27 or Older

Variable	Statistics	Cohort 1958–1967	1948–1957	1938–1947
Mother older than age 27	Mean	0.56	0.49	0.39
	Std. dev.	(1.84)	(2.39)	(2.27)
	N	7283	2555	2048
Average age of mothers	Mean	26.78	26.06	24.91
	Std. dev.	(19.93)	(27.03)	(24.12)
	N	7283	2555	2048

based on interviews with members of PSID households from 1985 to 1999 and contains all the births and adoptions to each member of the panel, dating back to 1910. As in the analysis to follow, we restrict attention to those children whose mothers were born between 1938 and 1967. We divide all births into "early" and "late," according to whether the mother was younger or older than 26 years when the child was born.[3]

Table I shows that the fraction of children born late was about 0.39 for those children whose mother was in the birth cohort of 1938–1947, and that this number grew to 0.49 for the children of the 1948–1957 mothers and to at least 0.56 for the 1958–1967 mothers.[4] This is a significant change in fertility behavior, on the order of the much better known change in the quantity of children per mother that occurred over the same cohorts. Furthermore, the youngest mothers in our sample were 32 years old in 1999, so their fertility was not yet complete; our results therefore tend to understate the degree to which the most recent cohort of women has postponed fertility. This is also reflected in the increase in the average age of mothers at childbirth, from 25 years in the earliest cohort to nearly 27 years in the latest.[5]

In the analysis to follow, we take advantage of the panel structure of the PSID to relate these changes to women's wages, income, and education. Because not all of these variables are available for all the mothers of the children in the above sample, our data set will be smaller than would be the case if we were to take the mothers of the above children. To maximize sample size, our sample is drawn from the entire PSID, rather than just

[3]This age was chosen so that for mothers in our baseline birth cohort of 1928–1937 about 1/3 of the births occurred in the late interval. The results are qualitatively similar if the cut-off age is chosen anywhere up to age 30.

[4]Children are weighted by their mother's individual core weight for the year in which the mothers born in the middle of the 10-year interval reach the age of 25 years.

[5]Observations here are weighted by the core sample weight of the mother; thus mothers with more children end up with a higher weight in the sample, holding constant their core weight.

the cross-sectional core sample of the PSID, and then reweighted appropriately to represent a random sample of U.S. women. Our basic women's sample is composed of all women from the 1938–1967 birth cohorts who are also present in the childbirth and adoption history file and have a positive sampling weight; this yields a total sample size of 3837 women.

Our wage data sample is a subset of the women's sample and consists of all women for whom there is at least one observation with at least 100 labor hours per year. Wage variables are constructed by dividing women's labor income by their total hours worked, for each year in which they worked more than 100 h. The labor income variable we use includes wages and salaries, as well as business income, tips, and commissions. Hourly wages less than $5 or more than $100 are recorded as missing.[6] Lifetime wages are defined as averages over all years. Restricting attention to those women for whom wage data are available for ages 20–26 reduces the sample size to 2136 women.

The birth histories are compiled from the childbirth and adoption history file of 1985–1999 and from the PSID individual data set (1968–1992), which contains birth year variables for the first through fifth children born before 1992. We use these to compute the age of the mother at the birth of each child. We compute the proportion of "late" children of each mother as the fraction of her children born after she reached age 27; for women with no children, we set this proportion equal to missing.

In Table II, we present a basic statistical description of women's birth histories by cohort for the wage data sample. As we go from the oldest cohort to the youngest, the table shows a decline in fertility from 2.6 to 2.0 and an increase of nearly two years in the average age at which women have their first and second children: women from more recent cohorts have fewer children and have them later in life. The fraction of women who remained childless before age 27 increased 97% over the same cohort range. While the change in fertility is uncertain because the youngest may still have more children in the future, the postponement of fertility is unambiguous. Furthermore, the average number of children born after the mother has reached age 27 has already grown to exceed that of the older cohorts who have virtually completed fertility. Finally, the proportion of children born after the mother reached age 27 rose from 0.36 to 0.51, very much as in the larger childbirth sample discussed above. Taken together, the picture is clearly a very strong move away from motherhood while women are in their 20's. One component of this change is a decrease in the number of children demanded, and the second is a shift in childbearing to the 30's.

[6]All dollar amounts in this paper are deflated to 1997 currency, using the CPI. For 1994–1999, the wages are drawn from the PSID 1994–1999 hours of work and wage files, which are constructed from a broader range of variables, including self-reported wages.

TABLE II
Timing of Births by Mother's Birth Cohort

Variable	Statistics	Cohort 1958–1967	1948–1957	1938–1947
Total number of kids	Mean	2.06	2.04	2.57
	Std. dev.	(5.94)	(6.26)	(7.49)
	N	1899	1188	750
Age of mother at first child	Mean	24.32	23.78	22.53
	Std. dev.	(18.79)	(26.46)	(21.60)
	N	1566	1044	697
Age of mother at second child	Mean	27.09	26.87	25.19
	Std. dev.	(17.93)	(25.67)	(24.15)
	N	1237	843	607
Women childless before age 27	Mean	0.44	0.37	0.23
	Std. dev.	(1.91)	(2.37)	(2.07)
	N	1899	1188	750
Number of kids born after age 27	Mean	0.97	0.79	0.79
	Std. dev.	(4.25)	(4.64)	(4.39)
	N	1899	1188	750
Fraction of kids after age 27	Mean	0.51	0.44	0.36
	Std. dev.	(1.53)	(1.95)	(1.76)
	N	1566	1044	697

The next table repeats the above analysis by mother's wage quintile, rather than by birth cohort. The wage measure is the average over ages 30–40, as this is assumed to be more closely related to lifetime labor income than the wage observed in the earlier period. Table III shows that women in the lowest wage quintile have more children and have them much earlier than do women in the top wage quintile. Thus fertility is 2.45 for quintile 1, compared to 1.77 for quintile 5, a differential of about 38%. The age at which women have their first child rises over the wage distribution from an average age of 23 for the lowest quintile to 26.7 years for the highest. The share of women who have no children before age 27 actually doubles, from 0.31 for the first quintile to 0.63 for the richest quintile. The fraction of children born after the mother reaches age 27 increases from 0.42 to 0.64 across the income distribution, though there is a dip in the second quintile to 0.33. However, the overall pattern is one of much lower fertility and much later childbearing for higher income women.[7]

[7]Note that the number of observations reported in the table represents the number of records in the data, not the weights assigned to each respondent. Hence the lowest quintile has many more observations, as the PSID oversampled poor households.

TABLE III
Timing of Births by Mother's Wage Quintile

		Wage quintile				
Variable	Statistics	1	2	3	4	5
Total number of kids	Mean	2.45	2.20	2.01	1.71	1.77
	Std. dev.	(8.12)	(5.67)	(6.24)	(5.99)	(6.66)
	N	2155	477	453	388	364
Age of mother at first child	Mean	22.95	22.23	23.55	25.25	26.74
	Std. dev.	(21.09)	(20.29)	(25.81)	(27.43)	(29.08)
	N	1874	432	399	309	293
Age of mother at second child	Mean	25.71	25.32	26.43	28.55	29.53
	Std. dev.	(22.48)	(20.59)	(23.76)	(25.68)	(27.21)
	N	1556	344	309	248	230
No kids before age 27	Mean	0.31	0.22	0.34	0.53	0.63
	Std. dev.	(2.15)	(1.95)	(2.30)	(2.61)	(2.61)
	N	2155	477	453	388	364
Number of kids before age 27	Mean	1.37	1.49	1.18	0.77	0.64
	Std. dev.	(5.81)	(5.30)	(5.58)	(5.05)	(5.15)
	N	2155	477	453	388	364
Number of kids born after age 27	Mean	0.94	0.65	0.72	0.86	1.02
	Std. dev.	(5.14)	(3.86)	(4.49)	(5.16)	(5.73)
	N	2155	477	453	388	364
Fraction of kids after age 27	Mean	0.42	0.33	0.41	0.54	0.64
	Std. dev.	(1.73)	(1.66)	(1.97)	(2.25)	(2.24)
	N	1874	432	399	309	293

It is quite plausible that both of these patterns of fertility timing, the changes over cohorts and over wage quintiles, are driven by differences in education. This hypothesis seems to be supported by Tables IV and V which show that education and marriage patterns closely track the fertility timing patterns. Thus the percentage of women who attended college doubles over the cohorts, while the shares of high school and college graduates increase from 69 to 83%, and from 11 to 19%, respectively.[8] The share of women who did not marry by ages 27 or 37 both tripled, which makes the divorce rate growth, from 12 to 19% of women divorced by age 27, even more significant than it may appear at first glance.

Across the wage distribution, the same patterns hold: the fraction of women with bachelor's degrees increases from 9 to 39% of women at the top quintile, while nonmarriage by age 27 increases from 24 do 29%. The divorce rate, however, is much lower for the top wage quintiles than for

[8]These statistics ignore high school completion after age 21, and college attendance after age 30. A substantial fraction of women in the earlier cohorts appear to return to school after raising children.

TABLE IV
Education and Marriage by Birth Cohort

Variable	Statistics	Cohort 1958–1967	1948–1957	1938–1947
High school graduate	Mean	0.83	0.78	0.69
	Std. dev.	(1.40)	(2.01)	(2.27)
	N	1105	1040	588
Attended college	Mean	0.48	0.33	0.22
	Std. dev.	(1.85)	(2.26)	(2.04)
	N	1105	1040	588
Received bachelor's degree	Mean	0.19	0.18	0.11
	Std. dev.	(1.44)	(1.86)	(1.54)
	N	1105	1040	588
Received masters' degree	Mean	0.06	0.05	0.02
	Std. dev.	(0.84)	(1.06)	(0.66)
	N	1105	1040	588
Did not marry before age 27	Mean	0.34	0.23	0.11
	Std. dev.	(1.80)	(2.06)	(1.55)
	N	1435	1187	691
Did not marry before age 37	Mean	0.21	0.13	0.06
	Std. dev.	(1.54)	(1.64)	(1.16)
	N	1435	1187	691
Divorced by age 27	Mean	0.19	0.20	0.12
	Std. dev.	(1.48)	(1.95)	(1.62)
	N	1435	1187	691

the bottom, suggesting a positive association between marital stability and women's human capital.

