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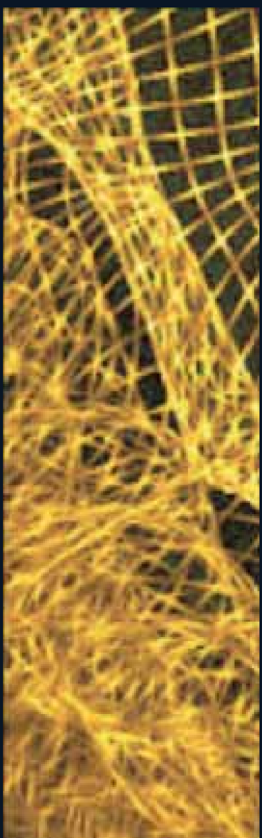

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A General Equilibrium Analysis of Parental Leave Policies†

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Abstract

Despite mandatory parental-leave policies being a prevalent feature of labor markets in developed countries, the aggregate effects of leave policies are not well understood. In order to assess the quantitative impact of mandated leave policies in the economy, we develop a general-equilibrium model of fertility and labor-market decisions that builds on the labor market framework of Mortensen and Pissarides (1994). We find that females gain substantially with generous policies, but this benefit occurs at the expense of a reduction in the welfare of males. Mandated leave policies have important effects on fertility, leave taking decisions, and employment rate of mothers with infants. These effects are driven by how policy affects bargaining in job matches: Young females anticipate that there are some states in the future in which their threat point in bargaining will be higher. Because the realization of these states depend on the decisions of females to give birth and take a leave, the change in the threat point induced by the policy subsidizes fertility and leave taking. Unpaid parental leaves have a small impact on the time that mothers spend with their children but *paid* parental leaves can be an effective tool to encourage mothers to spend time with their children after giving birth.

Keywords: Human capital, labor-market equilibrium, parental-leave policies, fertility, temporary separations.
JEL Classification: E24; E60; J2; J3.

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1 Introduction

Mandated parental-leave policies have been widely introduced in developed countries in the last two decades. These policies specify a minimum amount of leave time that a person is entitled to in order to care for a newborn child. In addition, job dismissal is prohibited during pregnancy and the job is guaranteed after the leave period. Despite the prevalence of mandatory parental-leave policies in developed countries, their effects on fertility, time at home with children, employment, and wages are far from being well understood.[1] While advocates of parental leave policies believe that parental leave favour the labor market attachment of women and allows for healthier children, opponents counter that the mandates, by restricting voluntary exchange between workers and employers, reduce economic efficiency and have negative effects on women (see the discussion in Ruhm (1998)). Moreover, advocates of leave policies claim that mandates allow women to keep firm-specific human capital by reducing their need to change jobs (Waldfogel, 1998a). However, the rational for policy intervention become less compelling if workers and employers can voluntary negotiate parental leave allowing the two parties in the match to internalize in their decisions the loss of firm-specific human capital.

The channels through which parental leave policies influence economic decisions are rather complex and are likely to have diverse effects across heterogeneous groups of individuals in the economy. Parental leaves entitlements are likely to increase the labor supply of the groups most likely to benefit from them. While these individuals may improve their "bargaining position"with parental leaves, firms are likely to pass the costs of hiring and training temporary workers to the groups benefiting from leaves. To the extent that firms may not be able to pass all the costs to workers, leave mandates may reduce labor demand and negatively affect employment of workers not directly affected by the policy. When leaves are paid and are financed with government tax revenue, as in most European countries, there is an important redistribution of resources from taxpayers to mothers on leave. Empirically, it is very hard to disentangle how these channels affect outcomes. Studies exploiting the

[1] See, for instance, Blau and Khan (1992).

variation of leave taking behavior on household level data, face the problem that the workers taking up leaves are likely to be a non-random selection of the population of workers (see, for instance, Dalto (1989) and Waldfogel (1997, 1998b)). To the extent that is hard to control for all relevant sources of (unobserved) heterogeneity and that the explanatory variables on the regressions are endogenous variables (labor market experience, tenure, number of children), the interpretation of empirical findings is subject to debate. Some empirical studies have used cross-country data to evaluate how changes in leave entitlements affect the gap between female and male outcomes (see Ruhm and Teague (1997) and Ruhm (1998)). These studies assume that changes in legislation do not affect the comparison group, but this exclusion restriction may not hold if, for instance, households substitute male labor for female labor. Moreover, the results are likely to overstate the effects of parental leaves as some countries may have implemented other "family" policies (such as child care) at the same time they expanded the generosity of parental leaves. The interpretation of results is also non-trivial as countries may differ on many dimensions that are difficult to control for. Lengthier leaves could be correlated with higher female employment if there are unobserved -country specific - factors that simultaneously increase female labor supply and a create a favorable political environment to extend leaves, suggesting that the direction of causality can go the other way around. Finally, empirical estimates are frequently imprecise due to small sample sizes and incomplete data (see the discussion in Ruhm (1998)). Summing up, the complexity of the issues involved together with data problems, the endogeneity of regressors, and the lack of a clear "natural" experiment poised important difficulties for the empirical work assessing the effects of parental leaves.

In view of the difficulties faced by empirical studies, we think that it is useful to build a benchmark model in order to improve our understanding of the mechanisms that drive the effects of parental leave policies on fertility, employment, time spent by mothers with children, and wages. We develop a framework that builds on the Mortensen and Pissarides (1994) labor-matching model in several dimensions. Females make fertility decisions and derive utility from spending time at home after giving birth. Females may want to temporary separate from a job to enjoy the utility value of staying with children without giving up their job-specific human capital. However, temporary separations are costly for employers. We consider as a benchmark a situation in which there is no government intervention in the labor market –firms and workers are free to agree on temporary separations. Moreover, bargaining leads to efficient outcomes because we assume perfect information on types and we do not impose any exogenous restriction on bargaining. The assumption of efficient bargaining is adopted not because of its realism but because it offers a useful benchmark. It also seems a natural first step before studying more complicated environments with asymmetric information or environments with limits to contracting. We model ex-ante heterogeneity across individuals to study the distributional effects of mandated leaves across education groups. Following the evidence in Topel (1991) and others, we allow for human-capital accumulation on the job, where part of this capital can be specific to a particular job relationship. The latter assumption ensures that the model is consistent with the evidence that career interruptions are followed by reductions in wages.[2]

The economy is calibrated to match key features of the labor-market and fertility behavior for the U.S. economy prior to the implementation of parental-leave policies at the federal level in 1993. We perform several quantitative policy experiments in order to study the quantitative impact of mandatory parental-leave policies. In our framework, parental parental leave policies affect equilibrium allocations and welfare through three channels: First, these policies increase the threat point used in bargaining for females that have the option of taking a parental leave (bargaining channel). Second, parental leaves reduce the value of posting vacancies which, in general equilibrium, reduces the job finding rate (general equilibrium channel). When leaves are paid there is a third channel that works through the redistribution of resources from workers –taxpayers– to mothers on leave (redistributive channel). To isolate the relative importance of these channels, we conduct some experiments that keep constant the probability of finding a job (general equilibrium channel) and eliminate the redistribution implied by paid parental leaves (redistributive channel).

