Life Cycle Fertility and Human Capital Accumulation

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- Both female labor supply and fertility behavior are topical issues of public interest:
  - worldwide declining rates of fertility, especially amongst educated women, has consequences for intergenerational wealth transfers, along with the demand for public infrastructure and privately produced goods;
  - the persistence of the gender gap in U.S. wages, after a long period of shrinking, may have implications for employment discrimination laws, and is a topic of continuing research for labor economists.
- Sociologists, demographers and economists all believe that female labor supply and fertility behavior are intertwined.
- So in principle public policies affecting fertility should also affect female labor supply, and vice versa.
- But quantifying the effects of such policies and their implementation is challenging.

- There are many ways to predict how public policies affect fertility and female labor supply. See survey by Gauthier (2007):
  1. Public opinion data, such as survey responses to hypothetical counterfactuals and ideal family size (European Commission,1990; Goldstein, Lutz and Testa, 2003)... *Would people really do what they say in 15-30 minute surveys?*
  2. Time series analysis, for example over the post war period (Butz and Ward, 1979, 1980; Buttner and Lutz,1990)... *How do you untangle other aggregate effects, and what is the role of heterogeneity?*
  3. Cross sectional studies, such as between OECD countries (Billari and Kohler, 2004; Kogel, 2004)... *How do we account for other differences in OECD countries, and should we be looking at other stratifications, such as religious affiliation as opposed to nationality?*
  4. Event studies, say related to the adoption of new programs (Milligan, 2005; Laroque and Salanie, 2008; Cohen, Dejejia and Romanov, 2010)... *How are expectations formed about the introduction and length of new programs, and how long does it take to see the results?*

- Our work joins a handful of studies that recognize the dynamic interactions between female labor supply and fertility by modeling and estimating the sequential determination of these joint events with panel data (Hotz and Miller,1988; Francesconi, 2002; Keane and Wolpin 2010; Adda, Dustman and Stevens, 2011)... *Are internally coherent models too simple to be useful?*
- The latter two also conduct counterfactual policy simulations:
  - Keane and Wolpin investigate changes to the welfare system;
  - Adda et al. simulate the effects of increasing child allowances.
- We conduct counterfactual simulations on four policies:
  1. Pay for expenditure on offspring.
  2. Provide child care.
  3. Pay women a wage to bear children.
  4. Retrain mothers who quit the labor force when they reenter it.

Introduction

How we do it

- To analyze these policies we formulate and estimate a dynamic model of labor supply and fertility.
- The model accounts for:
  1. maternal time spent raising offspring;
  2. effect of time spent on current and summed discounted expenditures on them.
- We estimate the model with the PSID data, and solve for the policy functions with the estimated parameters perturbed by the counterfactual policy innovations.

Introduction

Summarizing our results

- Generally speaking all the policies we investigate:
  1. increase total fertility rates (TFR) on almost all socioeconomic groups;
  2. do not affect labor force participation much.
- Retraining has the most pronounced increases in the birth rate, particularly amongst highly educated women.
- To amplify:
  - Most of our 18 stratified groups have estimated TFR below replacement rate (say 2.1) under the current regime;
  - If human capital lost from temporarily withdrawing from the labor force could be restored, than the TFR of all but one group (least educated unmarried white women) would rise to replacement rate.

- As a practical matter, our model predicts that a large proportion of human capital from working experience is acquired within one working year.
- Therefore our model predicts that retrospectively paying women the difference between their wages in their first two years at work after returning to work following an absence from work to give birth, would go a long way to raising the fertility rate of the most educated workers.
- More generally, subsidizing this labor market outcome raises substantially fertility rates without affecting participation rates very much.
- This serves to emphasize a point on the first slide: that public policy on these issues must account for both the fertility and female labor market responses.

Model

Choices

- The model is set in discrete time, and measures the woman's age beyond adolescence with periods denoted by $t \in \{0, 1, \ldots, T\}$.
- Two kinds of human capital are accumulated, offspring and labor market experience.
- The birth of a child at period t, a choice variable, is denoted by the indicator variable $b_{nt} \in \{0, 1\}$.
- There are two continuous choice variables, consumption $x_{nt} > 0$, and hours worked in the labor force, denoted by $h_{nt} \in [0, 1]$.

- Raising children requires market expenditure and parental time:
  1. The discounted summed cost of expenditures from raising a child is $z'_{nt}\pi$, which varies with household demographics z_{nt} that includes such variables as age, formal education, regional location, ethnicity and race.
  2. A k year old requires nurturing time of ϕ_k up until age ρ_c, and a constant input per period denoted by ϕ from then on.
- Letting c_{nt} denote the amount of time the n^{th} household spends nurturing children in the household, our nurturing specification implies:

$$c_{nt} = \sum_{s=0}^{t} \phi_s b_{n,t-s}$$

where $\phi_s = \phi$ for all $s > \rho_c$.

Model

Time budget

- Leisure in period t, denoted l_{nt}, is defined as the balance of time not spent at work or nurturing children.
- It follows that the time allocated between nurturing children, market work and leisure must obey the constraint:

$$1 = h_{nt} + l_{nt} + c_{nt}$$

where h_{nt} denotes the proportion of time worked in period t as a fraction of the total time available in the period.

Model

Preferences over children

- Births contribute directly to household utility. Denote by:
  - γ_0 the lifetime utility to a household from bearing their first child;
  - $\gamma_0 + \gamma_k$ the utility from the second child k years later;
  - $\gamma_0 + \gamma_k + \gamma_j$ the utility from the third, k and j years apart.
- So if the woman bears a child at t she receives utility of:

$$u_{nt}^{(b)} \equiv b_{nt}(\gamma_0 + \sum_{k=1}^{\rho_b} \gamma_k b_{n,t-k} + \gamma_b \sum_{k=\rho_b+1}^{T} b_{n,t-k})$$

- Thus siblings k years apart are complements if $\gamma_k > 0$, and substitutes if $\gamma_k < 0$.

- Leisure to the n^{th} female in period t, denoted by l_{nt}, is defined as the balance of time not spent at work or nurturing children.
- Current utility from leisure is:

$$u_{nt}^{(l)} \equiv I\left\{h_{nt} > 0\right\} z_{nt}' B_0 + z_{nt}' B_1 l_{nt} + \sum_{s=0}^{\rho_l} \delta_s l_{nt} l_{n,t-s}$$

where B_0 is a parameter vector characterizing the fixed-costs of participating in the work force, and B_1 shows the effect of exogenous time-varying characteristics on the marginal utility of leisure.

- Preferences are increasing in leisure if:

$$z_{nt}' B_{11} + 2\delta_0 l_{nt} + \sum_{s=1}^{\rho_l} \delta_s l_{n,t-s} > 0$$

concave if $\delta_0 < 0$, while $\delta_s < 0$ implies l_{nt} and $l_{n,t-s}$ are substitutes.

- We denote by:

$$u_{nt}^{(x)} \equiv \alpha^{-1} x_{nt}^{\alpha} \exp(z_{nt}' B_2 + \epsilon_{0nt})$$

the current utility from consumption of x_{nt} by household n in period t, where ε_{0nt} is identically and independently distributed across (n, t).

