# Changes in Women's Labor Force Participation: The E¤ect of Changing Returns to Experience¤

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Abstract

Over the past two decades married women's labor force participation has shown a considerable increase in the US. In particular, both the cross sectional and the life cycle behavior of married women's hours worked has undergone a substantial change. I show that a key factor underlying this trend is the change in behavior for married women with children. In particular, while in the past married women of childbearing age used to specialize in childrearing and homeproduction activities at the expense of engaging in market work, they now do not curb their labor participation.

What gives rise to this change in behavior? In this paper I focus on relative changes in returns to experience as an explanation. In particular, I quantitatively assess the contribution of changes in the return to experience to the change in married women's life-cycle pro…les of hours worked. I build a life-cycle model with human capital accumulation and home production in which the basic unit of analysis are married couples with children, and calibrate it using data from the 1970s and 1990s. I show that changes in returns to experience can account for a large part of observed changes. I also demonstrate that decreases in the gender wage gap cannot account for much of the change in the shape of life cycle pro…les for women.

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# 1 Introduction

An important trend in the American society in the last decades has been a considerable increase in married women's labor force participation. In particular, the disaggregation of the data by age shows that both the cross sectional and the life cycle pro…les of married women's hours worked have changed. Although in the seventies the pro…le had the typical "two-peaked" shape, it changed in the nineties to a "one-peak" shape, which is characteristic of men and single women life cycle behavior. This fact suggest that a key factor underlying this trend is the change in behavior for married women with children. In particular, while in the past married women of childbearing age used to specialize in childrearing and homeproduction activities at the expense of engaging in market work, they now do not curb their labor participation.

This paper documents these facts and focuses on relative changes in returns to experience as an explanation. Returns to experience have been rising within education groups both for men and women since the seventies. Prior studies (Blau & Kahn (1997), O'Neill & Polachek (1993)) have shown that women's increased actual experience and the relative increase in the return to experience can explain one third to a half of the decline in the gender wage di¤erential. Moreover, these studies provide evidence that returns to experience increased relatively more for women than for men over the past decades.

The goal of this work is to provide further evidence to this …ndings and quantitatively assess the contribution of changes in the return to experience to the change in married women's life-cycle pro…les of hours worked. For this purpose, I build a life-cycle model with human capital accumulation and home production in which the basic unit of analysis are married couples with children. Parents allocate their time between market, home and leisure activities. Childcare is produced through a combination of parental time and market goods and services. Human capital is accumulated in the form of learning-by-doing. As a consequence, wage pro…les are determined endogenously. The law of motion for human capital is assumed to be identical for agents of di¤erent gender[1].

In the analysis I will focus on how relative changes in the return to experience a¤ect life cycle pro…les of earnings and hours worked. The basic strategy is to calibrate the model using data from the seventies, and then ask how the model's predictions change when we allow for changes in the return to experience and the gender wage gap to their nineties values. The simulation results show that changes in returns to experience can account for a large part of observed changes. Moreover, I also show that decreases in the gender wage gap cannot account for much of the change in the shape of women's life cycle pro…les.

[1] Heckman, Lochner and Taber (1997) estimate a human capital production function with on-the-job training. They do not …nd evidence that the shape of the production function di¤ers by gender

Section 2 documents the facts. In Section 3 we provide evidence of the relative increase in returns to experience for women. We present the life cycle model in Section 4. Section 5 provides a discussion of the functional forms and the parameters used in the simulations. The results obtained for two sets of experiments are described in Section 6. Section 7 presents the general equilibrium version of the model and discusses the results obtained. Finally, some concluding remarks are provided in Section 8.

# 2 Facts

Married women's labor force participation increased substantially over the past two decades[2]. The extent of the increase in labor force participation is even more striking when we disaggregate the data by age. Table 1 summarizes percentage changes in labor force participation by age, gender and marital status based on Census data for 1970 and 1990[3]. Labor force participation of married women increased by 96% and 70% for the age groups 25 to 35 and 35 to 45 respectively. These are the age groups where the fertility decisions are taken. The group of married mothers with children of preschool age is characterized by the biggest increase in participation rates. For married mothers with children of preschool age in the same two age groups the increase is even bigger, the average number of hours worked per person more than double. On the other hand, it is worth noticing that for given age groups, labor force participation rates for single women and married men remained constant or slightly decreased between the two decades. Big decreases in participation at older ages shows the e¤ects of early retirement. These facts still hold true when we further disaggregate the data and we study the labor force participation of married mothers by number of children of preschool age. Moreover, disaggregating by education we still observe this increase. In fact, the education group that experiences the largest increase is married women and married mothers with a high school degree.

Table 1: Percentage change in average hours worked per person by age 1970 vs. 1990.

| women | 25-34 | 35-44 | 45-54 | 55-64 | 65-74 |
|---|---|---|---|---|---|
| married, spouse present | 96 | 70 | 49 | 18 | 9 |
| married, spouse present kids<6 | 134 | 117 | 53 | 29 | 78 |
| single | 3 | 9 | –0.2 | -23 | -40 |
| men | | | | | |
| married, spouse present | -0.12 | -0.4 | -1 | -18 | -33 |

[2] For an extensive description of this phenomen see Hotz, Klerman and Willis (1997), Olsen (1994), Goldin (xxx).

[3] Census data are taken from McGrattan and Rogerson (1998).

In order to better understand the extent of this increase we consider the age pro…les of weekly hours worked per person from the Census data[4]. In the seventies the age pro…les for hours worked were convex (two-peaked) for married women. Labor attachment was weaker during the childbearing age range. This is the typical shape of the women's pro…le as pointed out in the seminal work on women's earning and labor force participation by Mincer (1962, 1974) and Mincer and Polachek (1974). As is shown in Figure 1 in the nineties the negative relationship seems to disappear. In fact, the 1990 pro…le has the concave (one-peaked) shape which is typical for men. Moreover, the average number of hours worked for married women increased for every age group.[5] The information channeled by the data on the average hours of work per person includes information on changes on both the extensive and the intensive margin. In particular, the same life cycle behavior for the two decades can be observed when we look at data on the number of hours worked per worker (the intensive margin) and on the labor force participation rates disaggregated by age (the extensive margin).

The comparison of hours pro…les for di¤erent demographic groups gives a clearer picture of the extent of this change in married women's behavior. Figure 2 (a and b) compare Census data in 1970 and 1990 for married men and women, married mothers and single women. Married women and married mothers shows a di¤erent behavior in terms of pro…les relative to men and single women. The latter groups displayed the characteristic single-peaked shape for their hours pro…les in 1970. In the nineties married women's pro…les have the same shape as men's and single women's pro…les.

Moreover, the average hours worked do also increase. Marital status seems to play a much smaller role in the labor decision. This provides evidence of what we can de…ne as convergence of married women's pro…les to married men's and single women pro…les in terms of their shape. At the same time, as it is shown in Figure 3, the average hours worked per person for married women and married mothers converged to average hours for men and single women since the 1950s (Census data).

The second type of convergence is also documented by comparing annual hours worked in the seventies to annual hours worked in the nineties. Table 2 summarizes these results for the age range 30 to 45. Annual hours worked increased 13% over the period. The increase is up to 34% for married women whereas for married men the increase was only by 9%. This show evidence of a shift in participation from married men to women in the past twenty years.

[4] The same behavior is shown when we look at average hours worked per worker. Moreover, as it is shown in McGrattan and Rogerson (1998) the same change in behavior can be observed when we look at life cycle pro…les.