[2]Phipps, *et al.* (2001) using a panel of Canadian data show that among a group of employed workers women have a higher job to non-employment turnover (and of longer duration) than men. Also, career interruptions are mostly associated with childbirth for women and lack of job opportunities for men. These job interruptions are associated with reductions in wages. Wood, *et al.* (1993) present similar evidence by looking at a specific group of highly paid workers in the United States.

We find that a one-period (1 quarter) unpaid mandatory leave policy has a small impact on employment and wages consistent with the evidence in Ruhm (1998) for leaves of short duration in European countries, and in Klerman and Leibowitz (1999) for the United States. However, we find important changes in fertility and employment behavior across educational groups, as well as substantive (distributional) effects on steady-state welfare. Such effects are quantitatively more important for paid leaves and for leaves of longer duration. Females gain substantially with generous policies, but this benefit occurs at the expense of a reduction in the welfare of males. The introduction of parental-leave policies leads to aggregate (steady-state) welfare losses because these policies subsidize inefficient matches and encourage too much leave taking by fertile females. When leaves are paid and are of relatively long duration (6 months or more), the welfare effects are mostly driven by redistribution. Nonetheless, the general equilibrium and the bargaining channels have non-trivial effects on welfare. In some experiments, we find that the bargaining channel accounts for a reduction in the welfare of newborn females. At a first glance, this result might seem surprising: Since parental leave policies increase the threat point of females, one may expect that the bargaining channel should *increase* welfare of females. However, we find that parental leaves have an additional effect on bargaining outcomes: By subsidizing leave taking, these policies reduce the surplus of a match between a female and a job and, hence, the wages and welfare of females.

We find that the redistributive channel is not important for understanding the effects of parental leave policies on fertility, leave taking decisions, and employment rate of mothers with infants. These effects are driven by the bargaining channel as the changes in the threat point of mothers drive the impact of parental leave policies on fertility and leave taking behavior: Young females anticipate that there are some states in the future in which their threat point in bargaining will be higher. Because the realization of these states depend on the decisions of females to give birth and take a leave, the change in the threat point induced by the policy subsidizes fertility and leave taking.

We evaluate the impact of mandatory leaves on the time that mothers spend at home with children. Since these policies are designed to encourage females to spend time at home with their babies, we focus on the behavior of mothers with infant children. Mandatory leaves reduce the proportion of females giving birth that reject jobs and increase the proportion of mothers who take a leave after giving birth. Interestingly, these effects are much stronger when leaves are paid. Unpaid parental leaves have a small impact on the time that mothers spend with their children but *paid* parental leaves can be an effective tool to encourage mothers to spend time with their children after giving birth.

We use our framework to compare parental leave policies with other policies that subsidize mothers. In particular, we consider subsidies to mothers that work and subsidies to mothers that stay at home. We find that parental leave policies have stronger effects on fertility, employment of mothers with infants, and time that mothers spent at home after giving birth. Regarding welfare, it is interesting that the policy that subsidizes working mothers leads to the highest welfare gains of females and the smallest welfare losses for males across the three policies considered. Here it is important to keep in mind that working subsidies, unlike parental leave policies, are not costly for the firm to implement.

Our paper is related to a growing literature of calibrated models on the economics of the family, most notably Aiyagari, et al. (2000), Regalia and Ríos-Rull (1999), and Fernández and Rogerson (2000). Caucutt, et al. (2002) study the timing of births in an environment with fertility and marriage decisions. Differently from all these papers, we abstract from marriage issues and focus on labor-market decisions and temporary separations.[3] Da-Rocha and Fuster (2006) also abstract from marriage issues and develop a quantitative model to study recent observations of fertility rates and female employment ratios in O.E.C.D. countries. Erosa, et al. (2002) develop a decision-theoretic framework in order to study the interaction between fertility and labor-supply decisions, and their impact on human capital accumulation. The framework emphasizes the implications for human capital of the distinction between job-to-job and job-to-non-employment separations that is so prevalent between men and women. In the present paper, we abstract from the types of job separations and instead allow for temporary separations between a worker and a job. Allowing for temporary separations is essential in capturing the economics of leave policies. In addition, in

[3]There is some evidence that marital status does not change child penalties in wages for women while it generates a large premium in wages for men, Phipps, *et al.* (2001).

the present paper we model the demand side of the labor market to capture the potential general-equilibrium effects of mandatory leave policies. Nevertheless, despite these substantive differences in environment, the finding that loses of tenure capital account for a small portion of wage gaps is consistent with the results in Erosa, et al. (2002). Our paper is closely related to Bernal and Fruttero (2007) who use an extension of the model by Aiyagari et al. (2000) to evaluate the role of leave policies on parental investment in children. They find that mandated unpaid leaves have negligible effects on the time mothers spend with children but paid leaves substantially increase investment time in children.

The analysis proceeds as follows. In the next section, we describe a model with voluntary leaves that we use as a benchmark. We calibrate this benchmark economy to U.S. data before the implementation of the Family and Medical Leave Act in 1993, and evaluate its main properties. Section 3 extends the analysis to unpaid and paid mandatory leaves that resemble the characteristics of current labor markets in the U.S., Canada, and some European countries. This section also performs some experiments to understand the relative importance of the bargaining, general equilibrium and redistributive channels in accounting for the impact of parental leave policies. Moreover, mandated leaves are compared with other policies that also subsidize mothers. In Section 4 we conclude and in an Appendix we include some details of the demographics of the model economy.

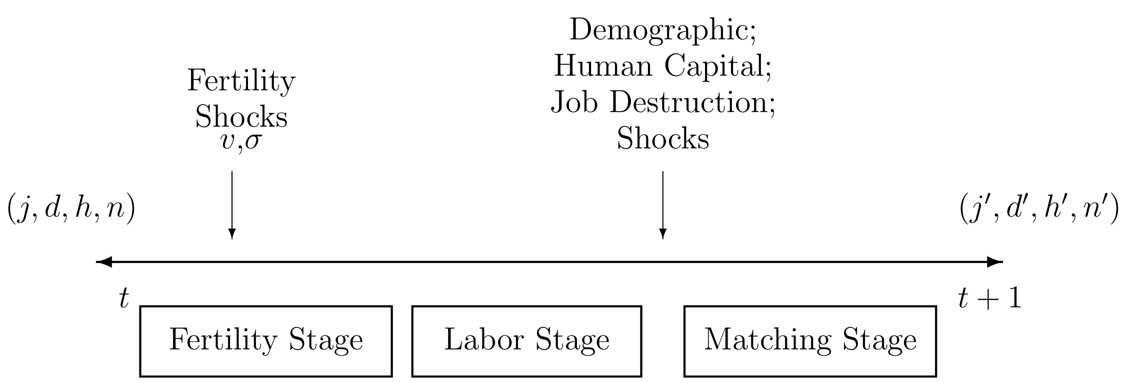
2 A Model with Voluntary Leaves

The economy is populated by a large number of workers that face exponential life –in every period there is a constant probability ρ of dying. The inter-temporal discount factor is $\widehat{\beta}$. We denote by $\beta = \widehat{\beta}(1-\rho)$ the effective discount factor, where $(1-\rho)$ is the survival probability. We assume that there is an equal proportion of males and females. Females face a constant probability ϕ of becoming non-fertile every period. People derive utility from consumption. In addition, females also derive utility from the number of children they have and from time spent with them. The instantaneous utility function is linear in consumption of goods and time spent with children, and concave with respect to the number of children.

