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High-Powered Jobs: Can Contraception Technology Explain Trends in Women's Occupational Choice? *

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Abstract

The rate at which young women enter managerial /professional occupations begain to rise steadily in 1960, the year that oral contraceptives first became available in the US. The fact that young mothers are comparatively rare in these occupations suggests the advent of more effective contraception may have played an important role in the occupational trend. This paper uses a lifecycle model of contraception, abortion and occupational choice to ask how much of the occupational trend could be explained by the change in contraceptive technology.

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> ...there are many professions and many activities, (including) the most prestigious activities in our society (which) expect of people who are going to rise to leadership positions in their forties near total commitments to their work. They expect a large number of hours in the office, they expect a flexibility of schedules to respond to contingency, they expect a continuity of effort through the life cycle, and they expect-and this is harder to measure-but they expect that the mind is always working on the problems that are in the job, even when the job is not taking place. And it is a fact about our society that is a level of commitment that a much higher fraction of married men have been historically prepared to make than of married women.

–Harvard President Larry Summers, January 2005[1]

1 Introduction

Since WW2, we have witnessed concomitant trends in women's labro-force participation and wages. A number of papers have pointed that one or both of these phenomena could be explained by a rise in returns to experience or skill for women's work. When other explanations are offered, such as change in household technology or child-care arrangements, accounting decompositions show that wage changes are much more important. Olivetti (2001) and Mulligan and Rubinstein (2005) for instance find that a rise in returns to experience and to skill, respectively, can explain the closing of the gender gap in wages. Both Olivetti and Buttet and Schoonbroodt (2006) find that the trend in returns to experience explains about half of the rise in women's LFP.

[1] Remarks at NBER Conference on Diversifying the Science & Engineering Workforce, Lawrence H. Summers, Cambridge, Mass.http://www.president.harvard.edu/speeches/summers/2005/nber.html

But occupations tend to vary in wage structure, and those with high rates of return to skill tend to be those with higher rates of return to experience. Fig 1 shows trend in occupation for people aged 25-30 over the period 1962-2000. These measures use the 1950's Census occupation classification. The top frame shows managerial/professional (occ<300) both with (measure 1) and without (measure 2) schoolteachers and nurses [2]. It is apparent that, until the 1990s, there was no trend in men's tendency to enter managerial or professional occupations, where rates of return to skill and experience are highest. At the same time, there has been a strong trend of women to these occupations. The top frame in Figure 2 shows that the trend is similar if we condition on being in the labor force; indeed before 1977, young female workers were less likely than male workers to be in skilled occupations; since then they are much more likely. The bottom frame shows that even conditional on college, the share of women in skilled occupations has increased, by about 50% for women in their late 20s, over birth cohorts. Blau and Kahn (1997) find that shifts of women into managerial/professional occupations accounted for 30.1% of the convergence in the gender wage gap in the 1980s. Can the occupational trend over the 1960-1990 period account for changes in women's return to experience?

What forces triggered the trend in occupational choice? Given that the occupation trends are only positive for women it would seem to be that the starting point in the search for ultimate causes must be something that affects women more than men and that occurred or was commonly anticipated by 1960. That early date rules out institutional changes associated with civil rights and women's liberation movements. Cultural diffusion of the underlying values, as in Fernández, Fogli, and Olivetti (2004), is possible but leaves the origins unexplained. An explanation involving household technology seems plausible because it is in household activities that men and women differ most. Recent papers by Greenwood, Seshadri, and Yorukoglu (2005) and Al-

[2] For the 1962-21967 period, the 1950 classifcation is not available. "nurses" there is taken to be all medical personell. Managerila/Profesional is all codes<11, and professional all codes <7.

banesi and Olivetti (2006) point to home appliances and infant formula, respectively, but since the underlying innovations had been commercialized by the 1930s, there is every reason to believe that the effect of these changes had been fully absorbed by 1960. Rising rates of divorce are also likely to have had a strong impact on career trends, but marital decisions are difficult to model and in any case do not constitute an exogenous shock.

Goldin and Katz (2002) argue that the advent of the contraceptive pill for single women in the late 1960s had a significant impact on women's entry into professional schools. The idea is that the pill permitted single women to have sex without fear of pregnancy. In a world where pregnancy precluded career advancement, sexual abstinence was a major part of the cost of professional training.[3] With respect to Figure 1, the timing of this event is clearly too late. However married women had access to the pill from 1960 onwards. Could the pill have had a significant impact on career incentives through its implications for married women? [4]

Deferral of pregnancy appears to be essential for a successful career in the managerial/professional occupations, but has little impact in other careers. Table 1, based on Census data, shows that in 1990, 56% of women in managerial/professional occu-

[3] In the 1960s, a common expectation for women was that they would leave work upon becoming pregnant.5 In 1978, the Pregnancy Discrimination Act was passed which prohibited employment discrimination on the basis of pregnancy or childbirth. This act covered hiring and firing policies as well as promotions and pay levels. Also at this time, changes to the federal tax code in 1976 permitted working families with a dependent child to take a tax credit on child care costs. Both these actions clearly marked the beginning of federal involvement in work-related issues and concerns of mothers. These laws affected both employment practices during pregnancy and net child care costs after the child was born, the latter item strongly related to the affordability of child care services which would enable a mother to return to work.–from Current

Population

Reports

[4] Greenwood and Guner also consider the implications of the pill, but like Goldin and Katz, focus mainly on the implications for sex outside of marriage.

pations had no kids by age 30, compared to 35% of women in other occupations. A slightly larger differential held in 1960, 26% vs 13%. In skilled occupations, recent research shows that early motherhood is associated with much larger wage penalties than in other occupations. According to Miller (2005), each year that motherhood is deferred before age 30 results in a 5% increase in wages in managerial/professional occupations, compared to 2% for clerical and zero effect for sales/service occupations. Since motherhood also affects working hours, the lifetime-earnings effect is even greater, about 10% per year for managerial/professional. It is not surprising therefore to see that women in skilled occupations to indeed have fewer children while young. By age 25, the number of kids at home is 0.4 for skilled women versus 1.0 for unskilled; Figure 4 shows that this difference disappear by age 45. Marriage on the other hand is not deferred: Figure 3, based on CPS data for the 1990-2005 period, shows that the fraction of women married at each age between 18 and 43 is very similar across occupations; between ages 22 and 28, marriage rates climb from 20% to 50% in both occupations. The largest gap, at age 25, is 35% for the unskilled vs 30% for the skilled women. So the fertility differential is unlikely to be caused by search/matching differences.

The fraction of women who experience first-time motherhood at age 30 and over tripled between 1960 and 1995, from 7 percent to 22 percent, according to Smith, Downs, and OŠConnell (2001).Taken as exogenous, such a strong trend in fertility delay suggests a significant increase in the fraction of women who would find a skilled career more lucrative than unskilled work.

According to Westoff and Westoff (1968), the average annual pregnancy rates for married women on the pill in the 1960s were about 4%, compared to 16-30% for the other commonly used contraceptives. The average first-year pregnancy rate for contracepting married women in the 1950-55 marriage cohort was 34%, compared to 20% for the 1961-65 marriage cohort [5]. These numbers imply that the pill provided greater

[5] They report that the annual "unwanted" pregnancy rate declined from 55 to 35 per thousand

assurance to women contemplating occupational choices that their careers would not be curtailed or impaired by the early arrival of children .If delay of pregnancy is more important for success in skilled careers than in other occupations, then the advent of the pill could have made skilled careers much more attractive to women, by allowing married women to choose fertility trajectories with more precision than was previously possible. It is not clear though whether these gains in contraceptive effectiveness played an important role in the trend to later parenthood remarked above or are economically significant with respect to occupation choice.

This paper explores the possibility that the advent of the contraceptive pill in 1960 played a significant role in the trend in women's occupational choice. I use 1990s household survey data on contraception and abortion to calibrate a lifecycle model of occupational choice for women subject to a stochastic fertility process that they can influence through the choice of contraception method and effort. I use the parametrized model to assess the impact on occupational choice of denying women access to the pill and to abortion.

