Using Cyclical and Secular Properties of Fertility to Distinguish Among Theories of Female Labor Participation (Job Market Paper) *

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Abstract

There has been a sharp rise in labor force participation of married women and especially women with young children between the 1970s and 1990s in the United States. Over the same period, cyclical and secular properties of fertility have changed significantly. In particular, I document that fertility rate is strongly countercyclical in the 1960s and 1970s and procyclical thereafter. In addition, women have postponed childbearing substantially. Using a life-cycle incomplete markets model with aggregate and idiosyncratic uncertainty, I show that cyclical properties and timing of fertility are related to labor force participation decisions of married women. The model calibrated to 1960s and 1970s generates countercyclical fertility. A number of explanations have been proposed to account for the increase in female labor supply, in particular a decrease in gender wage gap, an increase in women's returns to experience and a decrease in child care cost. I introduce these changes into the calibrated model and evaluate the implications for female labor force participation and properties of fertility. I find that each of them separately and all combined can explain some but not all features of the data. Taking into account the flattening of life-cycle earnings profile for males helps to account for the data but a significant discrepancy remains.

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1 Introduction

A fact that received a substantial attention in the literature is that there has been an increase in labor force participation of married women and especially women with young children between the 1970s and 1990s. For example, the employment rate has increased from 15% to 37% for married women with an infant and from 54% to 70% for married women without children under age of 18 from 1970 to 1990.

A number of explanations have been proposed to account for the increase in the labor supply of married women between the 1970s and 1990s.[1] Jones, Manuelli, and McGrattan (2003) argue that the decline in the gender wage gap can explain the increase in the average hours of work for married women. Olivetti (2006) argues that increase in the women's returns to experience can account for the changes in women's hours of work. Attanasio, Low, and Sanchez-Marcos (2008) find that the reduction in the cost of children and in the gender wage gap combined can explain the increase in labor force participation of married mothers. All of these papers either treat fertility as exogenous or do not model fertility at all. Nevertheless, each of the proposed mechanisms would have had an impact on fertility had it been a choice. If women expect cyclical movements in their income and spend some time away from the market work during pregnancy and when a child is born then parents prefer to time a birth when income is low. The procyclical response may result if households are liquidity constrained. Women who do not interrupt their career when they have a child and outsource child care prefer to time a birth when income is high as a way to smooth consumption.

A strong impact of young children and time spent on child care on labor force participation of mothers is confirmed by studies of Eckstein and Wolpin (1989) and Hotz and Miller (1988). Women's attachment to the labor force and time when they start childbearing are also connected.[2] Women who are relatively more productive at home are likely to have children early in the life-cycle. A career oriented women who prefer to outsource child care are

[1] A number of other studies focus on earlier period, for example, Greenwood, Seshardi, and Yorukoglu (2005) and Albanesi and Olivetti (2009) among others.

[2] The studies by Caucutt, Guner, and Knowles (2002), Conesa (2000) and Mullin and Wang (2002) find the strong link between the timing of fertility over the life-cycle and women's labor supply decisions.

likely to have children later, when household's income is higher, if households face liquidity constraints. Women who spend a significant time away from the market for childraising may delay fertility if on the job human capital accumulation is faster in the beginning of the life-cycle.[3] Different mechanisms that lead to the increase in the female labor supply may affect fertilty behavior in different ways.

Indeed, I document that there have been significant changes in cyclical propeties of fertility simultaneously with the change in female labor supply. In particular, fertility rate is strongly countercyclical in the 1960s and 1970s and becomes procyclical thereafter in the United States. More specifically, the correlation of fertility rate with the business cycle is negative for younger mothers (25 years old or less) in both periods. For older mothers (above 25 years old) it is slightly positive in the former period and strongly positive in the latter period and this change accounts for the overall change. There has also been a delay in fertility over the same period as pointed out in the literature. For example, the average age of mothers at first birth has increased from 21.4 in 1970 to 24.2 in 1990.[4]

The scientific interest to the relationship between births and economic activity was significant in the end of 19th century and the first half of 20th century in the United States. Silver (1965) surveys the findings covering various time periods from 1870 until 1957. A procyclical behavior of births has been established as one of the strongest empirical observations of that time.[5] Taking this finding into account, there have been two changes in the cyclicality of fertility rate: around 1960 and around 1980. The focus of this work is on the latter change, although the economic forces that shape cyclical properties of fertility are likely the same in the earlier period. In a related work, Jones and Schoonbroodt (2007) show that fertility is procyclical in a stochastic version of the dynastic model between 1910 and 1970. They consider 10 years period fluctuations in productivity, not the business cycle

[3]Goldin and Katz (2002) argue that the diffusion of the birth control pill in the 1960s had a significant influence on women's career decisions. The diffusion of the pill could lower the cost of professional education and lead to a delay in fertility. At the same time, Caucutt, Guner, and Knowles (2002) find that changes in the length of women's education can explain at most 30% of fertility delay.

[4]For more evidence of fertility delay since 1970s, see studies by Caucutt, Guner, and Knowles (2002), Hotz, Klerman, and Willis (1997) and Rindfuss, Morgan, and Offutt (1996).

[5]See, for example, Galbraith and Thomas (1941)

frequency fluctuations.

The objective of this work is to nest various mechanisms explaining the rise in married women's labor supply combined with fertility choice and to analyze their impact on secular and cyclical properties of fertility. I also want to understand what features of the model are needed to account for the cyclical properties of fertility rate. I consider a life-cycle overlapping generations model with aggregate and idiosyncratic uncertainty, female labor force participation, fertility and asset accumulation decisions. Women's productivity at home is stochastic. A woman with a child saves on child care costs if she stays home. I allow for asset accumulation because the role of fertility timing as a tool for consumption smoothing may be exaggerated without assets. I calibrate the model parameters to match the facts about married women's employment and fertility in 1960s and 1970s.

The model calibrated to the first period produces countercyclical fertility driven by younger women. The intuition is the following: women with high value of staying home prefer to have a child earlier, stay at home and save on child care costs; those at the margin between working and staying home prefer to have a child during a recession. Women who are relatively more productive in the market prefer to have a child later and pay the child care costs without interrupting their career. They prefer to give a birth during an expansion as a way to smooth consumption. Since participation of women with an infant is low in 1960s and 1970s, the countercyclical effect is dominating.

The results of the benchmark model show that cyclical properties of fertility and timing of fertility over the life-cycle are closely related to labor force participation decisions of married women. The proposed mechanisms that lead to the increase in women's labor supply may have different impacts on women with relatively high productivity in the market and women with relatively high productivity at home and thus, secular and cyclical properties of fertility. One of the goals of this work is to evaluate what mechanisms are consistent with observed properties of fertility.

I introduce changes in the determinants of female labor supply (decrease in gender wage gap, increase in women's returns to experience, decrease in child care cost) into the benchmark model and analyze the implications for female labor force participation and fertility. The decrease in gender wage gap and the increase in returns to experience for women separately can explain about a half of the increase in participation of mothers with an infant and women without children. The decrease in child care cost can account for about a third of the increase in participation of mothers with an infant and does not affect participation of women without children. The decrease in gender wage gap and the increase in returns to experience lead to a delay in fertility while the decrease in child care cost decreases the average age at first birth. Each alternative decreases negative correlation of fertility rate and business cycle for all women and younger women but does not change the correlation for older women. Combining all three alternatives together can account for the increase in participation of women without children and overshoots slightly the participation of mothers with an infant. It does not lead to a delay in fertility observed in the data and leads to overall procyclical fertility rate but driven by younger women not older as in the data.

A change in the earnings of husbands can potentially have an impact on women's labor participation and fertility. As documented in Kambourov and Manovskii (2005), there has been a significant flattening of life-cycle earnings profiles for the successive cohorts of male workers entering the labor market starting from late 1960s. I find that this change can account for about 15% of the increase in participation of mothers with an infant and about a half of the increase in participation of women without children. It leads to a delay in fertility and a stronger countercyclical fertility driven by younger women. Combined with other alternatives, it leads to a delay in fertility and dampens the strong procyclical fertility rate for younger women though it is not enough to generate the change in the cyclical properties of fertility observed in the data.

The rest of the work is organized as follows. Section 2 presents the empirical facts that motivate the paper, in particular facts about married women's participation and cyclical and secular behavior of fertility. In section 3, I develop a quantitative life-cycle overlapping generations model with discrete employment and fertility choices and aggregate and idiosyncratic uncertainty. In section 4, I describe how I calibrate the model parameters to match the facts about married women's employment and fertility in 1960s and 1970s and present the results of the benchmark model. In Section 5, I conduct quantitative experiments for the changes in the determinants of women's labor supply and discuss their results. Section 6 concludes and discusses potential extensions for future research.

2 Facts

In this section, I describe the facts about fertility and married women labor force participation. The data sources I use come from U.S. Bureau of Labor Statistics (BLS), National Center for Health Statistics (NCHS), United States Census of Population, Panel Study of Income Dynamics (PSID), Survey of Income and Program Participation (SIPP) and Current Population Survey (CPS). The variables and data sources are described in Appendix I.

2.1 Employment

In Table 1, I report employment rates for married women with their first child less than one year old and married women without children under age 18 in 1970 and 1990. The employment rate more than doubled from 15% to 37% for women with an infant and increased from 54% to 70% for women without children under age of 18 during that time.

Table 1: Employment Rate, 22-44 Years Old Married Women.

	1970	1990
Women with first child under age 1	0.145	0.372
Women with no children under age 18	0.544	0.701

Source: US Census of Population. Employment rate is the proportion of women who worked more than 30 hours during a reference week.