There is a continuum of entrepreneurs that can create production opportunities without a cost. Entrepreneurs have linear preferences over consumption and post vacancies to search for workers. Posting a vacancy requires c units of the output good every period. If a worker-vacancy pair is matched, then the following period the production unit can produce, be on leave, or be destroyed. A matched vacancy that is not destroyed faces a fixed cost of C units of output per period whether the unit is producing or not. A production opportunity requires one worker.

2.1 The Problem of a Fertile Female

We use the dynamic programming language to describe the decision problem of fertile females. Fertile females make a fertility decision, a labor-market decision, and are subject to fertility and human capital shocks. The timing of decisions and shocks are represented in the diagram below. Each period is divided in a fertility stage, a labor stage, and a matching stage.



Fertility Stage Fertile females start the period with a given 4-tuple (j, d, h, n) indicating job status $j \in \{e, u\}$ (whether they are matched to a job or not), domestic status $d \in \{0, 1\}$ (indicating whether they can enjoy the value of staying at home with children or not), human capital h, and number of children n. Their discounted lifetime expected value function is given by the value function $W_j^f(d, h, n)$. At the beginning of the fertility stage, fertile females draw two shocks: A stochastic fertility opportunity and a realization of the value of staying at home with children. We assume that a fertile female with n children draws a fertility opportunity with probability $\sigma(n+1)$. In this case, she faces the decision of whether she wants to have the $(n+1)$-th child or not. When a female does not receive a fertility opportunity, she can't give birth during the current period. Fertility opportunities will be calibrated to data on the distribution of children across the population and over the life-cycle of females. The utility value of spending time with children υ is drawn from a continuous and time-invariant distribution $F(\upsilon)$, where F is assumed to be the cdf of normal distribution with mean μ_υ and variance σ_υ^2. Children are costly in terms of time and goods. Each child reduces female labor supply (e.g., hours worked) in η units and cost ψ units of goods per period. These costs are only incurred while the mother is fertile. In particular, we assume that when a female becomes non-fertile her children become adults and, thus, they are no longer costly. These features imply that given a fertility opportunity, a fertile female assesses the benefits of having a newborn child (the utility flow and the option value of spending time with them) against the direct and indirect costs. Since females face exponential life, the expected cost of children are the same in every period but differ systematically across female types.[4]

The value of a fertile female before the realizations of the fertility opportunity and the value of staying at home is

$$W_j^f(d,h,n) = \int_\upsilon \{\sigma(n+1)\max\{V_j^f(d_1,h,n+1,\upsilon), V_j^f(d,h,n,\upsilon)\} + (1-\sigma(n+1))V_j^f(d,h,n,\upsilon)\}dF(\upsilon),$$

where V_j^f is the value of a fertile female at the beginning of the labor market stage and the max operator represents the decision of whether to give birth to the $(n+1)$-th child or not, a decision that can only be made if the female draws a fertility opportunity. When the female gives birth to a child, her domestic status is set to d_1 (or $d=1$), which indicates that she can enjoy the current realization of υ if she decides to stay at home in the labor stage. In this case, moreover, the female will start the next period with $d'=1$ so that she can still

[4]Modeling the time and goods cost of children allows the model to deliver fertility rates that vary by female types. This turns out to be important for matching fertility rates by education in the data.

enjoy the value of staying at home with children. On the other hand, if the female works during the current period d' is set to 0, indicating that next period she will not be able to enjoy the value of staying at home with children (unless she gives birth to another child). This assumption ensures that all employment separations to enjoy the value of υ (whether temporary or permanent) start with the birth of a child.

Labor Stage A fertile female that is currently matched to an entrepreneur-job ($j = e$) decides whether to accept (A), to reject (R), or to be on leave (L). We assume that production takes place at the Labor Stage. We represent the labor-market decision problem as,

$$V_e^f(d,h,n,\upsilon) = \max\left\{A^f(d,h,n,\upsilon), R^f(d,h,n,\upsilon), L^f(d,h,n,\upsilon)\right\}. \tag{1}$$

The value of accepting a job A is given by,

$$\begin{aligned} A^f(d,h,n,\upsilon) \quad = \quad & w^f(d,h,n,\upsilon) - \psi n + \gamma \log(1+n) \\ & + \beta(1-\phi)(1-\lambda)\sum_{h'} W_e^f(d_0,h',n)\pi_{hh'}^a \\ & + \beta(1-\phi)\lambda\sum_{h'} W_u^f(d_0,h',n)\pi_{hh'}^r \\ & + \beta\phi\left[(1-\lambda)\sum_{h'} W_e^n(h',n)\pi_{hh'}^a + \lambda\sum_{h'} W_u^n(h',n)\pi_{hh'}^r\right]. \end{aligned} \tag{2}$$

The first term $w^f(d,h,n,\upsilon)$ represents the labor market earnings of a fertile female in state (d,h,n,υ). We assume that wages are determined by a Generalized Nash Bargaining. In equilibrium, wages depend on the worker's human capital and number of children as they both affect the output of the job match. We allow for the possibility that when $d = 1$ wages depend on the value of staying at home υ. This assumption allows for efficient separations after a childbirth: When the decision to work maximizes the surplus of the match, a female with domestic status d_1 may be induced to work with a wage rate that compensates her for not enjoying the value of staying at home with children. When $d = 0$ the worker can't enjoy the value of staying at home, so that the realization of this value does not affect wages.[5] The terms ψn and $\gamma \log(1+n)$ in equation (2) represent the goods costs and the utility flow of having n children during the current period. The rest of the terms in equation (2) denote the expected discounted future utility.

Fertile female are subject to many shocks at the end of the labor market stage. She can become non-fertile with probability ϕ, be exogenously separated from her job with probability λ, and her human capital evolves according to a first-order Markov process. If the female remains fertile and her job match is not destroyed, an event with probability $(1-\phi)(1-\lambda)$, her future discounted value is given by the function W_e^f and her human capital evolves according to $\pi_{hh'}^a$. With probability $\beta(1-\phi)\lambda$ the female remains fertile and her job match is destroyed and, in this event, her future value is given by W_u^f and her human capital evolves according to $\pi_{hh'}^r$. With probability ϕ the female becomes non-fertile. In this case, her future utility is W_e^n if she remains matched to the job and W_u^n if she becomes unmatched. Whenever a fertile female works, her next period domestic status is set to d_0. Domestic status is not a state variable for non-fertile females.