The model is built around several features of the lifecycle that seem essential to the trade-off that women face between work and family. The first of these is that returns to experience are concentrated in the beginning of the lifecycle; in the model, wages in the skilled sector in later life depend mostly on experience before age 30. Fecundity also declines with age but at a lower rate; if you plan to be a mother and a partner at a law firm, it is usually best to focus on making partner first. The third feature is that while children can be very time-intensive, the demands are greatest when the children are young; in the model, the time cost of a child declines with age. In all three cases, the decline is exponential; this permits the model to abstract from ages of children and parents in, which otherwise would make for a high-dimensional

women from the 1955-60 period to 1965-70. Since this concept is subject to ex post rationalization, this paper focuses instead on the rate of contraceptive failure, even though some pregnancies that occured in the absence of contraception were probably unwanted.

state variable. Finally the model incorporates effort into the contraception choice because as argued in the next section, the method-specific differences in failure rates across occupation seem as large as the differences across methods. This suggests the possibility that contraceptive effectiveness may have increased over time, even without the pill in response to changes in the wage process.

The arguments made in this paper are closely related to those of Erosa, Fuster, and Restuccia (2005), who show that stochastic fertility may be essential for understanding the gender wage gap. In an earlier paper, Erosa, Fuster, and Restuccia (2002) established that if women can choose exactly when to have a child then fertility has little effect on women's wages, because women will defer children when returns to experience are strong. The later paper, in which fertility is stochastic, generates a much larger motherhood wage penalty under realistic calibration, because stochastic fertility implies that children often arrive at inopportune times. Anticipating this, women exert less effort on the job, and hence receive lower wages than men. In the current paper, the emphasis is more on observables: occupation choice replaces effort choice, and fertility decisions are calibrated to match contraception data. Wong (2006), also calibrates a lifecycle model to assess the possibility the pill caused women to take jobs in the high-technology sector, but finds this channel to be unimportant.

Preliminary results with a rough calibration of the model to US data on contraception usage and failure rates by occupation indicate the model can replicate the occupation distributions and age-fertility profiles observed in the data. Average failure rates of contraception are higher for unskilled than for skilled women in the model, as in the data. So far the model has been computed for only one contraceptive technology so the experiment with no pill has not been carried out. Removing abortion however has little impact, because women respond by exerting more effort to avoid pregnancies.

2 Contraception Effectiveness: more than a parameter

It might appear as though one could simply compute, under controlled conditions, the pregnancy risk associated with different contraceptives and then apply these to a lifecycle model with occupational choice. The problem is that even if such pregnancy-risk parameters exist, they would be irrelevant because contraceptive failure appears to be largely the result of user error, not technical defects or failures. While progress in contraception technology is usually associated with an increase in the theoretical maximum effectiveness, what really matters for effectiveness in practice appears to be the mapping from effort to effectiveness.

Consider the case of the pill. Trussell, Hatcher, Jr., Stewart, and Kost (1990) estimate the failure rate under consistent and correct use to be one tenth of one per cent in the first year of use, while that of the condom would be 2% and that of the diaphgram 6%. Survey studies however result in much higher failure rates. Reviewing recent studies, Trussell, Hatcher, Jr., Stewart, and Kost (1990) report typical condom failure rates of 12%, of the pill of 3% and diaphgrams 18%. Even in the 1960s the average annual pregnancy rates were remarkably similar: 4% for the pill and 16%-21% for condom diapghram and withdrawal in 1965 according to Westoff and Westoff (1968). [6]The wide gap between theoretical and average effectiveness imply the contribution of the pill is not measured by its theoretical effectiveness but rather by its effectiveness under normal conditions of use, which includes mistakes made by the users. Since avoiding mistakes requires effort, the rate of effectiveness will depend, inter alia, on the incentives to avoid pregnancy.

Contraception failure rates also vary considerably with income, race and educa-

[6]Henshaw (1998) reports that In 1990s failure rate for pill was 7% per year, rest the same Pill rate rose perhaps due to weaker formulation being less forigivng.) More recently, Fu, Darroch, Haas, and Ranjit (1999) report that in 1990-1995 the average failure rate per year was 8.5% for the pill and 15% for the condom.

tion. As income increases from below the poverty line to more than twice the poverty line, Henshaw (1998) finds that the fraction of pregnancies that were accidental fell from 62% to 38% in 2001. According to Fu, Darroch, Haas, and Ranjit (1999), for married women aged 20-24 the failure rate of the pill was 11.4% for households where income was less than twice the poverty level, and only 7.6% where income was above. For condoms, the rates were 22.7% and 12.3%, respectively. According to Mosher and Bachrach (1996), who review 50 studies based on 1988 data, the racial differential in unintended births accounts almost entirely for the fact that fertility of African-American women is double that of white women. Henshaw (1998) reports that 72% of pregnancies among black women in 1994 were unintended, compared to 43% among white women. While some of this differential is due to differences in contraceptive methods employed, Jones and Forrest (1989) shows that black women have a much higher rate of pregnancy for any given method of contraception. For instance married black women on the pill had failure rates of 8.4% compared to 3.4% for white women, while for condoms the numbers are 22.4% versus 11.2%, respectively. [7]

More to the point for the current paper, Table 2 shows how monthly pregnancy rates vary by occupation of the woman during the period of contraception. Based on data from the 1995 National Survey of Family Growth, the sample consists of sexually active without any known fecundity problems. The failure rate is the fraction of women using a given contraception method who become pregnant per month.

The mechanism of these linkages has not been definitively established, but it appears that a major role is played by the diligence with which contraception is applied. With respect to the pill, survey data show a high fraction of women who admit failing to adhere consistently to the daily schedule, and this inconsistency is associated with

[7] In relation to the effort hypothesis that follows its interesting to note that controlling for all observables, fertility intentions affect contraception failure rates. For instance, Vaughan, Trussell, Menken, and Jones (1977) showed that accidental pregnancy rates are about twice as high among women who contracept to delay children than among those who intend to have no more children, controlling for age and method.

a history of contraception failure. Peterson, Oakley, Potter, and Darroch (1998) found that 16% of women who rely on the pill are inconsistent users, with the rate more than twice as high among Hispanic and black women than other women. With respect to condoms, failure rates are overwhelmingly related to misuse, which is found to be less frequent among more educated users. That this is more related to effort than to education is suggested by the results of A.E.Albert (1995) who studied condom use among Nevada prostitutes, and found extremely low failure rates. The techniques employed to prevent failure, such as using two condoms simultaneously and adding lubricant, were simple and obvious, but likely to reduce enjoyment of the sexual activity. Altogether, these results indicate that the failure rates of a contraceptive method are a function of the effort one applies to making the method work.

The possibility that variation in incentives to avoid pregnancy can explain failure-rate disparities does not appear to be a consideration in the demographic literature[8]. This is understandable, because the irreversibility of children, combined with an aversion to abortion, imply that the incentives to avoid pregnancy are largely functions of the future economic trajectory of the household. Given that raising children tends to put severe constraints on the time allocation of the parents over many years, the marginal value of time in the workplace would seem to be a major component of variation in contraception decisions. In occupations where the wage depends on previous experience, the observed wage at the time of conception may be a poor indicator of the cost of pregnancy.

Economists, on the other hand, have a long tradition of modeling the trade-off between current effort and returns to experience in the workplace, but have been reluctant to apply these models to data on contraceptive methods. Recent papers in the labor literature that explore the role of human capital accumulation in the choice

[8] Fu, Darroch, Haas, and Ranjit (1999) concluded that "Income's strong influence on contraceptive failure suggests that access barriers and the general disadvantage associated with poverty seriously impede effective contraceptive practice in the United States".

of pregnancy risk include Francesconi (2002) and Gayle and Miller (2002). However they abstract from the choice among contraception methods, so their result are not informative about pregnancy-risk differentials under different technology sets. Carro and Mira (2006) consider the choice between temporary and irreversible contraception, but does not model the link to human-capital accumulation.

Consideration of incentives also provides a potential explanation of the fact that women often choose methods of birth control that would otherwise appear to be dominated by other methods. The rythm method and early withdrawal remain popular, despite a significantly higher rate of failure than then the condom, which itself appears to be dominated by more effective methods such as the pill and the IUD.