To assess the relative importance for fertility timing of changes in education attainment vs changes in fertility behavior given education, we conduct a simple experiment. In Table VI, we ask what would have happened to fertility timing under the following two counterfactual conditions: (1) suppose that fertility behavior had remained constant and that the education choices of the 1938–47 cohort had evolved to match that of the 1958–67 cohort; (2) suppose that education choices had remained the same, but fertility behavior had evolved to match that of the 1960s. The first part of the table gives the actual proportion of kids born after age 27 by mother's education. The second part gives the timing statistics under each of the counterfactual scenarios. The proportion of kids born late is much higher for the second scenario than for the first. If only the education distribution had shifted over time, the proportion of late children would have grown from 36 to 41%, while if only the behavior of each group had changed, the proportion would have risen to 48%. In other words, 70% of the change in

TABLE V
Education and Marriage by Wage Quintile

Variable	Statistics	Wage quintile 1	2	3	4	5
High school graduate	Mean	0.65	0.737	0.78	0.87	0.89
	Std. dev.	(2.18)	(2.10)	(2.00)	(1.78)	(1.73)
	N	1330	422	394	303	284
Attended college	Mean	0.24	0.28	0.33	0.49	0.55
	Std. dev.	(1.96)	(2.14)	(2.28)	(2.64)	(2.71)
	N	1330	422	394	303	284
Received bachelor's degree	Mean	0.09	0.05	0.13	0.27	0.39
	Std. dev.	(1.31)	(1.03)	(1.66)	(2.35)	(2.66)
	N	1330	422	394	303	284
Received master's Degree	Mean	0.02	0.01	0.04	0.06	0.13
	Std. dev.	(0.69)	(0.40)	(0.90)	(1.21)	(1.80)
	N	1330	422	394	303	284
Average wage, ages 20–26	Mean	12.06	11.15	12.36	13.29	17.29
	Std. dev.	(43.90)	(31.00)	(35.59)	(24.11)	(36.27)
	N	849	348	354	305	280
Did not marry before age 27	Mean	0.24	0.18	0.19	0.29	0.29
	Std. dev.	(1.92)	(1.80)	(1.92)	(2.37)	(2.46)
	N	1631	477	453	388	364
Did not marry before age 37	Mean	0.17	0.11	0.11	0.15	0.13
	Std. dev.	(1.69)	(1.50)	(1.53)	(1.85)	(1.82)
	N	1631	477	453	388	364
Divorced by age 27	Mean	0.19	0.19	0.21	0.15	0.12
	Std. dev.	(1.78)	(1.86)	(1.97)	(1.85)	(1.73)
	N	1631	477	453	388	364

the late proportion can be attributed to changes in the fertility behavior of women, taking education as given.

Another way to see this is to consider the regression estimates in Tables VII and VIII. The dependent variable is the proportion of late children. In Table VII, it is clear that log wages (lifetime averages) are strongly associated with later fertility, even when conditioning on the total number of kids. It is also clear that this effect is much stronger for the youngest cohort than it is for the older cohorts; the coefficient on log wage more than doubles, growing from 0.17 for the oldest cohort to 0.39 for the youngest. Thus it seems likely that the effect of wages on fertility delay has strongly increased over time.

It is possible that this effect of wages only reflects the fact that women are much less likely to have children while in school, and that high-wage women stay in school much longer than low-wage women. Ideally, adding education to the above regression would clarify this point, but the results can be

TABLE VI
Decomposition of Change in Proportion of Kids Born after Mother Is 27 Years Old[a]

Row	Birth cohort	Statistics	No diploma	High school diploma	Attended college	Bachelor's degree	Late prop.
0	1958–1967	Mass	0.17	0.35	0.29	0.19	0.53
		Late prop.	0.49	0.39	0.54	0.81	
1	1938–1947	Mass	0.306	0.48	0.11	0.11	0.36
		Late prop.	0.29	0.36	0.35	0.68	
		If Only Educational Attainment Had Changed					
2	Expt 1	Mass	0.17	0.35	0.29	0.19	0.41
		Late prop.	0.29	0.36	0.35	0.68	
		If Only Fertility Behavior Had Changed					
3	Expt 1	Mass	0.306	0.476	0.108	0.11	0.48
		Late prop.	0.49	0.39	0.54	0.81	

[a] Education attainment refers to *maximum* level attained of these four levels.

hard to interpret and parameter instability may arise from multicollinearity between wages, attainment, and years of education. This can be seen in Table VIII, where we add various measures of education to the equation. It is clear from the results that even after we control for the number of years of education, there is still a strong association between fertility delay and measures of human capital. The wage effect is naturally quite a bit smaller, and indeed it only remains significant at the 0.05 level for the youngest cohort. However, college attendance, bachelor's degree, and high school

TABLE VII
Lifetime Wages and Timing

Variable[a]	Statistics	Cohort 1958–1967	1948–1957	1938–1947
Intercept	Parameter estimate	−0.46	−1.63	−32.12
	Standard error	(0.16)	(2.71)	(60.66)
	t value	−2.93	−0.60	−0.53
	$Pr > \|t\|$	0.00	0.55	0.60
Log wage	Parameter estimate	0.39	0.21	0.17
	Standard error	(0.04)	(0.03)	(0.04)
	t value	9.83	6.58	4.47
	$Pr > \|t\|$	0.00	0.00	0.00
Number of kids ever born	Parameter estimate	−0.02	0.00	−0.03
	Standard error	(0.02)	(0.01)	(0.02)
	t value	−1.33	0.12	−1.94
	$Pr > \|t\|$	0.18	0.90	0.05

[a] Estimates for age polynomial omitted. Dependent variable is proportion of children born late.

TABLE VIII
Lifetime Wages, Education, and Timing

		Cohort		
Variable[a]	Statistics	1958–1967	1948–1957	1938–1947
Intercept	Parameter estimate	−1.09	−2.71	7.79
	Standard error	(0.20)	(2.41)	(64.80)
	t value	−5.53	−1.12	0.12
	$Pr > \|t\|$	0.00	0.26	0.90
Wage	Parameter estimate	0.24	0.03	0.07
	Standard error	(0.04)	(0.03)	(0.04)
	t value	5.51	0.92	1.81
	$Pr > \|t\|$	0.00	0.36	0.07
Years of education	Parameter estimate	0.07	0.03	0.04
	Standard error	(0.01)	(0.01)	(0.01)
	t value	5.46	4.25	3.26
	$Pr > \|t\|$	0.00	0.00	0.00
High school graduate	Parameter estimate	−0.02	0.08	0.13
	Standard error	(0.05)	(0.03)	(0.06)
	t value	−0.34	2.23	2.20
	$Pr > \|t\|$	0.73	0.03	0.03
Attended college	Parameter estimate	0.07	0.18	−0.17
	Standard error	(0.04)	(0.03)	(0.06)
	t value	1.73	5.19	−2.75
	$Pr > \|t\|$	0.08	0.00	0.01
Received bachelor's degree	Parameter estimate	0.00	0.19	0.40
	Standard error	(0.06)	(0.05)	(0.08)
	t value	−0.08	4.14	4.77
	$Pr > \|t\|$	0.94	0.00	0.00
Total number of children	Parameter estimate	0.00	0.01	−0.01
	Standard error	(0.02)	(0.01)	(0.02)
	t value	0.12	0.43	−0.40
	$Pr > \|t\|$	0.90	0.67	0.69

[a] Estimates for age polynomial omitted. Dependent variable is proportion of children born late.

graduation are all strongly associated with fertility delay for the middle cohort, and college attendance fails to delay fertility for the oldest cohort only. Since this latter effect is estimated while controlling for the bachelor's degree, the natural interpretation is that women of the oldest cohort were likely to interrupt their college career in order to have children.

Turning to the labor market, we explore how female labor supply depends on marital status, and how this dependence has changed over the three 10-year cohorts from 1928 to 1957. Marital status is divided into three categories: "single," which is taken to mean never married, "married," which means living with a spouse, and "divorced," which means previously married. Marital information is derived from the 1985–1999 PSID marital history file, which lists dates for legal marriages and divorces and from the married pairs variable in the family data, which includes domestic partners who are not legally married. Widows are excluded from the data.

Table IX shows that young married women work much less than single women but that this difference is largely erased by age 27 for the youngest two cohorts. Over time, the labor supply of married women age 20–26 has increased tremendously: from an average of 758 h for the 1938–1947 cohort to 1294 h for the youngest cohort. As observed in the Introduction, this has been commented upon in earlier research, such as Olivetti (2001) and is usually taken to reflect a decline in the pattern of young married women leaving the labor force temporarily to raise children. Wages of single women tend to be higher than those of married women at young ages, but married women catch up later. We interpret this as reflecting both timing of marriage (high-wage women marry later) and the selection out of the labor force among married women (high-wage married women tend to have higher nonlabor income and hence work less while young).

Table X shows the same data for men. The main point of this table is that none of the labor supply patterns we observed for women are present for men. Single men tend to work less than married men, which is the opposite of the case for women. There has been no trend, either up or down in the labor supply of young married men, although older married men now work about 10% more on average than they did in the older cohort. Wages for single men tend to be lower than for married men, but the differences in family income across marital status are much smaller than was the case for women, reflecting both higher wages and higher labor supply of men relative to women.

Our empirical analysis of a representative sample of the U.S. population confirms both the cross-sectional and time-series patterns alluded to in the Introduction. Women's wages play a key role in both the quantity and timing of children, and the time trend for recent birth cohorts has been toward women giving birth at later ages. These phenomena cannot be explained by women's education decisions; cross-sectional fertility differences match up better with household income than with mother's education, and the shift in timing patterns over cohorts is greater within than it is across education classes. The labor supply of young women has increased tremendously over the birth cohorts in our sample, partly because women are staying single longer, and partly because married women now work more hours. The significance of these statistics is not only that they confirm and quantify the phenomena that we would like to model, but also they provide targets that we will use below to discipline our model specification and assess its performance.