There has been an increase in proportion of educated women during the period of study. It is possible that changes in women's labor force participation are driven by differences in

Table 2: Employment Rate, 22-44 Years Old Married Women by Education.

	1970		1990	
Education	Employment Rate	Proportion	Employment Rate	Proportion
Panel A: First Child Less Then 1 Year Old.				
Less Then High School	0.140	0.11	0.218	0.04
High School	0.160	0.49	0.351	0.27
Some College	0.136	0.23	0.385	0.36
College and Higher	0.128	0.17	0.394	0.33
Panel B: No Children Under Age 18.				
Less Then High School	0.415	0.25	0.438	0.08
High School	0.593	0.41	0.659	0.30
Some College	0.579	0.18	0.734	0.33
College and Higher	0.645	0.16	0.804	0.29

Source: US Census of Population. Note: Employment rate is the proportion of women who worked more than 30 hours during a reference week.

education. Panel A of Table 2 shows the employment rate for married women with their first child less than one year old along with proportion of women by education attainment for 1970 and 1990. First, we can see that employment rate of married women with their first child less then one year old is approximately the same for all four education categories in 1970 and higher for all groups in 1990 with the increase being larger for more educated women. To understand the role of changes in education, I carry out a simple counterfactual experiment. Suppose that education distribution had remained fixed as in 1970 and only participation behavior had changed. The employment rate would have increased from 0.145 to 0.352. Assuming that participation choices had stayed the same and education distribution had changed the employment rate would have changed from 0.145 to 0.140.

Table 3: Employment Rate and Hours Worked, 22-44 Years Old Married Women.

	1970	1990
Average Hours	13.6	23.4
Average Hours, Employed	33.8	35.9
Employment Rate	0.42	0.68
Full-Time Employment Rate	0.29	0.51

Source: March CPS. Note: Employment rate is the proportion of women who are employed during a reference week. Full-time employment rate is the proportion of women who worked more than 30 hours during a reference week.

These calculations show that changes in women's education play no role in the increase in labor participation of married women with an infant.

Panel B of Table 2 shows the same statistics as in Panel A for married women without children under age 18. Unlike for women with a child, the employment rate is higher for more educated women comparing to their less educated counterparts in 1970. If education distribution had remained fixed as in 1970 and participation behavior had changed the employment rate would have increased from 0.544 to 0.640. If participation choices had stayed the same and education distribution had changed the employment rate would have increased from 0.544 to 0.589. These results imply that while the composition effect plays a role, it cannot account for the rise in employment of married women without children entirely.

In Table 3, I report average hours worked per person, average hours worked conditional on being employed, employment rate and full-time employment rate for married women in 1970 and 1990. We can see that there has been a large increase in average hours worked and only a marginal increase in hours worked conditional on being employed between 1970 and 1990. At the same time, there has been a sharp rise in employment rate and full-time employment rate. These statistics suggest the main change in women's labor supply occurred along the extensive margin. Attanasio, Low, and Sanchez-Marcos (2008) reach the same conclusion using PSID data.

2.2 Fertility

Cyclical Properties of Fertility

First, consider the behavior of fertility rate over the business cycle at aggregate level. I use labor productivity, defined as business output per worker, as a business cycle indicator. Table 4 shows the correlation between the business cycle frequency components of fertility rate and productivity for two periods, 1961-1981 and 1982-2007. The difference between two periods is remarkable. Fertility rate is countercyclical in period one and procyclical in period two.[6]

Table 4: Correlation of Fertility Rate and Productivity: 1961Q1-2007Q4.

	Period I 1961-1981	Period II 1982-2007
Productivity Lagged 3 Quarters	-0.45	0.48
Productivity Lagged 4 Quarters	-0.38	0.50
Productivity Lagged 5 Quarters	-0.29	0.44

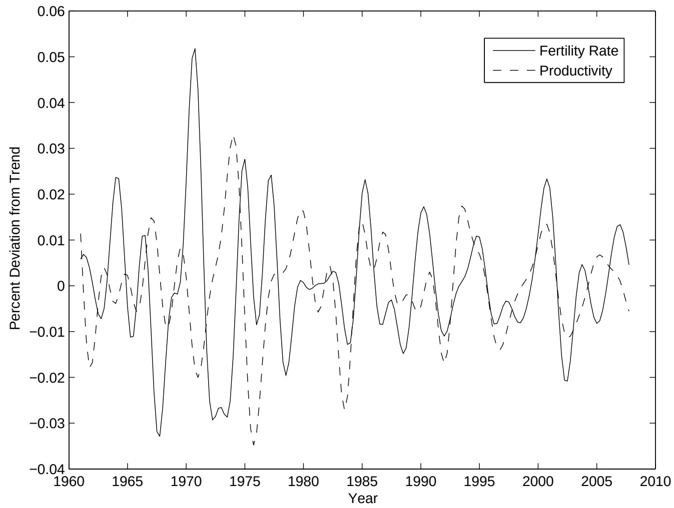
Source: Fertility rate - National Center for Health Statistics. Productivity - BLS. Note: Fertility rate - number of births per 1000 women aged 15-44 years. The quarterly series is obtained by averaging the original seasonally adjusted monthly data. Productivity is business output per worker. Both variables are detrended using band pass filter with frequency parameters 6 and 32 for quarterly data.

Since I am interested in a fertility decision rather than a fact of birth itself I use productivity lagged four quarters and also report the results for three and five quarter lags. Other commonly used cyclical indicators, such as output and unemployment are clearly endogenous with respect to fertility and participation decisions. The results based on these indicators are presented in Appendix III and confirm the findings reported here.

The choice of the break point, year 1981, is illustrated by Figure 1, which shows the detrended fertility rate and productivity series, with the latter lagged four quarters. We

[6] I use the band pass filter instead of the Hodrick-Prescott filter to detrend the series because it allows to isolate business cycle frequencies and remove the high frequency noise from the fertility rate series. The results for series detrended using the Hodrick-Prescott filter are qualitatively similar.

Figure 1: Fertility Rate and Productivity Lagged 4 Quarters, Percent Deviation from Trend.



Source: Fertility rate - National Center for Health Statistics. Productivity - BLS. Note: Fertility rate - number of births per 1000 women aged 15-44 years. The quarterly series is obtained by averaging the original seasonally adjusted monthly data. Productivity is business output per worker. Both variables are detrended using band pass filter with frequency parameters 6 and 32 for quarterly data.

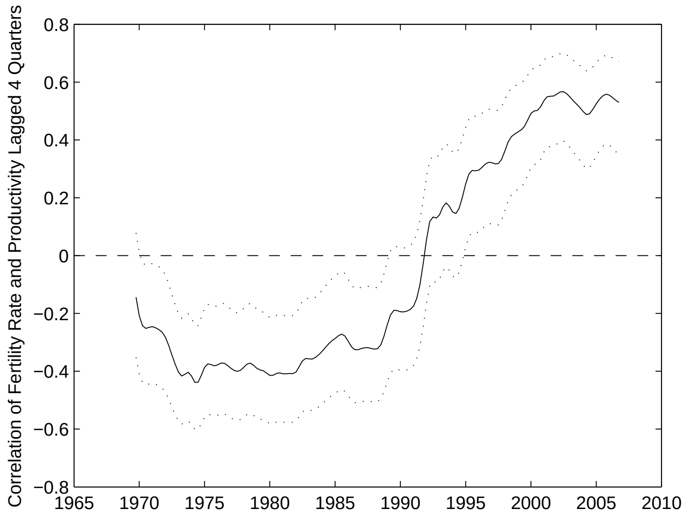
can see that the change in cyclicality of fertility occured around 1981.[7]

Figure 2 shows the change in cyclicality of fertility rate graphically. The solid line shows the correlation of fertility rate and productivity lagged four quarters over the eighty quarters, with the last observation given by the value of the coordinate on the horizontal axis. Dotted lines show 95% confidence interval.

Next, I use SIPP data to document the relashionship between births and business cycle at a more disaggregate level. I use the data from 1984 survey for the first period and 2001 survey for the second period. The details of the sample construction are described in Appendix I. Using the data on the date of birth and link to mother for every individual, I construct fertility and marital histories for all women and estimate the following linear

[7]The results presented in Table 4 are not sensitive to the choice of the break point.

Figure 2: Correlation of Fertilty Rate and Productivity Lagged 4 Quarters over the Previous 80 Quarters.



Source: Fertility rate - National Center for Health Statistics. Productivity - BLS. Note: Fertility rate - births per 1000 women aged 15-44 years. The quarterly series is obtained by averaging the original seasonally adjusted monthly data. Productivity is business output per worker. Both variables are detrended using band pass filter with frequency parameters 6 and 32 for quarterly data. For a given quarter, correlation between the detrended series is computed over the previous 80 quarters and represented by a solid line. Dotted lines show 95% confidence intervals.

probability model:

$$b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}, \tag{1}$$

where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t - 4$. The sample is restricted to married women. Table 5 shows the results.

I report the results restricting the age at birth to start from 15 to be consistent with statistics based on aggregate data described above and from 22 as will be relevant for the

Table 5: Probability of Birth over the Business Cycle in the SIPP Data.

	Period I 1966-1981	Period II 1984-2003
Age Group	$\hat{\beta}_1$ (s.e.)	$\hat{\beta}_1$ (s.e.)
Age 22-44	-0.024 (0.025)	0.178 (0.027)
Age 22-25	-0.116 (0.049)	-0.077 (0.057)
Age 26-44	0.023 (0.028)	0.226 (0.030)
Age 15-44	-0.032 (0.021)	0.093 (0.024)
Age 15-25	-0.085 (0.030)	-0.160 (0.040)

Note: Estimates from the linear probability model $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$.

quantitative analysis below.[8] They are very similar to the results for the aggregate series, with the probability of birth being countercyclical in the 1960s and 1970s and procyclical thereafter. These results also suggest that the change in the cyclicality of fertility is driven by the change in behavior of older women. While $\hat{\beta}_1$ is negative in both periods for younger women, it is slightly positive in the first period and strongly positive in the second period for older women. The results provided in the Appendix III show that the findings of this subsection hold for women with different level of education and for the first births only.