3 A Dynamic Model of Contraception Choice

The main idea of the model is that when returns to experience are high, the relative price of children in the future is low relative to children today. For young women, the anticipated gain from being in a skilled occupation versus an unskilled one is therefore increasing in the ability to defer motherhood. This ability is limited by the stochastic nature of fertility and the infeasibility of perfect birth control. Hence it is essential to allow choices over occupation, pregnancy risk, and abortion. A common obstacle to modeling such family decisions over the lifecycle is that the state variable tends to get very large. Accounting for children is a big part of this problem, because both the number and the ages of the children matter for the mother's time constraint. The model instead represents the time cost directly, as a Markovian process with exponential decay and large positive shocks associated with the arrival of babies. Rather than track age explicitly, the model assumes people differ according to fecundity and ability, both of which decay exponentially, albeit at different rates.

3.1 Model Environment

Agents are women who are infinitely lived and make choices regarding work, contraception and abortion. The state variable consists of eight components: number of kids, n, wage in the skilled occupation, w_s, wage in the unskilled occupation w_u, non-labor income y, time cost g, abortion cost χ, learnability Λ and fecundity Ψ.Women can differ along all of these dimensions.

Each woman i begins life with fecundity level ξ_i , which decays exponentially; the limiting value is $\xi_\infty \geq 0$. Let $x \in [0, \overline{x}]$ represent the effort a woman exerts to avoid pregnancy. Pregnancy risk is a function $\phi(x; \Psi_i) \leq \Psi_i$; in other words, there is one contraceptive technology that is represented by an effort-risk frontier, indexed by fecundity.[9] In the absence of contraception, pregnancy occurs with probability Ψ_i. Pregnancy results in a child the next period, unless a woman chooses abortion in the current period, in which case she pays a psychic cost $\widetilde{\chi}_i \geq 0$. This cost varies across women but remains constant over time. Kids are durable goods which produce a constant utility flow for the mother's entire lifetime; they do however entail some family-care time, particularly when new.

Let T be a woman's endowment of time, to be allocated across paid labor, family care and home production. A woman must spend a fraction g of her time on family care. This time cost evolves deterministically in response to fertility. Let discretionary time be $T - g$. A woman with n kids who ends this period pregnant loses a fraction θ_0 of discretionary time next period, and enters next period with $n + 1$ kids. Let $k \in \{0, 1\}$ indicate whether a woman delivers a child in the next period (i.e. got pregnant in the current period and opted against abortion).The initial time cost

[9] The choice of contraception method will be introduced in later versions of this paper.

$g_i \geq 0$. The law of motion of g is:

$$\begin{aligned} g' &= \Gamma(g,k) \\ \Gamma(g,k=1) &> \Gamma(g,k=0), \Gamma(g,k=0) < g \\ \Gamma_g(g,k) &> 0,, \Gamma_{gg}(g,k) < 0 \end{aligned}$$

Each period women choose whether to work in a skilled job, an unskilled job, or at home in non-market production. There is one way to supplement discretionary time: women can pay an unskilled worker the average wage $\overline{w_u}$ to carry out a fraction ρ of the time cost; let this decision be represented by $q \in \{0,1\}$. Available labor time is therefore $L = T - g(1-\rho q)$.Labor supply is discrete: work time in sector j is $l^j \in \{0, L\}$.

Women who work in sector j receive a wage w_j per T hours of labor, where $j \in \{h,s,u\}$ and w_h is a parameter, identical for all women. In addition, women in sectors $\{h,u\}$ receive a wage shock ε_{ij} that is iid across time and women with mean zero.

Wages and non-labor income follow processes in which growth rates and uncertainty dwindle over time as learnability Λ decays to some long-term value $\Lambda_\infty \geq 0$.At the end of each period, after all the current-period decisions have been made, the next-period wages for sector $\{u,s\}$ are realized. The growth rates can be either high or low, and are proportional to learnability Λ, so next-period wages in sector j are given by $w'_j \in \{w_j(1+\Lambda\gamma_H), w_j(1+\Lambda\gamma_L)\}$.The probability of the high realization γ_H is $\pi_j(j, l^m_t)$. This allows for the possibility that work in one sector affects the transition probability in the other, as in the case of general human capital, as well as occupation-specific human capital. Since Λ declines exponentially over time, wages will eventually be constant.

Non-labor income y, follows an exogenous stochastic process; there are two growth rates γ^Y_L and γ^Y_H and π^Y is the probability of the high growth rate. Over time both growth rates approach zero. As with the wage variables, this is represented by

$$y' \in \left\{ y\left(1+\Lambda\gamma_H^Y\right), y_j\left(1+\Lambda\gamma_L^Y\right)\right\}$$

3.2 Decision-Making

Suppose preferences are represented by the utility function $u(c,n,x)$, where c is consumption of market goods, x is contraceptive effort and n number of kids. Utility flows are discounted geometrically with factor β.Let the exogenous part of the current state vector be denoted by $z = (y, \chi, \Psi, \Lambda)$. A woman must decide which sector $J \in \{h, s, u\}$ to work in, how much contraceptive effort $x \in [0, \overline{x}]$ to exert, whether to hire paid help $(q \in \{0,1\})$, and whether to have an abortion in the event of pregnancy $(I_A \in \{0,1\})$.

The dynamic programming problem is

$$V(n, w_s, w_u, g|z) = \max_{J,x,q,I_A} u(c,n,x) + \beta E\left[V\left(n', w_s', w_u', g'|z'\right)|n, w_s, w_u, g, z, J, x, I_A\right] \tag{1}$$

subject to the budget constraint

$$c = c\left(n', w_s', w_u', g', z, J\right) = w_h l^h + w_u l^u + w_s l^s + y$$

the time constraint,

$$l^h + l^u + l^s \le L(g,q) = T - g(1-\rho q)$$

and the laws of motion described above:

$$\begin{aligned}
n' &\in \{n, n+1\} \quad \Pr(n' = n+1) = \phi(x,\Psi) \\
w_j'/(w_j\Lambda) &= \gamma \in \left\{\gamma_L^j, \gamma_H^j\right\}, \gamma_H^j > \gamma_L^j \quad \Pr\left(\gamma = \gamma_H^j | g, J, x, q\right) = \pi^j\left(L(g,q), J\right) \\
y'/(\Lambda y) &\in \left\{\gamma_L^Y, \gamma_H^Y\right\}, \gamma_H^Y > \gamma_L^Y \quad \Pr\left(y'/(y\Lambda) = \gamma_H^Y\right) = \pi^Y \\
g' &= \Gamma(g,k) \\
& \Psi' = \Psi e^{-\psi} \\
& \Lambda' = \Lambda e^{-\lambda}
\end{aligned}$$

For women who would choose abortion if pregnant, the expectation is therefore given by

$$\begin{aligned}
& E\left[V\left(n', w_s', w_u', g'|z'\right)|n, w_s, w_u, g, z, J, x, I_A = 1\right] \\
= \; & V\left(n, w_s\left(1+\Lambda\gamma_H\right), w_u\left(1+\Lambda\gamma_H\right), \Gamma\left(g, 0\right)|z'\right)\pi^u\left(L\left(g,q\right), J\right)\pi^s\left(L\left(g,q\right), J\right) \\
& + V\left(n, w_s\left(1+\Lambda\gamma_L^s\right), w_u\left(1+\Lambda\gamma_{^uH}\right), \Gamma\left(g, 0\right)|z'\right)\pi^u\left(L\left(g,q\right), J\right)\left[1-\pi^s\left(L\left(g,q\right), J\right)\right] \\
& + V\left(n, w_s\left(1+\Lambda\gamma_L^s\right), w_u\left(1+\Lambda\gamma_L^u\right), \Gamma\left(g, 0\right)|z'\right)\left[1-\pi^u\left(L\left(g,q\right), J\right)\right]\left[1-\pi^s\left(L\left(g,q\right), J\right)\right] \\
& + V\left(n, w_s\left(1+\Lambda\gamma_H^s\right), w_u\left(1+\Lambda\gamma_L^u\right), \Gamma\left(g, 0\right)|z'\right)\pi^s\left(L\left(g,q\right), J\right)\left[1-\pi^u\left(L\left(g,q\right), J\right)\right] \\
& - \phi\left(x; \Psi\right)\chi
\end{aligned}$$