Model

Realized lifetime utility to household

- Let $\beta \in (0,1)$ denote the subjective discount factor over time, we define realized lifetime utility as:

$$\sum_{t=0}^{T} \beta^t \left\{ u_{nt}^{(b)} + u_{nt}^{(l)} + u_{nt}^{(x)} + \sum_{k=1}^{4} d_{knt}\epsilon_{knt} \right\}$$

where:

$$\begin{aligned} d_{1nt} &\equiv I\{h_{nt} = 0\} I\{b_{nt} = 0\} \\ d_{2nt} &\equiv I\{h_{nt} > 0\} I\{b_{nt} = 0\} \\ d_{3nt} &\equiv I\{h_{nt} = 0\} I\{b_{nt} = 1\} \\ d_{4nt} &\equiv I\{h_{nt} > 0\} I\{b_{nt} = 1\} \end{aligned}$$

and ϵ_{knt} is a choice specific disturbance identically and independently distributed across (k, n, t) as a Type 1 Extreme Value random variable.

Model

Labor force opportunities

- Female labor market experience for the n^{th} household in our sample is embodied in the wage rate, denoted w_{nt}, and depends on labor market experience and the demographic variables z_{nt}.
- Following the literature real wages are the product of $\omega(\tau)$ and an index capturing the number of efficiency units embodied in a worker.
- Let τ_{nt} denote the calendar year when the n^{th} female is t years old, and $\omega(\tau)$ the wage of one efficiency unit of labor in year τ.
- The mapping from experience to the current wage rate in year τ_{nt} is given by:

$$w_{nt} = \omega(\tau_{nt}) \mu_n \exp\left[z'_{nt} B_3 + \sum_{s=1}^{\rho_w} (\delta_{1s} h_{n,t-s} + \delta_{2s} d_{2n,t-s} + \delta_{2s} d_{4n,t-s}) \right]$$

for some positive integer ρ_w.

- Aggregate effects are transmitted through the real wage $\omega(\tau)$ and interest rates.
- We denote by $\lambda(\tau_{nt})$ the value of a consumption unit discounted back t periods, in other words the price of consuming in period τ_{nt} denominated in $(\tau_{nt} - \tau_{n0})$ consumption units.
- Valued at calendar date τ_{n0}, net transfers to household n at age t are then:

$$\lambda(\tau_{nt}) \left(x_{nt} + z'_{nt} \pi b_{nt} - w_{nt} h_{nt} \right)$$

- We finesse questions about how efficiently markets and government interventions together allocate resources in this economy by modeling behavior as the solution to a social planner's problem.
- Denoting by η_n^{-1} the social weight attached to individual n, Pareto optimal allocations are found by maximizing:

$$E_0 \left\{ \sum_{t=0}^{T} \left[\begin{array}{c} \beta^t \left(u_{nt}^{(b)} + u_{nt}^{(l)} + u_{nt}^{(x)} + \sum_{k=1}^{4} d_{knt}\epsilon_{knt} \right) \\ -\eta_n \lambda \left(\tau_{nt} \right) \left(x_{nt} + z_{nt}' \pi b_{nt} - w_{nt} h_{nt} \right) \end{array} \right] \right\}$$

with respect to $\{x_{nt}, h_{nt}, b_{nt}\}_{t=0}^{T}$, sequences of random variables that are successively measurable with respect to the information available at periods $t \in \{0, 1, 2, \ldots, T\}$, subject to the individual household time and childcare constraints.

Optimization

State variables and policy functions

- Setting $\rho \equiv \max\{\rho_b, \rho_l + \rho_c, \rho_w\}$, the vector of state variables for the optimization problem are:

$$H_{nt} \equiv \left(t, z'_{nt}, \sum_{s=1}^{t-1} b_{ns}, b_{n,t-\rho}, ..., b_{n,t-1}, h_{n,t-\rho}, ..., h_{n,t-1}, \epsilon_{0nt}, \ldots, \epsilon_{4nt} \right)$$

- Aside from demographics, H_{nt} captures the dependence of the current household state on lagged labor supply and birth choices.
- Denote the optimal choices by $\{x^o_{nt,} h^o_{nt}, b^o_{nt}\}^T_{t=0}$.
- Also write d^o_{knt} for the value of d_{knt} induced by $\left(h^o_{nt}, b^o_{nt}\right)$, and set $h_{knt} \equiv h_k\left(H_{nt}\right) \equiv h^o_{nt}$ for each k where $h_{1nt} = h_{3nt} = 0$.
- Our estimators and policy functions are based on:
  1. the first order conditions for the continuous choices of consumption and hours worked conditional on participation;
  2. the four discrete choices defined by birth and participation combinations.

Optimization

Frisch consumption demand functions

- Differentiating the planner's objective function with respect to x_{nt} yields the (logarithm of the) Frisch consumption demand functions:

$$\log x^o_{nt} = (\alpha - 1)^{-1} \left(\log \eta_n + \log \lambda \left(\tau_{nt} \right) - z'_{nt} B_2 - \epsilon_{0nt} \right) \qquad (1)$$

- Since the current utility for x^o_{nt} is additively separable with respect to the other current choices, given the state variables, its choice does not depend on the discrete choices d_{nt} or the disturbance vector $(\epsilon_{1nt}, \ldots, \epsilon_{4nt})$.
- Consequently the remaining parts of the solution to the planning problem are determined separately.

Optimization

Current utility as a function of the discrete choices

- Let $u_k\left(H_{nt}\right)$ denote the deterministic component of current utility from leisure and births when $k \in \{1, \ldots, 4\}$ is paired with $h_k\left(H_{nt}\right)$.
- For example, when the woman does not work or give birth:

$$l_{nt} = 1 - \sum_{r=1}^{t} \phi_r b_{n,t-r}$$

and:

$$l_{n,t-s} = 1 - h_{n,t-s} - \sum_{r=s+1}^{t} \phi_r b_{n,t-r}$$

so current utility for $k = 1$ is:

$$\begin{aligned} u_1\left(H_{nt}\right) \equiv & \left(1 - \sum_{r=1}^{t} \phi_r b_{n,t-r}\right)\left[z'_{nt}B_1 + \delta_0\left(1 - \sum_{r=1}^{t} \phi_r b_{n,t-r}\right)\right] + \\ & \sum_{s=1}^{\rho_l} \delta_s\left(1 - \sum_{r=1}^{t} \phi_r b_{n,t-r}\right)\left(1 - h_{n,t-s} - \sum_{r=s+1}^{t} \phi_r b_{n,t-r}\right) \end{aligned}$$

- Substituting in the optimal hours choices when the woman participates, we define the current t period expected value function for the leisure and birth choices as:

$$V\left(H_{nt}\right) \equiv \max_{\{d_{ns}\}_{s=t}^{T}} E\left\{\sum_{s=t}^{T}\sum_{k=1}^{4} d_{kns}\beta^{s-t}\left[u_k\left(H_{ns}\right)+\epsilon_{kns}\right]\left|H_{nt}\right|\right\}$$

