Economics Department

The Dynamics of Female Time Allocation upon a First Birth

CHRISTIAN BELZIL

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The Dynamics of Female Time Allocation upon a First Birth.

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Abstract

A dynamic model of time allocation decisions between work, child care and search activities upon a first birth is analyzed using a non-stationary dynamic programming model. Using backward recursion methods, I estimate a model which incorporates the following sequence of decisions, whether to stop working or not, whether to give up tenure, when to undertake search activities (for those who give up tenure) and the setting of the optimal reservation wage. The model is non-stationary; the value of specializing in child care activities and search costs are age specific, those who give up tenure must absorb a human capital loss and offer probabilities are also duration dependent. The role of maternity benefits is also investigated. Overall, the model is able to explain the relatively large fraction of women who do not interrupt careers upon a first birth as well as the rapidly declining re-employment hazards.

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1 Introduction

Economic models concerned with fertility and the allocation of time within households have a long history in labor economics. For several decades, economists have tried to measure the impact of children on female labour supply. In the branch of the literature devoted to labour supply (surveyed in Nakamura and Nakamura, 1993), it is generally accepted that young children reduce both the participation probability and hours worked. Another branch of the literature is devoted to the effects of children on human capital accumulation. Following Mincer and Polachek (1974), authors have explained the gender wage gap by the fact that females have comparative advantages in household production and therefore tend to invest less in labour market oriented human capital.

Despite the large amount of work devoted to the estimation of labour supply functions or to the estimation of female earnings equations, very few authors have actually implemented structural dynamic/stochastic models characterizing the optimizing behaviour of females who give birth. Among the few exceptions are Hotz and Miller (1988), who have estimated a model of fertility and contraceptive choices and Wolpin (1984), who has implemented a dynamic model where the sequence of decisions made is to have a child or not. However, the decision to return to work upon a first birth has not yet been analyzed using dynamic programming principles.

The main objective of this paper is to estimate structural dynamic programming model which can describe accurately the sequence of discrete choices made by females upon a first birth. The model incorporates a sequence of four decisions; the decision to interrupt work or not (for those who are working), the decision to return to their previous job or not (the decision to give up tenure or not), the decision to initiate search activities and, for those who search, the setting of the optimal reservation wage. Various sources of non-stationarity are considered; the value of household activities in the presence of young children is allowed to be age-specific (household production when children are at school must be much lower than what it is in the initial years following birth) and the opportunity cost of search activities is higher in presence of young children, the decision to give up tenure implies that new wage offers must be drawn from the same distribution faced when the woman entered the labor market and I consider the case where the probability of receiving job offers conditional on search can vary (decline) as the period devoted to household activities progresses. In a version of the model, I allow women to receive maternity benefits for a finite period and, finally, I introduce heterogenenity in taste for work using a question

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in the CFS.

I implement the model on a sample of Canadian women extracted from the Canadian Fertility Survey (CFS) conducted in 1984. The model allows me to estimate the age specific value of non-market time in the presence of young children and the effect of marital status (or partner's income) on home productivity. I also pay a particular attention to the decision to interrupt employment or not upon a first birth and to the optimal investment in search activities. The model is able to predict a very high fraction of females who experience continuous employment spells despite child birth as well as rapidly declining re-employment hazards. Structural parameters imply that home productivity falls sharply after 4 years (home productivity seem to decline by an average between 6% and 10% per year) and that job opportunities are declining with elapsed non-employment spell lengths.

The paper is constructed as follows. In the following section (Section 2), I present the Canadian Fertility Survey and discuss some of the empirical facts to be explained. In section 3, I discuss the non-stationary dynamic programming model which I use to analyze the data, while Section 4 is devoted to the econometric specification of the data and the construction of the likelihood function. The empirical results are discussed in Section 5 while the conclusion is in Section 6.

2 The Canadian Fertility Survey

The Canadian Fertility survey was conducted in April and May of 1984 . The survey incorporates retrospective information on 5315 women who were between 18 and 50 years old as of January 1st 1984. The survey includes women residing in either one of all ten Canadian provinces but 62% of all respondents resided in either Québec or Ontario.[1] The Canadian Fertility Survey (CFS) is quite comprehensive. It incorporates questions about timing of births and pregnancies, marriage (s), education and work histories (timing of interruptions and re-entrance in the labor market). The respondents are also asked some

[1]The Canadian Fertility survey (CFS) was funded by the Social Sciences and Humanities Research Council. It is the first national fertility survey conducted in Canada. The survey is quite similar to the data set on Swedish women fertility behavior used by Heckman and Walker (1990). The CFS was actually generated from a bank of 14,239,721 phone numbers from which 22,169 numbers have initially been randomly chosen. This process resulted in 5315 completed interviews; 27% conducted in French and 73% in English.

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questions on their attitudes toward marriage, divorce, contraception, abortion, family values and the frequency at which they participate in religious activities.

The survey has information on the number of different past employment spells and employment interruptions as well as their duration in months[2]. In the CFS, earnings are observed twice; when a woman first entered in the labor force and at the survey time for those women who actually held employment at that time. For those women who were out of the labor force by the survey time, earnings at the completion of the last employment spell are also reported.

The occupation breakdown of the women used in our sample is as follows. A large majority of women (57%) reported to be employees while 10% are in technical occupations (including nurses) and 8% are teachers. Approximately 6% report working in supervising jobs while 6% work in managerial positions and 7% in professional occupations. The remaining 7% are laborers or are in occupations unclassified according to the Canadian Dictionary of Occupations.

In this paper, I work with a relatively small sample. First, I restrict the analysis to women who have given one birth and do not wish (or cannot have) anymore children.[3] This allows me to formulate a model where the number of options is tractable; work at home (household production), work in the labor market and search activities (needed for them who have stopped working long enough). Although the sample contains women who have given birth prior to labor market entrance (some women are actually not working at the birth of their first child), women who have worked part-time at first birth or subsequently (less than 30 hours per week) have not been included. In order to capture the fact that an interruption for fertility must designate a non-participation spell during which women are involved in child care activities (instead of participating in the labor market), I must use a definition flexible enough to include women who leave after the birth or sometime before the birth. In the case where a woman interrupt before the birth, I do not face serious problems. I impose that the recorded interruption must have taken place no more than 9 (nine) months prior to the actual birth. For those who report stopping work after 1st birth, I retain only those who stopped working no later than one moth after the birth of the first child.[4] These criteria, along with the elimination of women with

[2]A duration analysis of non-employment spell durations and incidence is performed in Belzil and Hergel (1995).