For non-aborters, the expression includes in addition the value of life with an additional child, which in turn affects the time-cost through Γ:

$$\begin{aligned}
& E\left[V\left(n', w_s', w_u', g'|z'\right)|n, w_s, w_u, g, z, J, x, I_A = 0\right] \\
= \; & E\left[V\left(n', w_s', w_u', g'|z'\right)|n, w_s, w_u, g, z, J, x, I_A = 1\right] + \phi\left(x; \Psi\right)\chi \\
& + V\left(n+1, w_s\left(1+\Lambda\gamma_H\right), w_u\left(1+\Lambda\gamma_H\right), \Gamma\left(g, 1\right)|z'\right)\pi^u\left(L\left(g,q\right), J\right)\pi^s\left(L\left(g,q\right), J\right) \\
& + V\left(n+1, w_s\left(1+\Lambda\gamma_L^s\right), w_u\left(1+\Lambda\gamma_{^uH}\right), \Gamma\left(g, 1\right)|z'\right)\pi^u\left(L\left(g,q\right), J\right)\left[1-\pi^s\left(L\left(g,q\right), J\right)\right] \\
& + V\left(n+1, w_s\left(1+\Lambda\gamma_L^s\right), w_u\left(1+\Lambda\gamma_L^u\right), \Gamma\left(g, 1\right)|z'\right)\left[1-\pi^u\left(L\left(g,q\right), J\right)\right]\left[1-\pi^s\left(L\left(g,q\right), J\right)\right] \\
& + V\left(n+1, w_s\left(1+\Lambda\gamma_H^s\right), w_u\left(1+\Lambda\gamma_L^u\right), \Gamma\left(g, 1\right)|z'\right)\pi^s\left(L\left(g,q\right), J\right)\left[1-\pi^u\left(L\left(g,q\right), J\right)\right]
\end{aligned}$$

It is convenient to adopt the following notation for the effect on the continuation value of having another child:

$$\begin{aligned}
& \Delta^k V\left(n, w_s, w_u, g|z\right) \\
= \; & E\left[V\left(n+1, w_s', w_u', \Gamma\left(g, 1\right)|z'\right)|n, w_s, w_u, g, z, J, x, I_A = 0\right] \\
& - E\left[V\left(n, w_s', w_u', \Gamma\left(g, 0\right)|z'\right)|n, w_s, w_u, g, z, J, x, I_A = 0\right]
\end{aligned}$$

Similarly, we can let the effect on the continuation value of having the high realization of skilled wage growth as:

$$\begin{aligned} & \Delta^s V\left(n, w_s, w_u, g|z\right) \\ = \; & E\left[V\left(n, w_s\left(1+\Lambda\gamma_H\right), w_u', \Gamma\left(g,1\right)|z'\right)|n, w_s, w_u, g, z, J, x, I_A\right] \\ & -E\left[V\left(n, w_s\left(1+\Lambda\gamma_L\right), w_u', \Gamma\left(g,0\right)|z'\right)|n, w_s, w_u, g, z, J, x, I_A\right] \end{aligned}$$

3.3 Optimality Conditions

Women have one continuous decision to make: contraceptive effort. Interior solutions satisfy:

$$u_x = \beta \frac{\partial \phi\left(x, \Psi\right)}{\partial x} \Delta^k V\left(n, w_s, w_u, g|z\right)$$

To understand occupational choice, it is convenient to consider the case where there is no market substitute for the time cost ($\rho = 0$), and so L is fixed by the current value of g. We simplify further by assuming that π^u is independent of j so that only the skilled wage w_s depends on sectoral choice. Then for any given level of pregnancy risk, women who are indifferent between occupations i and j satisfy the following condition:

$$\begin{aligned} & u\left(w_i L + y, n, x\right) - u\left(w_j L + y, n, x\right) \\ = \; & \beta\left[\pi_j^s\left(L, u\right) - \pi_i^s\left(L, u\right)\right] \Delta^s V\left(n, w_s, w_u, g|z\right) \end{aligned}$$

[To Be Completed]

3.4 Computation

The computation is in the spirit of the standard calibration procedure based on Kydland and Prescott (1982). For a given vector of model parameters Θ, the model is solved by iteration on a polynomial approximation to the value function $V\left(n, w_s, w_u, g|z\right)$ on a quasi-random sample over the state space.The solution method relies on an approximation to the value function by a polynomial in the logs of the state with coefficients Φ :

$$V\left(n, w_s, w_u, g|z\right) \approx P_W\left(n+\kappa, w_s, w_u, g, z|\Phi\right)$$

The parameter $\kappa > 0$ in this expression is used to allow for log representation of n; all other variables are bounded above zero. At the start of the algorithm, the coefficients θ of the approximation are set to θ_0.I then solve the dynamic problem (1), with the continuation value set equal to $P_W\left(\cdot|\theta_0\right)$. This yields a value function V_0.I then update θ to θ_1, which I obtain by least-squares regression of V_0 on the state variables. The procedure repeats, and as Φ is updated eventually $P_W\left(n+\kappa, w_s, w_u, g, z|\Phi\right)$ converges, generally monotonically, to a parameter set $\Phi^*\left(\Theta\right)$.

These parameters $\Phi^*\left(\Theta\right)$ are then used to compute life-cycle profiles for a simulated sample of women whose initial conditions are set according to the procedure described in the calibration section below. These profiles result in a set of statistics $S^M\left(\Theta\right)$ that can be compared to empirical analogues $S^D\left(\Theta\right)$. This procedure is repeated for each new Θ as the algorithm searches for a parameter vector Θ to minimize the distance $\varrho\left(S^M\left(\Theta\right), S^D\left(\Theta\right)\right)$.

3.5 Functional Forms

Before the model can be parameterized it necessary to specify functional forms for the preferences, the contraception technology and the transition functions. The preferences are assumed separable and the subfunctions for consumption and kids take the standard CES form, except that the argument for kids involves a constant $\kappa > 0$. Utility declines linearly with effort x. Since x is unobservable, linearity is without loss of generality.

$$u\left(c, n, x\right) = c^\sigma + \delta_0\left(n+\kappa\right)^{\delta_1} - \eta x$$

In the absence of new kids, the time cost decays geometrically at rate θ_1

$$\Gamma\left(g_t, k_t\right) = g_t^{-\theta_1} + \theta_0 k_t\left(T - g_t^{-\theta_1}\right)$$

The wage structure of the skilled and unskilled occupations is assumed to be the same for men and for women. The stochastic process for wages is chosen so as to match men's age-wage profiles in the CPS, with persistence parameters taken from the empirical labor literature. The probability of a high realization of the wage in sector $j \in \{u, s\}$ is assumed to be:

$$\pi^j(L, J) = \frac{\alpha_{0j} + L(\alpha_{1j} + \alpha_{2j} I_j(J))}{\alpha_{0j} + (\alpha_{1j} + \alpha_{2j})}$$

$I_j(J) = 1$ if the woman works in sector $J = j$.where the coefficients $\alpha_0 + (\alpha_1 + \alpha_2)$ are all positive and sum to one. Notice that the transition probability is independent of current fertility k, which only affects future working time. If α_{2j} is large relative to α_{1j}, then returns to experience are sector-specific, while if α_{0j} is large relative to the other coefficients, then returns to experience are unimportant. For non-labor income, the probability of a high realization is a parameter π^y, equal for everyone.

The process for pregnancy risk for each contraceptive method j is given by:

$$\phi_j(x, \Psi) = \begin{cases} \Psi \times (a_j x^2 + b_j x + c) & x \leq \overline{x}_j \\ \Psi \underline{\phi}_j & x > \overline{x}_j \end{cases}$$

The parameters are set so that at $x = 0$ a user with $\Psi = 1$ would have pregnancy risk $\overline{\phi}_j$ and at $x = x$, the derivative is zero and the pregnancy risk with $\Psi = 1$ would be the theoretical minimum $\underline{\phi}_j$, as reported in Trussell and Kost (1987). This implies the following mapping from data to parameters, leaving one degree of freedom:

$$a_j = \frac{b_j^2}{4}\left(\overline{\phi}_j - \underline{\phi}_j\right)^{-1}, c_j = \underline{\phi}_j$$

The quadratic form is convenient because with the disutility of contraception linear in effort, with parameter η_j, then an interior solution implies effort x is given by:

$$x^* = \frac{-1}{2a_j}\left(\frac{\eta_j}{\beta f_i \Delta^N V_{T-1}(w, n, y, g, 0)} + b_j\right)$$

Since the gain from fertility $\Delta^N V_{T-1}$ is negative for people who use contraception, a large absolute value raises the absolute value of the first term in the brackets, causing effort to rise. To the extent that -$\Delta^N V_{T-1}$ tends to be larger for women in skilled occupations, then they will choose higher levels of effort, generating lower failure rates.