- Defining the conditional value function for each discrete choice as:

$$V_k\left(H_{nt}\right) \equiv u_k\left(H_{nt}\right) + E\left[\beta V\left(H_{n,t+1}\right)\left|d_{ntk}=1, H_{nt}\right.\right]$$

- Bellman's principle implies that for all $j \in \{1, \ldots, 4\}$ if $d_{knt}^{o} = 1$ then:

$$V_k\left(H_{nt}\right) + \epsilon_{knt} \geq V_j\left(H_{nt}\right) + \epsilon_{jnt}$$

Optimization

Euler equation for interior labor supply choice

- For women participating in the labor force, hours of work satisfy a first order condition.
- For example if is no birth $d_{2nt} = 1$ and h_{2nt} solves:

$$\sum_{s=1}^{\rho} \delta_s \left(1 - \sum_{r=1}^{t-r} \rho_k b_{n,t-r-s}\right) = z'_{nt} B_1 + \lambda\left(\tau_{nt}\right) w_{nt} + \frac{\partial E\left[\beta V\left(H_{n,t+1}\right) | d_{knt} = 1, H_{nt}\right]}{\partial h_{2nt}}$$

- A similar expression holds for h_{4nt} (hours of work when a woman participating in the labor force gives birth).
- Our estimation framework is derived from:
  1. the specification for wages;
  2. the Frisch consumption demands;
  3. differences in the conditional valuation functions;
  4. the Euler equation above determining hours worked by women participating in the labor force.

Data

- The data for this study, summarized in Table I, are taken from the Family-Individual File, Childbirth and Adoption History File and the Marriage History File of the Michigan Panel Study of Income Dynamics (PSID).
- The sample has aged, household size has declined, and the decline is most pronounced amongst young children.
- The steep decline in household size and the aging evident in the sample is relative to aggregate US trends
- This feature largely reflecting the sampling mechanism of the PSID.
- Thus we cannot easily infer anything about trends in the US by reviewing trends in this sample.
- Household income has increased somewhat, household consumption of food has declined, but both food consumption and income per capita has increased over the sample period.
- Female income has also increased (due to both higher wages and greater hours), greatly outstripping increases in household income.

TABLE I
Main Sample Summary Statistics

(Standard Deviation is parenthesis)

Variable	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Age	18.57	19.25	19.77	20.31	20.82	21.36	21.91	22.41	22.91	23.31	24.31	25.31	26.31
	(12.59)	(12.67)	(12.81)	(13.01)	(13.17)	(13.33)	(13.51)	(13.72)	(13.93)	(14.19)	(14.19)	(14.19)	(14.19)
Education	11.31	11.30	11.27	11.25	11.22	11.20	11.18	11.14	11.13	11.13	11.13	11.13	11.13
	(2.31)	(2.31)	(2.30)	(2.30)	(2.29)	(2.28)	(2.28)	(2.25)	(2.25)	(2.22)	(2.22)	(2.22)	(2.22)
Family Size	5.78	5.67	5.49	5.36	5.23	4.98	4.81	4.65	4.52	4.42	4.31	4.15	4.05
	(2.62)	(2.66)	(2.66)	(2.63)	(2.61)	(2.45)	(2.38)	(2.29)	(2.22)	(2.15)	(2.05)	(1.95)	(1.90)
Young Kids	1.61	1.54	1.45	1.38	1.31	1.26	1.20	1.14	1.08	1.02	0.97	0.93	0.88
	(1.46)	(1.43)	(1.40)	(1.37)	(1.34)	(1.32)	(1.309)	(1.28)	(1.25)	(1.23)	(1.20)	(1.18)	(1.15)
Old Kids	0.50	0.49	0.48	0.47	0.46	0.44	0.42	0.39	0.37	0.36	0.35	0.35	0.35
	(1.13)	(1.12)	(1.09)	(1.08)	(1.04)	(0.99)	(0.94)	(0.90)	(0.85)	(0.81)	(0.79)	(0.75)	(0.74)
Birth	4.88	5.08	5.42	5.17	4.98	4.91	4.79	4.95	5.03	5.22	4.92	5.47	5.49
	(21.55)	(21.97)	(22.64)	(22.14)	(21.74)	(21.61)	(21.36)	(21.68)	(21.86)	(22.25)	(21.64)	(22.75)	(22.78)
Age at 1st Birth	28.82	28.81	28.88	28.86	28.90	29.00	29.05	29.15	29.19	29.22	29.22	29.22	29.22
	(11.31)	(11.31)	(11.33)	(11.34)	(11.36)	(11.39)	(11.41)	(11.43)	(11.44)	(11.44)	(11.44)	(11.44)	(11.44)
Martial status	23.11	24.51	25.65	27.01	28.59	30.13	31.33	31.95	32.66	33.73	34.35	35.80	36.73
	(42.16)	(43.02)	(43.68)	(44.40)	(45.19)	(45.88)	(46.39)	(46.63)	(46.90)	(47.28)	(47.49)	(47.95)	(48.21)
Black	43.06	42.93	42.76	42.70	42.26	42.19	41.91	41.69	41.65	41.47	41.47	41.48	41.48
	(49.52)	(49.50)	(49.48)	(49.47)	(49.40)	(49.39)	(49.35)	(49.31)	(49.30)	(49.27)	(49.27)	(49.28)	(49.27)
Hispanic	0.43	0.43	0.43	0.43	0.43	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	(2.03)	(2.04)	(2.03)	(2.03)	(2.04)	(2.03)	(2.05)	(2.06)	(2.05)	(2.05)	(2.05)	(2.05)	(2.05)
North East	16.65	16.44	16.63	16.60	16.53	16.61	16.43	16.18	16.04	15.97	15.86	15.37	15.13
	(37.26)	(37.07)	(37.24)	(37.21)	(37.15)	(37.22)	(37.06)	(36.83)	(36.70)	(36.63)	(36.53)	(36.07)	(35.84)
North Central	24.58	24.78	24.50	24.55	24.75	24.703	24.26	24.20	24.06	23.82	23.68	23.45	23.56
	(43.06)	(43.18)	(43.02)	(43.04)	(43.16)	(43.13)	(42.87)	(42.83)	(42.75)	(42.60)	(42.51)	(42.38)	(42.44)
South	44.72	44.61	44.44	44.62	44.85	44.73	45.29	45.26	45.25	45.47	45.33	45.95	46.122
	(49.73)	(49.71)	(49.70)	(49.71)	(49.74)	(49.731)	(49.78)	(49.78)	(49.78)	(49.79)	(49.79)	(49.84)	(49.85)
L.F. Participation	25.96	29.51	32.60	34.13	35.99	36.42	38.87	40.43	42.09	42.92	45.62	50.17	52.62
	(43.85)	(45.61)	(46.88)	(47.42)	(48.00)	(48.12)	(48.75)	(49.08)	(49.37)	(49.50)	(49.81)	(50.00)	(49.94
Hours Worked	299	339	375	394	415	436	480	494	515	542	586	656	693
	(641)	(670)	(697)	(706)	(725)	(739)	(768)	(764)	(778)	(790)	(815)	(846)	(857)
Hourly earnings	7.03	7.31	8.70	7.87	8.26	8.40	8.46	8.43	8.05	8.80	8.87	8.66	8.91
	(5.93)	(5.56)	(27.50)	(6.98)	(7.83)	(7.22)	(7.29)	(9.26)	(6.67)	(10.39)	(10.59)	(8.00)	(8.01
Food Consumption	7890	7577	7446	7464	7253	7704	7871	7323	7220	6665	6465	6546	63353
	(3432)	(3312)	(3226)	(3321)	(3258)	(3271)	(3606)	(3303)	(3358)	(3202)	(3264)	(3270)	(3213)
Observations	4691	4859	5040	5206	5407	5580	5758	5946	6142	6356	6356	6357	6357

Note: L.F. is an abbreviation for labor force. Education is years of completed education. Young kids is the number children less than 6 years old and Old kids is the number of children between the age of 6 and 14. Food consumption and hourly earnings are measured in 1996 dollars. Birth, race, martial status and regions is measured in percentage.