Secular Properties of Fertility

Table 6 shows that the average age of mothers at first birth has increased from 21.4 in 1970 to 24.2 in 1990.

Table 7 illustrates this delay in fertility from a different angle. The share of first time mothers who are 25 years old or younger decreases from 78% in 1970 to 41% in 1990.

[8] Data limitations do not allow me to use exactly the same periods as for aggregate series.

Table 6: Average Age of Mother at First Birth.

1970	1990
21.4	24.2

Source: Natinal Center for Health Statistics.

Table 7: Share of First Time Mothers with an Infant by Age.

Age	1970	1990
15-21	0.42	0.16
22-25	0.36	0.25
26-30	0.17	0.36
31-44	0.05	0.23

Source: US Census of Population.

3 Model

In this section, I describe the model I use to analyze the change in cyclical properties of fertility rate and the link between the changes in women's labor force participation and properties of fertility. I consider a stochastic life-cycle overlapping generations model with aggregate and idiosyncratic uncertainty.

3.1 Environment

The economy is populated by overlapping generations of agents. The unit of the analysis is a unitary household. Each household consists of a wife and her husband. In each period, a new generation of households of measure one enters the economy at age j_1. Households live T periods with certainty and leave the economy at age J.

Preferences

The expected lifetime utility of a household is:

$$\mathbb{E}\sum_{j=j_1}^{J}\beta^{j-j_1}U(c_j,n_j,v_j;e_j), \tag{2}$$

where c_j - household's consumption, $n_j \in \{0,1\}$ - number of children in the household, v_j - value of wife staying home, $\beta \in (0,1)$ - discount factor and e_j - equivalence scale for consumption. Successive cohorts of households are different depending on realization of aggregate shock but I suppress the time index for convenience.

Stochastic Processes

Since this work studies the cyclical properties of fertility, aggregate shock is an essential ingredient of the model. Each period, a household faces aggregate shock, which is assumed to follow AR(1) process:

$$log\ z' = \rho_z log\ z + \epsilon_z,\ \epsilon_z \sim N(0,\sigma_z^2), \tag{3}$$

where ϵ_z is standard normal random variable with standard deviation σ_z. Women's productivity at home is stochastic. A household entering the economy draws a value of home production for wife from a random distribution. Each period, wife's home production value is disturbed by idiosyncratic shock and evolves according to AR(1) process during the life-cycle:

$$log\ v' = \rho_v log\ v + \epsilon_v,\ \epsilon_v \sim N(0,\sigma_v^2). \tag{4}$$

The initial value, v_{j_1}, is drawn from the stationary distribution of v. The parameter μ_v is used to locate the mean of the distribution of v:

$$v := v - \mu_v. \tag{5}$$

Earnings

Husband and wife are endowed with one unit of time each. A husband plays a simple role in the model, he works and brings income to the household. I assume that husband always works since most married man work in the market over the life-cycle.[9] Husband's

[9]See, for example Blau (1998).

human capital, k_j^h, depends exogenously on his age j. Husband's earnings depend on the level of his human capital and aggregate state of the economy:

$$log\, y_j^h = log\, z + log\, k_j^h. \tag{6}$$

Since a woman's labor supply decision is essential in this study, women are modeled in a more complicated way. As shown in Table 3, the major change in the labor supply of women occured along the extensive margin. Based on this result, I assume that market time is indivisible and wife can either work in the market or stay home. Earnings of age j wife depend on the aggregate state of the economy and level of her human capital k_j^w:

$$log\, y_j^w = log\, z + log\, k_j^w. \tag{7}$$

Contrary to her husband, wife's human capital is determined endogenously depending on her employment history:

$$k_{j+1}^w = k_j^w + (\eta_0 + \eta_1 j) k_j^w I(E_j = 1), \tag{8}$$

where $I(.)$ - indicator function. The level of wife's human capital in the next period depends on the current level of human capital and the amount of human capital acquired on the job if she works in the current period. As in Attanasio, Low, and Sanchez-Marcos (2008) and Olivetti (2006), I assume that the increase in human capital associated with one more year of work depends on age and diminishes with age if $\eta_1 < 0$.

Budget Constraints

Each period, household's income consists of income of husband, income of wife if she is employed and assets brought from the previous period. The income is divided into consumption, assets carried into the next period and child care cost, which is paid if there is a child under age 18 in the household and wife works in the market:

$$y_j^h + y_j^w I(E_j = 1) + a = c + \frac{a'}{(1+r)} + p_c G(d) I(E_j = 1), \tag{9}$$

where $G(d)$ - units of child care required for a child of age d and $I(.)$ - indicator function. Price per unit of child care is denoted by p_c. I assume that households can borrow up to a certain limit, so that:

$$a' \geq a_{min}. \tag{10}$$

Households enter the economy with zero assets,

$$a_{j_1} = 0, \tag{11}$$

and cannot leave the economy in debt:

$$a_{J+1} \geq 0. \tag{12}$$

3.2 Household Decision Problem

Consider the dynamic programming problem of age j household. Denote the household's value if wife works by $W(x,d)$, the household's value if wife stays home by $H(x,d)$. A household state is given by $x := (z, j, k_w, v, a)$ and d, where d is the age of child.

The value function for a household without children ever born is given by:

$$V(x,0) = max_{a'}\{max\{W(x,0), H(x,0)\}\}, \tag{13}$$

where

$$W(x,0) = U(c,0,0) + \beta max\{EV(x',0), E(p_j V(x',1) + (1-p_j)V(x',0))\}, \tag{14}$$

$$H(x,0) = U(c,0,v) + \beta max\{E(V(x',0), E(p_j V(x',1) + (1-p_j)V(x',0))\}, \tag{15}$$

and p_j is the probability of having a child next period conditional on a household's conception decision in the current period.

The interpretation is straightforward. A household without children makes fertility, participation and consumption decisions simultaneously. If the households makes a conception decision this period, a child appears next period with probability p_j. If wife does not work, the household enjoys the value of her home production.

The value function for a household with a child of age $d \in [1, 17]$ is given by:

$$V(x,d) = max_{a'}\{max\{W(x,d), H(x,d)\}\}, \tag{16}$$

where

$$W(x,d) = U(c,1,0) + \beta EV(x', d+1), \tag{17}$$

$$H(x,d) = U(c,1,v) + \beta EV(x',d+1). \quad (18)$$

A household with a child makes only participation and consumption decisions. If wife works then the household has to pay the cost of child care $p_c G(d)$, which depends on the age of the child d. If wife stays at home then the household enjoys the value of home production v and does not have to pay the cost of child care.

The value function for a household after child leaves is given by:

$$V(x,0) = max_{a'}\{max\{W(x,0), H(x,0)\}\}, \quad (19)$$

where

$$W(x,0) = U(c,0,0) + \beta EV(x',0), \quad (20)$$

$$H(x,0) = U(c,0,v) + \beta EV(x',0). \quad (21)$$

This household solves the same problem as a household without children ever born but does not make a fertlity decision. Parents do not derive utility from a child after child leaves the household.

Denote household decision rules by $a'(x,d)$ for asset choice, $f(x,d)$ for conception decision and $l(x,d)$ for wife's labor participation decision. A solution to the household problem is a set of decision rules, $a'(x,d)$, $f(x,d)$ and $l(x,d)$ such that given interest rate r, $a'(x,0)$, $f(x,0)$ and $l(x,0)$ solve equations (13)-(15) subject to the budget constraints (10)-(12) for the household without children ever had, and $a'(x,d)$ and $l(x,d)$ solve equations (16)-(18) for the household with a child under age 18 and equations (19)-(21) for the household after child leaves subject to the same budget constraints (10)-(12).

4 Quantitative Analysis

In this section, I describe how I choose functional forms and the parameters for the benchmark model.

4.1 Calibration

Functional Forms

Utility function is separable, that is:

$$U(c_j, n_j, v_j; e_j) = log\frac{c_j}{e_j} + \gamma n_j + v_j \tag{22}$$

Following Hotz and Miller (1988), I specify the functional form for G as:

$$G(d) = \phi^{d-1} I(d \in [1, 17]). \tag{23}$$

Parameter ϕ allows to account for the difference in need for child care for children of different ages. The logarithm of husband's human capital is assumed to be a cubic polinomial in age:

$$log\ k_j^h = a_0 + a_1 j + a_2 j^2 + a_3 j^3. \tag{24}$$

The probability of birth function p_j is parametrized using a cubic polynomial:

$$p_j = b_0 + b_1 j + b_2 j^2 + b_3 j^3. \tag{25}$$

I assume that women are not fertile after age 44.

Parameters Set A Priori

Some of the model parameters can be independently determined. Their values are described in Table 8. The model period is chosen to be one year. This is a reasonable amount of time between the decision to have a child and the birth. In addition, this choice substantially reduces computing time. I assume that households enter the economy at age 21 and leave the economy at age 65. To determine e_j, I use McClements scale, which depends on the age and number of children.[10] The parameters for the earnings profile for males are taken from Kambourov and Manovskii (2005) for the cohort of males entering the labor market in 1968 at age 18. The earnings profile is normalized to 1 in the first period at age 21. The initial value for the wife's human capital process is chosen to match the ratio

[10]McClements scale assigns value 1 for a childess couple, 1.08 if a child is less than 2 years old and values increasing with age of child. See McClements (1977) for details.

of female and male median earnings at the beginning of their career.[11] Interest rate is set equal to 4%.