4 Empirical Strategy

The calibration strategy consists essentially of matching age-profiles for occupation share, wages and household income, in the March CPS, for occupational mobility from the PSID, and data on fertility, contraception and abortion by occupation from the 1995 National Survey of Family Growth(NSFG). The CPS and PSID statistics reflect averages over the period 1990-2001, while those of the NSFG over the period 1990-95. The benchmark parameters will be those that generate the best fit of these statistics with the corresponding outcomes of the model. In what follows, "skilled" refers to students and to workers in managerial/professional occupations, as defined in the 1950 census classification. All other workers are defined as "unskilled", and non-workers are referred to as "at home".

4.1 Occupational Calibration

The parameters of the wage process are fixed by calibrating a zero-fecundity version of the model to match age-profiles for men's occupation share, wages and household income in the CPS and occupational turnover in the PSID. These parameters are then held fixed while the fecundity-related parameters are calibrated to data on women's wages,household income and occupation in the CPS, and to occupational mobility from the PSID, again averaged over the same period.

The age profiles for men from the CPS are shown in Table 3a. The median skilled wage climbs from \$4.84 for to \$10.05 for 40-45 year olds, while for unskilled work, the median wage climbs much more modestly, from 4.11 to \$7.05 over the same age groups. In both cases growth is almost complete by age 35. Unskilled men also have less non-labor income, which tends to be spouse income: at age 25-29, the unskilled have about \$10,000 annually while the skilled have \$15,000. In both cases, income grows by \$5000 to age 40-45; over the entire 21-45 period however growth rates of non-labor income are roughly similar. The fraction not working hovers around 5% of the population, while the fraction skilled rises from 31% to 40% by age 40-45.

For women, shown in the next panel, the most striking differences are: a lack of apparent wage growth in the unskilled occupation, and non-labor income is twice as high as for men. The growth rate of the skilled wage is also much more modest for women, about 20% from age 25 to 45, compared to 50% for men, suggesting lower returns to years of experience for women could be important.

The data on occupational turnover is shown in Table 4. This was constructed from averages over the period 1990-2003 for the same age groups as for the CPS sample, and using a similar partition of occupations. The annual transition rates from skilled to not working are about 5% for men after age 29, about 9% before that. For women they decline steadily from 21% over age 25-29 to 11% for age 40-45. For men, the transition rate to unskilled work is about 15% after age 29, 22% before that; for women only slightly higher, declining from 20% to 16% . For unskilled men, the transition rate to skilled is about 9% per year and to not working about 8% per year. For women, the transition rates to not working are much higher, declining from 19% to 12%. Women also have a much lower transition rate from not working to unskilled jobs; for men this declines from 47% to 30% over the 25-45 age range, while for women the decline is from 25% to 18%. The differences in these patterns by sex, most notably the higher transition rate out of skilled work, and the lower transition rate out of not working are consistent with the hypothesis that differences in return to experience are due to women having more and longer career interruptions at every stage of the lifecycle, but particularly when young.

The calibration algorithm requires an initial distribution of the state variables. The data for wages hours and income are shown in Table 5,based on averages for people aged 23-25 over the 1990-2006 period. Since many people already have children by then, the statistics are reported by number of children the person has at home. For men, the number of children has little systematic effect on hours or wages, while for women, it is clear that median wages and hours are declining; skilled women without kids earn $5.48 hourly, compared $4.21 for those with 3 or more, while median hours decline from 40 to 32. A similar picture holds for unskilled, but the effect of kids on wages is about 50% smaller and the effect on hours about 50% greater. [10]

What we don't see in the data is the wage a person would have in the sector that he or she is not working in. For categories where people are doing market work, we're going to assume the average is a fraction ρ of the average observed wage; for nonworking categories, we'll set the averages the same as in the unskilled group.

The parameters selected by the calibration procedure are listed in Table 6, the targets and outcomes for male occupation and wages are listed in Table 7, and those for female occupation and fecundity are listed in Table 8.

5 Results

[To Be Completed]

6 Birth Control and Occupation in the 1960s

In this section we compare data from the 1965 National Fertility Survey to the results of the model when the parameters of the contraceptive technology have been reset to match the observed failure rates over the period 1960-62, when very few women were using the pill. Since the benchmark model is calibrated with a starting point of age 25, obviously at least two potentially important effect of the pill are omitted if we just change parameters: the effect on sex before marriage, and the effect on young

[10] In the model, the differences in the effect of kids on hours could be due to unskilled women having younger kids, or to skilled women relying on hired help to fulfill their home-time requirements.

married women. The first omitted effect is outside the scope of the current project, but the second effect could be partially accounted for by setting the initial number of children to match the 1960s distribution for ages 22-24, as we did for the 1990s.

[To Be Completed]

7 Conclusions

The hypothesis explored here is that occupational choice trends explain the trend in women's returns to experience and hence in LFP and the gender wage gap. As an example of a force that could set such a trends in motion, the paper explored the impact of changes in birth-control technology, namely the role of improved contraceptives and the liberalization of abortion.

[To Be Completed]

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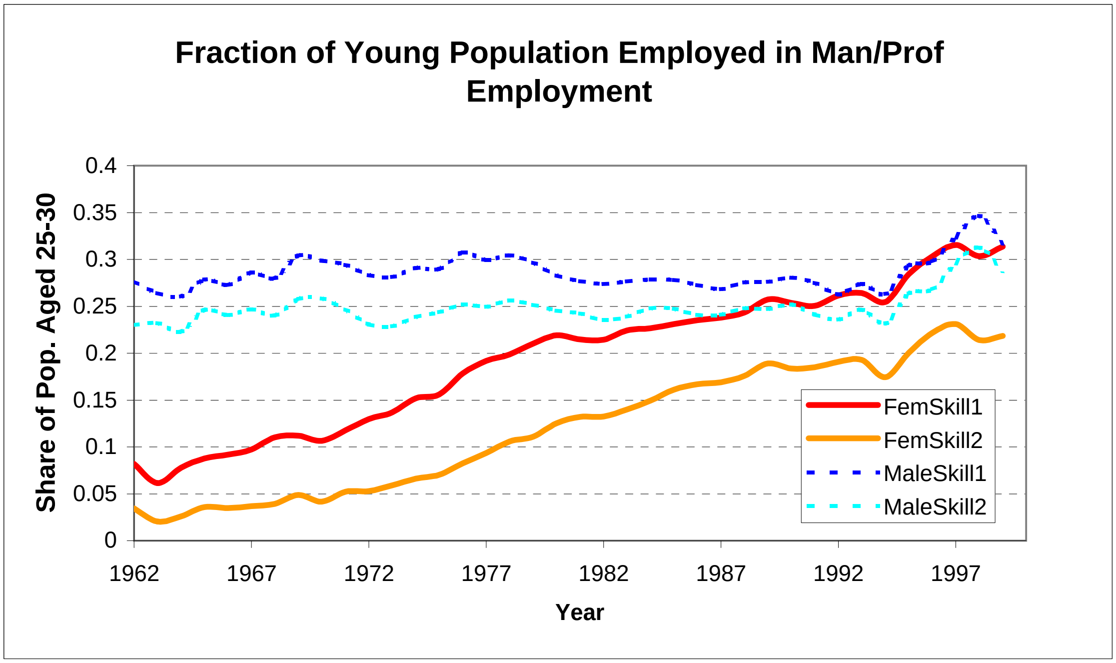