[3]In the CFS, women are actually asked whether or not they expect anymore children in the future.

[4]This can probably be explained by the fact that some women have vacation entitlements or have particular arrangements with their employers enabling them to receive income for a

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missing information for either education, marital status at child's birth, earnings and the reported individual value of having children, reduced the sample to 206 women.[5]

In Table1A, I report the empirical frequencies of women returning to work within 1 up to 8 years. I have split the sample according to two classifications; those women with more than 12 years of education and less than 12 years and those women who were working at the time of the first birth and those who were not. In Table 1B, I report some sample statistics. Empirical hazards for the full sample (computed per quarters) can be found in Figure 1.

Overall, the data indicate that a very large proportion of women return to work within a year (around 50%). This is true for both low and high education women. Not surprisingly, the fraction of women working at the time of (or 9 months before) birth who are back within a year is even larger. Although very few of the women not working at birth are actually will actually be working within one year following birth (only 14%), it is still interesting to note that more than half of those will be working within 5 years following a first birth. The empirical hazards (computed for each quarter) for the entire sample reveal a very interesting pattern (Figure 1). Around 37% of the women return to work within 3 months and therefore experience virtually continuous employment patterns despite birth. In the next two quarters, re-employment hazards are low but they raise significantly in the last three months of the first year (from 3% to 12%). These spikes in the first and fourth quarters suggest that women who return to work within a year probably have the option of returning to their previous work but can only preserve this option for a finite period. Furthermore, the payment of maternity benefits within the Canadian Unemployment Insurance system can also explain the sudden rise in re-employment rates around the time when the child turns one year old. Finally, the empirical hazards (Figure 1) show a very strong decline in the re-employment rates during the first two years and a slight increase in the following years, most probably caused by the drop in the value of non-market time when children reach schooling age. The sample statistics in Table 1B indicate that most women who gave birth were actually married when they gave birth and that there is only very little difference in work experience

short period following first birth. Related issues are discussed in Belzil and Hergel (1995).

[5]In the CFS, women are actually asked several questions about individual and moral values. In particular, they are asked whether they believe that "to be generally happy in life, individuals should have at least one child". This variable is going to be used as a proxy for individual heterogeneity in the taste (or value) of having children. Women have also been asked whether "to be generally happy in life, one needs to be able to take a job outside the home.

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accumulation between low and high education women.[6]

Table 1A-Fraction of Women Returning to Work

	High Education	Low Education	Working at Birth	Not Working at Birth
Within 1 year	.54	.44	.60	.14
Within 2 years	.59	.57	.67	.29
Within 3 years	.66	.63	.74	.35
Within 4 years	.71	.69	.78	.45
Within 5 years	.77	.72	.81	.53
Within 6 years	.82	.78	.86	.63
Within 7 years	.86	.84	.90	.71
Within 8 years	.91	.86	.92	.78
# of observations	95	111	155	51

Table 1B-Sample statistics[7]

	High Education	Low Education	Working at Birth	Not Working at Birth
Age at survey	33.3	30.9	32.3	31.7
Experience at 1st birth (months)	51.7	50.6	67.9	-
Earnings at First Job	.324	.334	.381	-
Fraction Married at 1st birth	.96	.90	.95	.86
Education (years)	15.0	11.5	13.1	12.7
Husband's Earnings	.522	.479	.541	.372
# of observations	95	111	155	51

[6]Although there is a very small number of lone mothers in my sample, there is evidence that single women tend to return faster. However, because of the large number of empty cells, I do not present the married/single distinction in Table 1B.

[7]All earnings are measured in thousands of Canadian dollars per week divided by the consumer price index.Earnings at first job refers to the first full-time job held before the birth of a first child.Husband's earnings are equal to 0 for those single or not in a stable union.

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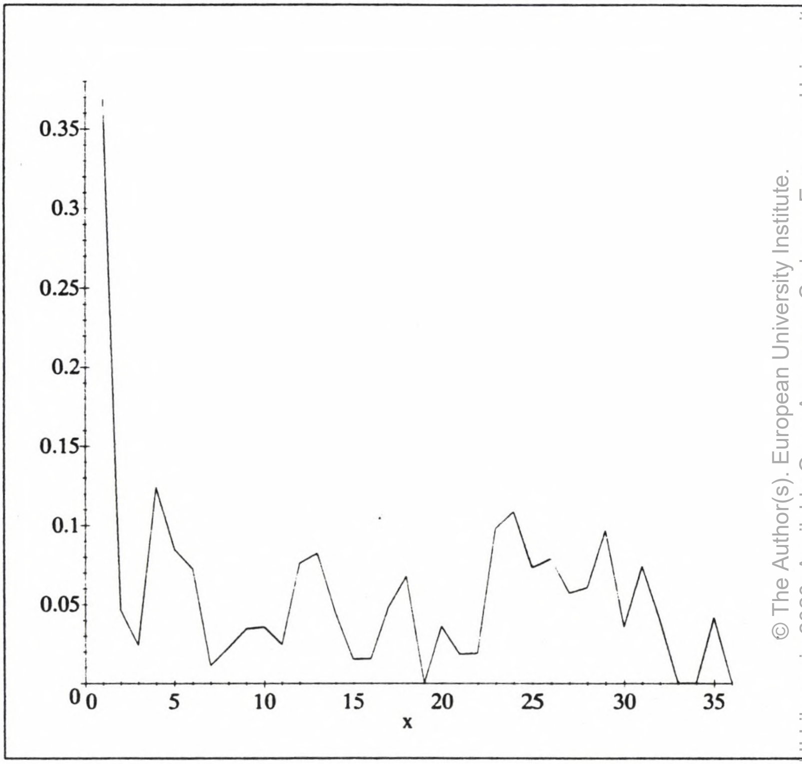
Figure 1- Empirical Reemployment Hazards (per quarter)



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3 An Estimable Dynamic programming Model

In this paper, I consider the sequence of discrete choices between labor market work or household production for those who have given birth. The decision to give birth is therefore ignored and women who gave birth can either continue work (or perhaps start working) or stop working in the initial period. I assume that those who do not work in the labor market are involved in child care activities but have the option of returning to their job within a certain period. Those who abandon the option on their previous job (those who give up tenure) must choose sequentially whether it is optimal to come back to work (which requires search investment) or to remain at home and be involved in child care activities.