TABLE IX

Women's Wages, Labor, and Income by Birth Cohort, Marital Status, and Age[a]

Age interval	Marital status	Statistic	1958–1967 Wage	1958–1967 Hours	1958–1967 Family income	1948–1957 Wage	1948–1957 Hours	1948–1957 Family income	1938–1947 Wage	1938–1947 Hours	1938–1947 Family income
16–20	Single	Mean	$10.78	1469	$20,432	$8.54	1430	$18,613	$3.20	1379	$22,629
		Std. dev.	(7.850)	(770)	(15,033)	(10.080)	(747)	(11,185)	(11.690)	(790)	(12,949)
		N	2124	2818	2818	1442	1892	1892	184	236	236
	Married	Mean	$9.21	1140	$43,372	$20.56	891	$42,500	$47.48	683	$44,111
		Std. dev.	(6.550)	(897)	(27,621)	(40.540)	(928)	(23,164)	(72.440)	(941)	(24,363)
		N	3280	4317	4317	3265	4821	4821	840	1469	1469
	Divorced	Mean	$7.88	1332	$19,973	$8.82	1311	$21,553	$5.30	1556	$22,211
		Std. dev.	(4.110)	(817)	(15,292)	(9.240)	(839)	(14,589)	(12.660)	(811)	(10,971)
		N	608	804	804	566	688	688	78	98	98
20–26	Single	Mean	$15.43	1669	$29,176	$13.19	1488	$26,288	$7.00	1457	$29,502
		Std. dev.	(15.520)	(663)	(20,717)	(8.620)	(734)	(19,220)	(7.990)	(743)	(13,812)
		N	1850	2220	2076	1517	2000	2000	424	559	559
	Married	Mean	$12.39	1294	$66,382	$12.31	1134	$60,791	$30.28	758	$59,985
		Std. dev.	(13.460)	(942)	(57,076)	(12.090)	(956)	(40,597)	(70.120)	(972)	(42,061)
		N	4274	4980	4683	4688	6166	6166	2542	4345	4345
	Divorced	Mean	$10.78	1520	$24,769	$10.80	1480	$26,004	$8.61	1550	$29,811
		Std. dev.	(8.260)	(751)	(18,021)	(6.850)	(795)	(18,105)	(8.640)	(736)	(18,602)
		N	1203	1398	1317	1402	1741	1741	563	711	711
26–37	Single	Mean	$11.91	1515	$25,263	$13.78	1526	$32,729	$13.73	1629	$34,418
		Std. dev.	(9.780)	(713)	(16,014)	(14.870)	(760)	(47,182)	(9.490)	(665)	(17,241)
		N	144	159	103	1182	1424	1323	800	971	971
	Married	Mean	$15.12	1336	$81,242	$13.92	1395	$80,776	$12.09	1179	$77,497
		Std. dev.	(20.840)	(912)	(90,923)	(25.550)	(952)	(79,187)	(11.070)	(1008)	(74,428)
		N	530	577	377	4816	5490	5063	4820	6418	6418
	Divorced	Mean	$11.41	1679	$23,045	$13.23	1705	$32,797	$14.17	1645	$36,898
		Std. dev.	(7.490)	(716)	(12,688)	(11.730)	(769)	(24,615)	(11.580)	(806)	(27,682)
		N	181	198	124	1790	2055	1910	1452	1733	1733

[a]Family income has been truncated at $0 and $1,000,000 with hours truncated at 2500 per year. All observations are restricted to household heads and spouses.

TABLE X

Men's Wages, Labor, and Income by Birth Cohort, Marital Status, and Age[a]

Age interval	Marital status	Statistic	1958–1967 Wage	1958–1967 Hours	1958–1967 Family income	1948–1957 Wage	1948–1957 Hours	1948–1957 Family income	1938–1947 Wage	1938–1947 Hours	1938–1947 Family income
16–20	Single	Mean	$11.75	1864	$25,102	$10.03	1760	$25,332	$1.67	1679	$22,041
		Std. dev.	(6.230)	(639)	(15,856)	(10.030)	(675)	(17,996)	(7.460)	(884)	(14,822)
		N	2072	2265	2265	1365	1471	1471	114	120	120
	Married	Mean	$12.26	2029	$38,554	$11.45	2019	$40,750	$4.99	2097	$42,971
		Std. dev.	(7.660)	(529)	(22,151)	(10.520)	(596)	(21,389)	(13.000)	(586)	(21,553)
		N	2589	2676	2676	3240	3316	3316	1141	1155	1155
	Divorced	Mean	$10.21	1937	$24,618	$9.81	1881	$30,153	$0.88	1946	$34,624
		Std. dev.	(7.450)	(591)	(13,391)	(8.260)	(686)	(18,193)	(2.140)	(577)	(17,855)
		N	316	339	339	272	284	284	33	36	36
20–26	Single	Mean	$14.75	1958	$34,150	$16.34	1843	$37,292	$8.99	2042	$29,308
		Std. dev.	(9.490)	(599)	(24,910)	(10.430)	(633)	(24,657)	(8.570)	(585)	(17,302)
		N	1459	1727	1655	1153	1312	1312	151	158	158
	Married	Mean	$18.74	2125	$62,564	$18.44	2075	$57,533	$11.98	2152	$55,500
		Std. dev.	(17.760)	(512)	(48,056)	(14.420)	(541)	(38,445)	(12.560)	(480)	(33,308)
		N	4048	4412	4161	5816	5990	5990	3748	3785	3785
	Divorced	Mean	$14.16	2015	$34,587	$15.53	1894	$40,605	$15.50	1894	$43,894
		Std. dev.	(8.780)	(560)	(22,676)	(8.530)	(653)	(26,994)	(22.570)	(765)	(30,969)
		N	683	771	728	847	936	936	331	346	346
26–37	Single	Mean	$16.49	1914	$40,197	$19.36	1730	$49,472	$14.13	1864	$34,140
		Std. dev.	(12.760)	(621)	(26,269)	(21.920)	(747)	(72,703)	(10.560)	(793)	(30,004)
		N	69	90	64	671	810	755	163	202	202
	Married	Mean	$26.01	2184	$77,449	$23.25	2105	$80,001	$21.74	2085	$77,392
		Std. dev.	(27.050)	(458)	(67,313)	(27.300)	(582)	(76,188)	(20.910)	(611)	(67,612)
		N	500	570	372	5014	5481	5038	5406	5662	5662
	Divorced	Mean	$14.66	1727	$35,687	$16.60	1810	$39,531	$19.17	1996	$51,392
		Std. dev.	(9.880)	(797)	(22,373)	(15.880)	(776)	(30,423)	(12.540)	(697)	(39,082)
		N	60	74	46	931	1096	1014	873	1005	1005

[a]Family income has been truncated at $0 and $1,000,000 with hours truncated at 2500 per year. All observations are restricted to household heads and spouses.

3. MODEL

3.1. *Economic Environment*

The economy is populated by people who live for five periods, two periods as children and three periods as adults. Adults differ in their sex, productivity, marital status, employment, and childbearing histories. Women can have children in the first two periods of their adult life. The children are attached to their mother throughout their two-period childhood and they make no economic decisions. Adults care about consumption, human capital investment in their children, and leisure.

Each period there is a marriage market where each single agent meets an agent of the same generation and the opposite sex. Married couples decide whether or not to stay married. If they divorce they are considered single and match immediately in the marriage market.

Each period, one- and two-period old married couples and single women decide how many kids, $k \in \{0, 1, \dots, K\}$, to have. Children impose a fixed time cost for their parents. This cost depends on the age of the child and on the gender of the parent. Let k_1 represent the number of kids who are one-period old and let k_2 represent the number of kids who are two-period old. The total number of kids in a household is given by $k = k_1 + k_2$. Only two-period old women can have children of different ages. When there is no confusion we use k to represent the number of kids of any age.

Let x denote the productivity (wage) of a female and z denote the productivity (wage) of a male; we assume that these are random draws from finite sets:

$$x \in \mathscr{X} \equiv \{x_1, \dots, x_N\} \quad \text{and} \quad z \in \mathscr{Z} \equiv \{z_1, \dots, z_N\}.$$

Each period the oldest generation of children become young adults, replacing the oldest generation of adults. The productivity of a first-period adult depends on the total human capital investment he or she receives during childhood. The productivity of a second-period adult depends on his or her initial productivity and labor supply in the first period. Similarly, the productivity of a third-period adult depends on his or her productivity and labor supply in the second period. The fact that future productivity depends on current labor supply decisions is key to the hypothesis that a change in the returns to labor market experience for women has led to a shift in the timing of births.

The utility function for females is represented by

$$F(c, h, k_1, k_2, 1 - l - t - \chi_f(k_1, k_2), \gamma),$$

where c is consumption, h is human capital investment in children, l is labor supply, t is child care, γ is a marriage match quality shock, and $\chi_f(k_1, k_2)$

is the fixed time cost of having k_1 one-period old and k_2 two-period old children at home. Similarly, for males, the utility function is represented by

$$M(c, h, k_1, k_2, 1 - n - \chi_m(k_1, k_2), \gamma),$$

where n is labor supply. For a single male, utility from human capital investment in children, h, is set to zero.

The total income of a household is represented by $Y(x, z, l, n)$, and per-member consumption is represented by $c = \Psi(p, k)[Y(x, z, l, n) - g]$, where p is the number of adult members in a household, k is the number of children, and g is the goods spent on kids.

Agents observe the match quality γ before they decide whether to accept or reject a match. Let $\gamma \in \{\gamma_1, \ldots, \gamma_M\}$, and assume that the realizations are independently and identically distributed with density function $\Gamma(\gamma_j)$. Human capital investment per child is represented by $h = H(g, t, k_1, k_2)$.

At the end of childhood, each child will have received a total human capital investment of $\mathfrak{h} = h_1 + h_2$, where h_1 and h_2 represent the human capital investment received when kids are one and two periods old, respectively. Initial productivity is drawn according to

$$\Pr[x = x_i] = \Xi[x = x_i|\mathfrak{h}], \quad \text{and} \quad \Pr[z = z_i] = \Theta[z = z_i|\mathfrak{h}].$$

In the second and third periods, the productivity levels evolve according to

$$X(x_j|x_i, l_{-1}) = \Pr[x' = x_j|x = x_i, l_{-1}],$$

where l_{-1} is the last period's labor supply. Similarly,

$$Z(z_j|z_i, n_{-1}) = \Pr[z' = z_j|z = z_i, n_{-1}].$$

Note that the dependence of the distribution on labor supply allows for returns to experience in the form of higher future productivity.

3.2. *The Equilibrium*

To define the equilibrium for this economy, it is necessary to list the problems agents solve at each point in time and define the decision rules that are optimal under our assumptions about decision making. We begin with the last period and use the value functions defined there to represent the problems of younger agents. At the beginning of each period, single people meet in a marriage market. If a couple chooses to marry, the spouses decide how many kids to have, how much to work, and how much to invest in their children. In all periods, we assume that the decision rules of married couples are given by the Nash solution to the fixed-threat bargaining problem, where agents have equal bargaining power. The outside options in this problem are given by the continuation values of their next best options, whether that is remaining single or taking a new draw from the marriage market.

3.2.1. *Third Period*

Three-period old women have either no kids at home or kids that were born last period. The value function for a single woman with productivity x and k two-period old and no one-period old kids is defined by a simple maximization problem

$$G_3(x, 0, k) = \max_{l,t,g}\{F(c, h, 0, k, 1 - l - t - \chi_f(0, k))\} \qquad P(3a)$$

subject to

$$c = \Psi(1, k)[xl - g],$$
$$h = H(g, t, 0, k).$$

Let the human capital investment for a third-period single woman be given by

$$h = H_3^s\big(g_3^s(x, 0, k), t_3^s(x, 0, k), 0, k\big),$$

where $g_3^s(x, 0, k)$ and $t_3^s(x, 0, k)$ are solutions to P(3a). Similarly, let

$$B_3(z) = \max_n\{M(zn, 0, 0, 0, 1 - n)\} \qquad P(3b)$$

be the value of single life for a three-period old man.