The value of rejecting a job offer R is given by,

$$\begin{aligned} R^f(d,h,n,\upsilon) \quad = \quad & \upsilon d - \psi n + \gamma \log(1+n) \\ & + \beta(1-\phi)p \sum_{h'} W_e^f(d,h',n)\pi_{hh'}^r \\ & + \beta(1-\phi)(1-p) \sum_{h'} W_u^f(d,h',n)\pi_{hh'}^r \\ & + \beta\phi \sum_{h'} \left[pW_e^n(h',n) + (1-p)W_u^n(h',n)\right]\pi_{hh'}^r. \end{aligned} \tag{3}$$

If a female stays at home, she receives the utility υd, but her labor income is zero. Note that the value of staying at home υ is enjoyed only if $d=1$. Moreover, $d'=d$ so that female can enjoy the value of staying at home for more than one period. Conditional on being alive, there is a probability p of receiving a job offer next period, a probability ϕ of

[5] Notice that if a female have given birth to n children, there are at most n periods in which the her wage rate could have been affected by the realization of the home value υ. This is because the domestic status is set to $d=0$ when the female works.

becoming non-fertile, and human capital evolves according to π^r. The superscript f (n) in the value function W indicates whether the female is fertile (non-fertile) and the subscript e (u) indicates if the female is matched (unmatched) to a job .

The value of being on leave L is given by,

$$\begin{aligned} L^f(d,h,n,\upsilon) \quad = \quad & w^l_f(d,h,n,\upsilon) + \upsilon d - \psi n + \gamma \log(1+n) \\ & + \beta(1-\phi)(1-\lambda)\sum_{h'} W^f_e(d,h',n)\pi^l_{hh'} \\ & + \beta(1-\phi)\lambda \sum_{h'} W^f_u(d,h',n)\pi^r_{hh'} \\ & + \beta\phi\left[(1-\lambda)\sum_{h'} W^n_e(h',n)\pi^l_{hh'} + \lambda \sum_{h'} W^n_u(h',n)\pi^r_{hh'}\right]. \end{aligned} \tag{4}$$

The first term represents the wage when the female is on leave. This wage is negotiated through bargaining and can be negative since the firm and the worker may share the cost of maintaining the match to preserve specific human capital. When on leave, a fertile female receives utility from staying at home with children υd and utility from having children. Conditional on the match not being exogenously destroyed, and contrary to when a fertile female is not employed, she receives in the following period an employment offer with probability 1, and human capital evolves according to $\pi^l_{hh'}$ instead of $\pi^r_{hh'}$.

An unmatched fertile female $(j = u)$ does not make any decisions in the Labor Stage. Her value coincides with that of a fertile female who rejects a job offer $V^f_u(d,h,n,\upsilon) = R^f(d,h,n,\upsilon)$.

Matching Stage New matches are formed at the end of the period (Matching Stage). In particular, matches between vacancies and workers are formed according to the following exogenous matching technology: $M(u,v) = ku^\alpha v^{1-\alpha}$ with $\alpha \in (0,1)$ and $k > 0$ where u is the mass of non-employed workers, v is the mass of vacancies posted, and $M(u,v)$ is the number (mass) of matches formed. The probability that a non-employed worker finds a job is denoted by $p = \frac{M(u,v)}{u}$. The probability that a firm matches a vacancy with a worker is $q = \frac{M(u,v)}{v}$. As previously discussed, matches are subject to an exogenous destruction probability λ every period.

2.2 The Problems of Non-Fertile Females and Males

We assume that when a fertile female becomes non-fertile, her children become adults and leave home. Upon becoming non-fertile, a female does not derive utility from spending time at home with children and her children are no longer costly in terms of goods or time. Therefore, at the beginning of the period, the state of a non-fertile female includes job status, human capital, and number of children (as she derives utility $\gamma \log(1+n)$ from the number of children). Non-fertile females only make labor-market decisions. A non-fertile female with a job considers whether to accept or reject it. It is straightforward to show that in this environment leaves are never optimal for non-fertile females. Therefore, the value of an offer for a non-fertile female is the maximum of two options,

$$V_e^n(h,n) = \max\left\{A^n(h,n), R^n(h,n)\right\}, \tag{5}$$

where the value of accepting and rejecting are simpler versions of the values for fertile females. A non-fertile female without a job does not make any decision and, therefore, the value of being unmatched (u) is the same as the value of rejecting $V_u^n(h,n) = R^n(h,n)$. At the beginning of the period, a male has as state variables job status $j \in \{e,u\}$ and human capital h. The problem of a male is similar to that faced by a non-fertile female with no children.

2.3 The Value of a Job for the Entrepreneur

The value of a job is assumed to be non-negative since matches can be broken at no cost. We assume that output is produced at the Labor Stage (e.g. before the realization of the job destruction shock λ and new matches are formed). We assume that the mapping between human capital and output is different for men and women. The output in a match, net of production costs C, with a fertile female f that has human capital h and n children is given by

$$y^f(h,n) = (1-\omega_g)(1-\omega_f\ n)\ h\ (1-\eta n) - C,$$

where labor productivity of a female is ω_g points lower than that of a male with the same human capital and each child reduces the labor productivity of mothers by ω_f points and working hours by η. Children do not affect the labor productivity and hours of work of non-fertile female. The output produced by a non-fertile female with human capital h satisfies

$$y^n(h) = (1-\omega_g)\ h\ \ - C.$$

In the calibration, the exogenous productivity differences (ω_g, ω_f) are chosen so that the equilibrium of the model generates gender and family wage gaps similar to the ones observed in the U.S. economy. We introduce the possibility of exogenous productivity differences across gender and family status since the distribution of wages across these types is crucial for fertility and labor-market decisions and the model abstracts from features that might be important in accounting for gender and family wage differences, such as mothers exerting less effort in accumulating human capital when working, discrimination in hiring, promotion, and the allocation of firm-provided training. Moreover, the relative size of the wages of mothers relative to the wages of non-mothers and men will determine the tax rate needed to finance the parental leave policies studied in the computational experiments in Section 3 of the paper.

The value of a job with a fertile female is the maximum between the value of producing, being on leave, and breaking the match. Formally,

$$J^f(d,h,n,\upsilon) = \max\left\{J_a^f(d,h,n,\upsilon), J_l^f(d,h,n,\upsilon), 0\right\}, \tag{6}$$

where the value of an active job is given by

$$
\begin{aligned}
J_a^f(d,h,n,\upsilon) \;=\;& y^f(h,n) - w^f(d,h,n,\upsilon) \qquad (7)\\
&+\beta(1-\phi)(1-\lambda)\sigma(n+1)\sum_{h'}\int_{\upsilon'}[b_e(d_0,h',n,\upsilon')J^f(d_1,h',n+1,\upsilon')\\
&+(1-b_e(d_0,h',n,\upsilon'))J^f(d_0,h',n,\upsilon')]dF(\upsilon')\pi^a_{hh'}\\
&+\beta(1-\phi)(1-\lambda)(1-\sigma(n+1))\sum_{h'}\int_{\upsilon'} J^f(d_0,h',n,\upsilon')dF(\upsilon')\pi^a_{hh'}\\
&+\beta\phi(1-\lambda)\sum_{h'} J^n(h',n)\pi^a_{hh'},
\end{aligned}
$$

where $y^f(h,n)$ denotes the output –net of the cost of maintaining a job C– produced in a job match with a fertile female with human capital h and number of children n. The expected value of a job next period depends on the realization of the human capital shock (h'), on whether the female remains fertile or not, and on the number of children in the next period. The latter is a random variable whose distribution depends on the realizations on the shocks for fertility opportunities, value of staying at home, and human capital. To forecast this distribution, we use the policy function $b_e(d_0,h',n,\upsilon')$ describing the decision to give birth.[6]