Assumption 1

Women maximize the present value of lifetime output over an infinite horizon which starts at the time of a first birth. The productivity in the labor market is given by the wage, w_t, while the value of specializing in child care activities (home production), $\Psi(t)$, is age specific and is such that

$\Psi(t) > 0$ for $0 \leq t < \tilde{t}$,

$\Psi(t) = \vartheta$ for t $\succeq \tilde{t}$,

where t is children's age and $\tilde{t}$ can be interpreted as the time at which children start full time schooling. I assume that it is impossible to work in the labor market and at home within a same period.

Assumption 2

At $t : 0 \leq t \leq \bar{t}$,

- $w_t = w_0$ with probability 1.

In words, $\bar{t}$ is the period during which each woman keeps an option on her previous job.

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Assumption 3

- At $t : t < t \leq \tilde{t}$,

  The probability of receiving one offer, $\theta(t)$, is non-increasing in t.

Assumption 4

- At $t : t \geq \tilde{t}$,

  $\theta(t) = \theta(\tilde{t})$

Assumption 5

- At $t : t > \bar{t}$, potential wages are distributed with density f(w) given by

$$f(w) = \lambda \exp(-\lambda w)$$

Assumption 6

- Wage offers accepted upon birth (whether the previous job or a new job) cannot grow.[8]

Assumption 7

Search is assumed to be time consuming. The opportunity cost of search activities, c(t), is expressed as a fraction of the home productivity. As the decision in period 0 is only between continue working at wage w_0 and stop working (and involve in child care activities), search is assumed only possible

[8]This assumption can be interpreted as the cost of bearing children and implies that the value of working at wage w_t (including w_0) is given by $\frac{w_t}{1-\beta}$ where β is the discount factor.

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from period $\bar{t}$ onward. I assume that search requires 50% of the time endowment, that is

At $t : t > \bar{t}$,

- $c(t) = .5.\Psi(t)$.

Assumption 1 ,4,5,6 and 7 allow me to solve the problem in closed form in period $\bar{t}$ so that backward recursions can be used to obtain a solution in period 0. Assumption 2 is made in order to take into account that many employers rehire women who have stopped working for a short period while assumption 3 takes into account that females who stayed out for a relatively long period might be not very attractive to prospective employers. Altogether, they imply that, beyond $\bar{t}$, each woman faces a stationary environment. Finally, assumption 6 is made in order to incorporate a physical or a psychological cost of bearing children.[9]

As it is usually the case in non-stationary dynamic programming problems, the solution can be characterized easily using backward recursion methods. First, as noted earlier (assumption 6), the value of accepting employment (either previous job or a new job) with wage w at time t, $V_t^e(w)$, is independent from t and is simply given by

$$V_t^e(w) = V^e(w) = \frac{w}{1-\beta} \tag{1}$$

It can be noted that the value of specializing in child care activities (not to search) at a given period t, (V_t^c), has the following form.

$$V_{s_t=0} = V_t^c = \Psi(t) + \beta E\{V_{t+1} \mid s_t = 0\} \tag{2}$$

while the value of search, V_t^s, is given by

$$V_{s_t=1} = V_t^s = \Psi(t) - c(t) + \beta E\{V_{t+1} \mid s_t = 1\} \tag{3}$$

where

[9]There is indeed empirical evidence that female wages tend to grow less than wages of males and that the gender wage gap is much smaller in the immediate years following labor market entrance. For some empirical evidence, see Light and Ureta (1995).

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$$EV_{t+1} = Max\{\frac{1}{1-\beta}\left[(1-\theta_{t+1}\pi(w^*_{t+1}))w^*_{t+1} + \theta_{t+1}\pi(w^*_{t+1})(w^*_{t+1} + \frac{1}{\lambda})\right], EV^c_{t+1}\} \tag{4}$$

and represents the value of following the optimal policy next period; either search (in square brackets) or child care activities (EV^c_{t+1}). The expectation is taken with respect to f(w). At $\tilde{t}$ onward, the optimization becomes stationary so the solution can be characterized easily. Given that non-market time has value ϑ at and beyond $\tilde{t}$, two cases are possible

i) It is optimal to search:

$$V_{\tilde{t}} = V^s_{\tilde{t}} = \Psi(\tilde{t}) - c(\tilde{t}) + \beta EV_{\tilde{t}+1} \tag{5}$$

where

$$EV_{\tilde{t}} = EV_{\tilde{t}+1} = ... = \frac{1}{1-\beta}\left[w^* + \frac{\theta(\tilde{t})}{\lambda}\exp(-\lambda w^*)\right] \tag{6}$$

The reservation wage, denoted w^*, is such that

$$\begin{aligned} w^*_{\tilde{t}} &= w^*_{\tilde{t}+1} = w^* = \Psi(\tilde{t}) - c(\tilde{t}) + \frac{\beta}{1-\beta}\frac{\theta(\tilde{t})}{\lambda}\exp(-\lambda w^*) = \\ &.5\vartheta + \frac{\beta}{1-\beta}\frac{\theta(\tilde{t})}{\lambda}\exp(-\lambda w^*) \end{aligned} \tag{7}$$

so

$$V^s_{\tilde{t}} = \frac{1}{1-\beta}\left[\Psi(\tilde{t}) - c(\tilde{t})\right] + \frac{\beta}{(1-\beta)^2}\frac{\theta(\tilde{t})}{\lambda}\exp(-\lambda w^*) = \frac{w^*}{1-\beta} \tag{8}$$

Case ii) It is optimal to drop out permanently from the labor market:

The value of not searching (and dropping out of the labour force permanently) is therefore given by

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$$V_{\tilde{t}} = V^c_{\tilde{t}} = \frac{\vartheta}{1-\beta} \qquad (9)$$

So the optimal choice between V_s and V_c (in period $\tilde{t}$) is obtained by comparing (3.7) and (3.8).