We refer to three-period old newly matched couples as new marriages. A three-period newly married couple can only have children who are now two periods old. The education decision rules, $g_3^{nm}(x, z, 0, k, \gamma)$ and $t_3^{nm}(x, z, 0, k, \gamma)$, and labor supply decision rules, $l_3^{nm}(x, z, 0, k, \gamma)$ and $n_3^{nm}(x, z, 0, k, \gamma)$, of the newly married couple solve

$$\max_{l,n,t,g}[F(c, h, 0, k, 1 - l - t - \chi_f(0, k)) - G_3(x, 0, k)]$$
$$[M(c, h, 0, k, 1 - n - \chi_m(0, k)) - B_3(z)]$$

subject to

$$\begin{aligned} c &= \Psi(2, k)[xl + zn - g], \\ h &= H(g, t, 0, k). \end{aligned} \qquad P(3n)$$

Denote the resulting human capital investment decision of a three-period old newly married couple by

$$h = H_3^{nm}\big(g_3^{nm}(x, z, 0, k, \gamma), t_3^{nm}(x, z, 0, k, \gamma), 0, k\big).$$

Let the values of being newly married be $W_3^n(x, z, 0, k, \gamma)$ for a woman and $V_3^n(x, z, 0, k, \gamma)$ for a man. These are simply the values of the utility functions evaluated at the decision rules that maximize the Nash bargaining product. Given these values, let $I_3^n(x, z, 0, k, \gamma)$ be the indicator function for the marriage decision of a newly matched, three-period old couple of type $(x, z, 0, k, \gamma)$,

$$I_3^n(x, z, 0, k, \gamma) = \begin{cases} 1, & W_3^n(x, z, 0, k, \gamma) \geq G_3(x, 0, k) \text{ and} \\ & V_3^n(x, z, 0, k, \gamma) \geq B_3(z) \\ 0, & \text{otherwise} \end{cases}. \qquad P(3n')$$

Some agents enter the third period already married. As before, such a couple can only have children who are now two-period old. For each agent, the outside option is to take a new draw from the marriage market; denote the value of this option $EW_3^{dr}(x, k)$ for women, and $EV_3^{dr}(z)$ for men. They are explicitly defined in the Appendix. Then for a couple with k kids and a match quality γ, the optimal decision rules, $g_3^{om}(x, z, 0, k, \gamma)$, $t_3^{om}(x, z, 0, k, \gamma)$, $l_3^{om}(x, z, 0, k, \gamma)$, and $n_3^{om}(x, z, 0, k, \gamma)$, solve

$$\max_{l, n, t, g} [F(c, h, 0, k, 1 - l - t - \chi_f(0, k)) - EW_3^{dr}(x, k)]$$
$$[M(c, h, 0, k, 1 - n - \chi_m(0, k)) - EV_3^{dr}(z)], \qquad P(3o)$$

subject to

$$c = \Psi(2, k)[xl + zn - g],$$
$$h = H(g, t, 0, k).$$

Again denote the human capital investment by a three-period old, already-married couple, by

$$h = H_3^{om}\big(g_3^{om}(x, z, 0, k, \gamma), t_3^{om}(x, z, 0, k, \gamma), 0, k\big).$$

Let $W_3^o(x, z, 0, k, \gamma)$ be the wife's value of continuing in the marriage and $V_3^o(x, z, 0, k, \gamma)$ be that of the husband, resulting from the optimal decision rules. The indicator function, $I_3^o(x, z, 0, k, \gamma)$, for continuing the marriage is then given by

$$I_3^o(x, z, 0, k, \gamma) = \begin{cases} 1, & W_3^o(x, z, 0, k, \gamma) \geq EW_3^{dr}(x, k) \text{ and} \\ & V_3^o(x, z, 0, k, \gamma) \geq EV_3^{dr}(z) \\ 0, & \text{otherwise} \end{cases}. \qquad P(3o')$$

3.2.2. *Second Period*

The second-period decision process differs from the third-period decision process in that there is no fertility decision for single women and married couples. The value of being a two-period old single woman of type x, who has k_2 two-period old kids is

$$G_2(x, k_2) = \max_{k, l, t, g} \Big\{ F(c, h, k, k_2, 1 - l - t - \chi_f(k, k_2))$$
$$+ \beta \sum_i EW_3^{dr}(x_i, k) X(x_i \mid x, l) \Big\} \qquad P(2a)$$

subject to

$$c = \Psi(1, k + k_2)[xl - g],$$
$$h = H(g, t, k, k_2).$$

Let the decisions that solve this problem be denoted by $g_2^s(x, k_2)$, $t_2^s(x, k_2)$, $K_2^s(x, k_2)$, and $l_2^s(x, k_2)$. The per-child investment in human capital made by a two-period old single woman is then given by

$$h = H_2^s\big(g_2^s(x, k_2), t_2^s(x, k_2), K_2^s(x, k_2), k_2\big).$$

For single men, we define $B_2(z)$ in the obvious way:

$$B_2(z) = \max_n \Big\{ M(zn, 0, 0, 0, 1 - n) + \beta \sum_j EV_3^{dr}(z_j) Z(z_j \mid z, n) \Big\}. \quad P(2b)$$

The decision rules for a newly married second-period couple in state (x, z, k_2, γ) are given by the Nash solution to the bargaining game $P(2n)$ below, with outside options $B_2(z)$ and $G_2(x, k_2)$. We denote the decision rules for fertility, investment, and labor supply by $K_2^{nm}(x, z, k_2, \gamma)$, $g_2^{nm}(x, z, k_2, \gamma)$, $t_2^{nm}(x, z, k_2, \gamma)$, $n_2^{nm}(x, z, k_2, \gamma)$, and $l_2^{nm}(x, z, k_2, \gamma)$, and the associated values of husband and wife as $V_2^n(x, z, k_2, \gamma)$ and $W_2^n(x, z, k_2, \gamma)$, respectively. These decision rules solve

$$\begin{aligned} \max_{l, t, n, g, k} \big[& F(c, h, k, k_2, 1 - l - t - \chi_f(k, k_2)) \\ & + \beta E W_3^{con}(\cdot \mid x, z, k_2, \gamma) - G_2(x, k_2) \big] \\ \big[& M(c, h, k, k_2, 1 - n - \chi_m(k, k_2)) \\ & + \beta E V_3^{con}(\cdot \mid x, z, k_2, \gamma) - B_2(z) \big], \end{aligned} \qquad P(2n)$$

subject to

$$c = \Psi(2, k + k_2)[xl + zn - g],$$
$$h = H(g, t, k, k_2).$$

Here $EW_3^{con}(\cdot \mid x, z, k_2, \gamma)$ and $EV_3^{con}(\cdot \mid x, z, k_2, \gamma)$ are expected third-period continuation values of being married in the state (x, z, k_2, γ) in the second period for females and males, respectively. Their explicit definitions are again left for the Appendix. The utility of being married today also includes the possible gains from remaining married to your spouse next period, or getting divorced and taking a draw from next period's marriage market. Since this is a new marriage, the threat point equals the value of remaining single in the second period. The associated indicator function for marriage is given by

$$I_2^n(x, z, k_2, \gamma) = \begin{cases} 1, & W_2^n(x, z, k_2, \gamma) \geq G_2(x, k_2) \text{ and } \\ & V_2^n(x, z, k_2, \gamma) \geq B_2(z) \\ 0, & \text{otherwise} \end{cases}. \qquad P(2n')$$

The outside options for already-married couples will depend on the expected value of going back to the marriage market. Suppose that the expected values of taking a draw in the second-period marriage market for men and women are given by $EV_2^{dr}(z)$ and $EW_2^{dr}(x, k_2)$ (see again the Appendix). Then for already-married couples in state (x, z, k_2, γ), the decision rules $K_2^{om}(x, z, k_2, \gamma)$, $l_2^{om}(x, z, k_2, \gamma)$, $t_2^{om}(x, z, k_2, \gamma)$, $n_2^{om}(x, z, k_2, \gamma)$, and $g_2^{om}(x, z, k_2, \gamma)$ are the solutions to problem $P(2o)$

$$\begin{aligned}\max_{k,l,t,n,g} &[F(c, h, k, k_2, 1 - l - t - \chi_f(k, k_2)) \\ &\quad + \beta EW_3^{con}(\cdot \mid x, z, k_2, \gamma) - EW_2^{dr}(x, k_2)] \\ &[M(c, h, k, k_2, 1 - n - \chi_m(k, k_2)) \\ &\quad + \beta EV_3^{con}(\cdot \mid x, z, k_2, \gamma) - EV_2^{dr}(z)], \qquad P(2o)\end{aligned}$$

subject to

$$\begin{aligned} c &= \Psi(2, k + k_2)[xl + zn - g], \\ h &= H(g, t, k, k_2). \end{aligned}$$

Let the value of continuing to be married in the second period that results from the decision rules that solve this problem be given by $W_2^o(x, z, k_2, \gamma)$ for the wife and by $V_2^o(x, z, k_2, \gamma)$ for the husband.

For a two-period old couple that considers divorce, we have the following indicator function,

$$I_2^o(x, z, k_2, \gamma) = \begin{cases} 1, & W_2^o(x, z, k_2, \gamma) \geq EW_2^{dr}(x, k_2) \quad \text{and} \\ & V_2^o(x, z, k_2, \gamma) \geq EV_2^{dr}(z) \\ 0, & \text{otherwise} \end{cases}. \qquad P(2o')$$

3.2.3. *First Period*

In the first period, the decision process is simplified because there are no already-married couples at the beginning of the first period. The value of being a one-period old single woman of type x is given by

$$\begin{aligned} G_1(x) = \max_{k,l,t,g} \Big\{ &F(c, h, k, 0, 1 - l - t - \chi_f(k, 0)) \\ &+ \beta \sum_i EW_2^{dr}(x_i, k) X(x_i | x, l) \Big\}. \qquad P(1a) \end{aligned}$$

Let $K_1^s(x)$ be the optimal fertility choice of the first period single woman with productivity x. Let a one-period old single woman make the following human capital investment in her children:

$$h = H_1^s(g_1^s(x), t_1^s(x), K_1^s(x), 0).$$

We can similarly define $B_1(z)$ for one-period old single men, and $W_1^n(x, z, \gamma)$ and $V_1^n(x, z, \gamma)$ for one-period old, newly married couples, and their corresponding fertility decisions, $K_1^{nm}(x, z, \gamma)$. Note that all marriages in period one are new marriages. The marriage decisions for the matches between first period single women and first period single men are given by

$$I_1^n(x, z, \gamma) = \begin{cases} 1, & W_1^n(x, z, \gamma) \geq G_1(x) \text{ and} \\ & V_1^n(x, z, \gamma) \geq B_1(z) \\ 0, & \text{otherwise} \end{cases}. \qquad P(1n')$$

3.2.4. *Definition*

A stationary equilibrium is a collection of value functions, household decision rules, marital decision rules, and matching probabilities such that all decision rules are optimal, taking the matching probabilities and decisions of other agents as given, and such that the value functions and matching probabilities are generated by the decision rules.