[5] The same age pro…le are displayed for married mothers with children of preschool age.

| Table 2: Time allocation: annual hours by gender and marital status | | | | | | | |
|---|---|---|---|---|---|---|---|
| | total | men | wom. | mar. wom. | mar. men | single wom. | single men |
| $\frac{n_{1995}}{n_{1975}}$ | 1.13 | 1.12 | 1.24 | 1.34 | 1.09 | 1.11 | 1.15 |

Data Source: CPS, Annual Demographic Files 1976 and 1996. Entries assume annual hours worked in 1975 equal to one.

To summarize in the past twenty years two forms of convergence seems to have happened for what concerns married women's labor force participation. The shape of married women's pro…les is now similar to the shape of men and single women pro…le. That is, women do not curb their participation when they get married and over the fertile ages. Moreover, average hours worked for married women is also closer to the average hours worked by men.

A nice interpretation of these facts is that less women childbearing age in were participating to the labor market or that women in the same age range who were already working were curbing their hours of work on the market, during the seventies. This phenomenon is far less so in the nineties. In particular, we could think that in the nineties married women moved from home production activities to market activities.

# 3 Why? The proposed "culprit"

The possible explanations for this behavior that have been proposed in the literature deal with changes in observed characteristics such as women's schooling and work experience, changes in fertility, family dissolution, and a general decline of the gender wage gap. In this work we identify the culprit in the change in relative returns to experience. As documented in di¤erent studies (Katz and Murphy (1992)) over this two decades returns to experience increased for every gender/education/experience combination. The following papers provide detailed evidence about the relationship between earnings and work characteristics for men and women. The focus of all these works is to document which factor contributed more to the decline of the gender wage gap since the seventies. Blau & Kahn (1997), and O'Neill & Polachek (1993) show that both the increase in return to experience and the increase in actual experience for married women contributed to explain a large portion of the decreasing gender wage di¤erential (see also Regalia & Rios-Rull (1999)). In particular, it is shown that convergence in work related characteristics (schooling and experience) may account for one third to a half of the drop in the gender gap, whereas the relative increase in women's returns to experience explains part of the rest[6]. Blau & Kahn (1997) provide estimates of female and male earning equations for 1979 and 1988 using PSID data. Their results show that, although both female and male return to experience increased

[6] Among the factors that are mentioned as a possible cause of this behavior are for instance, de-unionization, occupational shift and the decrease in blue collar wages.

over the time period, women's return to full time experience increased more than men's. Figure 4 (a and b) provides evidence of these facts. We plot the marginal return to experience function[7] with coe¢cients set accordingly to Blau and Kahn's estimates for a regression where only "supply" variables referring to human capital are introduced as explanatory variables.

O'Neill and Polachek (1993) use PSID data for the period 1976 to 1987 to investigate the main factors which contributing to the one percent yearly decrease in gender wage gap experienced in the US since 1976[8]. By running a regression for actual experience interacted with a time trend they are able to disentangle the contribution of changes in actual experience from the contribution of changes in return to experience to the decrease in the gender wage gap. Their estimates show that the average annual change in return to experience over this time interval has been positive both for men and women. This means that returns increased for both groups. Furthermore, the increase was faster for women. In fact, the average change in return for women of all experience level was more than twice as much the average change for men. For younger workers (i.e. workers with less years of experience), the relative increase in women's return to experience is even bigger. Young women working on the market faced an average increase in returns to experience four times bigger than the increase for men. These …ndings are summarized in Table 3.

Table 3: Percentage increase in wages due to 20 years of experience

| | Actual Experience | |
|---|---|---|
| | All levels | 1-15 Years |
| Female | 1.8% | 1.6% |
| Male | 0.8% | 0.4% |

The entries in the table are based on estimation results that appears in O'Neill and Polachek (1993) Table 8

The entries in the table are obtained by manipulating the estimated average annual change in the return to actual years of experience that are presented by O'Neill and Polachek (1993) (Table xx in their paper). Given their estimates of the average annual change in the return to experience for the period 1976-1987, we compute the average

[7] Blau and Kahn regression is given by

$$\ln w_t = \beta_0 + \beta_1 \exp + \beta_2 \exp^2 + \bar{}X + \varepsilon$$

where X is a vector of explanatory variable which include race and education. They consider both full time and part time experience.

[8] To be noticed both studies use PSID data. This is due to the fact that starting in 1976 data on actual number of years of work experience were collected. In fact, due to women's segmented labor force participation, potential experience does not provide an accurate measure of the actual number of years worked.

percentage increase in the wage that would be experienced by a worker with twenty years of actual experience.

To summarize, the result obtained by Blau and Kahn (1997) and by O'Neill and Polachek (1993) provide evidence of the two following facts 1) the return to experience increased over the time period for both men and women; 2) this increase was relatively larger for women. We now move to a description of the model and to a discussion of the main …ndings that we obtain.

# 4 The Model

We build a life-cycle model with human capital accumulation and home production where the basic unit of analysis are married couples with children. Parents allocate their time between market, home and leisure activities and human capital is accumulated in the form of learning-by-doing[9]. As a consequence, wage pro…les are determined endogenously. Furthermore, childcare is produced through a combination of parental time and markets goods and services. Thus, the parents' time allocation decision is key to the analysis. Individuals have perfect foresight about the length of their lifetime. We assume price taking behavior. Individuals take as given the rental rate of human capital, that di¤ers by gender, and the real interest rate. The earning pro…les are endogenously determined in equilibrium. Past working decision a¤ect earnings at later ages. In what follows we describe the model in details and we de…ne the equilibrium of the model.

### 4.0.1 Demographics

The basic unit of analysis is a married couple. Fertility is exogenous. A couple is assumed to have two children (one male, one female) in the second period of its life. Individuals live for four periods, where we would consider one period in the model as corresponding to ten years. We do not explicitly model the …rst two (ten years) periods of agents' life when they are children living with their parents. They become adults in the third period of their life as a married couple. Every couple "retire" at the end of period four.

According to this framework the adult lifespan is forty years long. We would refer to adults as to individuals in the age range 20 to 60. Hence, the …rst adulthood period corresponds to the age range 20-29, the second period (i.e. the parenthood period) corresponds to age 30 to 39 and so forth. Kids leave their parents household at age 20 and become adult as a married couple. Agents "retire" when they are 60.

[9] Shaw (1989) and Imai (1999) estimate life-cycle models with human capital accumulation. In the parametrization of the model, we will rely on the estimates of the human capital production function from Imai's work.

### 4.0.2 Preferences

We assume that each couple has preferences over joint consumption, husband's and wife's leisure, and children's quality. Preferences are given by:

$$\sum_{t=1}^{\infty} \beta^{t-1} (U(c_t; \ell_{mt}; \ell_{ft}) + V(x_t))$$

where $c_t$ represents family consumption, $\ell_{mt}$ is husband's leisure, $\ell_{ft}$ is wife's leisure, $x_t$ represents child's "quality" and $\beta$ $(0 < \beta < 1)$ is a discount factor.

### 4.0.3 Childcare production:

Child quality is produced using a combination of motherly and fatherly time and services purchased on the market. As we will see, a key element is the degree of substitutability between parental time and market services. More formally we assume:

$$x_t = X_t(h_{ft}; h_{mt}; s_t) \qquad t = 2; 3 \tag{1}$$

where $h_{mt}$ is the fatherly time spent in childcare, $h_{ft}$ represents motherly time spent in childcare and $s_t$ is the input of market goods and services. As we mentioned above, the production of childcare takes place only during the second and third period of a married couple's life. We allow for the function $X$ to differ at time $t = 2$ and $t = 3$ since we assume that as the child grows older the amount of parental time needed in the production of the child's quality decreases.