In period $\tilde{t}$-s (where s=1, 2,....$\tilde{t}$), the value of search and the value of specializing in child care activities are given respectively by

$$V^s_{\tilde{t}-s} = \Psi(\tilde{t}-s) - c(\tilde{t}-s) + \beta EV_{\tilde{t}-s+1} \qquad (10)$$

$$V^c_{\tilde{t}-s} = \Psi(\tilde{t}-s) + \beta EV_{\tilde{t}-s+1} \qquad (11)$$

where

$$EV_{\tilde{t}-s+1} = Max\{\tfrac{1}{1-\beta}\left[(1-\theta_{\tilde{t}-s+1}\pi(w^*_{\tilde{t}-s+1}))w^*_{\tilde{t}-s+1} + \theta_{\tilde{t}-s+1}\pi(w^*_{\tilde{t}-s+1})(w^*_{\tilde{t}-s+1} + \tfrac{1}{\lambda})\right],$$

$$E(\Psi_{\tilde{t}-s+1} + \beta EV_{\tilde{t}-s+2})\}$$

and where the first line of 3.11 represents the expected value of searching next period if it is optimal to do so while the second represents the value of opting out from labour force next period to specialize in household activities.

Clearly, at $\tilde{t}$-s, the optimal reservation wage must solve the following equation

$$\frac{w^*_{\tilde{t}-s}}{1-\beta} = \Psi(\tilde{t}-s) - c(\tilde{t}-s) + \beta EV_{\tilde{t}-s+1} \qquad (12)$$

That is the reservation wage in $\tilde{t}$-s must equal the value of rejecting an offer (Ψ-c) plus the expected value (properly discounted) of choosing the optimal strategy next period (including the possibility of specializing in child care activities). This must be true until period $\bar{t}$+1 (the first period when search is available). At $\bar{t}$, the decision is made between returning to previous job and investing in child care activities. Working backward until the initial period (period 0), each woman has the possibility of remaining employed (at wage w_0) or involve in household activities. It follows that the condition for remaining

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employed in t=0 (which is the condition to experience continuous employment despite first birth) is actually given by

$$\frac{w_0}{1-\beta} \geq \Psi(0) + \beta EV_{(1)} \tag{13}$$

4 Econometric Specification

The model presented in the previous section implies that at each period, the decision between working in the labour market, specializing in child care activities and investing in search activities, is made conditional on the values of the parameters of the model. Those individuals facing same parameters will undertake search activities or specialize in child care activities in the same periods and the dispersion in the time at which women are observed to re-enter the labor force could therefore be explained solely by the intrinsic randomness imbedded in search activities. This representation of the choices made by women would clearly be at odd with actual data which shows a relatively large dispersion in the timing of re-employment. For this reason, I must specify a model which can allow individuals with identical observed characteristics to choose different options. However, in order to use the restrictions implied by job search theory (the contraction mapping given by equation 7), I want to preserve the terminal conditions (when the problem becomes purely stationary) which allow me to identify the structural parameters. For this reason, I assume that home productivity is subject to random shocks, assumed independent over time, only for the period during which children require child care activities (before schooling). I assume that these shocks are known to the economic agent but unknown to the investigator.

Assumption 8

The value of specializing in child care activities, before $\tilde{t}$ is given by

$$\Psi_i(t) = \bar{\Psi}_i(t) + \varepsilon_{it}^{\psi}$$

$$\varepsilon_{it}^{\psi} \sim i.i.d.N(0, \sigma_{\omega}^2)$$

for $0 \leq t \leq \tilde{t}$. The random term ε_{it} represents all unobservable factors which can, in a given period, affect productivity at home (child or parents

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health...etc.) and is known by the optimizing agent but unknown to the econometrician. Given this assumption,

At any period $\tilde{t}-s, for s > 0$,

$$V(\tilde{t}-s)_{=}V^{c}_{\tilde{t}-s} = \text{ with probability } 1\text{-}\Phi(\frac{-.5\Psi(\tilde{t}-s)+\frac{\beta}{1-\beta}\frac{\theta(\tilde{t}-s)}{\lambda}\exp(-\lambda w^{*}_{\tilde{t}-s})}{\sigma_{\omega}}) \quad (14)$$

$$V(\tilde{t}-s)_{=}V^{s}_{\tilde{t}-s} = \text{ with probability } \Phi(\frac{-.5\Psi(\tilde{t}-s)+\frac{\beta}{1-\beta}\frac{\theta(t^{*}-s)}{\lambda}\exp(-\lambda w^{*}_{\tilde{t}-s})}{\sigma_{\omega}}) \quad (15)$$

$$\begin{aligned} EV_{t^{*}-s} &= 1-\Phi\left(\frac{-.5\Psi(\tilde{t}-s)+\frac{\beta}{1-\beta}\frac{\theta(\tilde{t}-s)}{\lambda}\exp(-\lambda w^{*}_{\tilde{t}-s})}{\sigma_{\omega}}\right)V^{c}_{\tilde{t}-s} \quad (16) \\ &+\Phi\left(\frac{-.5\Psi(\tilde{t}-s)+\frac{\beta}{1-\beta}\frac{\theta(\tilde{t}-s)}{\lambda}\exp(-\lambda w^{*}_{\tilde{t}-s})}{\sigma_{\omega}}\right)V^{s}_{\tilde{t}-s} \end{aligned}$$

Assumption 9

$\Psi(\tilde{t}) = \vartheta = 0.$

This assumption, along with assumption 7 implies that, from $\tilde{t}$ onward,

$$V^{c}_{\tilde{t}} = V^{c} = 0 < V^{s}_{\tilde{t}} = V^{s} = \frac{\beta\theta(\tilde{t})}{(1-\beta)\lambda}\exp(-\lambda w^{*})$$

which means that, beyond $\tilde{t}$, it is always optimal to search because the value of household production is 0.[10]

Assumption 10

For those women searching, at most one job offer is received per period. The probability of receiving one job offer is given by

[10]This implies that there is no value associated to leisure. Given that the overwhelming majority of women are working beyond five years, the assumption seems quite plausible.

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$$\text{Prob } (w_t > 0) = \Phi(\alpha_t) \text{ for } t > \bar{t}$$

where $\Phi(.)$ denotes the standard normal cdf.

Assumption 11

In order to estimate the model, I must specify a functional form for the value of non-market time in presence of children. I investigate two possible cases for $\Psi(t)$.

i) First, I consider a case where the productivity at home is allowed to be age specific with no monotonicity restrictions and assume that the function $\Psi(t)$ is given by

$$\Psi(t) = \exp(\tau(t) + X'\beta) \quad (17)$$

where t denotes the age of a child, X is a vector which contains marital status at birth (replaced in some cases by husband's income) and a binary variable (called fertility heterogeneity) equal to 1 for those women reporting that it is either very important or important to have children in order to be happy in life (see section 2) and 0 for those who did not . $\tau(t)$ plays the role of an age specific intercept term and allows me to obtain a flexible representation of home productivity from the time of birth until school enrolment. This is referred to as model 1.

ii) To reduce the number of parameters, I also consider a case where I impose a monotonic relationship between home productivity and children's age. In this case $\Psi(t)$ is given by

$$\Psi(t) = \exp(\tau + X'\beta).\omega^t \quad (18)$$

where $\Psi(t)$ is increasing (or decreasing) with age as ω is above (or below) 1.