TABLE I (Continued)
Main Sample Summary Statistics
(Standard Deviation is parenthesis)

Variable	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age	27.31	28.30	29.30	30.21	31.15	32.13	33.10	34.09	35.06	36.03	37.01	38.03
	(14.19)	(14.19)	(14.19)	(14.18)	(14.18)	(14.19)	(14.20)	(14.21)	(14.21)	(14.22)	(14.19)	(14.19)
Education	11.1312	11.13	11.13	11.13	11.13	11.136	11.13	11.14	11.14	11.15	11.15	11.16
	(2.22)	(2.22)	(2.22)	(2.22)	(2.22)	(2.22)	(2.22)	(2.23)	(2.23)	(2.23)	(2.23)	(2.23)
Family Size	3.97	3.87	3.79	3.72	3.63	3.56	3.48	3.42	3.37	3.30	3.25	3.17
	(1.90)	(1.83)	(1.80)	(1.72)	(1.67)	(1.65)	(1.61)	(1.58)	(1.58)	(1.57)	(1.57)	(1.54)
Young Kids	0.84	0.79	0.74	0.68	0.64	0.58	0.53	0.49	0.44	0.39	0.34	0.29
	(1.12)	(1.09)	(1.05)	(1.01)	(0.97)	(0.93)	(0.89)	(0.84)	(0.79)	(0.74)	(0.68)	(0.62)
Old Kids	0.35	0.36	0.37	0.37	0.38	0.39	0.41	0.41	0.41	0.42	0.41	0.41
	(0.73)	(0.73)	(0.73)	(0.74)	(0.75)	(0.75)	(0.76)	(0.77)	(0.77)	(0.77)	(0.76)	(0.77)
Birth	4.92	5.09	5.01	4.95	4.75	4.98	4.99	4.78	4.62	4.86	4.99	1.24
	(21.64)	(21.99)	(21.83)	(21.70)	(21.28)	(21.76)	(21.78)	(21.35)	(20.99)	(21.5)	(21.78)	(11.08)
Age at 1st Birth	29.22	29.22	29.21	29.21	29.20	29.21	29.21	29.21	29.24	29.19	29.17	29.21
	(11.44)	(11.44)	(11.43)	(11.43)	(11.42)	(11.42)	(11.42)	(11.41)	(11.40)	(11.39)	(11.38)	(11.39)
Martial status	37.28	38.05	39.11	40.11	40.91	41.31	41.68	42.35	43.04	43.55	43.68	43.75
	(48.36)	(48.56)	(48.80	(49.01)	(49.17)	(49.24)	(49.31)	(49.41)	(49.51)	(49.58)	(49.60)	(49.61)
Black	41.48	41.48	41.48	41.28	41.22	41.22	40.97	40.79	40.61	40.46	40.31	40.05
	(49.27)	(49.27)	(49.27)	(49.23)	(49.22)	(49.22)	(49.18)	(49.14)	(49.11)	(49.08)	(49.05)	(49.01)
Hispanic	0.44	0.44	0.44	0.44	0.44	0.44	0.43	0.43	0.43	0.43	0.43	0.44
	(2.05)	(2.05)	(2.05)	(2.05)	(2.05)	(2.05)	(2.04)	(2.03)	(2.04)	(2.04)	(2.04)	(2.04)
North East	14.96	14.77	14.48	14.38	14.18	14.09	13.92	13.69	13.50	13.08	12.75	12.54
	(35.67)	(35.48)	(35.20)	(35.09)	(34.89)	(34.79)	(34.62)	(34.38)	(34.18)	(33.72)	(33.35)	(33.12)
North Central	23.38	23.27	23.23	22.99	22.79	22.48	22.39	22.09	21.68	21.65	21.60	21.84
	(42.33)	(42.26)	(42.23)	(42.08)	(41.95)	(41.75)	(41.69)	(41.48)	(41.21)	(41.19)	(41.15)	(41.32)
South	45.95	45.95	46.02	46.25	45.94	45.67	45.64	45.57	45.43	45.60	45.10	45.53
	(49.84)	(49.84)	(49.84)	(49.86)	(49.83)	(49.81)	(49.81)	(49.80)	(49.79)	(49.81)	(49.76)	(49.80)
L.F. Particaption	54.47	55.01	55.85	57.74	61.75	62.71	64.57	67.01	68.32	70.76	72.13	71.47
	(49.80)	(49.75)	(49.65)	(49.39)	(48.60)	(48.36)	(47.83)	(47.02)	(46.52)	(45.48)	(44.83)	(45.15)
Hours Worked	725	744	761	790	879	907	937	980	1017	1041	1077	1085
	(866)	(875)	(883)	(889)	(915)	(929)	(927)	(938)	(947)	(937)	(946)	(962)
Hourly earnings	8.73	8.65	8.67	10.78	9.88	9.93	9.58	9.97	10.11	10.42	10.33	10.57
	(7.65)	(7.57)	(7.46)	(56.83)	(38.91)	(24.31)	(9.46)	(9.69)	(8.66)	(15.53)	(11.77)	(9.33)
Food Consumption	6162	5886	5753	5875	5963	5846	5741	5766	5631	5518	5435	5512
	(3118)	(2951)	(2966)	(3123)	(3707)	(3128)	(3105)	(2933)	(2835)	(3010)	(2834)	(3488)
Observations	6357	6357	6357	6298	6246	6159	6067	5971	5885	5815	5725	5627

Note: L.F. is an abbreviation for labor force. Note: Education is years of completed education. Young kids is the number children less than 6 years old and Old kids is the number of children between the age of 6 and 14. Food consumption and hourly earnings are measured in 1996 dollars. Birth, race, martial status and regions is measured in percentage.

Estimation

Overview

- Our estimation strategy essentially follows Altug and Miller (1998) by extending their framework of female labor supply and human capital accumulation to incorporate choices about fertility. We sequentially estimate:
  1. the wage equation;
  2. the individual fixed effects from the wage equation;
  3. the social weights of the social planner's problem from the Frisch consumption demands;
  4. the conditional choice probabilities;
  5. the remaining structural parameters of the model by exploiting the model's finite dependence property.
- Our standard errors account for the sequential estimation method.