### 4.0.4 Human Capital accumulation

We assume that agents accumulate human capital via a process of learning-by doing. In particular, human capital next period depends on the amount of human capital accumulated up to the current period and on the number of hours worked in the market in the current period. That is,

$$\mu_{gt+1} = G_g(\mu_{gt}; n_{gt}) \qquad \forall t;\ g \in \{m; f\} \tag{2}$$

where $n_{gt}$ is hours of market work at time t and $\mu_{gt}$ is the amount of human capital owned by an agent of gender g at time t: The human capital production function may differ for male and female. A married couple is indexed by its initial stock of human capital $(\mu_{m0}; \mu_{f0}) \in \mathbb{R}^2_+$; where $\mu_{g0}$; $g \in \{m; f\}$; is the initial stock of human capital of the partner of gender g.

### 4.0.5 Equilibrium

Given prices $\varkappa_g$ and r and the initial stock of human capital $(\mu_{m0}; \mu_{f0}) \in R^2_+$ a married couple solves the following decision problem:

$$\begin{aligned} & \max \sum_{t=1}^{N} \beta^{t-1} (U(c_t; \ell_{mt}; \ell_{ft}) + V(x_t)) \\ \text{s.t.:} \quad \mu_{gt+1} &= G(\mu_{gt}; n_{gt}) \quad \forall t; \text{ given } \mu_{g0} \; g \in \{f; m\} \\ a_{t+1} &= \sum_{g \in \{m;f\}} \mu_{gt} \varkappa_g n_{gt} + (1+R) a_t - (c_t + s_t) \quad \forall t; \; a_0 = a_{N+1} = 0 \\ n_{gt} + \ell_{gt} + h_{gt} &= 1 \quad g \in \{f; m\}; \; x_t = h_{gt} = s_t = 0 \text{ for } t \notin \{1; 2\} \end{aligned} \tag{3}$$

where $\varkappa_g$ is the efficiency wage of a worker of gender g whereas R is the rental rate of capital. We assume that married couples begin their life with no assets and that they consume everything they have during the last period of their life (no bequest).

# 5 Functional Forms and Parametrization

In this section we describe the functional form and the value of the parameters used in the simulation. The basic strategy is to calibrate the model using data from the seventies, and then ask how the model's prediction change when we allow for changes in the return to experience and the gender wage gap to their nineties values. In particular, for the baseline economy, we set the relative return to experience and the gender wage differential to their seventies value and we choose the remaining parameters following the standard evidence. When no empirical evidence is available we set parameter values in order to match hours and earnings profiles for both men and women in the seventies. In the second step returns to experience and the gender wage gap are set to their nineties values. We study the model's prediction in terms of earnings and hours worked age profiles in order to assess the contribution of those changes to the change in women's working behavior between the seventies and the nineties.

## 5.1 Functional Forms

### 5.1.1 Preferences

As is standard in the literature on labor supply, I assume that preferences are separable in consumption and leisure and also across time. In particular, I assume period utility functions of the form:

$$U(c_t; n_{mt}; n_{ft}; h_{mt}; h_{ft}) = \ln c_t - A\left[\frac{(n_{mt}+h_{mt})^{\alpha_m}}{\alpha_m} + \frac{(n_{ft}+h_{ft})^{\alpha_f}}{\alpha_f}\right] \quad (4)$$

$$V(x_{ct}) = \ln x_t \quad (5)$$

where $A > 0$ and $\alpha_g > 1; g \in \{f; m\}$. $\gamma_g = \frac{1}{\alpha_g - 1}$ is the intertemporal elasticity of substitution for hours worked. As mentioned above $x_t$ represents child's quality.

### 5.1.2 Childcare production

There seems to be no standard choices to rely on for this relationship. Since there is no evidence on the shape of this function, and the degree of substitutability between maternal time and market produced goods and services seems to play an important role, a natural choice seems to assume a constant elasticity of substitution childcare production function[10]. We consider the following functional form:

$$x_{ct} = \left[a_t h_{ft}^{\rho} + (1 - a_t) s_t^{\rho}\right]^{\frac{1}{\rho}} \quad (6)$$

where $\frac{1}{1-\rho}$ is the elasticity of substitution between maternal time and market goods and services (such as day care) in the production of childcare. We also assume different weights for maternal time and market goods and services which can be allowed to change over time as the children grow older.

### 5.1.3 Law of motion for human capital

I choose the functional form for human capital that was estimated in Imai (1999) for prime-age men. Obviously, this will facilitate the process of assigning parameter

[10] We can easily consider a more general childcare production function that include also fatherly time. Although we would need to assume some form of substitutability between motherly and fatherly time. In this case the function would generalize to:

$$x_t = \left[a_t \left[h_{ft}^{\gamma} + h_{mt}^{\gamma}\right]^{\frac{\rho}{\gamma}} + (1 - a_t) s_t^{\rho}\right]^{\frac{1}{\rho}}$$

where $\frac{1}{1-\gamma}$ is the elasticity of substitution between motherly and fatherly time. Assuming that only maternal time enters the production of childcare is consistent with the fact that genetically women must provide more of their time to their children. check lit.

values[11]. Speci…cally, I assume the following functional form:

$$\mu_{gt+1} = \mu_{gt}(1 - \pm_g) + \acute{}_{gt}\mu_{gt}n_{gt}^{\tilde{A}} \quad (7)$$

According to this speci…cation human capital is accumulated through learning-by-doing, that is the actual level of human capital is an increasing function of the level of human capital and of the number of hours worked in the previous period[12]. Moreover, human capital depreciates at a constant rate $\pm_g$: Returns to experience are represented by the …rst derivative of this function, and are proportional to $\acute{}_{gt}\tilde{A}$: $\acute{}_{gt}$ is allowed to be a function of age.

## 5.2 Parametrization

### 5.2.1 Preferences

In the micro literature the estimates for the elasticity of substitution for men range between 0.1 and 0.45[13]. Although there is consensus about the fact that the female elasticity of substitution is bigger for women than for men there is a wide variety of estimates for the intertemporal elasticity of substitution for women[14]. We set the elasticity to be consistent with the set of estimates, obtained by conditioning on fertility, reported in Smith and Ward (1985). This seems to be a sensible range of values since fertility is exogenous in the model[15]. In the experiments that we describe in the next section we set $®_g = 3{:}22$ for both men and women (which is equivalent to $¾ = 0{:}45$). This assumption is made in order to have men and women as similar as possible in terms of parameters and functional forms characterizing their behavior. In our benchmark economy we will set $®_m = 3{:}5$ (which is equivalent to $¾_m = 0{:}4$) and $®_f = 3$ (which is equivalent to $¾_f = 0{:}5$). The disutility of labor parameter A is set such that the model produces a realistic level of labor supply. We set $A = 2{:}5$ so that prime age workers in typical simulations work 40% of their time. We also assume the discount rate $\bar{} = \frac{1}{1+R}$ where $R = (1 + r)^{10}$ is the compounded real interest rate.

[11] Shaw (1989) estimates a similar life cycle model. She considers the law of motion for human capital to be quadratic in both hours worked and human capital stock plus a cross product term. On the other hand, the choice of a Cobb-Douglas technology is standard in the labor supply literature (Ben-Porath, Heckman..) although usually human capital accumulation is modeled in the form of on-the-job training.

[12] Using NLSY data the author documents the existence of this signi…cant complentarity between current wages and current hours worked in terms of learning-by-doing.

[13] For men we refer to Altonjj (1986) and to Pencavel (1986).

[14] See Mroz (1987) and Killingsworth and Heckman (1986).

[15] Smith and Ward (1985) estimate the intertemporal elasticity of substitution both conditioning on fertility (i.e. by assuming the fertility rate to be constant) and not conditioning on fertility. In the latter case they do not exclude the indirect e¤ects on fertility of an increase in wages. They obtain a value of 0.43, which is in the male range, for the conditioned elasticity. Moreover, Smith (1977) obtains a value of 0.56 using a di¤erent set of data. Intertemporal elasticity is much larger (1.632) when they do not condition on fertility.