Inspection of the optimal reservation wage equation (8) reveals that identification of the offer probability and the wage offer location parameter requires data on wages or earnings. However, in the CFS, earnings are measured once at the time a woman entered the labor force and once more at the survey time (for those employed in 1984) or when employed last. Accepted wages when a woman returned to work are therefore unknown. This means that in order to

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to estimate the model consistently, I need an estimate of wages for those who were employed at first birth but have not yet been back to work and I also need an estimate of the wage offer distribution faced when a decision is made about initiating search activities.

Assumption 12

To obtain reasonable estimates, I assume that the distribution parameter of wages (λ) earned at first birth is function of education and experience (in months), that is

$$\lambda = \exp(\lambda_0 + \lambda_1 . \text{ education} + \lambda_2 . \text{experience})$$

To make use of all observations efficiently, I estimate λ_0 and λ_1 from all 206 observations on weekly earnings at labor market entrance (when experience is 0). In order to obtain an estimate for λ_2 I cannot use all the observations in my sample. This is because the second earnings for women who have been back in the labor market after having an interruption are likely to underestimate the effect of experience if, indeed, work interruption imply a human capital loss. Similarly, if I use only women who never came back in the labor market after stopping work, I am likely to incorporate women who experienced much longer non-employment spells than average. So, in order to estimate the effects of experience, I use a sample of women who had not yet experienced an interruption but who were 25 years old or less at the survey time (this a subset of the sample analyzed in Belzil and Hergel, 1995) so that women with continuous work patterns are not over-represented. After having fixed λ_0 and λ_1 to the values obtained previously with 206 observations, I can obtained an estimate for the effect of experience and I can use all three estimates in the solution of the value functions. More details can be found in Appendix 2. Finally, in order to estimate the model, I fix the discount factor at 5% per year.

Given the assumptions made, it is relatively easy to write the likelihood function. Although the model is characterized by a sequence of decisions between search and specializing in child care activities, actual data on the age of child at reentrance in the labor market can be used to make inference about the structural parameters. Defining a sequence of R_t such that

$$\begin{aligned} R(t) &= 1 \text{ if a woman came back to work in year t} \\ R(t) &= 0 \text{ if a woman has not yet returned by year t.} \end{aligned} \tag{19}$$

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then, it is clear that for all t: t¿t̄,

$$\Pr(R_t = 1) = \Pr(S_t = 1).\theta(t)\exp(-\lambda w^*(t)) \tag{20}$$

$$\Pr(R_t = 0) = \Pr(S_t = 0). + \Pr(S_t = 1)\{1 - \theta(t)\exp(-\lambda w^*(t))\} \tag{21}$$

while for all t $\leq \bar{t}$

$$\Pr(R_t = 1) = \Pr(\bar{\Psi}_i(t) + \varepsilon_{it}^{\psi} + \beta EV_{t+1} < \frac{w_0}{1-\beta}) \tag{22}$$

$$\Pr(R_t = 0) = \Pr(\bar{\Psi}_i(t) + \varepsilon_{it}^{\psi} + \beta EV_{t+1} \geq \frac{w_0}{1-\beta}) \tag{23}$$

where the right hand side of (20) is the product of the probability that woman searched in year t and the probability that an acceptable offer has been received (accepted) while the right-hand side of (21) is the sum of the probability that a woman did not search and the probability that she search unsuccessfully (itself the probability that she searched times the probability that no acceptable offer has been received). Similarly, the right-hand side of (22) is the probability that the value of working for the wage earned at child birth's (w_0) exceeds to the value of child care activities while (23) is simply the probability of the converse. Note that (22) and (23), when evaluated in period 0, determine the probability that a woman will experience continuous employment spell despite child's birth. The likelihood for a sample of N uncensored waiting time until return to work (τ_i), $L^u(.)$ is given by

$$L^u(.) = \prod_{i=1}^{N}\left(\left\{\prod_{s=0}^{\tau_i - 1}\Pr(R_{i(s)} = 0)\right\}\Pr(R_{i(\tau)} = 1)\right) \tag{24}$$

For those women who have not been back by the end of $\tilde{t}$, is quite easy, the likelihood, L^c, is simply

$$L^c(.) = \prod_{i=1}^{N}\left\{\prod_{s=0}^{\tilde{t}}\Pr(R_{i(s)} = 0)\right\}$$

Maximizing the log likelihood requires that, at each iteration and for each period considered, the reservation wage $w^*(t)$ must be evaluated conditional on

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the structural parameters. The reservation wage at iteration p+1, w^*_{p+1} , is given by the following equation

$$w^*_{p+1} = w^*_p - \frac{1}{g'(w^*_p)} g(w^*_p)$$

where $h(w^*) = w^* - \frac{\beta}{1-\beta}\frac{\theta(\bar{t})}{\lambda}\exp(-\lambda w^*)$. This parameterization enables me to obtain reservation wages which depend explicitly on exogenous variables (education, marital status and the intrinsic taste for children) without having to stratify my sample into smaller sub-samples. I can therefore make use of all observations in the sample.

5 Empirical Results

The empirical results are divided into three sections. In section 1, I investigate the model where the productivity at home is allowed to depend on child's age in a flexible way (Model 1) and the model where home productivity is depending monotonically on child's age (Model 2). In the second section, I analyze two slightly different versions of model 1 and 2; one with husband's income (model 3) and one where I incorporate maternity benefits (model 4). Finally, in the third section, I consider a model with heterogeneity in taste for work using a question of the CFS (Model 5).

5.1 Investigating the Value of Home Productivity

As a starting point, I have implemented both model 1 (with flexible age specific productivity at home) and model 2 (with a baseline productivity shifted by ω^t). In order to facilitate estimation, I consider time periods of three months (quarters). Both models are estimated under the assumption that home productivity drops to 0 (and becomes non stochastic) after year 5 and assuming that it is optimal to search (see assumption 9). Finally, I also assume that jobs held at birth can be reintegrated within 4 quarters so that those coming back to work beyond 4 quarters give up tenure and I fix the discount factor to 5% per year.