The value of a job temporarily on leave is

$$
\begin{aligned}
J_l^f(d,h,n,\upsilon) \;=\;& -C - w_l^f(d,h,n,\upsilon) \qquad (8)\\
&+\beta(1-\phi)(1-\lambda)\sigma(n+1)\sum_{h'}\int_{\upsilon'}[b_e(d,h',n,\upsilon')J^f(d_1,h',n+1,\upsilon')\\
&+(1-b_e(d,h',n,\upsilon'))J^f(d,h',n,\upsilon')]dF(\upsilon')\pi^l_{hh'}\\
&+\beta(1-\phi)(1-\lambda)(1-\sigma(n+1))\sum_{h'}\int_{\upsilon'} J^f(d,h',n,\upsilon')dF(\upsilon')\pi^l_{hh'}\\
&+\beta\phi(1-\lambda)\sum_{h'} J^n(h',n)\pi^l_{hh'},
\end{aligned}
$$

where C is the cost of maintaining the job and w_l^f is the wage when the female is on leave. The value of a job next period depends on fertility, demographic, and human capital shocks.

[6]Since the female has worked during the current period, her domestic status at the Labor Stage next period is d_0.Moreover, since the job match has not been destroyed, the policy function is evaluated at the job status e, which is indicated by the subscript e in the policy function.

Again, the policy function for birth decisions are used to forecast the probability distribution of the number of children during the next period.

The value of a job with a non-fertile female and male are simpler versions of the value functions described above.

2.4 Wage Determination

The decisions of firms and workers regarding whether to accept, to be on leave, or to break the match maximize the total surplus of the match

$$\max\left\{A^i(s) - R^i(s) + J_a^i(s); L^i(s) - R^i(s) + J_l^i(s); 0\right\},$$

where $i \in \{m, f, n\}$ denotes the demographic type of worker (male, fertile female, and non-fertile female) and s is the state of each type depending on whose problem we are considering. If the firm and the worker decide not to break the match, then the wage is determined by a generalized Nash bargaining process. In particular, the wage rate is such that the value for the worker is the value of the outside alternative plus a proportion ε of the surplus, and similarly for the entrepreneur with a share of $1 - \varepsilon$ of the surplus. The wage rates of an individual accepting and on leave are given by,

$$A^i(s) - R^i(s) = \frac{\varepsilon}{1-\varepsilon}[J_a^i(s) - 0], \quad (9)$$

$$L^i(s) - R^i(s) = \frac{\varepsilon}{1-\varepsilon}[J_l^i(s) - 0]. \quad (10)$$

Note that the outside opportunity for the individual with an offer is the value of rejecting the job. Similarly, the outside opportunity for the firm is given by the value of posting a new vacancy, which is zero in equilibrium.

We assume that all workers search in a common labor market so that they have the same job finding rate. Moreover, the probability that a vacancy is matched with a worker of a given type (gender, human capital, and the fertility status and number of children of female workers) is given by the equilibrium distribution of types across non-employed workers. In equilibrium, the vacancy to non-employment ratio is such that the expected value of a vacancy is zero.

2.5 Calibration

The Family and Medical Leave Act (F.M.L.A.) instituting three months of unpaid maternity leave was approved by the U.S. Congress in 1993. We thus calibrate the benchmark economy (an economy with voluntary leaves) to U.S. data prior to 1993.[7] Whenever possible, we use data for 1988 that are less likely to be affected by changes in behavior due to the expectation of the passage of the F.M.L.A.[8] The objective of the calibration procedure is to make the equilibrium of the model with voluntary leaves consistent with observations relevant for the purpose of our research question – employment levels of males and females, human-capital accumulation, wage differences, and fertility rates. The calibration procedure has two main components. First, a set of parameter values are selected using a-priori information. Second, the remaining parameter values are selected so that the equilibrium of the model generates statistics that match data targets. We next describe in detail these steps.

2.5.1 Parameter Values Selected without Solving the Model

The length of the model period is inversely related to the computational cost of the model. Since the calibration exercise involves finding a large number of parameter values to match data targets, choosing the length of the period is a non-trivial issue. We choose a model period of one quarter because it is the longest period that allows us to study the mandated leave policies instituted by the F.M.L.A. in the U.S. of one quarter. Mandated leaves in European countries are typically longer than a quarter and may last for a year (4 model periods). The time preference parameter β is selected to match an annual interest rate of 4%. The probability of dying in a period ρ is selected to reproduce a working-life expectancy

[7] Waldfogel (1998a) documents that about 50% of females had some maternity leave coverage before 1993. We think, however, that most of these leaves can be understood as voluntary contracts between firms and workers.

[8] The Pregnancy Discrimination Act was approved in 1978 and the benchmark model does not allow for discrimination – vacancies are posted in a single market with random matching.

of 45 years. Similarly, the probability of becoming non-fertile is selected to reproduce an expected fertile life of 20 years.[9] We set the time cost per child η to 10 percent as suggested by the empirical estimates (see Angrist and Evans, 1998 and the references therein).

Human capital depends on three factors: (a) formal education, which is fixed through the individual's life; (b) general experience, which accumulates with time working; and (c) specific tenure, which accumulates with time working within a job. The human capital of an individual with education j_E, experience j_G, and tenure j_S is

$$h(j_E, j_G, j_S) = h_E(j_E) \;\; h_G(j_G) \;\; h_S(j_S),$$

where (h_E, h_G, h_S) is a triple of vectors describing how wages grow with education, experience, and tenure. We assume three educational types: high school or less $j_E = 1$, college dropouts and associate degrees $j_E = 2$, and complete college or more $j_E = 3$. The distribution of the adult population across these types is restricted to U.S. Census data from Bachu and O'Connell (2000). The human capital of the first educational type with no experience and no tenure is normalized to 1, hence $h(1,1,1) = h_E(1) \;\; h_G(1) \;\; h_S(1) = 1$. The human capital of the other two educational types $h_E(2)$ and $h_E(3)$ are fixed so that the average wage of males in these two educational categories relative to the least educated males is consistent with wage differentials across these groups in the data.[10]

We use estimates from Topel (1991) in order to select values for how wages grow with general experience and specific human capital (h_G, h_S). Since the vectors h_G and h_S do not vary with the gender or education of individuals, we have assumed that human capital increases with experience and tenure at the same rate for all individuals in the economy. For ease of computation, experience and tenure are measured in years and are restricted to take values in the set $\{0, 1, ..., 10\}$.[11] Since the calibration fix the model period to a quarter, we

[9] For non-fertile, the probability of dying is adjusted to generate an expected life after becoming non-fertile of 25 years.

[10] Relative human capital does not correspond entirely with relative wages because of differences in tenure and experience across education types, but it represents a close approximation.