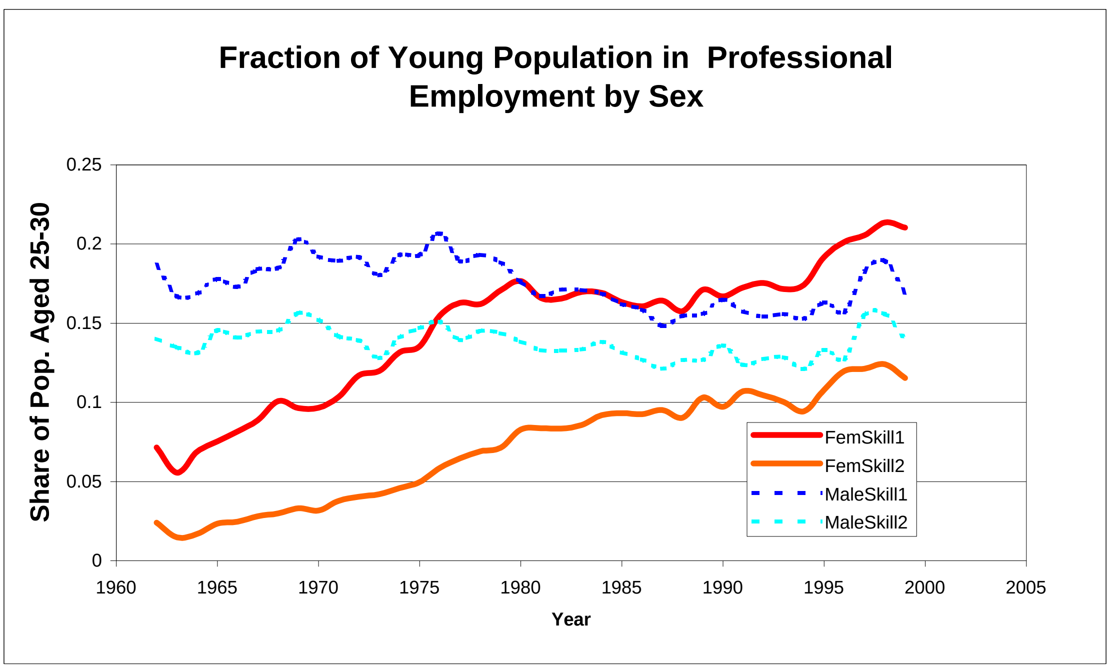

Fig 1: Occupational Trends in March CPS, 1962-2006

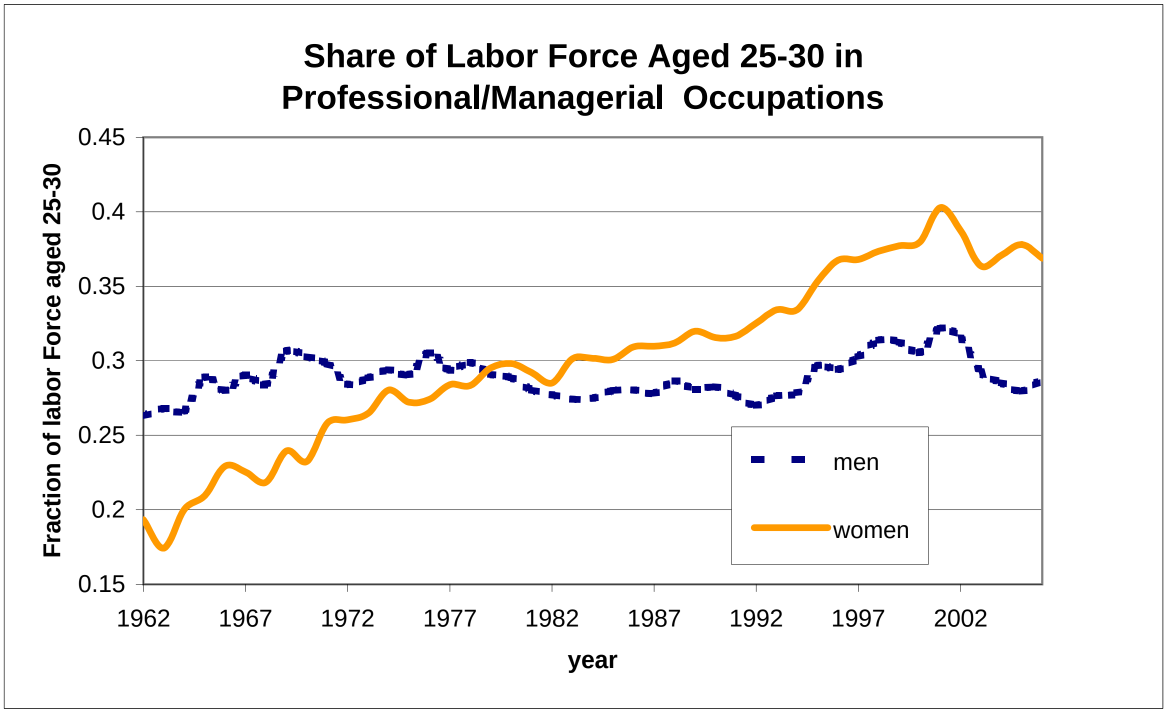

Fig 2: Occupational Trends for Workers in March CPS, 1962-2006

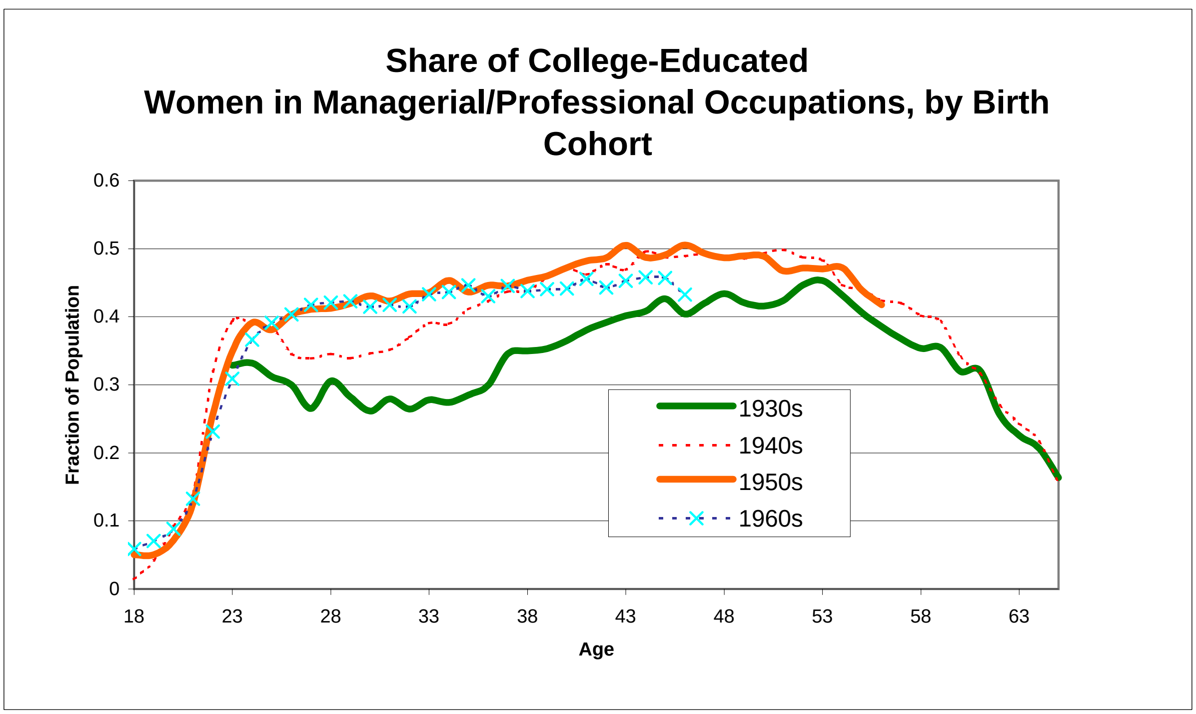

Fig 3: Occupational Trend for College Women in March CPS

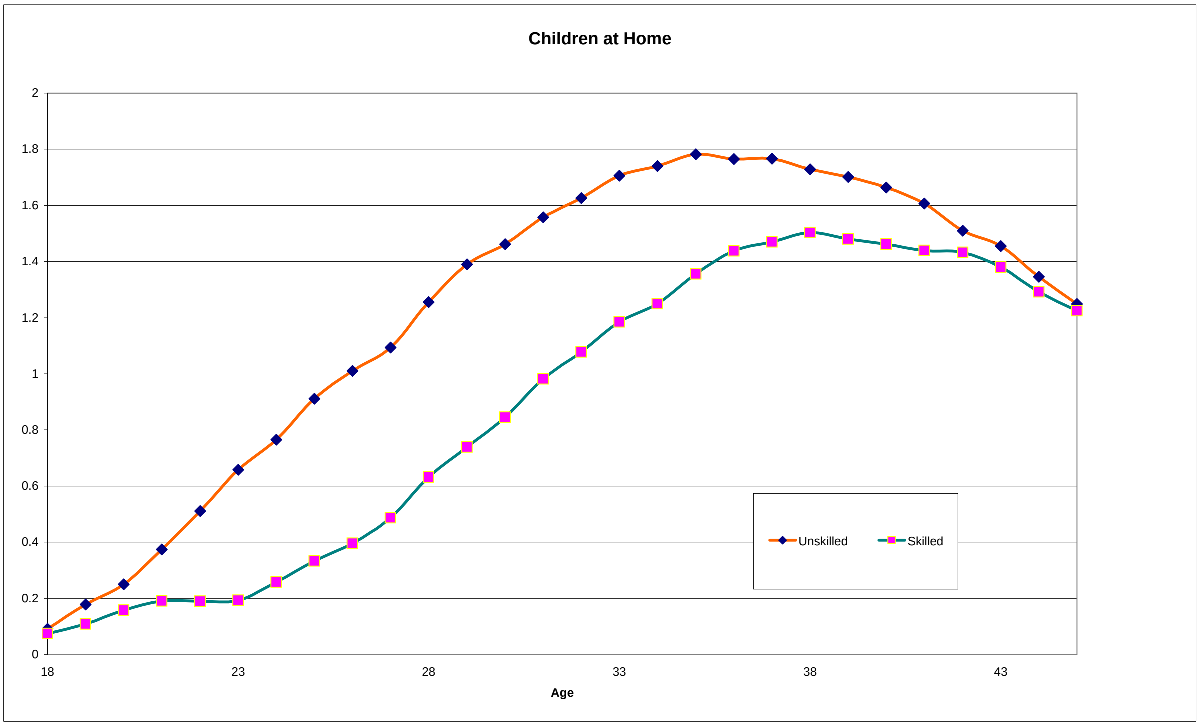

Figure 3 a: Children at home by age of mother, March CPS, 1990-2000

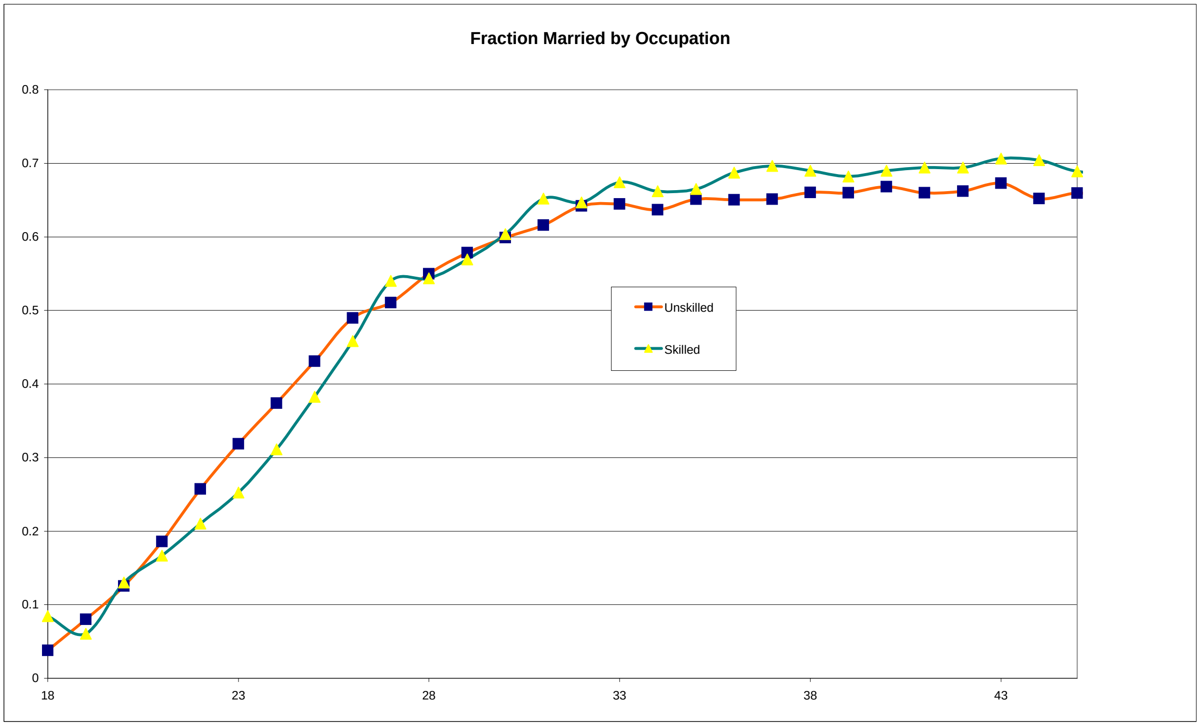

Figure 3 b: Fraction married by age of woman March CPS, 1990-2000

Table 1: Census Occupation and Motherhood

Year	Fraction in Man/Prof	No Kids	Mean Kids	Man./Prof Occupations	
				No Kids	Mean Kids
1950	0.037	0.225	1.553	0.59	0.64
1960	0.113	0.139	2.178	0.26	1.52
1970	0.178	0.181	1.922	0.36	1.19
1980	0.245	0.319	1.310	0.56	0.70
1990	0.298	0.352	1.236	0.56	0.72
2000	0.368	0.375	1.208	0.57	0.70

**Women aged 25-30 from Census IPUMS*

Table 2: Contraception usage and Failure Rates by age and occupation

Age	Occupation at Interview Date	Other		Pill		Total
		Share	Failrate	Share	Failrate	Failrate
21-24	Home	0.57	8.78E-03	0.43	8.14E-03	8.50E-03
	Unskilled	0.44	1.30E-02	0.56	6.47E-03	9.37E-03