That is, we assume the rate of time preferences to be equal to the compounded real interest rate over the (10 years) time period. This is consistent with the data when we control for changes in family size over the life cycle[16].

### 5.2.2 Childcare production

To my knowledge there is no evidence about a correct range of values for the parameter representing the elasticity of substitution between maternal time and market produced goods and services. In the following we set ½ = 0:7: This value is chosen in order to match the hours and earning age pro…les for both men and women in the seventies. Hotz and Miller (1988) provide evidence about the two following facts. The childcare intensity in mother's time decline as the children ages, $a_t = \pm^{t-1}a$; whereas the childcare intensity in market services, $b_t$, is constant over time[17]. In the model we incorporate their …ndings by assuming $a_1 = 0:55$ and $a_2 = 0:5$: On the other hand, the parameter representing the weight given to market services is set equal to 0:5 for both periods. That is, as the children grow older a relatively bigger amount of market goods and services (i.e. college tuition and fees, etc.) are needed relatively to parental time.

### 5.2.3 Law of motion for human capital

In the simulations we will assume that men and women are characterized by the same law of motion for human capital. As in Imai (1999) the function $´_{gt}$ includes a pure age e¤ect. This means that as an individual ages, proportionally less human capital can be accumulated. The following function is considered in Imai's work:

$$´_{gt} = ´_{g0} - (t - 20)´_1$$

where t=20, 21, 22.... represents age, and where NLSY yearly data from 1979 to 1993[18]are used to structurally estimate a life-cycle model with human capital accumulation of a form very similar to the one speci…ed in this work. Speci…cally, I will use the following values for the parameters of the human capital production function:

[16] As in Attanasio (1999) and Attanasio and Browning (1992).

[17] The assumption that ± = 0 cannot be rejected. ± is signi…cantly di¤erent from 1.

[18] The data sample include individuals 20 to 35 years of age. Imai restricts his attention to interior solutions. In fact, only 10% of the individuals in his sample worked zero hours.

| Table 4: Estimates for $\mu_{gt}(1-\pm) + \left[\acute{}_{g0} - (t-20)\acute{}_1\right]\mu_{gt}n_{gt}^{A}$ | |
|---|---|
| $(1-\pm)$ | 0.3491 |
| $\acute{}_{m0}$ | 0.1389 |
| $\acute{}_1$ | 0.0018 |
| Ã | 0.2323 |

The entries in the table are taken from Imai (1999) Table 4. We consider the estimates for high school graduates.

Since the estimates are obtained using yearly data, I rescale them to their 10 years period equivalent. Given that for each (10 years) period the number of hours worked is constant, this is simply done by iterating the yearly law of motion over the ten years period. As previously mentioned the model is estimated for prime-age men in Imai (1999). Therefore, we need to make assumptions about women's behavior. In particular, we restrict the parameters to be equal for men and women except for $\acute{}_{g0}$: In our …rst experiment we will set $\acute{}_{f0}$ for women to be 0.13 in the seventies. This corresponds to a 7% male-female di¤erential in returns to experience. In the nineties female returns to experience are set to be equal to male returns.

# 6 Results

In this section we describe the simulation results obtained for two particular experiments. We discuss the performance of the model by comparing the age pro…les for hours worked and hourly wage predicted by the model with actual age pro…les in 1975 and 1995. Figure 5 show the actual age pro…les for weekly average hours worked and hourly wages for married men and women[19]. We can notice the same patterns we discussed in Section2. In particular, for married women the cross sectional hours age pro…le is U-shaped in the seventies, whereas it displays the typical concave shape in the nineties. Moreover, women are characterized by a ‡at age earning pro…le in the 1975 which again becomes concave in the 1995. Married women in 1995 exhibit a cross-sectional behavior that is similar to men's typical behavior. In what follows we compare the actual pro…les to the ones predicted by the model in order to assess its performance.

We use the set of preferences and technology parameters described in the previous section for both experiments. Moreover, we assume that married couple are endowed with one unit of human capital and no assets at the beginning of their life. In the simulation we set the real interest rate to 4% annually. The compounded interest over the ten years period is therefore equal to 1.48. We assume the discount rate $\bar{} = \frac{1}{1+R}$ where $R = (1+r)^{10}$ is the compounded real interest rate. For what concerns the

[19] The …gure is based on CPS, annual demographic …le data for 1976 and 1996.

rental rates for human capital we choose parameters values such as the femal to male ratio equal the gender wage di¤erential in the 70s. We set this number to be 0.669 as in O'Neill (1985). This number represents the gender wage gap for white workers adjusted for di¤erences in hours worked[20].

The values chosen for the parameters are summarized in Table 5.

Table 5: Model Parameters

| Preferences | | Rental Rates | | Childcare production | |
|---|---|---|---|---|---|
| $\beta_g$ | 3.22 | r | 4% (yearly) | $\frac{1}{2}$ | 0.7 |
| A | 2.5 | $\frac{\pi_f}{\pi_m}$ | 0.669 | a | 0.55, 0.45 |
| $\bar{}$ | 0.675 | $\pi_m$ | 5 | b | 0.5, 0.5 |

As described in the previous section, we parametrize the human capital production function as in Imai. Moreover, the male-female di¤erential in returns to experience is assumed to be 7% in the seventies. In the nineties female returns to experience are set to be equal to male returns. Table 6 summarizes the parameter chosen for the human capital production function.

| Table 6: Human capital production parameters | |
|---|---|
| $(1 - \pm)$ | 0.3491 |
| $\acute{}_1$ | 0.0018 |
| $\tilde{A}$ | 0.2323 |
| $\acute{}^{70s}_{m0} = \acute{}^{90s}_{m0}$ | 0.1389 |
| $\acute{}^{70s}_{f0}$ | 0.13 |
| $\acute{}^{90s}_{f0} = \acute{}_0$ | 0.1389 |

Figure 6 show the hours and earning pro…les obtained from the experiment. A comparison of Figure 5 and Figure 6 shows that the model can reproduce the drop in women's hours worked per person in the seventies although hours do not increase again as the children grow older. The increase in $\acute{}_{f0}$, all the other parameters being the same, produces a concave pro…le for married women's hours worked. Since we are assuming interior solutions, the pro…les can be interpreted as the average hours worked (or years worked) over the time period. Also, married women earning pro…les are much ‡atter in the seventies than in the nineties when, indeed, they are similar to men's pro…les. Married men's behavior does not change much between the seventies and the nineties as a consequence of the change in women's behavior (men's are otherwise the same). Their pro…les closely resemble those observed in the data. To be noticed, in the simulation we only set the parameters in the model to match the seventies pro…les as given by the data. Hence, the fact that a change in the return to

[20] The gender wage ratio is adjusted by multiplying unadjusted earning ratioby race and sex-speci…c ratios (male-to-female) of average hours worked per week by workers on full-time schedule (non-agricultural).

experience generates the nineties wage and hours pro…les for women is particularly interesting. These results are fully consistent with the structure of the model. In fact, in the model as women's return to experience becomes relatively higher, the opportunity cost of a segmented labor force participation is also higher. In fact, since human capital depreciates, curbing the hours worked on the market in favor of childrearing and home production activities will highly reduce women's current and future earnings. Moreover, we increase the female to male wage ratio to its nineties value. The change does only generate an increase in levels of participation, women work more hours on average, but it does not contribute to the change in the shape of the age pro…le.