The results are in Table 2A. The estimates of model 1 have been obtained by imposing that home productivities remain constant over a 2 year period (except for period 0). I estimated 3 different productivities; one for period 0, one for period 1 and 2 and one for year 3 and 4. The estimates for the

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intercept terms indicate that home productivity is virtually equal to 0 at the beginning of year 4 and that home productivity increase slightly from year 0-1 to year 2-3 while the estimate for ω in model of 2 (ω = .94) indicates an overall decline in age specific home productivity of 6 % per year. As it can be found in Table 2A, model 2 imputes a much larger role to marital status in the determination of household productivity (the effect of marital status is 1.44 as opposed to .10 in model 1). In order to illustrate the age specific distribution of home productivity and the role of marital status as well as taste heterogeneity, I computed the predicted home productivities for the four classes of women in Table 2B (model1) and 2C for model 2. It can also be noted that, both in model 1 and model 2, those women reporting that having children is important to them tend to have lower home productivity (and will therefore be more likely to return to work early). Both model 1 and model 2 predict that job opportunities become more scarce as a woman remains absent from the labor market; the implied sequence of offer probabilities in model 1 is 1 (in year1), .86 (in year 2 and year 3) and .45 (from year 4 onward) while the corresponding sequence in model 2 is given by 1, .81 and .18.

In Table 2D and 2E, I compute the sequence of reemployment hazards, Search hazards (conditional probability of initiating search in a given period) and reservation wages implied by the parameters obtained in 2A. Given the parameterization I used, I must select a given value of earnings at birth, education, marital status and taste heterogeneity. The values reported in 2D and 2E are those obtained for married women with 15 years of education (a relatively high level in the sample) who earned 324 dollars per week at first birth. As I have assumed that search was initiated only in year 1, the search hazards are only defined in year 1 (from the 5th quarter onward) and reservation wages reported for the first four quarters (in year 0) are wages equating the value of specializing in child care activities while those reported from year 1 are wages that equate the value of search (rejecting an offer). For both model 1 and model 2, I have included (in brackets) the empirical hazards for the group of married women who have 13 years or more of education.

Overall, the predicted reemployment hazards (for either model 1 or model 2) can fit the data relatively well; we observe a very high probability of returning to work within 3 months (which typically means no work interruption) followed by a steep decline in the reemployment hazards for both the second and third quarter and a very clear increase in the last quarter . This spike in reemployment before the end of the initial year of child bearing seems to validate the hypothesis that jobs can be recalled for a one year period although

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other possible explanations will be analyzed in the next section. From the second year (year 1) onward, predicted hazards as well as empirical hazards are relatively low. The estimates for the probability of searching in a given quarter conditional on no search in previous quarters (search hazards) indicate that search is typically initiated shortly after the child turns one year old and that the probability drops very rapidly. The sequence of reservation wages is also generally declining although, in model 1, reservations are increasing from the beginning of year 3 to reach a maximum of 126.72 at the beginning of period 5 (to save spaces reservation wages , hazards are reported for the first 4 years (year 0,1,2 and 3). In model 2, home productivity is monotonically decreasing and reservation wages are uniformly decreasing.[11]

Table 2A- Structural parameters in Model 1 and Model 2[12]

		Model 1	**Model 2**
Home Productivity			
	Intercept (0)	-0.98 (0.17)	-
	Intercept (1-2)	-.20 (0.04)	-
	Intercept (3-4)	-8.7 (1.12)	-
	Intercept	-	-2.31 (0.72)
	ω (age)	-	0.94 (0.08)
	Married	.10 (0.65)	1.44 (0.78)
	Heterogeneity	-.009 (.006)	-0.24 (0.08)
	Variance (σ^2_ψ)	4.97 (0.56)	5.02 (0.43)
Offer Probabilities	Year 2-3	$\Phi(1.08)$	$\Phi(0.87)$
	Year 4-∞	$\Phi(-0.115)$	$\Phi(-0.90)$
Log Likelihood		-327.5	-366.7

[11] Indeed, in an intial version of the paper I have estimated a similar model where home productivities were flexibly estimated and where offer probabilities were fixed to one over the entire period. I obtained increasing reservation wages from year 2 up to the end of year 4; a result quite implausible.

[12] Asymptotic standard errors are in parantheses.

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Table 2B- Values of Home Productivity for Model 1 (in dollars per week)

	Year 0	Years 1-2	Years 3-4
Married/ heterogeneity=high	408.0	897.0	.20
Married/ heterogenity=low	413.0	905.0	.20
Single/heterogenity=high	370.0	811.0	.00
Single/heterogeneity=low	374.0	819.0	.00

Table 2C-Values of Home Productivity for Model 2 (in dollars per week)

	Year 0	Year 1	Year2	Year 3	Year 4
Married/ hetero.=high	330	310	291	274	258
Married/ hetero=low	419	394	370	348	327
Single/hetero=high	78	73	69	65	61
Single/hetero=low	99	93	87	82	77

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Table 2D- Reemployment Hazards, Search Hazards and Reservation Wages in Model 1[13]

		(1) Reemp. Hazards	(2) Search Hazards	(3) Reser. Wages
Year 0	1	0.4921 (0.4105)	-	328.94
	2	0.2534 (0.0357)	-	324.72
	3	0.1307 (0.0185)	-	315.62
	4	0.0679 (0.1698)	-	293.78
Year1	1	0.0099 (0.0227)	0.4277	274.33
	2	0.0081 (0.0697)	0.2448	261.70
	3	0.0072 (0.0250)	0.1400	238.47
	4	0.0064 (0.0000)	0.0802	214.03
Year 2	1	0.0047 (0.0256)	0.0459	188.30
	2	0.0038 (0.0263)	0.0263	161.21
	3	0.0037 (0.0270)	0.0113	132.69
	4	0.0032 (0.1111)	0.0150	102.68
Year 3	1	0.0030 (0.0938)	0.0086	84.11
	2	0.0020 (0.0000)	0.0058	88.53
	3	0.0014 (0.0345)	0.0029	93.19
	4	0.0009 (0.0000)	0.0014	98.08

[13]The numbers in brackets are the empirical hazards computed for married women who have 13 years of education or more.