Estimating the Labor supply and Fertility Parameters

Choice paths establishing finite dependence

- We can establish finite dependence by defining four choice paths that might be taken $\rho + 2$ periods into the future starting period at t, and the induced history of state variables:
  1. $H_{1nt}^{(s)}$ comes from $d_{1nt} = 1$, $d_{3n,t+1} = 1$ and $d_{1n,t+s} = 1$ for $s > 1$.
  2. $H_{2nt}^{(s)}$ only differs from $H_{1nt}^{(s)}$ by setting $d_{2nt} = 1$ (and $h_{nt} = h_{2nt}$).
  3. $H_{3nt}^{(s)}$ sets $d_{3nt} = 1$ and $d_{1n,t+s} = 1$ for all $s > t$.
  4. $H_{4nt}^{(s)}$ sets $d_{4n,t+1} = 1$ and $d_{1n,t+s} = 1$ for all $s > t$.
- By construction $H_{knt}^{(\rho+2)} \equiv H_n$ for all $k \in \{1, 2, 3, 4\}$.
- Thus the consequences of any choice made in period t can be obliterated $\rho + 2$ periods hence by equalizing family size in period $t + 1$ and not working or having any more children.

Lemma

Let $l_{knt}^{(s)}$ denote leisure in period $t+s$ when $H_{knt}^{(s)}$ is induced, and define:

$$\begin{aligned} W_k\left(H_{nt}\right) &= u_k\left(H_{nt}\right) + \beta^{\rho+2-t} V\left(H_n\right) \\ &+ \sum_{s=1}^{\rho+1} \beta^{s-t} \left\{ z'_{n,t+s} B_1 l_{knt}^{(s)} + \sum_{r=1}^{\rho} \delta_s l_{knt}^{(s)} l_{knt}^{(s-r)} - \sigma \ln p_1\left(H_{knt}^{(s)}\right) \right\} \end{aligned}$$

Then $V_k\left(H_{nt}\right) = W_k\left(H_{nt}\right)$ for $k \in \{3,4\}$ and for $k \in \{1,2\}$:

$$\begin{aligned} V_k\left(H_{nt}\right) &= W_k\left(H_{nt}\right) + \sigma\beta\left[\ln p_1\left(H_{knt}^{(1)}\right) - \ln p_3\left(H_{knt}^{(1)}\right)\right] \\ &+\beta\left(\gamma_0 + \sum_{k=1}^{t} \gamma_{k+1} b_{n,t-k}\right) - \eta_n \lambda\left(\tau_{n,t+1}\right) z'_{n,t+1}\pi \end{aligned}$$

- We modify the usual formula for the log odds ratio to account for the fact that wages and the marginal utility of wealth are determined as pure numbers. For $j \in \{1, \ldots, 4\}$:

$$V_j\left(H_{nt}\right) - V_k\left(H_{nt}\right) = \sigma \ln p_j\left(H_{nt}\right) - \sigma \ln p_k\left(H_{nt}\right)$$

- Substituting our representation of the conditional value functions into this formula provides the basis for a minimum distance estimator.
- Differentiating the representation for the conditional value functions at the optimal hours yields the first order condition:

$$\begin{aligned} &\eta_n \lambda\left(\tau_{nt}\right) w_{nt} - z_{nt}' B_1 - 2\delta_0 l_{4nt}^{(0)} \\ = &\sum_{s=1}^{\rho+1} \beta^{s-t} \left\{ \sigma \frac{\partial p_1\left(H_{4nt}^{(s)}\right) / \partial h_t}{p_1\left(H_{4nt}^{(s)}\right)} - \delta_s l_{4nt}^{(s)} \right\} \end{aligned}$$

for $j = 4$, and a similar first order condition for $j = 2$, both of which can also be sequentially estimated.

- Working an extra hour increases the wage rate for up to four years albeit in sharply diminishing amounts. (see Table II.)
- For example the change in log wage rate for a woman who works the sample average of hours for participants is 0.12, but if the woman only begins working one period ago and then works the sample average the change in the log current wage rate is still 0.08.
- Timing matters less for work experience gained many years ago; an extra hour worked last year has about twice the effect on current log wages as an extra hour worked two years ago, but the corresponding difference between extra hours worked three and four years ago is less than 40%.
- Experience has a nonlinear effect, negative coefficients on lagged participation offsetting about 1500 hours of past experience.

TABLE II
Wage Equation

$$\ln(w_{nt}) = \ln(\omega_t) + \ln(\mu_n) + z_{nt}'B_3 + \sum_{s=1}^{4}(\delta_{1s}h_{n,t-s} + \delta_{2s}d_{2n,t-s} + \delta_{2s}d_{4n,t-s})$$

Variable	Parameter	Estimate†
Lags of hours worked		
$\triangle h_{n,t-1}$	δ_{11}	14.1011 (0.2337)
$\triangle h_{n,t-2}$	δ_{12}	10.9974 (0.2471)
$\triangle h_{n,t-3}$	δ_{13}	8.8360 (0.2437)
$\triangle h_{n,t-4}$	δ_{14}	5.4729 (0.2227)
Lags of participation		
$\triangle(d_{2n,t-1} + d_{4n,t-1})$	δ_{21}	-6.8664 $(4.01E-02)$
$\triangle(d_{2n,t-2} + d_{4n,t-2})$	δ_{22}	-4.4241 $(4.46E-02)$
$\triangle(d_{2n,t-3} + d_{4n,t-3})$	δ_{23}	-2.8986 $(4.44E-02)$
$\triangle(d_{2n,t-4} + d_{4n,t-4})$	δ_{24}	-1.6065 $(3.92E-02)$
Socioeconomic Variables		
$\triangle AGE_{nt}^2$	B_{31}	-0.0114 $(3.0E-04)$
$\triangle(AGE_{nt} \times EDU_{nt})$	B_{32}	0.0161 $(3.1E-03)$

† Estimated standard error in parenthesis. Note: EDU is the years of completed education.

- Table III shows the estimates obtained from the frisch demand curves for consumption.
- The marginal utility of consumption increases with family size and children consume less than adults, since the coefficients on children between the ages of zero and fourteen are negative and smaller in absolute magnitude than the coefficient on total household size.
- Furthermore, the behavior of consumption over the life-cycle is concave since the coefficient on age squared is negative.
- At 0.98, with estimated standard error 0.019, the risk aversion parameter is not significantly different from one, risk neutrality.