In the second experiment we set the parameter $\acute{}_{g0}$ to match the male-female di¤erential in returns to experience as estimated by Blau and Kahn (1997) respectively for 1979 and 1989. According to their estimates the ratio $\frac{\acute{}_{m0}}{\acute{}_{f0}}$ is equal to 1.45 in 1979 and to 1.05 in 89. Hence, although men were characterized by returns to experience 45% larger than women in 1979, the di¤erential dropped to 5% in the late eighties. Table 7 summarizes the parameter values chosen for the human capital production function.

| Table 7: Human capital production parameters | |
|---|---|
| $(1 - \pm)$ | 0.95 |
| $\acute{}_1$ | 0.0017 |
| $\tilde{A}$ | 0.2 |
| $\acute{}_{m0}^{70s}$ | 0.0372 |
| $\acute{}_{f0}^{70s}$ | 0.025 |
| $\acute{}_{m0}^{90s}$ | 0.04 |
| $\acute{}_{f0}^{90s}$ | 0.038 |

Figure 7 show the hours and earning pro…les obtained from the experiment. Again, the comparison of the predicted pro…les with the actual ones is encouraging. In particular, in this case we improve upon the …rst experiment for what concerns married women's hours and earning pro…les. In fact, average hours worked increase as the children leave their parents' household (as observed in the data). Moreover, the pro…le for hours worked in the seventies is more similar to the one observed in the data.

Based on these simulation results we run a regression similar to the one run by Blau and Kahn[21] and we compare the marginal return to experience we obtain to the one they estimate in the data. Although this is not meant to be a de…nite assessment, the model prediction goes in the right direction. The model produces estimates for the

[21] In order to do this we set the yearly hours endowment to 5000 and we consider 2000 as the number of hours worked by a full time worker. Therefore, the following normalization $\frac{h5000}{2000}10$, where $h$ is the number of hours worked during the time period, provide information about the number of years (out of the 10 available) worked full time by the agents.

log wage regression that imply marginal return functions similar to the ones obtained by using Blau and Kahn's estimates.

Therefore, at least to a …rst approximation, we can conclude that the model and the explanation chosen are a good approximation of the reality. In particular, the shape of the seventies and the nineties pro…les can be reproduced by the model based only on the change in the return to experience.

# 7 The General Equilibrium version of the model

We now consider the general equilibrium version of this model. The OLG version of the model provides a plausibility check in terms of the equilibrium prices behavior. In fact, the general equilibrium e¤ect is not very big and equilibrium rental rates are not unrealistic for the parameter values chosen. In particular, we make the following assumptions. There is no bequest. Parents consume all their assets in the …nal period of their life. We assume no population growth. In every period the oldest couple "retire" and it is replaced by the oldest children that become adults. There is a Uniform distribution of agents for every age group that is time invariant. Moreover, the rental rate of human capital for men and women and the real interest rate are determined endogenously in equilibrium as the result of a …rm's maximizing behavior. We assume that labor of di¤erent ages is homogeneous. Aggregate labor is the sum of e¢ciency units of work. Male and female labor are heterogeneous.

In what follows we add the assumptions made about the production side to the life cycle model described in the previous section and we de…ne the equilibrium of the model. We will restrict our attention to the steady state equilibrium, i.e. we assume factor prices to be constant over time.

### 7.0.4 Technology

Output is produced by using e¢ciency units of female and male labor and capital as inputs. There is a constant return to scale production technology given by:

$$y = F(H_m; H_f; K)$$

where $H_m$ and $H_f$ represents aggregate e¢ciency units of labor for men and female. Each period the physical capital depreciates. We denote the rate of capital depreciation by $\pm_k$.

Once the technology is de…ned we can formulate the recursive version of the model and provide the equilibrium de…nition. In this economy the agents individual state variable is given by $z_t = (a_{t;}\mu_{mt}; \mu_{ft})$. Given that we set the value function in the terminal period equal to zero, the optimal decision rules $c(z_t); s(z_t); n_{gt}(z_t); h_{gt}(z_t)$ $g \; 2 \; ff; mg$ will solve the dynamic programming problem:

$$W_t(z) = \max\left(U(c_t; \grave{}_{mt}; \grave{}_{ft}) + V(x_t)\right) + \bar{W}_{t+1}(z')$$

subject to the period constraints.

We can now move to the description of the equilibrium for this economy. I focus on an equilibrium concept where factor prices, aggregate capital and aggregate labor are constant over time.

## 7.1 Equilibrium

A stationary equilibrium is a list of functions $\{c(z_t); s(z_t); n_{mt}(z_t); h_{mt}(z_t); n_{ft}(z_t); h_{ft}(z_t)\}$, $¼_m; ¼_f; r; K; N_m; N_f$ and initial condition $z = z_0$ such that:

1) optimization.

$c(z_t); s(z_t); n_{mt}(z_t); h_{mt}(z_t); n_{ft}(z_t); h_{ft}(z_t)$ are optimal decision rules;

2) competitive inputs markets.

$$¼_m = F_1(H_m; H_f; K)$$
$$¼_f = F_2(H_m; H_f; K)$$
$$r = F_3(H_m; H_f; K) - ±_k$$

3) market clearing

$$\sum_{t=0}^{N} {}^1{}_t \mu_g(z_t)\, n_g(z_t) = H_g \qquad g \in \{m; f\}$$
$$\sum_{t=0}^{N} {}^1{}_t a(z_t) = K$$
$$\sum_{t=0}^{N} {}^1{}_t \left(c(z_t) + s(z_t)\right) = F(H_m; H_f; K) - ±_k K$$

A brief discussion of the equilibrium follows. The …rst condition simply describes the optimal decision rules. Taking prices and initial condition as given, agents solve their decision problem. The second condition requires rental rates of capital and of labor to be equal to their marginal product. Market clearing conditions require that 1) the aggregate labor input in e¢ciency units equals the labor inputs summed over the population; 2) assets holdings are su¢cient to keep total capital constant over time; 3) aggregate consumption must be equal to total output minus the amount of capital that depreciates. Moreover, we are considering only interior solutions. The number of hours worked in each ten-years period can be interpreted as the average amount of time that is worked by a male or female individual (or alternatively, as the average number of years of work experience).

The functional forms chosen for the production function and its parametrization are discussed below. Obviously, the strategy followed here is the same as for the life-cycle model.

Output is produced according to the following Cobb-Douglas production function:

$$y = ©K^{°}(Á_m N_m + Á_f N_f)^{1 i °} \quad (8)$$

We assume complementaries between male and female labor. In the absence of evidence about this issue this speci…cation provide a reasonable starting point. We choose $Á_g$ such that $\frac{Á_f}{Á_m}$ equal the gender wage di¤erential in the 70s. We set this number to be 0.669 as in O'Neill (1985). This number represents the gender wage gap for white workers adjusted for di¤erences in hours worked[22]. Moreover, we set the labor share ° to 0:36 as it is typical in the Real Business Cycle literature. The depreciation rate is set to 10% yearly which is equivalent to a period depreciation $±_k$ = 2:59: The parameter © is a scale parameters and is set to 10:

We run simulation for the same set of parameters discussed in the previous section though, in this case, we will also consider a case where the period discount rate is set equal to 0:6. This value is equivalent to a yearly discount rate that is bigger than one or to a negative rate of time preferences[23]. Although a negative value may seem surprising it is consistent with the results found in consumption studies. This may re‡ect the fact that preferences for consumption grow systematically over some periods of the life cycle (for instance as the family size increases). For the general equilibrium model, negative rates of time preferences give raise to more realistic steady state values for the real interest rate.

## 7.2 Results

In this section we describe the simulation results obtained for the OLG model for the same two experiments we conducted for the life cycle model. We use the set of preferences parameters described in the previous section for both experiments. For what concerns the technology parameters we assume that:

| Table 8: Technology | |
|---|---|
| © | 10 |
| ° | 0.36 |
| $\frac{Á_f}{Á_m}$ | 0.669 |
| $±_k$ | 2.59 (10% yearly) |

[22] The gender wage ratio is adjusted by multiplying unadjusted earning ratioby race and sex-speci…c ratios (male-to-female) of average hours worked per week by workers on full-time schedule (non-agricultural).