Table 8: Parameter Values Chosen A Priori.

Description	Values
Model Period	1 year
Age	$J = 65, j_1 = 21, d \in \{0, 1, 2, ..18\}$
Equivalence Scale	McClements scale, $e_j = 1$ for childless couple, increases with age of child
Human Capital, Husband	$a_0 = 9.3224, a_1 = 0.102,$ $a_2 = -0.00322, a_3 = 0.000029$ Normalized to 1 at j_1
Initial Human Capital, Wife	$k^w_{j_1}/k^h_{j_1} = 0.805$
Interest Rate	$r = 0.04$

Calibrated Parameters

Table 9 shows the set of parameters that I calibrate along with the description of calibration targets. There are 15 parameters that are calibrated to match the same number of data statistics for 1970. It is clear that a change in each parameter leads to the changes in all statistics so the mapping between the parameters and targets is intended to show what parameters play a main role in determining respective statistics.

The calibrated model parameters are: utility of having a child, three coefficients for the birth probability equation[12], persistence and standard deviation of aggregate shock, two parameters governing human capital accumulation for females, price of child care, units of child care function parameter, discount factor, borrowing limit and three parameters for value of home production (persistence, standard deviation and mean locator).

[11]The value is computed using the CPS March 1971 data. The sample is restricted to include married men and women who worked full time 50 weeks or more during the previous year, 18-19 years old with high school degree and 21-22 years old with college degree.

[12]The fourth is set so that probability of birth next period equals to 0 for women of age 44 and older.

The parameters are calibrated to match the following selected statistics:

1. Fertility rate for 22-25 years old married women, computed using the US 1970 census of population data as the ratio of number of first time births and number of women between ages 22 and 25.

2. Shares of first time mothers for the following three age categories: 22-25, 26-30 and 31-35. These statistics are computed using the US 1970 census of population data and rescaled to account for the fact that households enter the economy at age 21. The original statistics are shown in Table 7 in the Facts section above.

3. Persistence and volatility of productivity, where productivity is output per worker BLS series. The annual productivity series is detrended using the Hodrick-Prescott filter with smoothing parameter 100.

4. The wage growth for two groups of women: younger than 34 years old and 34 years old or older. Following Attanasio, Low, and Sanchez-Marcos (2008), these two statistics are computed using PSID data for married women who have worked 90% of their lifetime at each age. The wage growth is measured as a parameter β_1 in the following regression:

$$log\, y_j^w = \beta_0 + \beta_1 j + \epsilon_j \tag{26}$$

5. Wealth to income ratio. The choice of this statistic is not straightforward since the model considered in this work does not have many features that determine wealth accumulation. In particular, there is no precautionary motive, no retirement and no health shock. The ratio of household financial wealth (net worth excluding owners' equity in household real estate) to disposable personal income is 3.87 in 1970.[13] I assume that the model has to account for a third of that number and do a sensitivity analysis with respect to this choice.

6. Debt to income ratio. For the total debt to income ratio I use the ratio of consumer debt outstanding to disposable personal income.[14]

The following statistics are computed using the US 1970 census of population data.

7. Employment rate for women with 6 years old child.[15]

[13]See Table B.100 at *http://www.federalreserve.gov/releases/z1/Current/annuals/a1965-1974.pdf.*

[14]See Table B.100 at *http://www.federalreserve.gov/releases/g19/hist/cc_hist_r.html.*

[15]Employment rate is the proportion of married women who worked more than 30 hours during a reference week.

8. Employment rate for women younger than 34 with infant, their first child.

9. Employment rate for women aged 34 or more with infant, their first child.

10. Employment rate for women younger than 34 without children under age 18.

11. Employment rate for women aged 34 or more without children under age 18.

Thus, there are fifteen targets to pin down fifteen parameters.

Table 9: Calibrated Parameters.

Parameters	Description	Calibration Targets
γ	Utility from a Child	Fertility Rate, Age 22-25
b_1	Probability of Birth	Share of Births, Age 22-25
b_2	Probability of Birth	Share of Births, Age 26-30
b_3	Probability of Birth	Share of Births, Age 31-35
ρ_z, σ_z	Shock	Volatility and Persistence of Productivity
η_0	Women's HK	Wage Growth, Age 22-33
η_1	Women's HK	Wage Growth, Age 34-44
p_c	Child Care Cost	Employment Rate, Age 22-33, with Infant
ϕ	Child Care Function Parameter	Employment Rate, Women with 6 y.o. Child
β	Discount Factor	Wealth Income Ratio
a_{min}	Borrowing Limit	Debt Income Ratio
$\sigma_v^2, \mu_v, \rho_v$	Value of staying home	Employment Rate, Age 34-44, with Infant
		Employment Rate, Age 22-33, no Children
		Employment Rate, Age 22-33, no Children

5 Results from the Calibrated Model

5.1 Benchmark Calibration

To find the parameter values the model is solved numerically according to the computational algorithm described in Appendix II. Table 10 shows the performance of the model in matching targets. We can see that the model matches the important features of the data. Calibrated parameter values are shown in Table 11 and they are quite reasonable. For example, child care function parameter, ϕ, which determines how the need for child care depends on age of child, equals to 0.901. Hotz and Miller (1988) estimate the same parameter in their micro study and obtain the value 0.89. The price of child care unit relative to women's earnings is simular to that obtained by Attanasio, Low, and Sanchez-Marcos (2008). Borrowing limit approximately equals to a household's period income at age 25 if wife has always worked, which is not unreasonable. The implied probability of birth given a conception effort is about 0.4 at age 21 and decreases to zero at age 44. The probability of conception is somewhat lower relative to natural fertility for a modern sect practicing no birth control, which equals 0.55 for 20-24 years old women (See Clark (2007)) but similar to the estimates reported in Hotz and Miller (1988) and Rosenzweig and Schultz (1985), who find a monthly conception probability of around 2.5% on average during fertile years.[16]

5.2 Properties of the Model

The cyclical properties of fertility rate, computed using the SIPP data and the simulated data from the calibrated model are shown in Table 12. We can see that the benchmark model produces countercyclical fertility rate driven by younger women. To understand the results, let us consider a new cohort of households entering the economy. First, the utility from a child is high enough to guarantee that all agents want to have a child. The question is about timing and it depends on the value of home production and aggregate state of the economy. Recall that households draw a value of wife's staying home in the first period from a stochastic distribution. Women who have a high value prefer to stay home and

[16] Annual probability of conception equals $1 - (1 - 0.025)^{12} = 0.262$

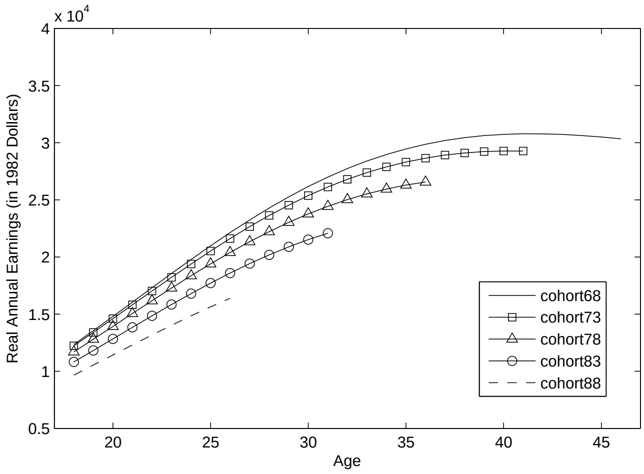
have a child early since they derive utility from having a child and do not pay a child care cost if they stay home. Women at the margin between working and staying home choose to give a birth during a recession when the opportunity cost of staying home is lower. Women who draw a low value of staying home face the following trade off. On the one hand, they want to have a child early because of discounting. On the other hand, the opportunity cost of staying home is high, so they choose to work in the market and pay the child care cost. The desire to smooth consumption is a force to have a child later, when income is higher. These women prefer to have a child during an expansion as a way to smooth household's consumption. This intuition is clear if we assume that the value of staying home is drawn randomly in the first period and stays constant over the life-cycle. One undesirable implication of this assumption is that the employment rate is close to zero for younger women and close to one for older women with a young child. However, the employment rate varies little by age for women with an infant as shown in Table 10. The introduction of persistent stochastic process for the value of staying home allows to obtain the employment rate for women of different ages with an infant as in the data and at the same time preserves cyclical properties of fertility rate depending on value of staying home. Another property of the model is that fertility is more important as a tool to smooth consumption in early ages and assets are more important later in life. This explains much stronger cyclical response of fertility for younger households comparing to older households.

6 Experiments

In this section, I consider several changes in the determinants of female labor supply that occurred between the two periods and have been proposed in the literature to explain the increase in married women labor supply. I focus on the following candidates: 1) increase in wage level for females (implying decrease in gender wage gap), 2) increase in returns to experience for femals and 3) decrease in child care cost. It has been argued that each of these changes is a major contributor to the changes in the female labor supply.[17] The goal

[17] See Jones, Manuelli, and McGrattan (2003), Olivetti (2006), Attanasio, Low, and Sanchez-Marcos (2008) for candidates 1), 2) and 3) respectively.

Figure 3: Life-Cycle Male Earnings Profile.



Source: Kambourov and Manovskii (2005).

here is to evaluate the implication of each alternative for the cyclical and secular properties of fertility in the model with endogenous fertility.