TABLE III

Log Frisch Consumption Demand

$$\ln(x_{nt}) = (1-\alpha)^{-1}[z'_{nt}B_2 - \ln(\eta_n) - \ln(\lambda_t) + \epsilon_{0nt}]$$

Variable	Parameter	Estimate†
Risk Aversion	α	0.98 (1.9$E-02$
Socioeconomic variables		
$\triangle FAM_{nt}$	$(1-\alpha)^{-1}B_{21}$	$3.19E-02$ $(3.0E-04)$
$\triangle YKID_{nt}$	$(1-\alpha)^{-1}B_{22}$	$-3.33E-02$ $(1.6E-03)$
$\triangle OKID_{nt}$	$(1-\alpha)^{-1}B_{23}$	$-1.12E-02$ $(1.2E-03)$
$\triangle AGE^2_{nt}$	$(1-\alpha)^{-1}B_{24}$	$-1.0E-04$ (0.0000)
Region Dummies		
$\triangle NC_{nt}$	$(1-\alpha)^{-1}B_{25}$	$-3.7E-03$ $(3.3E-03)$
$\triangle SO_{nt}$	$(1-\alpha)^{-1}B_{26}$	$-1.19E-02$ $(3.2E-03)$

† Estimated standard error in parenthesis. Note: EDU is the years of completed education,FAM is the number of individual in the household, YKid is the number of kids less than 6 years old, Okid is the number of children between age 6 and 14, while NC and SO are regional dummies for the North Central and South respectively.

- Our estimates in Table IV show:
  - Women participating in the labor force also incur a utility loss.
  - Age reduces this loss, but at a decreasing rate.
  - Education also decreases the loss
  - Moreover, the difference attributable to education becomes more pronounced with age.
  - Married women have a lower cost of participation and blacks have a higher cost of participation, confirming previously published results.

TABLE IV

Fixed Utility from Labor Force Participation

$(d_{nt2} + d_{nt4})\, z'_{nt} B_0$

Variable	Parameter	Estimate†
$CONSTANT$	B_{00}	-5.23 (0.66)
AGE_{nt}	B_{01}	0.26 $(4.6E-2)$
AGE^2_{nt}	B_{02}	$-4.8E-3$ $(7.46E-4)$
$AGE_{nt} \times EDUC_n$	B_{03}	$2.0E-3$ $(4.25E-4)$
$MART.STATUS_{nt}$	B_{04}	0.12 $(4.9E-2)$
$BLACK_{nt}$	B_{05}	$-5.9E-2$ $(5.2E-2)$

† Estimated standard error in parenthesis. Note: EDU is the years of completed education and MART. STATUS is a dummy variable equal 1 if the female is married and zero otherwise.

- Table V contains the results from the estimation of the fraction of time spent nurturing a child.
- They contain two surprising and controversial findings:
  1. older offspring demand greater nonwork time than younger offspring, or more generally raise the marginal utility of leisure more than younger offspring;
  2. young children do not significantly take away from leisure, or more generally, affect the marginal utility of leisure.
- The results suggest that offspring are likely to have their main direct impact on reduced labor force participation once they grow older, and that the impact of young children is largely driven by anticipating early withdrawal from the labor force and hence the reduced investment value of job working experience.

TABLE V

Nurturing Time Cost

$$c_{nt} = \sum_{s=0}^{5} \phi_s b_{n,t-s} + \phi_6 \sum_{s=6}^{t} b_{n,t-s}$$

Variable	Parameter	Estimate†
b_{nt}	ϕ_0	$4.0E-5$ $(2.28E-1)$
$b_{n,t-1}$	ϕ_1	$3.8E-4$ $(1.65E-1)$
$b_{n,t-2}$	ϕ_2	$1.1E-4$ $(9.0E-2)$
$b_{n,t-3}$	ϕ_3	$7.2E-5$ $(6.1E-2)$
$b_{n,t-4}$	ϕ_4	$2.7E-3$ $(1.0E-1)$
$b_{n,t-5}$	ϕ_5	$1.7E-2$ $(5.5E-2)$
$\sum_{s=6}^{t} b_{n,t-s}$	ϕ_6	$1.8E-2$ $(7.0E-03)$

† Estimated standard error in parenthesis

Results

Utility Cost of Leisure

- Table VI implies utility is concave increasing in leisure.
- Leisure taken in different periods are substitutes.
- Age and age squared are both insignificant, suggesting that retirement is explained by labor market productivity.
- Marriage reduces the value of leisure:
  1. Since marriage is voluntary, and spouses typically do not work with each other, one explanation for this finding is that males contribute to domestic household production.
  2. In our sample AFDC is essentially available to unmarried but not married mothers, conditional on not working. (Empirically welfare participation among female heads is about one third.) In this way the leisure of female heads is subsidized, thus providing a second explanation for these results.

TABLE VI
Utility of Leisure

$$z'_{nt}B_{11}l_{nt} + \sum_{s=0}^{4} \delta_s l_{n,t-s} l_{nt}$$

Variable	Parameter	Estimate†
l_{nt}	B_{110}	1.96 (0.22)
$AGE_{nt} \times l_{nt}$	B_{111}	$-2.1E-3$ $(1.13E-2)$
$AGE^2_{nt} \times l_{nt}$	B_{113}	$-5.1E-6$ $(1.8E-4)$
$AGE_{nt} \times EDUC_n \times l_{nt}$	B_{113}	$2.3E-4$ $(1.0E-4)$
$MART.STATUS_{nt} \times l_{nt}$	B_{114}	$-3.6E-2$ $(1.2E-2)$
$BLACK_{nt} \times l_{nt}$	B_{115}	$5.4E-2$ $(1.2E-2)$
l^2_{nt}	δ_0	-0.14 $(5.8E-2)$
$l_{nt}l_{n,t-1}$	δ_1	-0.33 $(6.6E-2)$
$l_{nt}l_{n,t-2}$	δ_2	-0.17 $(4.5E-2)$
$l_{nt}l_{n,t-3}$	δ_3	-0.24 $(4.5E-2)$
$l_{nt}l_{n,t-4}$	δ_4	$-1.5E-2$ $(4.3E-2)$
variance	σ^{-1}	$1.0e-2$ $(7.8e-3)$

† Estimated standard error in parenthesis. Note: EDU is the years of completed education and MART. STATUS is a dummy variable equal 1 if the female is married and zero otherwise.

- We found separating the monetary costs of offspring from the direct benefit a birth difficult.
- The complementarity and substitution effects are however clear. There are benefits from having children two to three years apart, but costs from having them closer or further apart.
- Turning to the cost of a child:
  - having at least a high school education significantly increases that cost.
  - blacks incur significantly lower costs than whites and hispanics.
- Noting that more educated parents put more market inputs into their own children, the model does not assume that offspring from different family backgrounds are identical to each other.

TABLE VII

Utility from Offspring and Monetary Costs

$$\gamma_0 b_{nt} + \sum_{k=1}^{5} \gamma_k b_{nt} b_{n,t-k} + \gamma_6 \sum_{k=6}^{t} b_{nt} b_{n,t-k}$$

$$z'_{nt}\pi_1$$

Variable	Parameter	Estimate†
b_{nt}	γ_0	-1.17 (0.30)
$b_{nt}b_{n,t-1}$	γ_1	-0.23 (0.08)
$b_{nt}b_{n,t-2}$	γ_2	0.79 (0.12)
$b_{nt}b_{n,t-3}$	γ_3	0.41 (0.08)
$b_{nt}b_{n,t-4}$	γ_4	-0.14 $(7.5E-2)$
$b_{nt}b_{n,t-5}$	γ_5	-0.22 (0.08)
$\sum_{k=6}^{t} b_{nt}b_{n,t-k}$	γ_6	-0.41 (0.05)
$NO\ HIGH\ SCH_{nt}$	π_1	$-5.1E-3$ (0.13)
$BLACK_{nt}$	π_2	$1.6E-2$ $(8.4E-2)$

† Estimated standard error in parenthesis. Note: NO HIGH SCH is dummy variable equal one if the female has not graduated high school and zero otherwise.