[23] This issue is discussed in Hotz, Kydland and Sedlachek (1988). Moreover, negative rate of time preferences are also assumed in Rios-Rull (). A negative value is also assumed in Auerbach and Kotliko¤ ().

Moreover, the (10 year) period discount factor is set to $\bar{\beta} = 0.47744754$ which corresponds to an annual rate of $\bar{\beta} = 0.994$ which is commonly used in the literature. As described in the previous section, in the first experiment we set the male-female differential in returns to experience to 7% in the seventies. In the nineties female return to experience is set to be equal to male returns. The results obtained in terms of hours and earning profiles resemble those produced by the life cycle model as described in Figure 6. For the second experiment we also obtain hours and wages profiles that are similar to the ones produced by the partial equilibrium model (as in Figure 7). Moreover, for both experiments the general equilibrium version of the model does also generate estimates for the log wage regression that imply marginal return functions similar to the ones obtained by using Blau and Kahn's estimates. Therefore, the introduction of a general equilibrium effect allows us to check for the realism of the price behavior while keeping the basic properties of the model unaltered.

A few general comments on the results we obtain for the equilibrium rental rates apply. First, given the value chosen for the discount factor, in both experiments the steady state equilibrium real interest rate is around 7% in the seventies and it is of the order of 8% in the nineties. In order to obtain more realistic values for the real rate of return to capital we run the same experiment setting the period discount factor beta to 0.6 (this values corresponds to a negative yearly rate of time preferences). This allows us to generate an equilibrium interest rate around 5% which is more realistic. Second, in general, as we move from the economy that represents the seventies to the economy that represents the nineties the real interest rate increases whereas the efficiency wage for both gender decreases. That is, the capital/labor ratio is smaller in the nineties. In conclusion, at least to a first approximation, we can claim that the model and the explanation chosen provide a good approximation of the reality. In particular, the shape of the seventies and the nineties profiles can be reproduced by the model based only on the change in the return to experience.

# 8 Conclusion

In this paper I investigate the contribution of changes in return to experience to the change in the aggregate and life cycle behavior of married women on the labor market. A life-cycle model with human capital accumulation and home production in which the basic unit of analysis are married couples with children reproduces the evidence for hours worked and wages profiles both for men and women. In particular, the higher increase in women's returns to experience relative to men in a model which is otherwise unchanged can predict the female and male hours worked age profiles both for the seventies and for the nineties.

Further exploration of this relationship necessarily requires the estimation of the human capital production function both for men and women and over the two time periods of interest. The estimation will also be used to provide evidence on the

relative changes in the return to experience over the two decades.

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Figure 1: Weekly average hours worked per married woman