	Man./Prof	0.35	8.31E-03	0.65	1.30E-03	3.73E-03
25-29	Home	0.70	8.42E-03	0.30	9.61E-03	8.77E-03
	Unskilled	0.54	8.42E-03	0.46	3.70E-03	6.25E-03
	Man./Prof	0.44	7.24E-03	0.56	1.09E-03	3.77E-03
30-34	Home	0.81	4.08E-03	0.19	5.09E-03	4.28E-03
	Unskilled	0.73	4.17E-03	0.27	3.59E-03	4.01E-03
	Man./Prof	0.66	6.14E-03	0.34	1.77E-03	4.65E-03
35-39	Home	0.89	1.44E-03	0.11	1.89E-03	1.49E-03
	Unskilled	0.88	1.96E-03	0.12	2.61E-03	2.03E-03
	Man./Prof	0.84	1.75E-03	0.16	2.73E-03	1.90E-03
40-45	Home	0.97	0.00E+00	0.03	0.00E+00	0.00E+00
	Unskilled	0.96	5.48E-04	0.04	5.16E-03	7.43E-04
	Man./Prof	0.93	4.07E-04	0.07	0.00E+00	3.79E-04

Based on computations from NSFG 1995

Table3(a) Calibration Targets from March CPS 1994-2005: Men

Age	Medians					Percent of Population by Occupation		
	Skilled		UnSkilled		At Home			
	Wage	Other Income	Wage	Other Income	Other Income	Not Working	Skilled	Unskilled
21-24	$4.84	$10,000	$4.11	$7,848	$9,666	8.45	20.50	71.05
25-29	$6.76	$15,024	$5.34	$10,238	$11,288	4.87	31.40	63.74
30-34	$8.23	$15,602	$6.06	$10,600	$11,122	4.44	35.93	59.63
35-39	$9.61	$16,000	$6.62	$12,000	$12,010	4.80	38.27	56.92
40-45	$10.05	$19,846	$7.05	$15,080	$14,909	6.09	40.43	53.48