I also consider one more potential candidate that may have contributed to the rise in the female labor supply. As documented in Kambourov and Manovskii (2005) and shown in Figure 3, a significant flattening of life-cycle earnings profiles for successive cohorts of males occurred since the late 1960s. It is clear that this change in the earnings of their husbands may induce women to increase their labor supply. Based on the properties of the model described above, it may also lead to delay of fertility for women who are more productive in the market relative to home. I want to evaluate these effects quantitatively.

The nature of the experiments is the following. I introduce changes in the determinants of the female labor supply that occurred between the two periods considered in this work, compute the new steady state using the benchmark model with appropriate changes in parameters and analyze the changes in female labor participation and properties of fertility between the two steady states. To carry out the experiments, I need to quantify the changes in the determinants of female labor supply and map them into changes in the parameters of the benchmark model. For the change in females' wage level experiment, I compute the ratio of female and male median earnings at the beginning of their career in 1990 the same way as for the benchmark model using the CPS March 1991 data. Once again, the sample is restricted to include married men and women who worked full time 50 weeks or more during the previous year, 18-19 years old with high school degree and 21-22 years old with college degree. The ratio changes from 0.805 in 1970 to 0.907 in 1990, an increase by about 12.7%. For the flattening males life-cycle earnings profile experiment I use the parameters for the males earnings profile from Kambourov and Manovskii (2005) for the cohort of males entering the labor market in 1988 at age 18. As in the benchmark case, the earnings profile is normalized to 1 in the first period at age 21. There is no direct measure of historic child care price but Attanasio, Low, and Sanchez-Marcos (2008) argue that a 15% decline is not unreasonable. I use this number and also 20% increase in marginal returns to experience for females averaged over the life-cycle used in their work.[18] This value is of the same order of magnitude as the estimate reported in Olivetti (2006). Using the PSID data she finds a 25% increase in the elasticity of growth of hourly wages with respect to hours of work for women between 1970s and 1990s. Since there is an empirical evidence of changes in all determinants of female labor supply considered in this work, I consider all changes simultaneously and then one by one and study the implications for the cyclical and secular properties of fertility using the framework developed in this work.

Experiment I. Changing All Determinants Proposed in the Literature Combined

In the first experiment, I introduce the changes in all determinants proposed in the literature: 1) 12.7% increase in the initial females' wage level (implying decrease in gender wage gap), 2) 20% increase in returns to experience for females and 3) 15% decrease in child care cost. Table 13 shows the results. Combining all three alternatives together can account for the increase in participation of women without children, overshoots the participation of mothers with an infant by about 23% for younger women and about 15% for older women and does not lead to a delay in fertility. The last result stems from the fact that the increase in the females' wage level and returns to experience on the one hand, and the decrease in child care cost on the other hand, balance each other out as explained in the discussion of the Experiment II results below. Table 18 shows the changes in cyclicality of fertility as

[18]They consider increases by 10%, 20% and 40%.

a result of the changes in all three determinants combined. We can see that fertility rate becomes procyclical as in the data but this result is driven by the change in behavior of younger women, not older as in the data.

Experiment II, Changing Each Determinant Separately

To understand the role of each alternative, I carry out the set of experiments changing the determinants of female labor supply one at a time. The results are shown in Table 15. Column (W) shows the results of the increase in females' wage level. In particular, I change the ratio of female and male median earnings at the beginning of their career from 0.805 in 1970 to 0.907 in 1990. These statistics are computed using the CPS data as explained in the beginning of this section. The implied female-male earnings ratio increases from 0.597 to 0.697. These numbers are very close to the numbers estimated in Blau (1998), who reports an increase from 0.562 in 1969 to 0.692 in 1989 for full-time workers between ages 25 and 64. Column (E) shows the results of the increase in returns to experience for females. More specifically, I increase η_0 so that the implied marginal returns to experience averaged over the life-cycle increase by 20%.[19] Column (C) shows the results of the decrease in child care cost, p_c, by 15%. Finally, Column (M) shows the results of the flattening males life-cycle earnings profile as estimated in Kambourov and Manovskii (2005). We can see that the change in each determinant leads to a rise in women's employment rate but none of them can account for the increase entirely. The results of the increase in females' wage level and returns to experience are similar, they produce the increase in employment rate of younger and older women with an infant and without children under age of 18. They also deliver a delay in fertility. The only difference is that, not surprisingly, the increase in returns to experience leads to higher employment rate for older women comparing to the increase in wage level case. In the former case, women accumulate more human capital in early ages and participate more when they become older. Attanasio, Low, and Sanchez-Marcos (2008) find similar results for the gender wage gap experiment but they find that the increase in returns to experience has a small effect on women's labor supply. They contribute this limited impact of the returns to experience to the presence of uncertainty

[19] Note that marginal returns to experience depend on age.

in their model as households work and save more early in life and do not respond fully to intertemporal incentives. After careful examination, the results of the decrease in child care cost experiment are similar to those reported in Attanasio, Low, and Sanchez-Marcos (2008) in terms of female labor force participation. Participation of women without children remains unchanged, participation of women with young children increases by about the same percent, 26% for women under age of 29 and 36% for women above 29 in their work and 26% for younger women and 48% for older women in this paper. The differences are that they consider changes between the cohorts of women born in 1944-1948 and 1954-1958, women with children under age of three and account for the change in participation rates from 0.42 to 0.53 for younger women with children under age of three and from 0.53 to 0.72 for older women with children under age of three. So the impact of the decrease in child care cost is very similar in two models but it is not enough to account for the changes in the women's labor participation statistics used in this work. The decrease in the child care cost counterfactually predicts that women begin childbearing earlier. The last experiment, flattening of males life-cycle earnings profile, delivers the increase in employment rate for all categories of women but, as in previous cases, not enough to account for the changes in the data. It also produces a delay in fertility.

Before discussing the intuition behind the results of the experiments let us consider their impact on cyclical properties of fertility rate. Table 16 shows the results. Each alternative except flattening of males life-cycle earnings profile decreases negative correlation of fertility rate and business cycle for all women and younger women but does not change the correlation for older women.

To understand the economics behind the results of each experiment it is useful to recall the mechanism behind the results of the benchmark model. Women who draw a high value of staying home prefer to have a child as soon as they enter the economy and those at the margin between working and staying home prefer to do it during a recession. Women who draw a low value of staying home prefer to work in the market, have a child later when household's income is high enough and pay the child care cost. They time their fertility to good times to smooth household's consumption.

To understand how the experiments work we need to consider how those two groups of households are affected. The intuition behind the increase in females' wage level and returns to experience experiments is similar. Higher current or expected future wage level decreases the threshold value of staying home and induces more women to work in the market comparing to the benchmark case. These women delay their fertility and fertility rate declines for younger women. Women with low value of staying home prefer to have a child earlier because the household's income is higher. The effect for the former group dominates and there is a delay in fertility as a result. Since the market wage increases while the value of staying home and child care cost remain unchanged, employment rate is higher for younger and older women with a child and without children. Correlation of fertility rate and business cycle increases for all and younger women because of the change in behavior of women with low value of staying home. The number of women with high value of staying home who prefer to have a child during a recession stays about the same while the number of women who prefer to work in the market and pay a child care cost when they give a birth increases.[20] At the same time, women with low value of staying home prefer to have a child earlier comparing to the benchmark case because household's income is higher.

The decrease in child care cost case is different from the experiments described above because women with high value home production stay home when they have a child, do not pay child care cost and therefore, they are not affected. Women with low value of staying home have a child earlier comparing to the benchmark case and childbearing shifts to earlier ages as a result, the opposite to what we see in the data. The employment rate of women without children is not affected while it increases for women with a child as in the wage level and returns to experience cases. As women with low value of staying home start bearing a child earlier and employment rate increases for women with a child, correlation of fertility rate and busines cycle increases for all and younger households.

The flattening of males life-cycle earnings profile operates in the following way. As their husbands' income decreases more women work in all categories comparing the benchmark

[20]The change in the number of women in the former case depends on the change in the mass of agents around the threshold value of home production and it is relatively small because the threshold is located around the median.

case. The impact on women with high value of staying home is the same as in the wage level and returns to experience experiments. The threshold value of staying home decreases, more women work and delay their fertility. The impact on women with low value of staying home is unique for this experiment. The decline in household's income leads to a delay in fertility for these women since they wait longer till the household's income is high enough. Both groups of women delay fertility, that is why the delay in fertility is the most pronounced among all experiments. The delay in fertility by the group with low value of staying home is the reason that fertility rate becomes stronger countercyclical and that this is driven by younger women. As women with low value of staying home, whose fertility response to aggregate shock is procyclical, delay the birth of their child and fertility becomes less important as a tool to smooth consumption, the countercyclical response of younger mothers becomes more pronounced and dominates the overall response.

Experiment III. Changing All Four Determinants Combined

In experiment III, I introduce the changes in all four determinants: 1) 12.7% increase in wage level for females (implying decrease in gender wage gap), 2) 20% increase in returns to experience for females, 3) 15% decrease in child care cost and 4) flattening males life-cycle earnings profile. Column (L) in Table 17 shows the results from experiment I (changes 1), 2) and 3) combined) and Column (L+M) shows the results obtained changing all four determinants. All changes combined lead to higher employment rates for all categories of women in the second period comparing to the data. The employment rate increases by 35% higher for women with an infant and by about $7-10\%$ higher for women without children comparing to the data. Adding flattening of the life-cycle earning profile generates a delay in fertility as observed in the data. Fertility rate declines for the youngest households and women have their first child later comparing to the benchmark case.