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Table 2E -Reemployment hazards, Search Hazards and Reservation Wages in Model 2[14]

		(1) Reemp. Hazards	(2) Search Hazards	(3) Reser. Wages
Year 0	1	0.5045 (0.4105)	-	304.16
	2	0.2567 (0.0357)	-	295.63
	3	0.1316 (0.0185)	-	274.75
	4	0.0721 (0.1698)	-	194.28
Year1	1	0.0088 (0.0227)	0.4735	181.50
	2	0.0066 (0.0697)	0.2493	179.66
	3	0.0050 (0.0250)	0.1313	175.98
	4	0.0038 (0.0000)	0.0691	172.11
Year 2	1	0.0024 (0.0256)	0.0365	168.31
	2	0.0019 (0.0263)	0.0192	164.83
	3	0.0015 (0.0270)	0.0101	161.17
	4	0.0012 (0.1111)	0.0053	157.32
Year 3	1	0.0009 (0.0938)	0.0028	153.53
	2	0.0007 (0.0000)	0.0015	150.02
	3	0.0005 (0.0345)	0.0008	146.34
	4	0.0004 (0.0000)	0.0004	142.46

5.2 Partner's Income and Maternity Benefits

Overall, although the model fits the data relatively well, it can be criticized for two main reasons. First, information on husband's income is likely to be more useful than marital status in capturing heterogeneity in the value of non-market time. To resolve this issue, I reestimate model 2 where marital status is replaced by husband's (or partner's) earnings measured at the time of the survey. This becomes model 3.

[14]The numbers in brackets are the empirical hazards computed for married women with 13 years or more of education.

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Secondly, estimates for home productivity (Table 2B and 2C) seem relatively high if one considers that the average earnings is only 330 but substantial number of women return to work within a year and , in particular, within 3 months. A possible explanation is that the value of female market time is biased by the presence of unemployment income (maternity benefits). In Canada, since 1973, females who stop working after a birth can draw UI benefit for a period which can go up to 40 weeks. Although the CFS does not provide information on maternity benefits, I can evaluate it using the product of the wage earned at birth and a replacement rate parameter to be estimated.[15] For this matter, I redefine the value of non-market time in model 2 as

$$\Psi(t) = \exp(\tau(t) + X'\beta) + \alpha(t).W_0 \tag{25}$$

where $\alpha(t)$ is a positive parameter to be estimated. I assume that every individuals is entitled to maternity benefits for 4 quarters so that α is set to 0 after one year. I refer to this specification as model 4.

[15]For a more detailed discussion of the Canadian Unemployment Insurance system, see Belzil (1995).

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Table 3A- Structural Parameters in Model 3 and Model 4[16]

		Model 3	Model 4
Home Productivity			
	Intercept (0-1)	-	-1.263 (0.23)
	Intercept (2-3)	-	-1.074 (0.37)
	Intercept (4-5)	-	-2.618 (0.08)
	Intercept	-1.657 (0.70)	-
	Husband's Income	0.7843 (0.06)	-
	Married	-	0.312 (0.09)
	Heterogeneity	-0.083 (0.05)	-0.023 (0.07)
	ω (child's age)	0.913 (0.27)	-
	Variance (σ^2_ψ)	4.39 (0.87)	4.78 (0.68)
Maternity Benefit	(α)	-	.353 (0.29)
Offer Probabilities	Year 2- 3	$\Phi(.53)$	$\Phi(.31)$
	Year 4- ∞	$\Phi(-.42)$	$\Phi(-1.36)$
Log Likelihood		-335.7	-311.9

Table 3B- Values for Home Productivity in Model 4

	Year 0	Year 1-2	Year 3-4
Married/ hetero=high	378	456	97
Married/ hetero=low	386	467	100
Single/hetero=high	276	334	71
Single/hetero=low	283	342	73

[16] Asymptotic standard errors are in parantheses.

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Table 3C- Reemployment Hazards, Search Hazards and Reservation Wages in Model 4.

		(1) Reemp. hazards	(2) Search hazards	(3) Reser. Wages
Year 0	1	0.6012	-	259.91
	2	0.0818	.4697	239.39
	3	0.0678	.2491	227.80
	4	0.0555	.1321	215.60
Year1	1	0.0433	.0691	210.79
	2	0.0341	.0371	207.04
	3	0.0270	.0199	199.71
	4	0.0213	.0107	191.98
Year 2	1	0.0162	.0057	183.85
	2	0.0124	.0031	175.29
	3	0.0100	.0017	166.28
	4	0.0077	.0009	156.79
Year 3	1	0.0062	.0005	155.88
	2	0.0044	.0003	151.72
	3	0.0031	.0001	155.88
	4	0.0022	.0000	-160.27

The results for model 3 do not appear much different from model 2. However, the intercept term for the baseline productivity in year 0 has increased from -2.31 to -1.657. As a consequence, female productivities will have much higher spread. Again, there is evidence that home productivity is generally declining with age. In this case, productivity drop by 9% per year.

The most interesting results are probably those concerning model 4. The reduction of the period during which women have an option on their previous job couple with the introduction of maternity benefits has reduced the re-employment rates in quarter 2 and quarter 3 of the first year and has raised to re-employment hazards in year 1 (from quarter 5 to 8) to levels much more comparable with empirical hazards observed in the data. Interestingly, the estimates for home productivity appear much flatter than before (although there

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is still an increase in year1-2) and, in particular, the level of home productivity in year 3 and 4 is now between 70 and 100 dollars (while it was virtually 0 in model 1). The offer probabilities are 1, .70 and .34 for model 3 and 1, .62 and .09 for model 4.

5.3 Inclusion of Taste for Work

The final modification analyzed in the paper is the introduction of a variable which takes into account that women might differ not only in terms of their taste for fertility but also in terms of taste for work outside the home. Again, I can make use of the information available in the CFS as women have actually been asked to say whether they attached high or low value to having a job outside the home. If I assume that a fraction τ of the population attaches a value ξ_h to work (the high value) and a fraction (1-τ) attaches value ξ_l (the low value) where ξ_l =0, then I can use the information contained in the answer given by each women about the value they attach to having a job to split the sample into two groups; those who reported having a very high or a high value of working outside the home and those who did not. Given this, value functions and reservation wages can be adjusted in a straightforward manner, the value of accepting employment is now given by

$$V^e(w) = \frac{w + \xi}{1 - \beta}$$

and reservation wages must equate $V^e(w)$ and the value of search V^s (equation 10 or equation 8). In order to analyze the model with taste for work, I keep the specification of model 4 (with maternity benefits and no job recall).