Policy simulations

Overview of the simulations

- We stratified the population into 18 categories, setting the marginal utility of wealth and endowed marginal product of labor for each category, to the estimated category means:
  1. 3 racial types, Black, Hispanic and White;
  2. 2 types of marital status, "M" if she was married at age 25 or before, and "U" if not.
  3. 3 educational groups, "$>$" who completed some years at college, "HS" who completed at most some years at high school , and "$<$" for those with less education than that.
- The models we simulated are slightly less complex than the estimation framework:
  1. the labor supply choice set is discrete, 10 equally spaced choices in the $[0, 1]$ interval.
  2. the value of marginal consumption is linearized around the marginal utility of consumption achieved in the current regime.
  3. the economy has no aggregate shocks.

- The model was solved for each group under five policy regimes:
  1. The benchmark regime, labelled **Estimation**, is the current one, which may be compared with the conditional sample means from the data set.
  2. In the regime labelled **Expenses**, the state pays all the estimated monetary costs associated with raising children, removing the wedge in the marginal utility of wealth between households that have children and those that do not.
  3. Under the **Daycare** policy, maternal time is replaced with publicly funded child care centers.
  4. The **Wages** policy would pay the mother the wages she would have received if she had decided against having her child.
  5. If the **Retraining** policy is adopted, mothers are given retraining upon reentering the workforce that fully restore the human capital from lost workforce experience.
- In **Expenses** and **Daycare** the subsidy to a child does not vary with the recipient, but in **Wages** and **Retraining** it does.

- The Type 1 extreme value also implies that for each $j \in \{1, \ldots, 4\}$

$$V_k\left(H_{nt}\right) = u_k\left(H_{nt}\right) + \beta \log\left\{\sum_{j=1}^{4} \exp V_j\left(H_{n,t+1} \left| d_{knt} = 1\right.\right) + 5772\ldots\right\}$$

- Differentiating with respect to hours we have:

$$\lambda\left(\tau_{nt}\right) w_{nt} - z'_{nt} B_1 - 2\delta_0\left(1 - c_{nt} - h_{knt}\right) - \sum_{s=1}^{\rho} \delta_s l_{n,t-s}$$

$$= \sum_{j=1}^{4} p_j\left(H_{n,t+1} \left| d_{knt} = 1\right.\right) \frac{\partial V_j\left(H_{n,t+1} \left| d_{knt} = 1\right.\right)}{\partial h_{knt}}$$

  where $p_j\left(H_{nt}\right)$ is the CCP for discrete choice j given H_{nt}.
- We combined policy function iteration (using Newton steps) with value function iteration (using the contraction operator on the value function). Convergence to the solution of the associated infinite horizon problem typically occurred within seven iterations.

Policy simulations

Solving the model for a representative within each observed category (Estimation)

- The labor force participation rate and expected fertility rate over this period (essentially the TFR) for each type is reported in the second column of Tables VIII and IX under the heading of **Estimation**.
- With regards fertility Table VIII shows that:
  - only nonwhite women with less than high school education exceed the replacement rate
  - controlling for marital status and race, college educated groups have the lowest fertility rates
- Turning to labor supply Table IX shows that
  - with the notable exception of college educated whites, unmarried women are more likely to participate in the labor force
  - participation increases with education
  - blacks exhibit the biggest variation in labor force participation rates across education and marital status categories.

TABLE VIII

Predicted Completed Fertility Outcomes under Different Policies

	Marital	Education	Actual	Estimation	Expenses	Daycare	Wages	Retraining
Black								
	M	<	2.12	2.45	2.63	2.41	2.57	2.69
		HS	1.93	2.03	2.60	2.8	2.19	3.00
		>	1.35	1.68	1.71	2.3	1.66	2.50
	U	<	2.15	2.35	2.56	2.58	2.41	2.57
		HS	1.82	1.97	2.04	2.1	1.98	2.05
		>	1.23	1.17	1.26	1.85	1.37	2.24
Hispanic								
	M	<	2.08	2.19	2.23	2.31	2.25	2.02
		HS	1.83	1.79	1.89	2.03	1.87	2.35
		>	1.55	1.46	1.50	1.87	1.49	2.03
	U	<	2.00	2.15	2.23	2.26	2.23	2.31
		HS	1.78	1.87	1.96	2.12	1.89	2.38
		>	1.46	1.56	1.67	2.00	1.72	2.30
White								
	M	<	1.78	2.04	2.12	2.16	2.09	2.07
		HS	1.34	1.52	1.63	2.30	1.67	2.45
		>	1.12	1.23	1.32	1.97	1.24	2.03
	U	<	1.47	1.56	1.54	1.78	1.58	1.87
		HS	1.25	1.31	1.56	1.90	1.67	2.08
		>	1.11	1.24	1.39	1.78	1.48	2.03

TABLE VIII(Percentage Change)
Predicted Completed Fertility Outcomes under Different Policies

					Percentage Change of Estmation			
	Marital	Education	Actual	Estimation	Expenses	Daycare	Wages	Retraining
Black								
	M	<	2.12	2.45	7.35	-1.63	4.90	9.80
		HS	1.93	2.03	28.08	37.93	7.88	47.78
		>	1.35	1.68	1.79	36.90	-1.19	48.81
	U	<	2.15	2.35	8.94	9.79	2.55	9.36
		HS	1.82	1.97	3.55	6.60	0.51	4.06
		>	1.23	1.17	7.69	58.12	17.09	91.45
Hispanic								
	M	<	2.08	2.19	1.83	5.48	2.74	-7.76
		HS	1.83	1.79	5.59	13.41	4.47	31.28
		>	1.55	1.46	2.74	28.08	2.05	39.04
	U	<	2	2.15	3.72	5.12	3.72	7.44
		HS	1.78	1.87	4.81	13.37	1.07	27.27
		>	1.46	1.56	7.05	28.21	10.26	47.44
White								
	M	<	1.78	2.04	3.92	5.88	2.45	1.47
		HS	1.34	1.52	7.24	51.32	9.87	61.18
		>	1.12	1.23	7.32	60.16	0.81	65.04
	U	<	1.47	1.56	-1.28	14.10	1.28	19.87
		HS	1.25	1.31	19.08	45.04	27.48	58.78
		>	1.11	1.24	12.10	43.55	19.35	63.71

TABLE IX
Predicted Annual Labor Force Participation Rates under Different Policies