Table 18 shows the changes in cyclical properties of fertility rate. Combined with other alternatives, the flattening of the life-cycle earnings profile for males dampens the strong procyclical fertility rate for younger women though it is not enough to generate the change in the cyclical properties of fertility observed in the data

7 Conclusion

I document and analyze the change in cyclical behavior of fertility rate at business cycle frequencies. I find that fertility rate is countercyclical in the 1960s and 1970s and procyclical thereafter. Countercyclical fertility is shaped by behavior of younger women in the first period and the change in the second period is driven by the change in behavior of older women. I find that a standard model with incomplete markets can generate countercyclical fertility in the 1960s and 1970s. The model implies that properties of fertility are related to labor force participation decisions of married women. The following candidates have been suggested in the literature to explain the rise in married women's labor supply between the 1970s and 1990s:

1. A decrease in the gender wage gap.
2. An increase in returns to experience for females.
3. A decrease in child care cost.

These changes have implications for the properties of fertility. The decrease in gender wage gap and the increase in returns to experience lead to fertility delay while the decrease in child care cost shifts childbearing to earlier ages contrary to the data. Each alternative decreases negative correlation of fertility rate and business cycle for all women and younger women but does not change the correlation for older women. Combining all three alternatives together does not change the age of women at first birth and leads to overall procyclical fertility rate as observed in the data but driven by younger women not older as in the data.

The flattening of life-cycle earnings profile for males leads to a delay in fertility and stronger countercyclical fertility rate driven by younger women. Combining it with other candidates dampens the strong procyclical fertility rate for younger women though it is not enough to generate the change in the cyclical properties of fertility observed in the data.

The key message of this work is that female labor force participation and timing of fertility are determined by the same economic forces and implications for fertility can be used to distinguish among theories of the rise in labor force participation of married women.

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Table 10: Benchmark economy.

Statistic	Data	Model
Fertility Rate, Age 22-25	0.217	0.221
Employment Rate, with an Infant, Age 22-33	0.145	0.146
Employment Rate, with an Infant, Age 34-44	0.164	0.164
Employment Rate, no Children, Age 22-33	0.596	0.598
Employment Rate, no Children, Age 34-44	0.472	0.483
Share of Births, Age 22-25	0.621	0.601
Share of Births, Age 26-30	0.288	0.298
Share of Births, Age 31-35	0.060	0.059
Wage Growth, Age 22-33	0.026	0.026
Wage Growth, Age 34-44	0.013	0.013
Productivity, Standard Deviation	0.015	0.015
Productivity, Persistence	0.456	0.459
Wealth Income Ratio	1.290	1.295
Debt Income Ratio	0.178	0.174

Note: The table describes the performance of the model in matching the calibration targets.

Table 11: Calibrated Parameter Values.

Parameter	Definition	Value
γ	Utility from a Child	0.308
$b(1)$	Probability of Birth Function	-0.001
$b(2)$	Probability of Birth Function	0.008
$b(3)$	Probability of Birth Function	-0.312
ρ_z	Persistence of Aggregate Shock	0.896
σ_z	Standard Deviation of Aggregate Shock	0.016
η_0	Women's Human Capital Accumulation	0.056
η_1	Women's Human Capital Accumulation	0.001
p_c	Child Care Cost	0.573
ϕ	Child Care Function Parameter	0.901
β	Discount Factor	0.971
a_{min}	Borrowing Limit	-2.128
σ_v^2	Value of Staying Home, Standard Deviation	0.297
μ_v	Value of Staying Home, Mean Locator	0.446
ρ_v	Value of Staying Home, Persistence	0.476

Note: The table contains the calibrated parameter values in the benchmark calibration.

Table 12: Data and Results from the Benchmark Model.

Statistic	Data	Model
$\hat{\beta}_1$ (Age 22-44)	-0.024	-0.037
(s.e.)	(0.025)	
$\hat{\beta}_1$ (Age 22-25)	-0.116	-0.130
(s.e.)	(0.049)	
$\hat{\beta}_1$ (Age 26-44)	0.023	0.002
(s.e.)	(0.028)	

Note: Estimates from the linear probability model $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$.

Table 13: Experiment I, Changing All Determinants Proposed in the Literature Combined.

Statistic	Data	Data	Model
	Period I	Period II	Period II
Fertility Rate, Age 22-25	0.217	0.154	0.227
Emp Rate w/ Infant, Age 22-33	0.145	0.368	0.451
Emp Rate w/ Infant, Age 34-44	0.164	0.405	0.461
Emp Rate, no Kids, Age 22-33	0.596	0.738	0.765
Emp Rate, no Kids, Age 34-44	0.472	0.664	0.662
Share of Births, Age 22-25	0.621	0.297	0.578
Share of Births, Age 26-30	0.288	0.438	0.321
Share of Births, Age 31-35	0.060	0.205	0.061

Table 14: Experiment I, Changing All Determinants Proposed in the Literature Combined.

Statistic	Data	Data	Model
	Period I	Period II	Period II
$\hat{\beta}_1$ (Age 22-44)	-0.024	0.178	0.178
(s.e.)	(0.025)	(0.027)	
$\hat{\beta}_1$ (Age 22-25)	-0.116	-0.077	0.730
(s.e.)	(0.049)	(0.057)	
$\hat{\beta}_1$ (Age 26-44)	0.023	0.266	0.065
(s.e.)	(0.028)	(0.030)	

Note: Estimates from the linear probability model $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$.

Table 15: Experiment II, Changing Each Determinant Separately.

Statistic	Data I	Data II	(W)	(E)	(C)	(M)
Fertility Rate, 22-25	0.217	0.154	0.177	0.183	0.278	0.125
ER w/ Infant, 22-33	0.145	0.368	0.242	0.246	0.215	0.170
ER w/ Infant, 34-44	0.164	0.405	0.249	0.310	0.207	0.219
ER, no Kids, 22-33	0.596	0.738	0.675	0.682	0.593	0.678
ER, no Kids, 34-44	0.472	0.664	0.548	0.595	0.479	0.553
Share of Births, 22-25	0.621	0.297	0.509	0.510	0.686	0.407
Share of Births, 26-30	0.288	0.438	0.367	0.362	0.239	0.416
Share of Births, 31-35	0.060	0.205	0.075	0.077	0.045	0.107

Note: ER - Employment Rate. Columns Data I and Data II show the statistics from the data for Period I and Period II respectively. Columns (W), (E), (C) and (M) show the statistics computed using the model simulated series obtained increasing wage level for females, increasing returns to experience for females, decreasing child care cost and flattening life-cycle earnings profile for males respectively.

Table 16: Experiment II, Changing Determinants Separately.

Statistic	Data I	Data II	(W)	(E)	(C)	(M)
$\hat{\beta}_1$ (Age 22-44)	-0.024	0.178	0.021	0.059	0.037	-0.143
(s.e.)	(0.025)	(0.027)				
$\hat{\beta}_1$ (Age 22-25)	-0.116	-0.077	0.050	0.009	0.060	-0.754
(s.e.)	(0.049)	(0.057)				
$\hat{\beta}_1$ (Age 26-44)	0.023	0.266	-0.001	0.048	-0.013	-0.033
(s.e.)	(0.028)	(0.030)				

Note: Estimates from the linear probability model $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$. Columns Data I and Data II show the statistics from the data for Period I and Period II respectively. Columns (W), (E), (C) and (M) show the statistics computed using the model simulated series obtained increasing wage level for females, increasing returns to experience for females, decreasing child care cost and flattening life-cycle earnings profile for males respectively.

Table 17: Experiment III, Changing All Four Determinants Combined.

Statistic	Data I	Data II	(L)	(L+M)
Fertility Rate, Age 22-25	0.217	0.154	0.227	0.169
Emp Rate w/ Infant, Age 22-33	0.145	0.368	0.451	0.495
Emp Rate w/ Infant, Age 34-44	0.164	0.405	0.461	0.546
Emp Rate, no Kids, Age 22-33	0.596	0.738	0.765	0.790
Emp Rate, no Kids, Age 34-44	0.472	0.664	0.662	0.730
Share of Births, Age 22-25	0.621	0.297	0.578	0.446
Share of Births, Age 26-30	0.288	0.438	0.321	0.415
Share of Births, Age 31-35	0.060	0.205	0.061	0.084

Note: Columns Data I and Data II show the statistics from the data for Period I and Period II respectively. Columns (L) and (L+M) show the statistics computed using the model simulated series obtained changing all three determinants proposed in the literature and all four determinants respectively.

Table 18: Experiment III, Changing All Four Determinants Combined.

Statistic	Data I	Data II	(L)	(L+M)
$\hat{\beta}_1$ (Age 22-44)	-0.024	0.178	0.179	0.118
(s.e.)	(0.025)	(0.027)		
$\hat{\beta}_1$ (Age 22-25)	-0.116	-0.077	0.730	0.614
(s.e.)	(0.049)	(0.057)		
$\hat{\beta}_1$ (Age 26-44)	0.023	0.266	0.065	0.084
(s.e.)	(0.028)	(0.030)		

Note: Estimates from the linear probability model $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$. Columns Data I and Data II show the statistics from the data for Period I and Period II respectively. Columns (L) and (L+M) show the statistics computed using the model simulated series obtained changing all three determinants proposed in the literature and all four determinants respectively.

APPENDICES

I Data

Output. Output is business output series constructed by BLS.[21]

Productivity. Productivity is business output per worker constructed by BLS.

Unemplyment Rate. Unemployment rate is civilian unemployment rate computed using the Current Population Surveys (CPS) data.

Employment Rates, Birth Shares. Women's employment rates and birth shares for first time mothers in 1970 and 1990 are computed using the US census of population data available at *http://usa.ipums.org/usa/*.

Gender Wage Gap. Gender wage gap for individuals entering the labor market is computed as explained in the paper using the Current Population Survey March Supplement data available at *http://cps.ipums.org/cps/*.

Wage Growth. Females wage growth rates are computed as explained in the paper using the Panel Study of Income Dynamics (PSID) data available at *http://simba.isr.umich.edu/*.