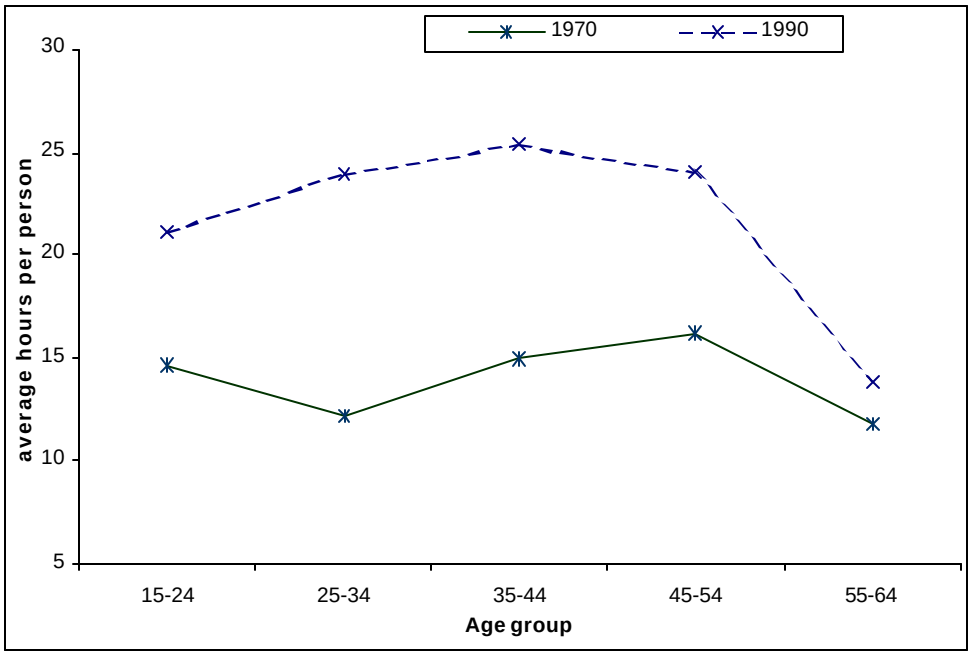


Figure 2a: Weekly average hours worked per person: Census 1970

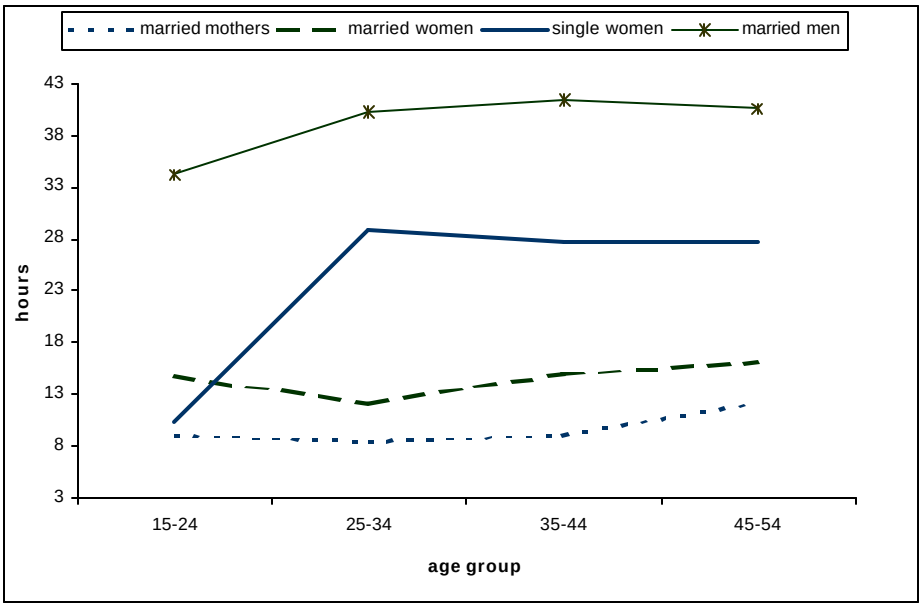



Figure 2b: Weekly average hours worked per person: Census 1990

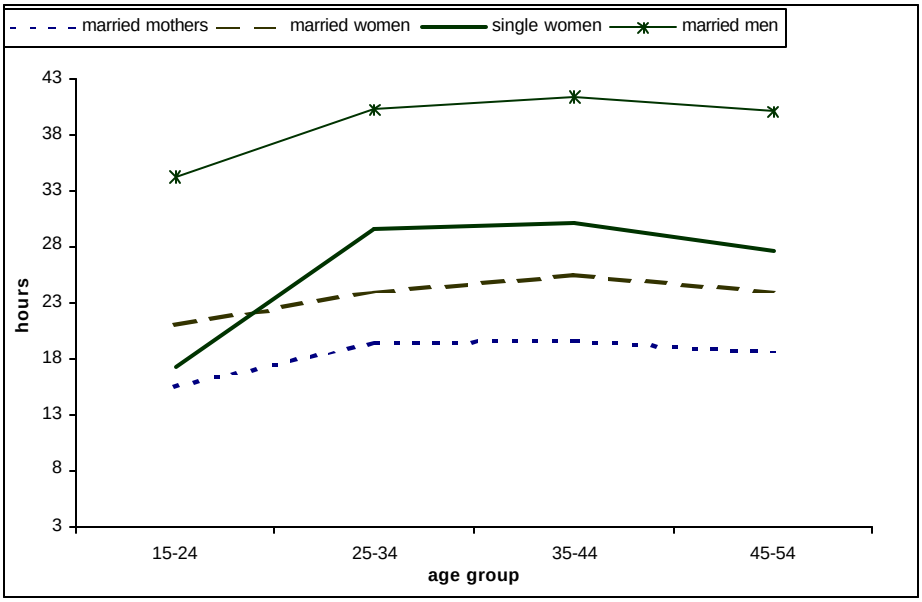


Figure 3: Convergence in average hours worked per person Census 1950 to 1990

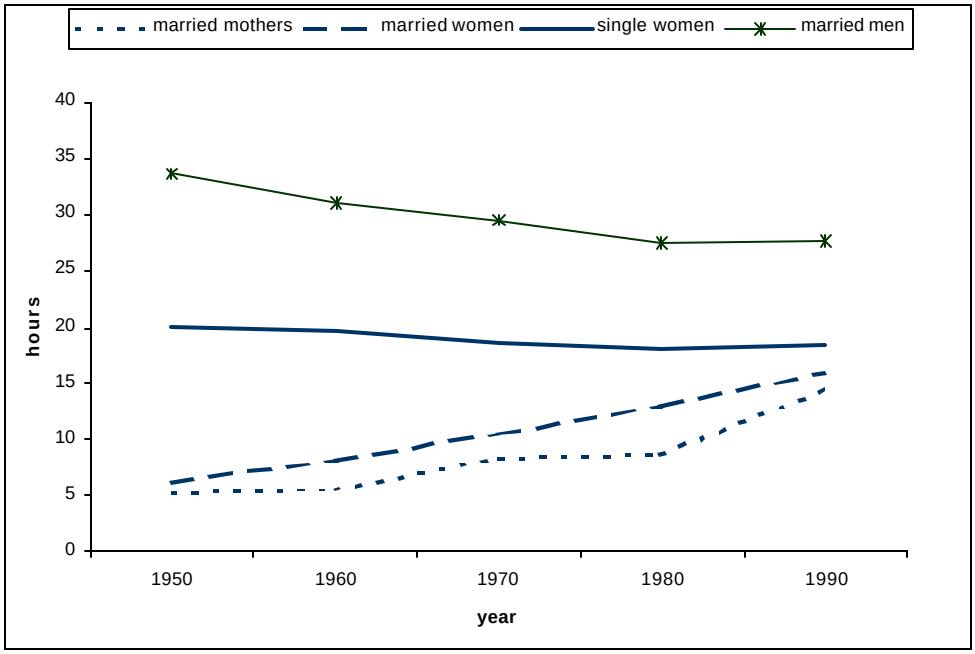


Figure 4a: Men's returns to experience (Blau and Kahn (1997))

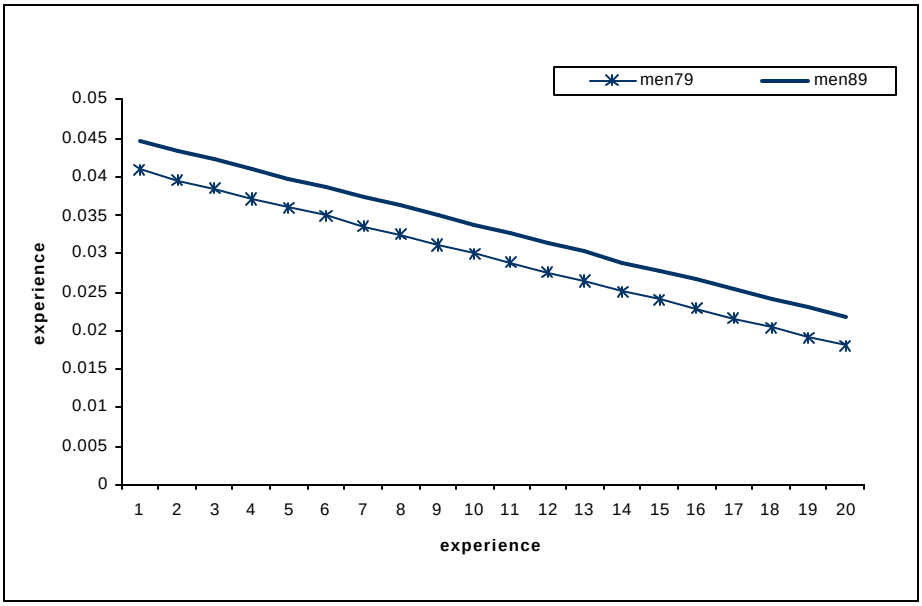
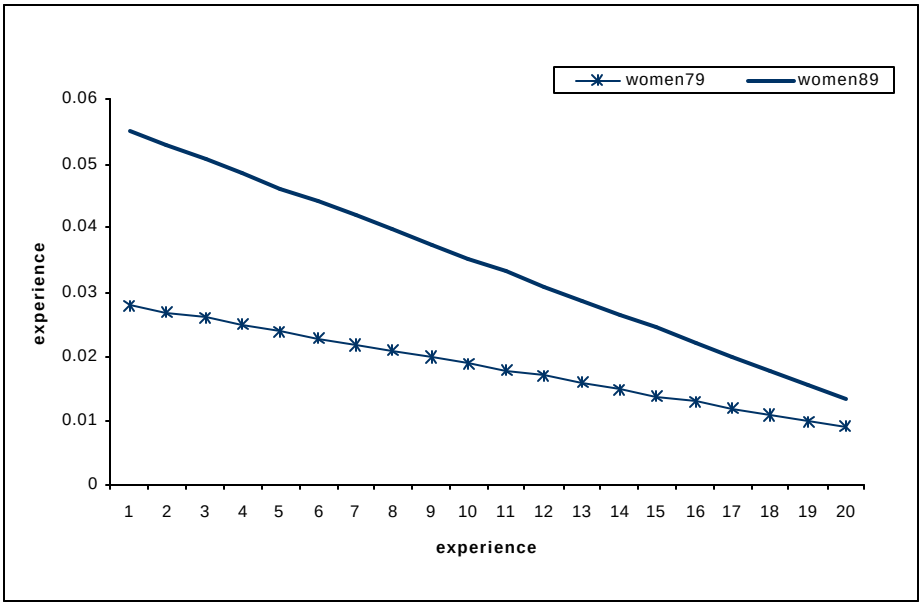
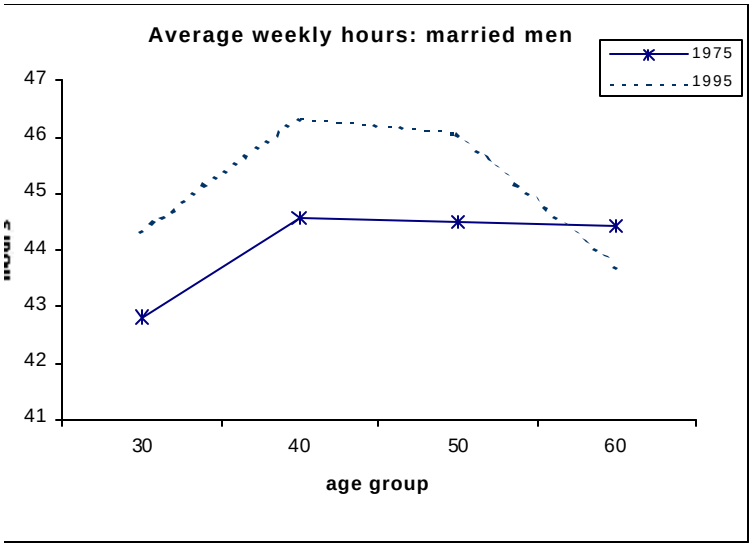
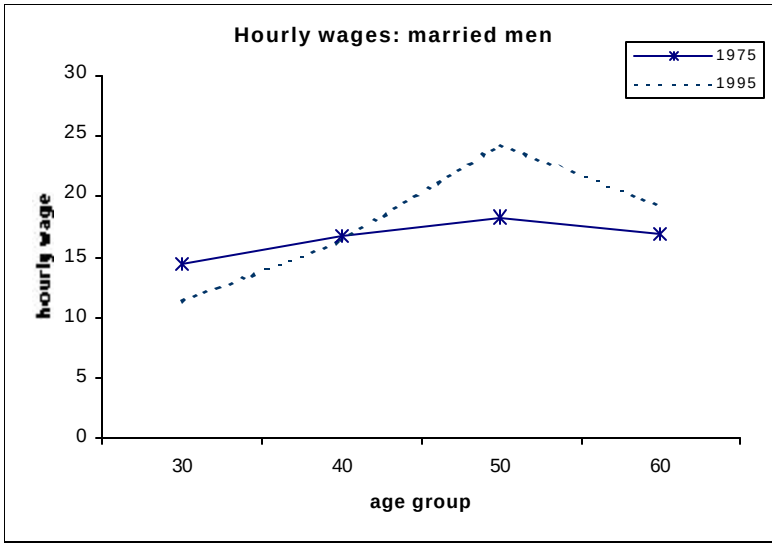