[11] The vector of general human capital h_G describes wage growth as experience varies between 0 to 10 years and is given by 1.00, 1.0697, 1.1356, 1.1973, 1.2544, 1.3070, 1.3551, 1.3992, 1.4396, 1.4773, 1.5130, 1.5478, 1.5830, 1.6198, 1.6597, 1.7045, 1.7561, 1.8166, 1.8887, 1.9756, 2.0809; and the vector of specific human capital

assume that when an individual works during the current period both experience and tenure increase by a year with probability 1/4 and that they remain constant with probability 3/4.[12] We assume that during all work interruptions (reject or leave) experience remains constant. During a temporary leave, we assume that specific human capital remains constant with probability 1. During a permanent separation (reject or exogenous job destruction), all the specific human capital accumulated on the job is destroyed (j_S is set to 1 and $h_S(1) = 1$).[13] The probability distributions (π^a, π^l, π^r) in the Bellman equations above are set to be consistent with the evolution on human capital just described.[14]

Following Blanchard and Diamond (1989) we assume a constant returns-to-scale matching technology, $M(u, v) = ku^{\alpha}v^{1-\alpha}$. These authors estimate $\alpha = 0.4$ using monthly U.S. data. According to van Ours and Ridders (1992), the average duration of a vacancy in the U.S. economy is 45 days. Following Andolfatto (1998), we use this statistic to compute the probability that a vacancy is matched in a quarter as $q = 1 - \left(1 - \frac{1}{45}\right)^{90} = 0.8677$. The Economic Report of the President indicates that the average duration of unemployment is 12 weeks, which implies a probability of being matched in a day of 1/84, and therefore $p = 1 - \left(1 - \frac{1}{84}\right)^{90} = 0.6597$. Using these targets for p and q, the equations defining these two probabilities, and the value $\alpha = 0.4$, we obtain $\frac{u}{v} = 1.3153$ and $k = 0.7776$.

There is little empirical evidence that can be used to estimate the parameter describing the bargaining power of workers in the Nash bargaining equation, ε. We find that this parameter plays a key role in determining the aggregate cost of vacancies over output in the model. When ε is low, the value of a match for the firm is high as the firm obtains a large portion of output. A large number of vacancies must be posted in equilibrium

h_S describes wage growth as tenure varies between 0 to 10 years and is given by 1.00, 1.0514, 1.0964, 1.1354, 1.1685, 1.1963, 1.2194, 1.2385, 1.2543, 1.2675, 1.2788. These values are such that an average worker in the model has an experience and tenure profile of wages similar to those estimated by Topel (1991).

[12] We make human capital evolve stochastically only for computational reasons. Since human capital is a state variable in the decision problems and we consider a quarterly period, this assumption substantially saves on grid size and as a result on computational costs. Note that since the model features risk-neutral workers and entrepreneurs, this assumption is not likely to play an important role in the results.

[13] For evidence on the behavior of wages during temporary and permanent separations see Phipps, et al. (2001), Albrecht, et al. (1999), and Wood, et al. (1993).

[14] For instance, π^a is such that when an individual with human capital $h(j_E, j_G, j_S)$ works, his next period human capital is $h' = h(j_E, j_G, j_S)$ with probability 3/4 and $h' = h(j_E, j_G + 1, j_S + 1)$ with probability 1/4.

to generate zero profits, and the total cost of vacancies over output is high. When ε is high, the value of a match is low, and less vacancies are required to make the value of a vacancy zero in equilibrium. Therefore, the total cost of vacancies over output is low. This mapping depends on the value of non-market activities. The model abstracts from the value of leisure, unemployment insurance, and home production. The model extended to include these features would increase the outside alternative for workers, diminishing the surplus to be shared between the worker and the firm, and the value of vacancies. This would reduce the number of vacancies posted in equilibrium and therefore the total cost of vacancies over output. Hence, a lower value of ε can generate the same cost of vacancies over output if these features were considered. The importance of the value of non-market activities as well as the bargaining weight figures prominently in a recent literature on the business-cycle properties of the Mortensen-Pissarides framework (see for instance Hagedorn and Manovskii, 2008). These and other authors report findings in the empirical literature that suggest an average labor cost of vacancies per worker between 2 to 4.5 percent. We select $\varepsilon = 0.9$ which generates a cost of vacancies over output close to 2 percent and implies an average cost of hiring a worker around 2.5 percent the output per worker.

Table 1 summarizes the parameter values that are selected without solving the model.

2.5.2 Calibration of Other Parameters

Given the previous set of parameter values, finding an equilibrium in our model economy involves finding a non-employment to vacancy ratio so that the value of a vacancy is equal to zero. The remaining parameter values are selected by solving the model. We compute statistics from the model to compare with data targets. There are 12 parameter values that need to be selected in this step: exogenous job destruction λ, preference parameter for the number of children γ, goods cost of children ψ, fertility opportunities $\sigma(1)$ and $\sigma(4)$, the mean and the standard deviation of fertility-home shock (μ_v, σ_v), the cost of posting a vacancy c, the cost of keeping a match C, the parameter k in the matching technology,

Table 1: Parameters Calibrated without Solving the Model

Parameter	Value
β – time preference	0.99
ρ – probability of dying	0.0056
ϕ – probability of becoming non-fertile	0.007
η – time cost of children	0.10
ε – bargaining power of workers	0.90
α – matching technology	0.40
Distribution across education:	
Edu1 (HS or less)	0.4
Edu2 (Dropout)	0.3
Edu3 (College)	0.3
Relative human capital by education:	
Edu1 (HS or less)	1.0
Edu2 (Dropout)	1.3
Edu3 (College)	2.2

and the exogenous gender and family productivity gaps (ω_g, ω_f).[15] The values of these parameters are chosen so that the equilibrium of the model reproduces the targets for the following 12 statistics: the employment-to-population ratio of males, the aggregate fertility rate, the fertility rate of females with low education level, the employment-to-population ratio of mothers with infants (children less than one year old), the fraction of age-40-women who are childless, the fraction of age-40-women who have 3 children, the probability of matching a vacancy, the fraction of mothers of a three-month-old child who are on leave, the employment-to-population ratio of fertile females, the gender wage gap, the family wage gap, and the job finding rate. We solve for an equilibrium and the calibration at the same time. As a result, our procedure involves solving numerically a system of 13 variables to match 13 targets (12 calibration targets and the equilibrium zero-profit condition for vacancies).

We calibrate the cost of children in terms of goods ψ so that the benchmark economy

[15] In the computations we restrict the maximum number of children that a female can have to six; however, we do not think that this is a severe restriction since the fraction of women with more than six children in the data is less than 0.3 percent. Also, to economize in parameters, we restrict fertility opportunities σ so that the first three components associated with the first three children take a common value and so do the last three components. We thus need to find two parameter values for σ.

reproduces the fertility rate of women with low education. According to data from the U.S. Census reported by Bachu and O'Connell (2000), women with an educational attainment of a high school degree or less have a fertility rate of 2.46 children. We use this statistic as a calibration target.[16]

We calibrate the cost of a vacancy c so that in equilibrium $\frac{u}{v} = 1.3153$. Once this target is matched, and as our discussion of the calibration of k shows, the targets for p and q are automatically matched.