The structural parameters are in table 4A. As indicated by the obtained values for the intercept terms (home productivity), model 5 is the only model specification where the age specific home productivities are uniformly declining (when estimated flexibly). The estimates for home productivity (in Table 4B) are actually higher than those in Table 3B. Not surprisingly, the estimate for ξ is positive (.81). This means that women who report that working outside is very important attach a value of 81$ per week to holding a job when compared to the other type of women. The parameter estimate has however a very high standard error. The inclusion of ξ (if positive) clearly reduces the reservation wage (and therefore the value of search) but raises the value of keeping the job held at first birth. This can be verified in Table 4C where I report both

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reemployment hazards and reservation wages for those with the low level of taste for work (column 1 and 2) and those with a high level (column 3 and 4). Reservation wages for those who have a positive taste for work are uniformly lower than for those who do not. As expected, those with a taste for work are more likely to return to work within 3 months but the structural parameters do not imply a meaningful difference in the reemployment hazards. Finally, the introduction of two types of women who differ in terms of their taste for work has raised the offer probabilities somewhat. Previous models implied a much stronger decline in the probability of receiving an offer than model 5.

Table 4A- Model with Heterogeneity in the Taste for Work[17]

		Model 5
Home Productivity		
	Intercept (0)	-0.973 (0.28)
	Intercept (1-2)	-1.112 (0.36)
	Intercept (3-4)	-2.046 (0.54)
	Intercept	-
	Husband's Income	-
	Married	0.202 (.06)
	Heterogeneity	-0.004 (0.04)
	ω (child's age)	-
	Variance (σ^2_ψ)	4.44 (0.76)
Maternity Benefit	(α)	.325 (0.27)
Offer Probabilities	Year 2- 3	$\Phi(.92)$
	Year 4- ∞	$\Phi(.07)$
Taste for Work	ξ (heterogeneity)	0.812 (.66)
Log Likelihood		-306.2

[17] Asymptotic standard errors are in parantheses.

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Table 4B- Values for Home Productivity in Model 5

	Year 0	Year 1-2	Year 3-4
Married/ hetero=high	445	391	153
Married/ hetero=low	463	407	159
Single/hetero=high	364	320	125
Single/hetero=low	379	333	130

Table 4C- Reemployment Hazards and Reservation wages in Model 5

		-1- Reemp. hazards $\xi = \xi_l = 0$	-2- Reser. Wages $\xi = \xi_l = 0$	-3- Reemp. Hazards $\xi = \xi_h = .81$	-4- Reser. Wages $\xi = \xi_h = .81$
Year 0	1	0.4887	331.11	0.5281	306.35
	2	0.0827	288.96	0.0829	259.88
	3	0.0754	264.50	0.0741	236.20
	4	0.0680	238.76	0.0654	211.26
Year 1	1	0.0611	226.17	0.0575	199.73
	2	0.0483	224.23	0.0445	198.36
	3	0.0384	220.39	0.0345	195.67
	4	0.0304	216.35	0.0267	192.83
Year 2	1	0.0233	212.09	0.0199	189.85
	2	0.0185	207.62	0.0155	186.73
	3	0.0147	202.90	0.0120	183.41
	4	0.0156	197.94	0.0093	179.94
Year 3	1	0.0092	194.40	0.0073	180.54
	2	0.0070	193.90	0.0054	181.89
	3	0.0054	193.37	0.0041	183.31
	4	0.0041	192.80	0.0031	184.81

6 Conclusion

In this paper, I have used a non-stationary dynamic programming model to analyze the decision to return to work upon a first birth. In particular, the model

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has allowed me to obtain estimates for female productivity in presence of young children. Despite the very large fraction of women who return within a year (in particular within three months), the results indicate relatively large values for home productivity in the first three years but a quite important decline in subsequent years along with a relatively important decline on job opportunities. As a consequence, the value of holding a job in periods surrounding first birth are relatively high and, either a large fraction of the women in the sample either remain employed (or come back within three months) or initiate search activities within two years following child birth. The results also indicate that marital status at birth has an important impact (positive) on home productivity.

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Appendix 1- Emprirical Hazards for the Full Sample

	1st quarter	2nd quarter	third quarter	fourth Quarter
Year 0	0.3689	0.0462	0.0242	0.1240
Year 1	0.0849	0.0722	0.0111	0.0225
Year 2	0.0345	0.0357	0.0247	0.0759
Year 3	0.0822	0.0448	0.0156	0.0159
Year 4	0.0484	0.0678	0.0000	0.0364
Year 5	0.0187	0.0192	0.0980	0.1087
Year 6	0.0732	0.0789	0.0571	0.0606
Year 7	0.0968	0.0357	0.0741	0.0400
Year 8	0.0000	0.0000	0.0417	0.0000

Appendix 2

Estimation of the Parameters of the Wage Offer Distribution

In order to estimate the parameters of the wage offer distribution, I proceed as follows.

1st Step

I split my original sample into 4 groups (high education/single, high education/married, low education/single and low education/married and I compute the observed minimum wage for each group and use it as an estimator for the

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reservation wage. As I can use only observations on wages earned when they entered the labor market for those who have worked before birth, I have a smaller sample (155 women). The minimum wages are given in the following Table.

	Low education / Single	Low education / Married	High education / Single	High education / Married
Min Wage	.167	.068	.335	.178
# of obs.	6	76	2	71

2nd Step

I estimate the wage offer location parameter, λ, under the assumption that

$$\lambda = \exp(\lambda_0 + \lambda_1 education)$$

using the fact that observed wages are distributed with density g(w) given by

$$g(w_i) = \lambda \exp(-\lambda(w_i - w_i^*))$$

where w_i^* is the observed minimum wage for individual i (according to education and marital status). However, in practice, my results were almost identical when I used only education as a class variable.

3rd Step

I use a larger sample of young women (sample is used in Belzil and Hergel,1995) who had only one interruption and whom have not yet been back to work. For these young women, wages are recorded at survey time so I can estimate the effects of experience under the assumption that

$$\lambda = \exp(\lambda_0 + \lambda_1 education + \lambda_2 \text{ experience})$$

using the same reservation wages and the same parameter estimates (λ_0 and λ_1) obtained in step 2. The final estimates are $\lambda_0 = 1.7422$, $\lambda_1 = -.0332$ and $\lambda_2 = -.0411$. These estimates seem to be quite plausible (education and experience increase wages).

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