Figure 4b: Women's returns to experience (Blau and Kahn (1997))



igure 5: Hours and Earning pro…les: CPS, Annual Demographic (March) Files.
1975 vs 1995



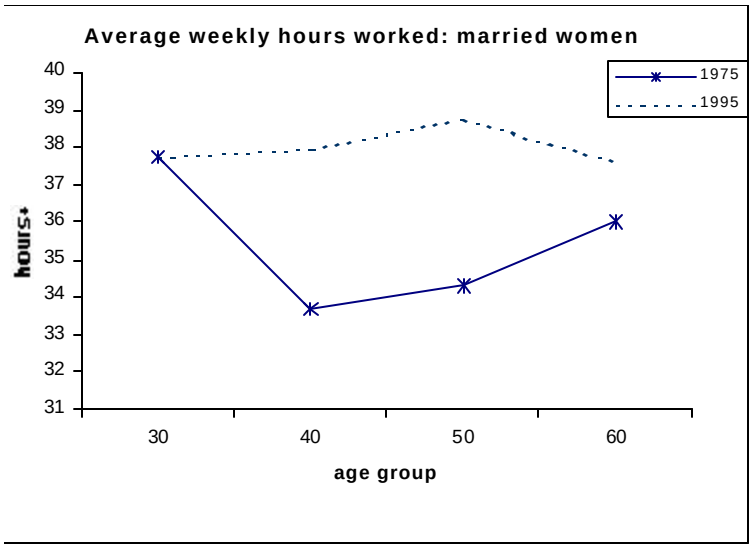
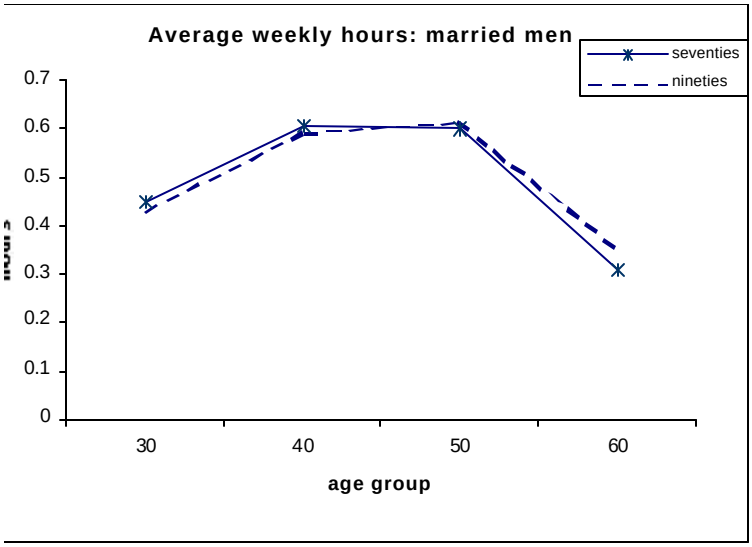
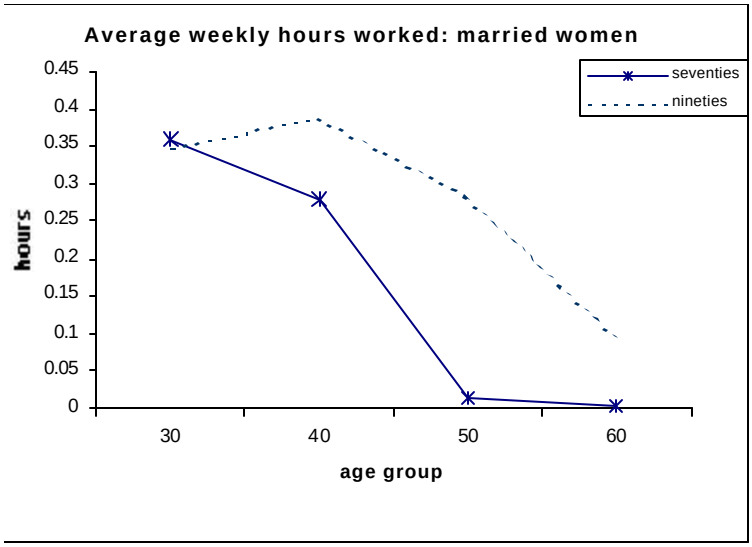




Figure 6: Hours and Earning pro…les: Experiment II







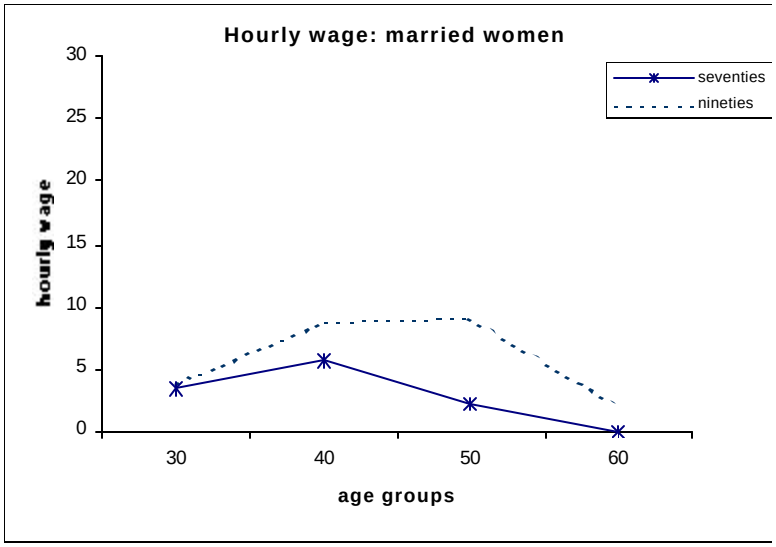



Figure 7: Hours and Earning pro…les: Experiment II