	Marital	Education	Actual	Estimation	Expenses	Daycare	Wages	Retraining
Black								
	M	<	0.570	0.452	0.436	0.421	0.476	0.423
		HS	0.673	0.772	0.722	0.732	0.724	0.723
		>	0.781	0.729	0.745	.742	0.732	0.732
	U	<	0.678	0.616	0.606	0.627	0.601	0.591
		HS	0.723	0.763	0.751	0.749	0.761	0.763
		>	0.897	0.912	0.913	0.916	0.915	0.921
Hispanic								
	M	<	0.612	0.634	0.632	0.625	0.623	0.618
		HS	0.722	0.745	0.739	0.738	0.737	0.735
		>	0.823	0.856	0.842	0.845	0.835	0.812
	U	<	0.732	0.742	0.692	0.693	0.695	0.683
		HS	0.752	0.765	0.745	0.746	0.748	0.746
		>	0.824	0.878	0.867	0.857	0.856	0.872
White								
	M	<	0.678	0.693	0.687	0.598	0.662	0.597
		HS	0.897	0.876	0.874	0.873	0.878	0.871
		>	0.912	0.927	0.921	0.928	0.926	0.923
	U	<	0.753	0.734	0.727	0.714	0.701	0.692
		HS	0.857	0.876	0.767	0.798	0.845	0.855
		>	0.866	0.857	0.867	0.849	0.867	0.856

TABLE IX(Percentage Change)
Predicted Annual Labor Force Participation Rates under Different Policies

					Percentage Change of Estmation			
	Marital	Education	Actual	Estimation	Expenses	Daycare	Wages	Retraining
Black								
	M	<	0.57	0.452	-3.54	-6.86	5.31	-6.42
		HS	0.673	0.772	-6.48	-5.18	-6.22	-6.35
		>	0.781	0.729	2.19	1.78	0.41	0.41
	U	<	0.678	0.616	-1.62	1.79	-2.44	-4.06
		HS	0.723	0.763	-1.57	-1.83	-0.26	0.00
		>	0.897	0.912	0.11	0.44	0.33	0.99
Hispanic								
	M	<	0.612	0.634	-0.32	-1.42	-1.74	-2.52
		HS	0.722	0.745	-0.81	-0.94	-1.07	-1.34
		>	0.823	0.856	-1.64	-1.29	-2.45	-5.14
	U	<	0.732	0.742	-6.74	-6.60	-6.33	-7.95
		HS	0.752	0.765	-2.61	-2.48	-2.22	-2.48
		>	0.824	0.878	-1.25	-2.39	-2.51	-0.68
White								
	M	<	0.678	0.693	-0.87	-13.71	-4.47	-13.85
		HS	0.897	0.876	-0.23	-0.34	0.23	-0.57
		>	0.912	0.927	-0.65	0.11	-0.11	-0.43
	U	<	0.753	0.734	-0.95	-2.72	-4.50	-5.72
		HS	0.857	0.876	-12.44	-8.90	-3.54	-2.40
		>	0.866	0.857	1.17	-0.93	1.17	-0.12

Policy simulations

Sample means for the 18 observed categories (Actual versus Estimation)

- Recall we set the marginal utility of wealth and endowed marginal product of labor for each category to the estimated category means when solving the model for a given category.
- The simulated results for our estimated model do not match the corresponding sample category means very closely, but most of the inequalities within each racial group are preserved.
- Five factors explain the differences:
    1. misspecification error in the model (but note that a fully saturated model is not overidentified, and we include almost everything that is "statistically significant");
    2. sample error in both columns (which we should check);
    3. the sample contains many incomplete birth histories, so reported fertility cannot be interpreted as TFR;
    4. aggregate effects are accounted for in estimation but not in the data summary (but these are small);
    5. values of the household unobservables accounted for in estimation but not in the data summary.

Policy simulations

Child-care support (Expenses)

- We implement **Expenses** in our model by eliminating market inputs into offspring, setting $\pi_0 = 0$ and $\pi_1 = 0$ in the expression for child care costs:

$$\pi\left(z_{nt}\right) = \pi_0 + z_{nt}'\pi_1$$

- In a static model, we might predict women would have more children, but reduce both their leisure and hours worked.
- The results of the dynamic simulations support this intuition:
    - in all but one instance fertility rises, with 6 groups (compared to 4) now above the replacement rate;
    - strongest increases occur amongst lower educated blacks;
    - in 16 of the 18 groups labor force participation declines;
    - biggest reduction is amongst unmarried high school educated whites.

Policy simulations

Providing day care (Daycare)

- We implement **Daycare** in our model by eliminating maternal inputs for preschoolers, setting $\phi_i = 0$ for $i \in \{1, \ldots, 5\}$.
- In a static model, fertility would increase in response to a reduction in one of its factor inputs, maternal time.
- If there were no time inputs into older children one predicts that both leisure and labor supply would increase.
- Focusing first on fertility changes under the day-care policy:
  - Every group except one increases fertility, with 12 now at or above the replacement rate;
  - Married high school educated white females register the biggest increase (from a TFR of 1.52 to 2.30);
  - Unmarried whites and all college educated groups except married blacks still do not achieve the replacement rate.
- Labor force participation rates decline for the most part, because:
  - higher fertility increases time devoted to older offspring;
  - anticipating earlier retirement reduces investment value of current work.

Policy simulations
Paid Maternity Leave (Wages)

- We implement paid **Wages** by setting:
  - τ_n^* the number of periods she would have taken off if there were no provisions for paid maternity leave;
  - $h_{n,t+s}^*$ the n^{th} woman's labor supply s periods after the birth in t, conditional on working since then as if no birth occurred;
  - $w_{n,t+s}^*$ her wage rate s periods after the birth in t when generated by the $h_{n,t+s}^*$ sequence.
- Then in this policy regime the maximum amount she receives is:

$$\sum_{s=0}^{\tau_n^*} \lambda^s w_{n,t+s}^* h_{n,t+s}^*$$

  where λ is the steady state market discount factor.
- TFR increases in all but one category, but less overall than with **Daycare**.
- In 13 out of the 18 cases the labor supply participation falls, because of the substitution effect into child rearing activities, the subsidy to stay at home, and the compounding effect of human capital depletion.

- We implement **Retraining** by restoring mother's to the wage trajectory they would have been on had they not withdrawn from the workforce to have children.
- In our framework the labor force experience over the previous ρ_w periods helps determine the current wage.
- Thus, if female n reenters in period t, say ρ^* periods after she gave birth, log wages increase by:

$$\sum_{s=0}^{\min\{\rho_w,\rho^*\}} \left(\delta_{1s} h^*_{n,t-s} + \delta_{2s} d^*_{n,t-s}\right)$$

- Tables IX shows that the:
  - TFR of every group except the least educated unmarried white females rises above the replacement rate;
  - impact on fertility of college educated women is the most pronounced.
- The effect on labor force participation is under 5 percent change in most cases.

Conclusion

- Our estimates reaffirm the importance of dynamic factors in labor supply and fertility choices:
  1. Wages increase with experience up to four years in the past, recent experience counting the most.
  2. Leisure taken in different periods are substitutes.
  3. Estimated preferences peg optimal birth gestation at about two years.
- From a policymaker's perspective:
  1. Restoring human capital from work experience is the biggest factor in raising TFR, even though this does not directly subsidize childbearing and fertility inputs.
  2. Paying for daycare, expenses incurred raising children, or women a working wage while they have children, all increase fertility rates.
  3. None of the policies have much effect on labor supply, which is largely determined by the human capital considerations.