Fertility Rate. The seasonally adjusted monthly fertility rate is taken from National Vital Statistics Reports for the years 1998-2007 (available at *http://www.cdc.gov/nchs/products/nvsr.htm*, Monthly Vital Statistics Reports for the years 1970-1997 (available at *http://www.cdc.gov/nchs/products/mvsr.htm#vol12s*) and U.S. U.S. Census (1939-2002) Vital Statistics for the years 1951-1969. Monthly series is averaged into quarterly series.

SIPP data. SIPP 1984 and 2001 Panels are formed from nationally representative samples of individuals of 15 year of age and older of the civilian noninstutionalized population. Information is collected about sampled individuals and their household members. 1984 Panel

[21]BLS data are available at *http://data.bls.gov/cgi-bin/dsrv?pr*.

began interviews in October 1983 with sample members in 19,878 households. The interviewes were conducted once every four months over a 32-month period. 2001 Panel began interviews in February 2001 with sample members in 36,700 households. The interviewes were conducted once every four months over a 36-month period. The Panel was divided into four rotation groups. Each rotation group was interviewed in a separate month. An interview wave is a set of interviews covering all four rotation groups during four months. Respondents were asked questions about previous four months during each interview. A core set of questions was repeated at each wave of interviewing. Some sets of questions, labeled "Topical Modules", were assigned to particular interviewing waves. These modules were designed to obtain the detailed information about a variety of topics including marital and fertility history. Marital history contains information about the first, the second and the last marriages for individuals ever married. Fertility history contains information about the first and the last child for women who had children. In particular, the 1984 Panel includes a month and a year of the beginning of each marriage, divorce and separation and a month and a year of birth of the first and the last child. The 2001 Panel includes only a year of all aforementioned events.

To construct the fertility histories for women in 1984 and 2001 Panels, I identify all individuals of age 18 and below at time of an interview and locate their mothers using the person number of parent variable, $PNPT$[22], from 1984 Panel and the person number of mother variable, $EPNMUM$, from 2001 Panel. I use variable $ETYPMOM$ to consider only biological children of women in 2001 Panel. Panel 1984 does not have this information. Since the majority of mothers are biological mothers for children who live with mothers in their households, the results will not be affected most likely[23]. Since a month and a year of birth are available for all individuals in the data; for a given women, I obtain the dates of births of her children who live in the same household. I link core files and topical modules files[24] and construct women's marital histories using the topical module data. The

[22]This variable identifies mother if a mother and her child live in the same household.

[23]For example, the likelihood that a child lives with his or her biological mother given that this child has a mother in a household is above 97% based on 2001 Panel data.

[24]See *http://www.census.gov/sipp/linking.html)* for details about using and linking files.

resulting 1984 sample contains about $10,000$ women. The total number of births is about 400 on average every year during 1960s and 1970s. The number of first births is about 160 on average every year during the same time. The resulting 2001 sample contains about $21,000$ women. The total number of births is about 900 on average every year during 1980s and 1990s. The number of first births is about 400 on average every year during the same period.

II Numerical Solution and Algorithm

Since agents face a finite horizon, the numerical solution of the model is obtained recursively starting from the terminal period. Given the household's state vector and the value function for the next period, the current value function and decision rules are solved for. A state vector, $x := (z, j, k_w^j, v^j, a, 0)$, consists of six variables: aggregate shock, age, wife's human capital, value of staying home, asset stock and age of child. Given a state vector, a household without children ever had ($d = 0$) makes a labor participation decision for a wife, a fertility decision and asset accumulation decision according to Bellman equations (13)-(15) and subject to the budget constraints (10)-(12). A household with a child ($d \in [1, 17]$) makes a labor participation decision for a wife and asset accumulation decision according to Bellman equations (16)-(18) and subject to the same budget constraints (10)-(12). A household after leaving of the child ($d > 18$), makes a labor participation decision for a wife and asset accumulation decision according to Bellman equations (19)-(21) and subject to the same budget constraints (10)-(12).

The combination of the discrete choices and the continuous choice implies that the value functions are not necessarily concave or differentiable. The problem arises because of participation and fertility decisions in future periods. As asset level increases, consumption can decrease because of changes in future labor force status or presence of child. Therefore, I discretize continuous state variables and solve for approximate solution of the household problem.

There are four continuous state variables: the aggregate shock, wife's human capital, the value of staying home and the asset stock. The state space of the problem is the subset of

$\mathbb{R}^6$ space: $(\mathbb{R}^+ \times \{j_1, .., J\} \times \mathbb{R}^+ \times \mathbb{R} \times [a_{min}, \infty] \times \{0, .., 18\})$. Continuous stochastic processes for aggregate shock, z, and value of staying home, v, are approximated by discrete processes with 7 and 15 states respectively using Tauchen (1986) algorithm. Given the initial value of wife's human capital, the maximum value is computed assuming she never stays home during her life and a nonlinear grid with 30 points is employed with points concentrated near the initial value. The upper bound for asset stock of 22 is chosen so that it never binds and a nonlinear grid with 40 points is used with points concentrated near the borrowing limit and zero. As a result, the discretized state space has the size $(7 \times 45 \times 30 \times 15 \times 40 \times 19)$. To reduce the approximation error, I solve for optimal asset decision rule, a', in two steps. In the first step, given a current state, I find an optimal a' among the grid points, in the second step, I use a golden search method to find an optimal a' around the point obtained in the first step and do a sensitivity analysis with respect to this procedure. I use a weighted linear approximation of expected continuation value to obtain its value at a point outside of the set of gridpoints for asset stock and wife's human capital state variables.

I employ the simulated method of moments (SMM) to find parameter values that produce target statistics. The following algorithm is used to find a solution of household's problem. First, guess values are assigned to the calibrated parameters summarized in Table 9. Using these parameters as well as parameters set a priori, optimal decisions rules for asset holding, labor participation and fertility are obtained employing finite dynamic program. In the next step, I simulate the aggregate shock history for $4,000$ periods. Every period, a value of staying home is drawn from a stationary distribution for $5,000$ households entering the economy and simulated for the rest of the households[25]. Using the simulated values and optimal decision rules the target statistics summarized in Table 9, the value of the SMM objective function is calculated for the model economy. The procedure that I use to minimize the objective function is Downhill Simplex. Since this is a local optimization procedure I use different initial parameter values and Simulated Annealing global routine to make sure that the optimal parameter values represent a unique solution of the optimization problem.

[25] There are $5,000$ households of each age from 21 to 65 in any given period in the economy.

III Sensitivity Analysis

III.1 Alternative Business Cycle Indicators and 1st Order Fertility Rate

Table A-1 shows the correlation of fertility rate with different business cycle indicators, in particular productivity, output and unemployment rate. We can see that all in all the results are not sensitive to the choice of the business cycle indicator. It is not clear a priori what indicator is more appropriate to measure the cyclicality of fertility rate since it is not known what information households use to form expectations about the state of the economy. The results are reasonable in terms of the lag structure since productivity leads output by about two quarters and unemployment rate is sluggish. I use the band pass filter (Baxter and King (1999)) rather than Hodrick-Prescott filter to isolate frequencies that are relevant for business cycle analysis, because the former removes the high frequency fluctuations from the fertility rate series.

Since a household can have only one child in the model, in Table A-2 I report the correlation of 1st order fertility rate with business cycle indicators. The results are virtually unchanged compared to when the overall fertility rate is used.

At the micro level, Table A-3 shows the results for the first births using the SIPP data. We can see that the results are very similar to the results for all births shown in Table 5. Countercyclical fertility in the first period is driven by younger women while procyclical fertility in the second period is driven by older women.

Since the proportion of educated women has increased substantially during the period of study (See Panels A and B in Table 2), it is possible that women with different educational achievements behave in a different way and the changes in the cyclical properties of fertility are driven by the composition effect. Table A-4 shows that this not the case since women with different level of education experienced similar changes as all women. Table A-5 shows the results for the first births by education. Again, the results are qualitatively the same as for all births.

III.2 Benchmark Model Assumptions

Here, I discuss the sensitivity of the results to the choice of two target statistics: wealth to income ratio and debt to income ratio, as well as intertemporal elasticity of substitution of consumption, $\frac{1}{\sigma}$, which is set equal to 1 (log utility)[26]. The desire to smooth consumption is the important force in the model so it is clear that the choice of σ is important. For example, in the linear utility case ($\sigma = 0$), fertility rate is countercyclical because households have no desire to smooth consumption and have no incentives to time a birth when income is higher while the incentive to have a child when income is low remains for women at the margin between working and staying home. Discount factor, β, and borrowing limit, a_{min}, are the most important parameters determining wealth to income and debt to income ratios in the model. Instead of changing the target statistisc and recalibrating the model, I change β and a_{min} and analyze the impact on the results of the benchmark model. One more important issue to consider is the assumption about the price of the child care unit, p_c. I assume that it is constant but it may be argued that p_c may change over the business cycle since households child care expenditures are used to pay wages to those who provide child care services and since wages are procyclical so should be the child care price. There is no direct evidence about the child care price behavior over the business cycle so I do a sensitivity analysis assuming that elasticity of p_c with respect to wage equals to one.