The parameters (ω_g, ω_f) are chosen so that the model generates gender and family wage gaps similar to their values in the U.S. economy. Blau and Kahn (2000) report a gender wage ratio of 0.805 when adjusting for age, education, and experience differences between individuals in the sample (the unadjusted wage ratio is 0.724). Waldfogel (1998a) reports that after controlling for age, education, experience, year, and individual fixed effects, on average, a child reduces women's wages by 4.6 percent. We emphasize that in our model these gaps can have important consequences for fertility and labor-market behavior, so it is crucial that the model is consistent with relative wage observations.

A short remark on the choice of some of the data targets is worth making. First, because there is an important time trend in the employment of women, the aggregate employment-to-population ratios of older women tend to be lower than those of women of recent cohorts. Because our model abstracts from this time trend, we choose a target of employment of younger women which is less subject to a time trend. Using U.S. Census data, Bachu and O'Connell (2000) report an employment-to-population ratio of women aged 25 to 44 of 0.66. We choose this number to be our target for the employment-to-population ratio of fertile females. Second, our calibration also targets the employment-to-population ratio of mothers with infants, and the fraction of mothers with 3-month-old children who are on leave. By targeting the labor market behavior of women after childbirth, our calibration emphasizes the importance of matching female labor turnover associated with childbirth.

[16]The calibrated values for the goods and time cost of children, ψ and τ, generate an aggregate cost of children relative to output of 16 percent in the model. According to Haveman and Wolfe (1995), the cost of children relative to GDP in the U.S. economy is around 10 percent. Since he model abstracts from physical capital, using a capital income share of 0.36, we calculate the cost of children relative to labor income to be around 15.4 percent in the data, which is close to the 16 percent implied by the model.

The target statistics are obtained from Klerman and Leibowitz (1994) who use data from the Current Population Survey and supplements for recent mothers. These authors report an employment-to-population ratio of mothers with infants of 45 percent and a fraction of 8.2 percent of mothers with 3-month-old children who are on leave.

Table 2 reports the values of the parameters calibrated by solving the model and the target statistics.

Table 2: Parameters Calibrated by Solving the Model and Data Targets

Parameter	Value	Target	Value
λ	0.13	Employment-to-population ratio of males	0.86
γ	1.26	Fertility rate	2.1
c	0.16	Probability of matching a vacancy	0.87
C	0.20	Mothers of 3-month-old child on leave	0.08
μ_v	0.66	Employment-to-population ratio of fertile females	0.66
σ_v	1.92	Employment-to-population ratio of mothers with infants	0.45
ψ	0.24	Fertility rate of females with low education	2.46
$\sigma(1)$	0.05	Fraction of age-40-women childless	19.0
$\sigma(4)$	0.025	Fraction of age-40-women with 3 children	18.2
ω_g	0.12	Gender wage gap	0.20
ω_f	0.046	Family wage gap	0.10
k	0.77	Probability of finding a job	0.66

2.6 Properties of the Benchmark Economy

In this section, we show that the calibrated economy is consistent with U.S. data on a number of key dimensions. We view this as a successful first step in building a quantitative theory of labor-market and fertility decisions in the U.S. economy. We discuss some key statistics of the benchmark economy in order to help the reader understand how it behaves.

2.6.1 Calibration Results

Table 3 compares the results of the benchmark economy with U.S. data along the targets specified in the calibration section. The model matches very closely the targets for male and female employment, leaves, fertility, and wage gaps. In particular, the model matches almost exactly the targets for employment-to-population ratios of fertile females and mothers with infants together with the target for the fraction of women of 3-month-old children who are on leave. Fertility has an important impact on female employment, both in our model and in the data. While 66 percent of fertile females are employed, the employment-to-population ratio of mothers with infants is only 45 percent. These observations suggest that the model economy is generating plausible amounts of labor-market turnover due to fertility decisions.

Table 3: Calibration Results: Targets

Target	Data	Model
Employment-to-population ratio of males	0.86	0.85
Fertility rate	2.1	2.1
Probability of matching a vacancy (q)	0.87	0.81
Mothers with 3-month-old children on leave	0.08	0.08
Employment-to-population ratio of fertile females	0.66	0.66
Employment-to-population ratio mothers with infants	0.45	0.44
Fertility rate of females with low education	2.46	2.43
Fraction of age-40-women childless	19.0	20.7
Fraction of age-40-women with 3 children	18.2	17.5
Gender wage gap	0.20	0.20
Family wage gap	0.10	0.10
Probability of finding a job (p)	0.66	0.70

There is a close connection between fertility and labor turnover in the data. It is thus important that the benchmark economy not only generates fertility rates that are consistent with the data, but also that it delivers a plausible distribution of number of children across females. Table 4 compares the distribution of number of children across women between 40 and 44 years of age in the U.S. data with the distribution of children across non-fertile females in the benchmark economy (e.g., women that have completed their fertility stage). The first column in the table contains data taken from the June Supplement to the 1998 CPS and the second column contains statistics from our calibrated economy. The model generates a reasonable distribution of number of children across females. The largest differences are that the model understates the number of women with two children and overstates the number of women with four or more children.[17]

Table 4: Distribution of Number of Children across Women

	Data*	Model**
No child	19.0	20.7
One child	17.3	16.4
Two children	35.8	25.3
Three children	18.2	17.5
4 children or more	9.6	20.0

*Women 40-44 years of age

**Non-fertile Females

2.6.2 Other Implications

Next, we explore the implications of the theory in other dimensions which were not targeted in the calibration.

Employment and Fertility by Education Table 5 shows statistics on fertility and female employment by education level. Both in the benchmark economy and in the U.S. data, employment levels increase and fertility rates decrease with the level of education. While the model economy generates differences in female employment across education groups that are larger than those observed in the U.S. economy, the pattern between fertility and employment by education groups is broadly captured by the model.

Fertility and Labor Turnover by Education The difference between employment of fertile females and employment of mothers with infants provides a measure of the impact of fertility decisions on employment. Table 6 shows that fertility has a negative impact on the employment of females for all educational groups. The reduction in employment is

[17]While the model was calibrated to an aggregate fertility rate of 2.1, the data in the first column of Table 4 imply an average of 1.8 children per woman. Therefore, we could not ask the model to reproduce these two observations exactly. We note that fertility rates in the U.S. are not constant over time, thus, it should not be surprising that the mean of the distribution of children among 40-44 year-old women does not coincide with the target for the fertility rate in the data.

Table 5: Fertility and Female Employment

	Edu1	Edu2	Edu3
Fertility Rate:			
Model	2.43	2.24	1.54
Data	2.5	2.0	1.7
Female Employment-to-Population:			
Model	0.49	0.72	0.84
Data	0.59	0.69	0.74

large for females with low education: the employment-to-population ratio of mothers with infants is 23 and 24 percentage points lower than that of fertile females in the first two educational categories. Another way to evaluate the impact of fertility on labor-market decisions is to consider the decisions of females who have just given birth and are matched with a job: among these females, 38 percent work, 51 percent permanently separate, and 11 percent temporarily separate from the job for at least one period. Table 6 shows that, among females in the first educational category that give birth and are matched with a job, 73 percent decide to break the job match (reject), while for highly educated females, 73 percent return to work immediately after giving birth.[18] These implications of the model are broadly consistent with data. Using panel data from the NLSY, Erosa et al. (2005) report that the employment ratio of mothers with children less than 3 months old is 0.29 for non-college vs. 0.48 for college women. Employment ratios increase with the age of the youngest child so mothers with the youngest child between 1 to 5 years old have employment ratios of 0.54 for non-college and 0.69 for college women. We note that, in all educational categories, there is a non-negligible fraction of females taking leaves of at least one period (three or more months). This occurs even though leaves are costly for them.[19]

[18] We interpret this observation as 73 percent of females with high education return to work, with the same employer, within the three-month period after giving birth.