DEFINITION 1. A stationary matching equilibrium is a set of child quantity and quality allocation rules, $K_1^{nm}(x, z, \gamma)$, $K_2^{nm}(x, z, k, \gamma)$, $K_2^{om}(x, z, k, \gamma)$, $K_1^s(x)$, $K_2^s(x, k)$, $H_3^{nm}(g_3^{nm}, t_3^{nm}, 0, k)$, $H_3^{om}(g_3^{om}, t_3^{om}, 0, k)$, $H_3^s(g_3^s, t_3^s, 0, k)$, $H_2^{nm}(g_2^{nm}, t_2^{nm}, K_2^{nm}, k)$, $H_2^{om}(g_2^{om}, t_2^{om}, K_2^{om}, k)$, $H_2^s(g_2^s, t_2^s, K_2^s, k)$, $H_1^{nm}(g_1^{nm}, t_1^{nm}, K_1^{nm}, 0)$, and $H_1^s(g_1^s, t_1^s, K^s, 0)$ a set of accept/reject decision rules, $I_1^n(x, z, \gamma)$, $I_2^n(x, z, k, \gamma)$, $I_3^n(x, z, 0, k, \gamma)$, $I_2^o(x, z, k, \gamma)$, $I_3^o(x, z, 0, k, \gamma)$, and a set of matching probabilities, $\Phi_1(x)$, $\Phi_2(x, k)$, $\Phi_3(x, k)$, $\Omega_1(z)$, $\Omega_2(z)$, and $\Omega_3(z)$ such that:

1. The household decision rules are optimal taking as given the marital decision rules and the matching probabilities; i.e., they solve $P(3a)$, $P(3b)$, $P(3n)$, $P(3o)$, $P(2a)$, $P(2b)$, $P(2n)$, $P(2o)$, and $P(1a)$ defined above (as well as corresponding problems for first-period single men and newly married couples that are not explicitly defined).

2. The marital decision rules for a given sex are optimal, taking as given the marital decision rules of the other sex, the household decision rules, and the matching probabilities; i.e., they solve $P(3n')$, $P(3o')$, $P(2n')$, $P(2o')$, and $P(1n')$ defined above.

3. The matching probabilities, $\Phi_1(x)$, $\Phi_2(x, k)$, $\Phi_3(x, k)$, $\Omega_1(z)$, $\Omega_2(z)$, and $\Omega_3(z)$ are the fixed points of the mappings implied by the marital and household decision rules.

3.3. *Computation*

Given the measures of each type in the marriage market, in each period, $\Omega_1(z)$, $\Phi_1(x)$, $\Omega_2(z)$, $\Phi_2(x, k)$, $\Omega_3(z)$, and $\Phi_3(x, k)$, we solved the model working backward from period three. For married couples, this required finding the Nash solution to the bargaining game where the threat points are the values of life as single. It is well known that the Nash solution to the bargaining game maximizes the product of the net gains of the participants. Instead of solving the couple's bargaining problem directly, we maximized the weighted sums of the spouse's utility from marriage, and then chose the weights so that the solution maximized the product of the gains from marriage. Since the Nash solution is a selection from the set of Pareto-optimal allocations, such a weight must exist if the problem is well defined. Furthermore, provided that concavity of the product is satisfied, which is the case in our model, then the weight that equates the two problems is given by a simple first-order condition.[9]

Clearly, successful computation depends on the concavity of the objective functions of the weighted Pareto problems. In the first and the second periods these objective functions contain future continuation utility, as future productivity depends on current labor. The concavity of the objective function with respect to labor is maintained through appropriate restrictions on the functional forms that link future productivity and current labor. We need restrictions on the continuation values because when a married couple decides how much each should work, even though one may be better off by working more and accumulating more human capital, it is not clear that they are always better off if their partner works more. If the partner works more and accumulates more human capital, he or she has a greater incentive to leave the current partner and look for a better partner. Hence, from the perspective of men and women, the continuation values are not simple functions of current labor supply decisions. Once we have computed the decisions, we then update Ω and Φ. The solution is a fixed point of the Ω and Φ distributions.

4. CALIBRATION

In this section we describe the functional forms and parameterization of our benchmark model. The purpose of calibrating the model is to restrict attention to a region of the parameter space where the average behavior of agents in the model resembles that observed in U.S. data, at least along the dimensions that are most relevant for our analysis. Since we want to use the model to explore the interaction between childraising and female

[9]Consider an allocation resulting from maximizing a weighted sum of utilities of the husband and wife, $\rho H + (1-\rho)W$. When $\rho = \frac{F-G}{(M-B)+(F-G)}$, the solution to the weighted Pareto problem corresponds to the Nash bargaining solution with equal bargaining power, where G and B represent the outside options of the wife and the husband, respectively. This can be demonstrated by comparing the first-order conditions associated with the two problems.

labor supply, we concentrate on matching statistics directly related to average fertility and labor supply, conditional on marital status, as well as the distribution of the population over marital states. Our basic strategy is to fix the parameters that can be mapped directly to published estimates, and then choose the remaining "free" parameters so that the steady state of the model matches an equal number of statistics from the U.S. data. Where possible, we take these statistics from published sources; however, in some cases we report our own statistics, computed from the PSID samples discussed earlier.

The productivity level grids $(\mathscr{X}_t, \mathscr{Z}_t)$ have seven grid points in the first period ($t = 1$), nine in the second ($t = 2$), and 11 in the third ($t = 3$). We set each model period to 10 years. We consider the first two periods of the model as partitioning the fertile portion of the female life-cycle. As we indicate in our empirical analysis one way to think about these subperiods is as ages 16 to 26 and 27 to 36. In calibrating the model, however, we will be more freely interpreting the first period as representing the 20's and the second period the 30's of the lifecycle. We set the discount factor, β, to 0.676, which is the standard annual value of 0.96 compounded to match our longer periods. The choices of functional forms and the other parameters are described below.

4.1. *Parameters Set Directly from Existing Estimates*

The effect on per-capita consumption of adding more members to the family is assumed to be given by the following function:

$$\Psi(p, k) = \frac{1}{(p + bk)^{\sigma}}.$$

The parameters $b = 0.5$, $\sigma = 0.5$ are set to the midpoints of the intervals provided by Cutler and Katz (1992), who reported ranges of estimates for these parameters, based on their analysis of the U.S. poverty line and other available estimates.

We assume that the fixed time cost of children is linear in the number of one- and two-period old children, and given by

$$\chi_f(k_1, k_2) = \chi_f^1 k_1 + \chi_f^2 k_2, \;\; \chi_m(k_1, k_2) = \chi_m^1 k_1 + \chi_m^2 k_2,$$

where χ_g^i is the fixed time cost of an i-period old kid for gender g. For women, we can set these parameters directly from the results of Hotz and Miller (1988), who reported that a newborn requires 660 h of parental time per year.[10] This requirement declines geometrically at a rate of

[10] One can imagine that over time improvements in child care technology will allow women to spend less time with kids and more time in the labor market.

12% per year. If people have 16 h of nonsleeping time, in its first year a newborn takes up about 11.3 percent of a woman's potential work and leisure time. Using the facts that a period is 10 years and that the decay rate of the time requirement is 12% annually, we can set $\chi_f^1 = 0.0736$ and $\chi_f^2 = 0.0257$.[11] For men, direct estimates are not available, but we assume the cost in father's time is proportional to that of the mothers. Using time use data Robinson and Geoffry (1997) found that in 1985, men were spending about half as much time as women in total family care (housework, shopping/services, and child care). Hill (1985) also reported that married men spend about 40% of the time married women spend in household work, and about half of the time married women spend in shopping/services and child care. Hence, we set the fixed time cost for men at half of the values for women, $\chi_m^1 = 0.0368$ and $\chi_m^2 = 0.0128$.

4.2. *Parameters Chosen to Match Model to Data*

To set the remaining parameters of the model, we choose a set of targets from the U.S. data and pick a collection of parameters such that analogous statistics from the model's steady state match these targets. As is standard in the literature, we choose the number of targets equal to the number of free parameters. The list of targets, along with the corresponding parameters and the model statistics, is given in Table XI.

We assume that marriage quality can take on one of two values in a given period. These values are the same for the first two adult periods and are given by γ_1 and γ_2; for the final period, they differ and are given by γ_1^o and γ_2^o.[12] The probabilities, $\Gamma(\gamma_1)$ and $\Gamma(\gamma_2) = 1 - \Gamma(\gamma_1)$, of these realizations are assumed independent of previous realizations and identical in each period. Since marriage quality determines marriage and divorce rates in our model, we set these parameters to match the period-specific marriage statistics from previous studies. Based on data published by the U.S. Census Bureau, our targets include: the percentage of women age 25–29 over the period 1969–1979 who were married (83%), the percentage of males in the 35–39 age group over the same period who were not married (7.4%), and the average percentage of U.S. women who were married between

[11] Hotz and Miller (1988) did not differentiate between the fixed time cost and the time for nurture. Robinson (1987) reported separate estimates for physical and nonphysical time costs of kids. His estimates for fixed time cost of children were about 3.5% of nonsleeping time per child.

[12] Since old couples do not have children, their gains from marriage are much smaller in our model, and hence marriage quality must be increased on average to keep divorce rates realistic.

TABLE XI
Benchmark Economy

Statistics	Parameter	Benchmark	Data
Marital status of population			
Marriage rate for the first period (%)	$\gamma_1 = 0.575$	83	83
Never married males by the end of second period (%)	$\gamma_2 = 1.575$	7.5	7.4
Average remarriage rate for women (%)	$\Gamma(\gamma_1) = 0.4$	68	67
Average marriage rate (%)	$\gamma_1^\circ = 0.5$	78	78
Never married women (%)	$\gamma_2^\circ = 1.2$	8	8.2
Timing of births			
Kids born in second period (%)	$\psi = 0.3$	36	36
Fertility			
The total fertility rate	$\omega = 0.365$	2.4	2.4
Fraction of kids born to single mothers in the first period (%)	$\xi = 0.35$	10	10
Average fraction of kids with married parents (%)	$\vartheta = 0.3$	84	82
Income inequality			
Income of single females in the first period (as a fraction of married females)	$\nu = 0.5$	0.45	0.49
Labor supply			
Married men in the first period	$\delta = 3.9$	0.44	0.43
Married women in the first period	$\varsigma = 0.05$	0.13	0.15
Investment in kids			
Average income share spent on kids (%)	$\alpha = 0.38$	14	14
Initial productivity levels			
Mean log wages for males in the first period	$\lambda_1 = 10.5$	2.3	2.3
Mean log wages for females in the first period	$\lambda_2 = 0.5$	2	2
Productivity dispersion in the first period	$\sigma_0 = 0.45$	0.55	0.55
Wage and labor supply growth for males			
Males, wages form 20–29 to 30–39 (%)	$a_{\mathrm{m}} = 0.6$	27	27
Married males, labor supply 20–29 to 30–39 (%)	$\phi_{\mathrm{m}} = 0.45$	0	0

ages 20 and 54 (78%).[13] From the U.S. Census Bureau (1999), we also target the average fraction of females who remarry between ages 30 and 49 (67%). Finally, given estimates from Schoen and Weinick (1993), we target

[13]The data on marital status of population is based on several issues of U.S. Census Bureau publication *Marital Status and Living Arrangements* (series P-20). The current issues can be downloaded at: http://www.census.gov/population/www/socdemo/ms-la.html.

the percentage of women between 1970 and 1980 who were never married (8.2%).