Tables A-6 shows the sensitivity of the benchmark model results to the changes in β, a_{min} and childcare price elasticity. Column (B) shows the results of the benchmark model. Columns (1) and (2) show the results of setting $\beta = 0.965$ and $\beta = 0.975$ respectively. We can see that households have a child earlier and fertility rate becomes less countercyclical as a result of the decrease in β. This happens because women with low value of staying home want to have a child earlier. The increase in β has the opposite effect. The effect on employment rate is very small. Columns (3), (4) and (5) show the results of setting $a_{min} = -2.5$, $a_{min} = -1.5$ and $a_{min} = 0.0$ respectively. Employment and fertility rates are not affected significantly. As expected, increasing borrowing limit leads to stronger countercyclical fertility rate as households can smooth consumption better and decreasing borrowing limit

[26] $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$.

leads to the opposite effect. It is clear that fertility rate will be strongly countercyclical in case of the "natural" borrowing constraint[27]. In case of no borrowing ($a_{min} = 0.0$) fertility rate becomes procyclical. Column (6) shows the results setting elasticity of child care price with respect to wage equal to one. The only significant change is that fertility rate becomes stronger countercyclical.

This analysis shows that the results are not sensitive to small changes in β and a_{min}, which means that they are not sensitive to small changes in wealth to income and debt to income ratios. Assuming procyclical child care price leads to a stronger countercyclical fertility rate. In this case, setting borrowing limit to zero or decreasing the intertemporal elasticity of substitution and recalibrating the parameters brings the results of the benchmark model and experiments back. Changing σ, I essentially target the cyclicality of fertility rate. Once I get the cyclicality of fertility rate as in the benchmark model, the results of experiments still hold.

[27]The "natural" borrowing constraint arises if the utility function satisfies the Inada condition and households never choose an asset position such that they may end up with zero consumption in some future state with positive probability.

Table A-1: Correlation of Fertility Rate and Business Cycle Indicators.

Lag	Productivity		Output		Unemployment	
	Period I	Period II	Period I	Period II	Period I	Period II
Current	-0.429*	0.145	-0.619*	0.399*	0.607*	-0.492*
1 Quarter	-0.489*	0.259*	-0.576*	0.485*	0.458*	-0.559*
2 Quarters	-0.492*	0.382*	-0.487*	0.526*	0.274*	-0.539*
3 Quarters	-0.449*	0.475*	-0.378*	0.502*	0.093	-0.438*
4 Quarters	-0.375*	0.500*	-0.273*	0.401*	-0.049	-0.281*
5 Quarters	-0.294*	0.436*	-0.189**	0.231*	-0.139	-0.097
6 Quarters	-0.226*	0.294*	-0.129	0.009	-0.180	0.095

Source: Fertility rate - National Center for Health Statistics. Output and productivity - BLS.

Note: Fertility rate is the number of births per 1000 women between the ages of 15 to 44. Output is business output, Productivity is business output per worker. Unemployment rate is civilian unemployment rate. All variables are detrended using band pass filter with frequency parameters 6 and 32 for quarterly data. Single '*' and double '**' indicate that the coefficient is statistically significant with 5% and 10% level of significance.

Table A-2: Correlation of 1st Order Fertility Rate and Business Cycle Indicators.

Lag	Productivity		Output		Unemployment	
	Period I	Period II	Period I	Period II	Period I	Period II
Current	-0.509*	-0.091	-0.584*	0.334*	0.530*	-0.575*
1 Quarter	-0.531*	0.082	-0.476*	0.477*	0.372*	-0.674*
2 Quarters	-0.503*	0.284*	-0.330*	0.579*	0.077	-0.674*
3 Quarters	-0.427*	0.461*	-0.178	0.607*	-0.138	-0.578*
4 Quarters	-0.314*	0.558*	-0.044	0.543*	-0.288*	-0.414*
5 Quarters	-0.183	0.545*	0.056	0.386*	-0.359*	-0.213*
6 Quarters	-0.060	0.428	0.119	0.163	-0.366*	-0.002

Source: Fertility rate - National Center for Health Statistics. Output and productivity - BLS.

Note: 1st order fertility rate is the number of first time births per 1000 women between the ages of 15 to 44. Output is business output, Productivity is business output per person. Unemployment rate is BLS civilian unemployment rate. All variables are detrended using band pass filter with frequency parameters 6 and 32 for quarterly data. Single '*' and double '**' indicate that the coefficient is statistically significant with 5% and 10% level of significance respectively.

Table A-3: Probability of Birth over the Business Cycle, 1st Order Births, SIPP data.

	Period I	Period II
	1966-1981	1984-2003
Age Group	$\hat{\beta}_1$ (s.e.)	$\hat{\beta}_1$ (s.e.)
Age 22-44	-0.013 (0.017)	0.129 (0.017)
Age 22-25	-0.034 (0.035)	0.028 (0.041)
Age 26-44	0.019 (0.016)	0.130 (0.019)
Age 15-44	-0.019 (0.015)	0.094 (0.017)
Age 15-25	-0.039 (0.024)	-0.058 (0.032)

Note: Estimates the linear probability model $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a first birth in period t and $b_{it} = 0$ otherwise, d_{t-4} the percentage deviation of productivity from trend in period $t-4$.

Table A-4: Probability of Birth over the Business Cycle, SIPP data.

	Low Skilled		High Skilled	
	Period I	Period II	Period I	Period II
	1966-1981	1984-2003	1966-1981	1984-2003
Age Group	$\hat{\beta}_1$ (s.e.)	$\hat{\beta}_1$ (s.e.)	$\hat{\beta}_1$ (s.e.)	$\hat{\beta}_1$ (s.e.)
Age 22-44	-0.004 (0.031)	0.232 (0.043)	-0.059 (0.041)	0.145 (0.034)
Age 22-25	-0.127 (0.065)	0.025 (0.101)	-0.101 (0.073)	-0.112 (0.067)
Age 26-44	0.055 (0.034)	0.223 (0.046)	-0.034 (0.050)	0.226 (0.040)
Age 15-44	-0.024 (0.027)	0.163 (0.040)	-0.047 (0.033)	0.050 (0.030)
Age 15-25	-0.105 (0.041)	-0.082 (0.068)	-0.055 (0.043)	-0.167 (0.048)

Note: Estimates the linear probability model $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$. Low skilled category includes women with high school degree or lower education attainment at time of interview. High skilled category includes women with some college or higher education attainment.

Table A-5: Probability of Birth over the Business Cycle, 1st Order Births, SIPP data.

	Low Skilled		High Skilled	
	Period I	Period II	Period I	Period II
	1966-1981	1984-2003	1966-1981	1984-2003
Age Group	$\hat{\beta}_1$ (s.e.)	$\hat{\beta}_1$ (s.e.)	$\hat{\beta}_1$ (s.e.)	$\hat{\beta}_1$ (s.e.)
Age 22-44	0.019 (0.019)	0.113 (0.026)	-0.029 (0.029)	0.126 (0.023)
Age 22-25	-0.026 (0.044)	0.079 (0.066)	-0.046 (0.059)	-0.004 (0.052)
Age 26-44	0.041 (0.018)	0.104 (0.026)	-0.020 (0.031)	0.143 (0.026)
Age 15-44	-0.001 (0.018)	0.116 (0.026)	-0.021 (0.024)	0.080 (0.022)
Age 15-25	-0.048 (0.031)	-0.012 (0.051)	-0.023 (0.035)	-0.073 (0.040)

Note: Estimates the linear probability model $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a first birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$. Low skilled category includes women with high school degree or lower education attainment at time of interview. High skilled category includes women with some college or higher education attainment.

Table A-6: Benchmark economy.

Statistic	(B)	(1)	(2)	(3)	(4)	(5)	(6)
Fertility Rate, Age 22-25	0.221	0.278	0.151	0.232	0.211	0.197	0.235
Emp Rate w/ Infant, Age 22-33	0.146	0.144	0.159	0.153	0.162	0.166	0.160
Emp Rate w/ Infant, Age 34-44	0.164	0.156	0.176	0.163	0.164	0.163	0.163
Emp Rate, no Children, Age 22-33	0.598	0.564	0.654	0.588	0.615	0.636	0.599
Emp Rate, no Children, Age 34-44	0.483	0.460	0.501	0.484	0.483	0.484	0.483
Share of Births, Age 22-25	0.601	0.676	0.418	0.619	0.589	0.504	0.613
Share of Births, Age 26-30	0.298	0.242	0.414	0.283	0.305	0.369	0.288
Share of Births, Age 31-35	0.059	0.048	0.099	0.058	0.062	0.075	0.059
Wage Growth, Age 22-33	0.026	0.026	0.026	0.026	0.026	0.026	0.026
Wage Growth, Age 34-44	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Productivity, Standard Deviation	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Productivity, Persistence	0.459	0.447	0.469	0.464	0.471	0.474	0.455
$\hat{\beta}_1$ (Age 22-44)	-0.037	0.041	-0.196	-0.052	-0.021	0.185	-0.057
$\hat{\beta}_1$ (Age 22-25)	-0.130	0.074	-0.914	-0.276	-0.040	1.015	-0.464
$\hat{\beta}_1$ (Age 26-44)	0.002	0.015	-0.063	-0.022	-0.009	0.051	0.011
Debt Income Ratio	0.174	0.278	0.051	0.221	0.133	0.000	0.177
Wealth Income Ratio	1.295	0.672	2.247	1.125	1.322	1.602	1.284

Note: $\hat{\beta}_1$ is obtained estimating the following linear probability model: $b_{it} = \beta_0 + \beta_1 d_{t-4} + \epsilon_{it}$, where $b_{it} = 1$ if woman i gives a first birth in period t and $b_{it} = 0$ otherwise, d_{t-4} is the percentage deviation of productivity from trend in period $t-4$. Column (B) shows the results of the benchmark model ($\beta = 0.97$, $a_{min} = -2$), column (1): $\beta = 0.965$, column (2): $\beta = 0.975$, column (3): $a_{min} = -2.5$, column (4): $a_{min} = -1.5$, column (5): $a_{min} = 0$, column (6): procyclical child care price.