Table3(b): Calibration Targets from March CPS 1994-2005: Women

Age	Medians					Percent of Population by Occupation		
	Skilled		UnSkilled		At Home			
	Wage	Other Income	Wage	Other Income	Other Income	Not Working	Skilled	Unskilled
21-24	$4.56	$17,000	$3.69	$15,000	$13,760	29.02	18.83	52.15
25-29	$6.36	$25,089	$4.43	$19,464	$20,048	26.16	28.45	45.39
30-34	$7.14	$30,000	$4.56	$22,174	$27,752	26.00	29.16	44.84
35-39	$7.34	$34,032	$4.68	$25,000	$33,856	24.04	31.14	44.82
40-45	$7.62	$36,771	$4.71	$28,374	$33,870	21.48	34.27	44.25

Table 4: Initial Conditions*

Sex	Occupation	Number of Kids	Median Income	Hourly Wage	Median Hours Worked	Population Share
Male	non-worker	0	$15,862	.	.	11.0%
		1	$7,565	.	.	0.6%
		2	$5,583	.	.	0.4%
		3 or more	$5,804	.	.	0.2%
	unskilled	0	$13,632	$4.25	38.46	51.8%
		1	$5,471	$4.78	40.00	8.4%
		2	$3,675	$4.61	40.00	4.7%
		3 or more	$2,702	$4.44	40.00	1.7%
	Skilled	0	$14,375	$5.68	40.00	18.2%
		1	$7,298	$5.18	40.00	1.8%
		2	$5,426	$5.78	40.00	0.8%
		3 or more	$2,953	$5.81	40.00	0.3%
Female	non-worker	0	$14,581	.	.	10.6%
		1	$11,862	.	.	6.4%
		2	$10,951	.	.	5.7%
		3 or more	$8,215	.	.	3.2%
	unskilled	0	$14,061	$4.13	35.00	29.5%
		1	$10,290	$3.89	30.00	11.5%
		2	$8,691	$3.76	21.00	6.6%
		3 or more	$6,162	$3.39	12.00	2.5%
	Skilled	0	$15,343	$5.48	40.00	18.7%
		1	$12,376	$5.06	35.00	3.3%
		2	$11,358	$4.31	30.77	1.6%
		3 or more	$8,509	$4.21	32.00	0.4%

**CPS Sample Aged 23-25 in the 1990-2006 period*

Table 5: Occupation Transitions by sex from PSID 1990-2003

Sex	Age	N	Skill to Not Working	Skill to Unskilled Work	Unskilled to Not Working	Unskilled to Skilled Work	Not Working to Unskilled	Not Working to Skilled
Men	21 to 24	1544	0.18	0.35	0.10	0.09	0.44	0.09
	25 to 29	4631	0.09	0.22	0.09	0.11	0.47	0.11
	30 to 34	6622	0.05	0.17	0.08	0.09	0.41	0.10
	35 to 39	7741	0.05	0.15	0.08	0.09	0.34	0.11
	40 to 45	8440	0.04	0.15	0.07	0.10	0.30	0.10
	46 to 60	10481	0.06	0.14	0.08	0.09	0.16	0.06
Women	21 to 24	2527	0.32	0.30	0.25	0.13	0.28	0.08
	25 to 29	6061	0.21	0.20	0.19	0.13	0.25	0.09
	30 to 34	8319	0.17	0.18	0.16	0.12	0.21	0.08
	35 to 39	9211	0.16	0.19	0.14	0.11	0.22	0.09
	40 to 45	9459	0.11	0.16	0.12	0.13	0.18	0.09
	46 to 60	11414	0.10	0.15	0.13	0.10	0.11	0.04

Table 6: Parameters for calibrated benchmark model

Wage Process and Male Occupation		Fecundity and Female Occupation	
Value	Role	Value	Role
0.0653	long-run learnability	0.5	%alpha: utility weight for kids
-0.0919	Log Growth rate of skilled wage	0.3	fraction of time cost that can be substituted
1.3081	long-run learnability	3	%home wage (value of leisure)
0.5484	Consumption-utility elasticity	0.85	%theta0 time cost of new kid
2.1482	Effect of hours on wage-raise probability	7	%Kid utility parameter
0.8412	Effect of skilled hours on wage-raise probability	1	%decay rate of time cost
1.2615	High skilled-wage growth rate	0	%cost of pill
0.147	SD of unskilled wage shock	1	%Params(47) AbortionCost mean
0.2264	SD of unskilled wage shock	0.75	%minimum hours in skilled occ
1.1858	decay rate of learnability	0.05	%Params(59) effort disutility
0.7958	SD of unskilled wage shock	0.4	%scalewage
0.4972	Layoff coefficeint	0.505	%initial fecundity
0.3927	initial wage dispersion	0.0131	%long-run fecundity
0.5784	learnability standard deviation	0.15	%Fecundity Decay Rate

Table 7: Occupation Targets and Results

Age	Description	Men		Women	
		Targets	Result	Targets	Result
25-29	Unskilled wage	5.34	5.57	4.43	4.65
	Unskilled other income	5.12	5.33	12.54	10.65
	Median Wage Ratio	1.27	1.25	1.44	1.12
	Median Income Ratio	1.47	1.44	1.29	1.60
	Fraction unskilled	0.64	0.60	0.45	0.37
	Fraction skilled	0.31	0.33	0.28	0.30
	Prob. UnSkill to Skill	0.11	0.13	0.13	0.06
	Prob. Skill to NoWork	0.09	0.07	0.21	0.39
	Prob. Skill to UnSkill	0.22	0.23	0.20	0.10
30-34	Unskilled wage	6.06	6.07	4.56	4.59
	Median Wage Ratio	1.36	1.39	1.57	1.36
	Fraction unskilled	0.60	0.60	0.45	0.45
	Fraction skilled	0.36	0.35	0.29	0.32
	Prob. UnSkill to Skill	0.10	0.11	0.12	0.07
	Prob. Skill to NoWork	0.05	0.05	0.17	0.25
	Prob. Skill to UnSkill	0.17	0.19	0.35	0.08
35-39	Unskilled wage	6.62	6.29	4.68	4.49
	Median Wage Ratio	1.45	1.47	1.57	1.53
	Fraction unskilled	0.57	0.59	0.45	0.46
	Fraction skilled	0.38	0.36	0.31	0.35
	Prob. UnSkill to Skill	0.10	0.09	0.11	0.06
	Prob. Skill to NoWork	0.04	0.05	0.16	0.19
	Prob. Skill to UnSkill	0.15	0.14	0.16	0.06
40-45	Unskilled wage	7.05	6.61	4.71	4.51
	Median Wage Ratio	1.43	1.54	1.62	1.65
	Fraction unskilled	0.53	0.58	0.45	0.45
	Fraction skilled	0.40	0.37	0.31	0.38
	Prob. UnSkill to Skill	0.10	0.09	0.10	0.06
	Prob. Skill to NoWork	0.04	0.04	0.10	0.17
	Prob. Skill to UnSkill	0.14	0.13	0.15	0.06

Table 8: Fecundity Targets and Results

Age	Description	Women	
		Targets	Result
25-29	Mean Parity skilled	0.45	0.71
	Mean Parity unskilled	1.00	1.23
	Fraction contracepting skilled	0.61	0.64
	Fraction contracepting unskilled	0.54	0.36
	Fail rate contracepting skilled	0.01	0.02
	Fail rate contracepting unskilled	0.04	0.05
	Abortions/Pregnancies	0.16	0.07
30-34	Mean Parity skilled	1.06	1.22
	Mean Parity unskilled	1.55	2.34
	Fraction contracepting skilled	0.66	0.83
	Fraction contracepting unskilled	0.62	0.45
	Fail rate contracepting skilled	0.02	0.02
	Fail rate contracepting unskilled	0.05	0.04
	Abortions/Pregnancies	0.13	0.10
35-39	Mean Parity skilled	1.44	1.48
	Mean Parity unskilled	1.82	2.86
	Fraction contracepting skilled	0.69	0.76
	Fraction contracepting unskilled	0.66	0.48
	Fail rate contracepting skilled	0.03	0.02
	Fail rate contracepting unskilled	0.03	0.02
	Abortions/Pregnancies	0.15	0.13
40-45	mean Parity skilled	1.60	1.65
	Mean Parity Unskilled	2.29	3.17