The production function for children's education is assumed to be given by

$$H(g, t, k_1, k_2) = \left(\frac{g}{k_1^{\psi} + k_2^{\psi}}\right)^{\alpha} \left(\frac{t}{k_1^{\psi} + k_2^{\psi}}\right)^{1-\alpha}.$$

We set $\alpha = 0.38$ and $\psi = 0.3$, in order to match the aggregate fraction of goods that parents spend on their kids (14% according to Olson (1983)) and the fraction of kids born in the second model period (36% of children are born to mothers over 27, according to Table II).[14]

Childhood education in turn determines the probability distribution over initial adult productivity. Given a lifetime human capital investment of $\mathfrak{h} \equiv h_1 + h_2$, the conditional means of log wages are given by

$$\mu_x(\mathfrak{h}) = E[\log(x)|\mathfrak{h}] = \mu_z(\mathfrak{h}) = E[\log(z)|\mathfrak{h}] = \log(\lambda_1 \mathfrak{h}^{\lambda_2}).$$

The standard deviation around this conditional mean is given by σ_0. We assume that the effect of human capital investment on children is symmetric between males and females. We further assume that initial productivity levels (x, z) are distributed log normally and approximated using our grid points for the initial model period for males and females. We take as targets the means and standard deviations from the 1988 PSID, restricted to full-time nonfarm employees. Thus the targets are the mean log wages of men (2.3), the mean log wages of women (2.0), and the standard deviations of log wages (0.55 for both men and women). The corresponding parameters are $\lambda_1 = 10.5$, $\lambda_2 = 0.5$, and $\sigma_0 = 0.45$.

We assume that the utility functions have the following forms

$$F(c, h, k_1, k_2, 1 - l - t - \chi_f(k_1, k_2)) = \frac{c^{\nu}}{\nu} + w\frac{k^{\xi}}{\xi}\frac{h^{\vartheta}}{\vartheta} + \delta\frac{(1 - l - t - \chi_f(k_1, k_2))^{\varsigma}}{\varsigma} - \gamma,$$

for females, and

$$M(c, h, k_1, k_2, 1 - n - \chi_m(k_1, k_2)) = \frac{c^{\nu}}{\nu} + w\frac{k^{\xi}}{\xi}\frac{h^{\vartheta}}{\vartheta} + \delta\frac{(1 - n - \chi_m(k_1, k_2))^{\varsigma}}{\varsigma} - \gamma,$$

[14]Aiyagari *et al.* (2000) and Greenwood *et al.* (in press) used human capital production functions that are similar to the function used here. Restuccia and Urrutia (2001) used a human capital function where the only input is goods spent on children and the spending is subject to decreasing returns. While these papers attempt to analyze different questions, they all are able generate a high degree of persistence across generations.

for males. This implies six more free parameters, which we restrict on the basis of fertility behavior and labor supply. Assuming each agent has a time endowment of 5000 h per year, then Table X implies that, in the birth cohort 1938–1947, married males aged 20–26 spent about 43% of their time working. Table IX shows that statistic to be about 15% for married females. We use these statistics, and the ratio of single women's to married women's household income, to pin down the parameters $\delta = 3.6$, $\varsigma = 0.05$, and $\nu = 0.5$. Table IX shows that in the birth cohort 1938–1947 the total family income of single females is about 49% of married females for younger women and drops to around 44% for women in their 30's.[15]

The parameters that govern utility for children are set to match the following targets: the total fertility rate for women between 15 and 40 years old (2.4, in 1970, according to Ventura *et al.* (1998)), the percentage of children born to single women (10%, between 1970 and 1980, according to Ventura and Bacharach (2000)), and the fraction of kids living in two-parent families (82%, between 1969 and 1979, according to U.S. Census Bureau data).[16] Finally, we allow each female to have at most $K = 2$ new children in any given period.

Although published estimates of the returns to labor market experience exist, there is no consensus in the literature regarding how to treat the problems arising from self-selection into work or the endogeneity of the number of hours worked. It is clear, however, that labor market experience does raise wages, and that for women this effect became much stronger in the 1970s than it had been previously. Moffitt (1984) found that an additional year of work experience raises wages for men by a little more than 4%, and Blau and Kahn (1997) found that an additional year of full-time experience, in 1988, increases log female wages by 0.0289 and male wages by 0.0458. However, these studies do not take selectivity bias into account. More recently, Olivetti (2001) estimated the return to experience for men and women and showed that there has been a significant rise in the returns to experience, particularly for females, for whom wage growth between ages 20–29 and 30–39 was not significantly different from zero in the 1970s.

We assume that all wage growth is due to the returns to experience, as represented by a function that maps current productivity levels and current labor supply decisions into the next period's productivity levels. To minimize the need for new parameters, we assume that depending on current labor supply decisions, productivity can either go up one level, go down one

[15]For men, the differentials are 53% for the young cohort in their 20's and 44% for older men.

[16]The fraction of kids living with married couples is based on U.S. Census Bureau data on the living arrangements of children under 18, which is available at http://www.census.gov/population/www/socdemo/hh-fam.html.

level, or stay the same. For each sex, this process is characterized by two parameters, a_s and ϕ_s, as

$$\Pr[x_{i-1}|x_i, l] = (1 - a_f)(1 - l^{\phi_f}),\ \Pr[z_{i-1}|z_i, n] = (1 - a_m)(1 - n^{\phi_m}),$$
$$\Pr[x_i|x_i, l] = a_f(1 - l^{\phi_f}),\ \Pr[z_i|z_i, n] = a_m(1 - n^{\phi_m}),$$

and

$$\Pr[x_{i+1}|x_i, l] = l^{\phi_f},\ \Pr[z_{i+1}|z_i, n] = n^{\phi_m}.$$

In our benchmark economy, we set these two parameters to match the observed wage and labor supply growth. For males, we choose $a_m = 0.6$ and $\phi_m = 0.45$. This gives a wage growth rate for males between the first two model periods of about 27% (which is the average value we calculate for males between ages 20–29 and 30–39 using PSID data between 1969 and 1979). In the benchmark, the average labor supply of married men between the first two periods is about constant (which matches the data on labor supply for the birth cohort 1938–1947 in Table X). Olivetti (2001), using PSID data for 1973, showed that the wage growth for married females between ages 20–29 and 30–39 was negative. Using the PSID data between 1969 and 1979, we also find that the wage growth for all females between ages 20–29 and 30–39 was close to zero. Hence, for females we assume that there is no wage growth in our benchmark economy.

5. INEQUALITY AND FERTILITY TIMING

In this section we analyze the interactions between wage inequality and the timing of fertility. We show that the marriage market plays a central role in determining the timing of fertility, as well as in the propagation of inequality across generations.

The main result of our benchmark model is that women's productivity (wages) delays fertility even when the labor market returns to work experience are zero. This is evident from Table XII, where we report fertility patterns by the marital status and productivity of the mothers.[17] Each cell reports the total number of kids and the fraction of kids born in the second model period. Three important patterns are evident:(1) The completed fertility rate is declining in the productivity level of the mothers. Women who are in the top half of the wage distribution have on average 2.1 kids whereas

[17] The marital status and productivity levels correspond to the second model period. Hence, single mothers are those who have never been married or those who experienced a divorce but did not get remarried. New marriages are those formed in the second period, while old marriages are the intact marriages from the first period.

TABLE XII
Fertility Decisions in Benchmark Economy

	Total number of kids	Fraction born in the second period
All mothers		
Top half of the wage distribution	2.10	0.41
Bottom half of the wage distribution	2.70	0.30
Single		
Top half of the wage distribution	2.21	0.47
Bottom half of the wage distribution	3.26	0.55
Newly married		
Top half of the wage distribution	1.88	0.50
Bottom half of the wage distribution	2.57	0.25
Intact marriages		
Top half of the wage distribution	2.21	0.36
Bottom half of the wage distribution	2.53	0.18

those in the bottom half have 2.7. (2) The proportion of the children born in the mother's first adult period is declining in the mother's wages. (3) Single women delay fertility more than married women, and women in stable marriages delay fertility the least.

The fact that women's fertility is declining in their education level is well known (see Rindfuss *et al.* (1996) and Matthews and Ventura (1997) for some recent evidence, and Browning (1992) and Hotz *et al.* (1997) for reviews of literature). In our model, this is driven by the time costs of both fertility and investment in human capital. Children are time intensive, and thus more costly for women with high productivity.

In our benchmark model, women do not receive a return to labor market experience in the form of higher wages, because we have set the experience effect on wages equal to zero for women. However, more productive women tend to have children later than less productive women. Thus, the lowest productivity mothers who are newly married in the second period have about 74% of their children in the first period; the corresponding figure for the highest productivity level is 15%. The same figures are 78 and 50% for women who are in an intact marriage, and 45 and 28% for women who are single in the second period. This pattern is due to the fact that women with low wages who meet high-wage men in the first period are more likely to marry than women with high productivity who meet low-wage men. The reason that matches where spouse's wages are unequal are less stable when the woman has the higher wage is that the gains from specialization are much lower because men are less effective in producing and raising children.

The third result is that single women postpone their childbearing more than married women. Once the second period marriage market is cleared, however, they have their children. The same is also true for marriages that are more likely to end in divorce in the first period. Such marriages result in fewer kids in the first period than those that are more likely to remain intact.[18] These effects arise because becoming a single mother is costly, both in a pecuniary sense, and in terms of reduced marital prospects for the future.

This effect is stronger for women with higher productivity, which explains why high productivity single women delay their childbearing. Low-productivity women have a lower probability marrying a high-productivity man in the future marriage market and hence less incentive to wait for a better match before having kids. In addition, high-productivity married women are more likely to dump their low-productivity husbands from the first period and look for a more productive mate in the second.[19]

As further evidence of the effect in our model of matching incentives on the timing of births, we also run the following simple experiment: suppose the match quality levels for the last period of the model are now given by $\gamma_1^o = 0$ and $\gamma_2^o = 1.2$. In other words, we improve the match quality for the last period. Not surprisingly, this increases people's chances of getting married in the last model period, and the aggregate marriage rate rises to 84 from 78%. More importantly, on average, about 37% of the kids are now born in the second model period (instead of 36%). Hence, better marriage prospects simply lead to later births as we expected.

The human capital of children in the model depends on both the marital status of the parents and the timing of fertility. The effect of marital status is due to larger investments of both goods and mother's time, which is driven by the fact that the child's education now benefits two parents rather than just the mother, raising the return on mother's time in childraising relative to market labor. On average a child with a single mother receives about one-third of the human capital investment received by a child in a married couple household.[20] Empirical support for this sort of interaction is discussed in McLanahan and Sandefur (1994). In the benchmark economy, children that are born in the second period receive about 13% more human capital investment than those born in the first period. These children receive

[18]In fact this effect of divorce on childbearing is observable in U.S. data, according to estimates by Lillard and Waite (1993).

[19]As a robustness check, we ran some experiments with lower fertility rates for single women, by imposing a utility cost (or stigma) for having an out-of-wedlock birth. Our basic result regarding the shift in the timing of births with the introduction of returns to experience for women did not change.

[20]See Greenwood *et al*. (2001) for a more detailed discussion of the role of human capital investment in producing intergenerational persistence of income in such models.

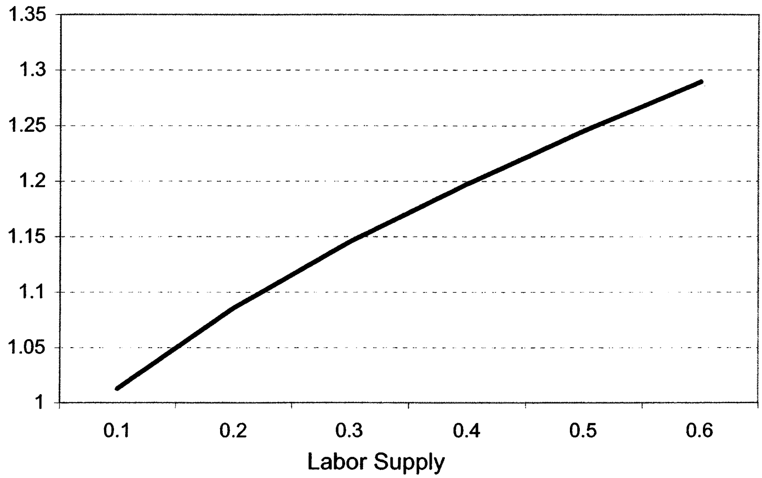

FIG. 1. Endogenous wage growth for women.

more investment in our model for two reasons. First, women who have children later tend to be of higher productivity and thus have both higher household incomes and fewer children. Second, the wage growth of the fathers increases household income, so that there are more resources for investment in the later born children.

5.1. *Changes in the Return to Experience*

An interesting application of our model is to explore the effect on fertility and marriage behavior of increasing the returns to women's labor market experience, which were set to zero in the benchmark model. This change is consistent with other evidence, such as Olivetti (2001) and Blau and Kahn (1997) who indicated the return to experience has grown much faster for women than for men since the 1970s. In particular, we assume that now women face the same labor experience process as men, but it is parameterized to generate a wage growth rate for women that is close to what we observe in the PSID between 1980 and 1992 (based on our calculations using the PSID, from ages 20–29 to 30–39, wages for women grow on average about 12% during this period).

To match this growth rate, we now set the parameters $a_f = 0.62$ and $\phi_f = 0.6$ in the woman's function for returns to experience. The effect of this change on wage growth is depicted in Fig. 1, where we show wage growth as a function of labor supply. Women who spent 10% of their time working in the first period experience wage growth of 3%, but those who worked for 60% of the period experience a wage growth of close to 30%.

TABLE XIII
Returns to Experience for Women

Statistics	Benchmark	Experiment
Timing of births		
Kids born in second period (%)	36	38
Fertility		
The total fertility rate	2.4	2.25
Fraction of kids born to single mothers, 20–29 (%)	10	12
Average fraction of kids with married parents (%)	84	83
Marital status of population		
Marriage rate for the first period (%)	83	82
Never-married males by the end of second period (%)	7.5	8.4
Average remarriage rate for female (%)	68	67
Average marriage rate (%)	78	75
Never-married women (%)	8	9
Income inequality		
Income of single females in the first period (as a fraction of married females)	0.45	0.51
Labor supply		
Married men in the first period	0.44	0.46
Married women in the first period	0.13	0.16
Investment in kids		
Average income share spent on kids (%)	14	12.5
Wage growth		
Males, wages from 20–29 to 30–39 (%)	27	27
Females, wages from 20–29 to 30–39 (%)	0	11

The results of this experiment are shown in Table XIII. The change in the returns to experience for women causes a further delay in the timing of births. Now about 38% of children are born when their mother is over 30 years, instead of the 36% in the benchmark case. It makes sense to question if the shift in the model resembles what we see in the data for later cohorts. As the data in Table II indicate, for the birth cohort of 1948–1957, about 44% of the births occurred to women older than 30 years. Hence, we are able to explain some of the changes in the timing behavior by changes in the returns to experience for women. Along with the increase in the delay of childbearing, total fertility falls from 2.4 to 2.25.

The aggregate marriage rate falls from 78 to 75%. The aggregate fraction of married people, however, does not tell the whole story. What is happening is that more women choose to remain single and accumulate human capital in the first two periods (i.e., they refuse to marry men with low productivity). The marriage rates in the third period are the same in this experiment as they are in the benchmark. The pattern of a delay in marriage without a significant change in the aggregate number of people

TABLE XIV
Labor Supply

	Benchmark	Experiment	Data
Single men in the first period	0.34	0.34	0.39
Single women in the first period	0.25	0.29	0.30
Married men in the first period	0.44	0.46	0.43
Married women in the first period	0.13	0.16	0.15
Single men in the second period	0.31	0.31	0.38
Single women in the second period	0.19	0.23	0.33
Married men in the second period	0.44	0.44	0.42
Married women in the second period	0.13	0.16	0.24

who will eventually get married is consistent with recent evidence on U.S. marriage patterns documented by Goldstein and Kenney (2001, p. 517) who stated that “the major change in marriage patterns has been a shift to older ages of marriage with only a small decline in eventual levels of marriage.”

Since the timing of births is the key link between labor and marriage markets in our model, we provide a more detailed look at the labor supply behavior in Table XIV. The data are based on Tables IX and X. The first column is the labor supply numbers from our benchmark economy, and the first two rows are the numbers that are directly targeted by our parameters. The benchmark economy produces, however, reasonable labor supply behavior for other marital status and age groups, which is very encouraging.[21] The labor supply numbers for women are higher when we have positive returns to experience for women. This is not surprising as women work more to take advantage of returns to experience. Note that as more women work and choose to remain single in the first period, the relationship between labor supply and age also more closely resembles what we observe in the data. Finally, this change results in a more equal income distribution. Now female-headed households’ labor income is about 51% of that of married couples for the first model period (as opposed to 45%).

What about the effect on children? There are three channels through which a change in returns to women’s experience can affect investment in children. First, it can directly affect time and resource investment decisions. The direct effect in this experiment is minimal. Second, changes in matching incentives can affect the number of children born to single mothers.

[21]The singles in the second period of our model, however, look a little different than the singles in the data. The key force behind this discrepancy is the role of marriage market in our model. The marriage market selects more productive people into marriages, and the resulting singles’ pool consists mainly of low-productivity people.

In our experiment, the fraction of all kids who live with single mothers is unchanged; however, the fraction who live with young single mothers rises (10 to 12%). Children born to single mothers continue to receive around a third of the human capital investment of those born to married couples. And lastly, a shift in fertility timing changes the number of children born in the second period relative to the first. With returns to experience for women, more kids are born in the second period, and they receive more human capital investment than those born in the first period of their mothers' lives. Overall, total human capital investment falls just under 4%, so the single mother effect dominates the shift in timing.

5.1.1. *Discussion*

The key factor that causes the shift in the timing of births is the changing return to experience for women. It is important to contrast this channel with the return to age in order to understand why women delay their childbearing decisions here. If, on one hand, the growth in wages was mainly a result of the return to age, then women would experience a higher wage tomorrow independent of today's labor supply. This leads women to have kids sooner rather than later.[22] On the other hand, depreciation of wages by age, or a negative return to experience, would create a force for later childbearing. When we increase the return to experience for women, we get a slightly negative return to age: if a woman does not supply any labor when she is young, she experiences about a 10% decline in her wages next period. This depreciation is much less than, for example, numbers estimated by Olivetti (2001), who found that a woman with zero labor supply between ages 20 and 29, loses about 50% of her human capital by age 30. Hence, our results are not driven by an implausibly large negative return to age, and on average women experience wage growth close to the data. Furthermore, the fact that the actual experience matters most for the wage growth is also consistent with recent analysis of the effect of fertility and labor turnover on employment and wages by Erosa *et al.* (2002).

6. CONCLUSION

The goal of this paper was to understand the economic forces that cause women with high lifetime labor income to have children later in life than women with lower labor income. We argued that this phenomenon is interesting not only for understanding wage inequality over the lifetime, but also,

[22] Indeed, using the current model, one can generate a decline in the fraction of kids that is born in the second model period, if all wage growth for females is due to returns to age.

via fertility and investment in children's education, for the evolution of the income distribution over time. Our basic hypothesis was that cross-sectional differences in fertility behavior and labor supply behavior are due to differences in the dynamic returns to fertility. Because both fertility and labor supply decisions are strongly linked to women's marital status, we argued that a deep understanding of these patterns requires a dynamic model of marital status that incorporates both fertility timing and labor supply.

The main result of our calibrated, benchmark model is that the steady-state equilibrium replicates the key qualitative features of fertility behavior in the data: fertility rates are declining in family income and lower-wage women have children earlier than do higher-wage women. In addition, we find that increasing the gains from marriage leads to further delays in fertility, confirming that marriage-market incentives are indeed responsible, in our model, for the cross-sectional pattern of fertility timing. The reason is that matches where spouse's wages are unequal are much less stable when the woman has the higher wage as men are less effective in producing and raising children. Furthermore, single mothers tend to be low-wage women because their forgone marital prospects are less attractive; high-wage men are less likely to marry them, and even should such a marriage occur, low-wage women get a much lower share of the surplus than would a high-wage woman. Therefore the matching incentives for fertility delay are much weaker for low-wage women, and hence they have their children earlier.

Finally, we explored the effect of allowing women's wages to respond to work experience, which we took to be analogous to the increases over the past 30 years in the returns to experience for women, as reported by Blau and Kahn (1997) and Olivetti (2001). We found that increasing the effect of labor market experience on women's wages results in higher labor supply for young women and a further delay in the timing of fertility; the proportion of children born to mothers over the age 30 rises 5%, compared to a 13% increase in the data. Total fertility rates fall by about 7%, and the proportion of the population never married falls 4%. Since all of these changes correspond to changes that actually occurred in the U.S. over the same time period, we feel our results indicate that these changes were due, to a significant extent, to increases in the labor market incentives for fertility delay.

Our results suggest that women in the more recent U.S. birth cohorts perceived that their future wages were more responsive to their labor experience than was the case for the older cohorts. The causes of this change are outside the scope of this research but are consistent with the intense campaign waged in the 1970s against sex discrimination not only with respect to wages, but also with respect to occupational choice and career advancement.

APPENDIX: DECISION RULES

The expected values of having a new draw from the marriage market in the third period are given by

$$\begin{aligned}EW_3^{dr}(x,k) &= E_{z,\gamma}\big[W_3^n(x,z,0,k,\gamma)I_3^n(x,z,0,k,\gamma)\\ &\qquad + G_3(x,0,k)\big(1-I_3^n(x,z,0,k,\gamma)\big)\big]\\ &= \sum_i\sum_j\big[W_3^n(x,z_i,0,k,\gamma_j)I_3^n(x,z_i,0,k,\gamma_j)\\ &\qquad + G_3(x,0,k)\big(1-I_3^n(x,z_i,0,k,\gamma_j)\big)\big]\Omega_3(z_i)\Gamma(\gamma_j),\end{aligned}$$

for females and

$$\begin{aligned}EV_3^{dr}(z) &= E_{x,k,\gamma}\big[V_3^n(x,z,0,k,\gamma)I_3^n(x,z,0,k,\gamma)\\ &\qquad + B_3(z)\big(1-I_3^n(x,z,0,k,\gamma)\big)\big]\\ &= \sum_i\sum_k\sum_j\big[V_3^n(x_i,z,0,k,\gamma_j)I_3^n(x_i,z,0,k,\gamma_j)\\ &\qquad + B_3(z)\big(1-I_3^n(x_i,z,0,k,\gamma_j)\big)\big]\Phi_3(x_i,k)\Gamma(\gamma_j),\end{aligned}$$

for males, where $\Phi_3(x,k)$ is the probability of meeting a three-period old single woman of type x, with k two-period old kids, in the third period marriage market, and $\Omega_3(z)$ is the probability of meeting a three-period old single man of type z, in the third period marriage market.

These continuation values for people who are married in the second period are simply defined as

$$\begin{aligned}&EW_3^{con}(\cdot|x,\ z,\ k_2,\ \gamma)\\ &\quad = \sum_i\sum_j\sum_m \max\big\{W_3^o(x_i,z_j,0,k,\gamma_m)I_3^o(x_i,z_j,0,k,\gamma_m), EW_3^{dr}(x_i,\ k)\big\}\\ &\quad\quad \times X(x_i|x,\ l)Z(z_j|z,n)\Gamma(\gamma_m),\end{aligned}$$

and

$$\begin{aligned}&EW_3^{con}(\cdot|x,\ z,\ k_2,\ \gamma)\\ &\quad = \sum_i\sum_j\sum_m \max\{V_3^o(x_i,z_j,0,k,\gamma_m)I_3^o(x_i,z_j,0,k,\gamma_m), EV_3^{dr}(z_j)\}\\ &\quad\quad \times X(x_i|x,\ l)Z(z_j|z,n)\Gamma(\gamma_m).\end{aligned}$$

Finally, the values of having a new draw from the marriage market in the second period are given by

$$\begin{aligned}EW_2^{dr}(x,k_2) &= E_{z,\gamma}\big[W_2^n(x,z,k_2,\gamma)I_2^n(x,z,k_2,\gamma)\\&\qquad + G_2(x,k_2)\big(1-I_2^n(x,z,k_2,\gamma)\big)\big]\\&= \sum_i\sum_m\big\{W_2^n(x,z_i,k_2,\gamma_m)I_2^n(x,z_i,k_2,\gamma_m)\\&\qquad + G_2(x,k_2)\big(1-I_2^n(x,z_i,k_2,\gamma_m)\big)\big\}\Omega_2(z_i)\Gamma(\gamma_m),\end{aligned}$$

and

$$\begin{aligned}EV_2^{dr}(z) &= E_{x,k_2,\gamma}\big[V_2^n(x,z,k_2,\gamma)I_2^n(x,z,k_2,\gamma)\\&\qquad + B_2(z)\big(1-I_2^n(x,z,k_2,\gamma)\big)\big]\\&= \sum_i\sum_{k_2}\sum_m\big\{V_2^n(x_i,z,k_2,\gamma_m)I_2^n(x_i,z,k_2,\gamma_m)\\&\qquad + B_2(z)\big(1-I_2^n(x_i,z,k_2,\gamma_m)\big)\big\}\Phi_2(x_i,k_2)\Gamma(\gamma_m).\end{aligned}$$

REFERENCES

Aiyagari, S. R., Greenwood, J., and Guner, N. (2000). "On the State of the Union," *Journal of Political Economy* **108**, 213–244.

Altug, S., and Miller, R. A. (1998). "The Effect of Work Experience on Female Wages and Labor Supply," *Review of Economic Studies* **65**, 45–85.

Becker, G. S. (1973). "A Theory of Marriage: Part I," *Journal of Political Economy* **81**, 813–846.

Becker, G. S. (1974). "A Theory of Marriage: Part II," *Journal of Political Economy* **82**, S11–S26.

Blau, F. D., and Kahn, L. W. (1997). "Swimming Upstream: Trends in the Gender Wage Differential in the 1980s," *Journal of Labor Economics* **15**, 1–43.

Browning, M. (1992). "Children and Household Economic Behavior," *Journal of Economic Literature* **30**, 1434–1475.

Chiappori, P., Fortin, B., and Lacroix, G. (2002). "Household Labor Supply, Sharing Rule, and the Marriage Market," *Journal of Political Economy*, **110**, 37–72.

Conesa, J. C. (1999). "Educational Attainment and Timing of Fertility Decisions." mimeo.

Cutler, D. M., and Katz, L. F. (1992). "Rising Inequality? Changes in the Distribution of Income and Consumption in the 1980s," *American Economic Review* **82**, 546–551.

Eckstein, Z., and Wolpin, K. I. (1989). "Dynamic Labor Force Participation of Married Women and Endogenous Work Experience," *Review of Economic Studies* **56**, 375–390.

Erosa, A., Fuster, L., and Restuccia, D. (2002). "Fertility Decisions and Gender Differences in Labor Turnover, Employment, and Wages," *Review of Economic Dynamics* **5**, 856–891.

Goldstein, J. R., and Kenney, C. T. (2001). "Marriage Delayed or Marriage Forgone? New Cohort Forecasts of First Marriage For US Women," *American Sociological Review* **66**, 506–519.

Greenwood, J., Guner, N., and Knowles, J. (2002). "More on Marriage, Fertility, and the Distribution of Income," *International Economic Review,* forthcoming.

Gunderson, M. (1989). "Male–Female Wage Differentials and Policy Responses," *Journal of Economic Literature* **27**, 46–72.

Hill, M. S. (1985). "Patterns of Time Use," in *Time, Goods and Well-Being* (F. T. Juster, and F. P. Stafford, Eds.), Ann Arbor: Univ. of Michigan Press.

Hotz, V. J., and Miller, R. A. (1988). "An Empirical Analysis of Life Cycle Fertility and Female Labor Supply," *Econometrica* **56**, 91–118.

Hotz, V. J., Klerman, J. A., and Willis, R. J. (1977). "The Economics of Fertility in Developed Countries," in *Handbook of Population and Family Economics* (M. R. Rosenzweig and O. Stark, Eds.), Amsterdam: Elsevier.

Lewis, C., and Ventura, S. (1990). "Birth and Fertility Rates by Education: 1980 and 1985," *Vital and Health Statistics* **21**. [National Center for Health Statistics]

Lillard, L. A., and Waite, L. J. (1993). "A Joint Model of Marital Childbearing and Marital Disruption," *Demography* **30**, 653–681.

Mare, R. (1995). "Changes in Educational Attainment and School Enrollment," in *The State of the Union: America in the 1990s* (R. Farley, Ed.), New York: Sage.

Mathews, T. J., and Ventura, S. J. (1997). "Births and Fertility Rates by Educational Attainments: United States, 1994," *Monthly Vital Statistics Report* **45**. [National Center for Health Statistics]

McLanahan, S., and Sandefur, G. (1994). *Growing Up with a Single Parent: What Hurts and What Helps.* Cambridge/London: Harvard Univ. Press.

Moffitt, R. (1984). "The Estimation of a Joint Wage–Hours Labor Supply Model," *Journal of Labor Economics* **2**, 550–566.

Morgan, S. P. (1996). "Characteristic Features of Modern American Fertility," in *Fertility in the United States: New Patterns, New Theories* (J. B. Casterline, R. D. Lee, and K. A. Foote, Eds.), New York: The Population Council.

Mullin, C. H., and Wang, P. (2001). "The Timing of Childbearing and Human Capital Investment with Ability Heterogeneity," mimeo.

Olivetti, C. (2001). "Changes in Women's Labor Force Participation: The Effect of Changing Returns to Experience," mimeo.

Olson, L. (1983). *Costs of Children*, Lexington, MA.

Regalia, F., and Ríos-Rull, J. V. (1999). "What Accounts for the Increase in Single Households and the Stability of Fertility?" mimeo.

Restuccia, D., and Urrutia, C. (2001). "Intergenerational Persistence of Economic Status: Sources and Policy," mimeo.

Rindfuss, R. R., Morgan, S. P., and Offutt, K. (1996). "Education and the Changing Age Pattern of American Fertility: 1963–1989," *Demography* **22**, 277–290.

Robinson, J. P., and Geoffry, G. (1997). *Time For Life*, University Park, PA: Pennsylvania State Univ. Press.

Robinson, W. C. (1987). "The Time Cost of Children and Other Household Production," *Population Studies* **41**, 313–323.

Rubalcava, L., and Thomas, D. (2000). "Family Bargaining and Welfare," mimeo.

Scheon, R., and Weinick, R. M. (1993). "The Slowing Metabolism of Marriages: Figures from 1988 US Marital Status Life Tables," *Demography* **30**, 737–746.

U.S. Bureau of Census (1999). "Marriage, Divorce, and Remarriage in the 1990's," Special Population Reports P23X-00-180.

Ventura, S. J., and Bachrach, C. A. (2000). "Nonmarital Childbearing in the United States, 1940–1999," *National Vital Statistics Reports* **48**. [National Center for Health Statistics]

Ventura, S. J., Martin, J. A., Curtin, S. C., and Mathews, T. J. (1998). "Report of Final Natality Statistics, 1996," *Monthly Vital Statistics Reports* **46**. [National Center for Health Statistics]

Waldfogel, J. (1998). "Understanding the 'Family Gap' in Pay for Women with Children," *Journal of Economic Perspectives* **12**, 137–156.