[19] Females on leave make on average a side payment to their employer (receive a negative wage) so that the match is not broken while they enjoy the value of staying at home with their children. The average wage among females on leave relative to the average female wage is -0.26, -0.21, and -0.13 in each education group. While negative wages do not occur in practice, we think that the environment where leaves are efficient is a useful benchmark against which to asses the impact of mandatory leaves. In the next section we illustrate how restricting the environment to non-negative wages and more than one-period mandatory leaves induces

Table 6: Employment and Labor-Market Decisions of Females

	Edu1	Edu2	Edu3
Employment-to-Population:			
Fertile Females	0.49	0.72	0.84
Mothers with Infants	0.26	0.48	0.77
Labor-Market Decisions of			
Females Giving Birth:		(fraction)	
Accept	0.22	0.34	0.73
Reject	0.73	0.51	0.10
Leave	0.05	0.15	0.17

Wage Gaps by Education We define the gender wage ratio as the average wages of females relative males and the family wage ratio as the average wages of females with children relative to females without children. Gender and family earnings ratios are defined similarly.[20] The gender and family wage ratios in the benchmark economy are 0.81 and 0.89 as targeted in the calibration procedure. The gender and family earnings ratio, however, are only 0.68 and 0.70 due to the impact of children in hours of work of mothers. Gender and family wage ratios in the model differ across education groups because, as discussed previously, fertility and labor market decisions are impacted by the level of education. Table 7 shows that the gender and family wage ratios are lower for less educated females, however, the differences are not quantitatively large. This result is broadly consistent with data. Erosa et al. (2005) report that the average gender wage ratio is 0.77 for non-college and 0.80 for college women between 20 and 40 years of age. Other authors have documented the negative impact of the number of children on wage ratios and since women with less education have more children this is consistent with the increase in the family wage ratio for more educated females in the model.

inefficient levels of leave taking by females.

[20]Since people in our model differ in the level of education and experience, we compute gender and family ratios within each education and experience level. We then use the distribution of experience to construct a weighted average of gender and family ratios for each education level and the distribution of education in order to construct an aggregate gender and family ratio that controls for differences in education and experience across genders and family status. As a result, these statistics are readily comparable with those reported in the empirical literature (see, for instance, Blau and Kahn 1997 and 2000).

Table 7: Gender and Family Wage Ratios by Education

	Fertile Females			
	All	Edu1	Edu2	Edu3
Gender Wage Ratio:				
Model	0.81	0.81	0.80	0.82
Exogenous	0.80	0.78	0.79	0.82
Family Wage Ratio:				
Model	0.89	0.88	0.88	0.91
Exogenous	0.90	0.89	0.90	0.93

To understand the differences in wage ratios by education, recall that in the model, females can have a lower wage than males for three factors: (1) the exogenous gender productivity gap ω_g and the exogenous family productivity gap per child ω_f; (2) the Nash bargaining due to expected labor turnover associated with children; and (3) the lower accumulation of specific human capital (even with the same labor market experience). This last factor is due to child-related career interruptions of females. Permanent separations can be costly in the model since all accumulated specific (tenure) capital is lost upon separation. We can decompose the gender and family ratios into an exogenous component given by the productivity factors in (1) and the endogenous component given by factor (2) and the impact of fertility and labor market decisions on specific human capital in (3). Since the bargaining power of workers in the calibration is 0.9, wages are close to productivity in the model and factor (2) should play a small role in gender wage ratios. We approximate exogenous gender and family wage ratios as follows: $(1-\omega_g)(1-\bar{n}\omega_f)$ as the exogenous gender wage ratio and $(1-\bar{n}\omega_f)$ as the exogenous family wage ratio, where $\bar{n}$ is the fertility rate. We compute these exogenous wage ratios using the fertility rate of each educational group. In aggregate, the gender wage ratio is 0.81 while the exogenous ratio is 0.80. In turn, the family wage ratio is 0.89 and the exogenous ratio is 0.90. As a result, the exogenous productivity factors in the model account for most of the differences in wages across gender and family status. Specific human capital accounts for less than 10 percent of the family wage gap in the model (1 percentage point out of 11). The quantitative importance of tenure capital in explaining wage gaps is mitigated by the endogeneity of fertility and labor market decisions in the model. If tenure capital was substantial, females would find it optimal not to destroy job matches and perhaps even not to have children. In other words, in the model mothers are systematically selected from the group of females with low tenure capital, and thus permanent separations have a small impact on human capital. This result is consistent with the findings in Erosa, et al. (2002) using a more elaborate decision-theoretic model of job transitions but that abstracts from the demand side of the labor market and from temporary separations.

We also emphasize the differences in wage ratios across education groups. The exogenous component of the gender and family wage ratio decreases with the level of education and this is a direct result of higher fertility rates for less educated females. However, the endogenous component of the gender and family gap – factor (3) – is larger for more educated females (-3 percentage points for Edu1 and 0 for Edu3 in the case of the gender gap; 1 percentage point for Edu1 and 2 percentage points for Edu2 and Edu3 in the case of the family gap). These results are related to the selection mechanism discussed previously. Females of low education are rarely at work relative to the same group of males (the employment-to-population ratio is 0.49 for females and 0.84 for males), and the females working are self-selected among the ones with high tenure capital. The selection effect implies that these females have higher tenure capital than males with the same experience and education, leading to a decrease of the gender gap relative to the exogenous gap. At the same time, the selection effect is so important for this group of females that there is almost no difference between the tenure capital of females with and without children. Females of high education have similar employment ratios as males and, therefore, the selection effect here is small, leading to similar gender gaps. Since the selection effect is not important for this group, females with children tend to have less tenure capital than females without children.

3 Mandatory Leaves

In this section, we consider an economy with an institutional arrangement that entitles females to take maternity leaves after giving birth. The objective is to study the aggregate and distributional impact of mandatory parental leaves on employment, labor-market turnover, fertility, wages, and welfare.

3.1 The Economy with Mandatory Leaves

We assume that females are entitled to take a leave of $\bar{e}$ periods after giving birth. Since we consider experiments where mandatory leaves are unpaid as well as paid, we keep the notation as general as possible. If leaves are paid, we assume that employers do not pay the benefits that females are entitled to, but face a cost C of the leave. Mandatory paid leaves are financed through a proportional tax, collected on the labor income of all employed workers regardless of gender. Females on leave receive a benefit equal to a fraction θ of the last wage (when leaves are unpaid we set $\theta = 0$, and the tax rate on labor income $\tau = 0$). Mandatory-leave policies in O.E.C.D. countries resemble the institutional arrangement just described.[21]

We assume that females can only collect benefits when they are attached to a job. In particular, a female cannot reject a job offer and collect benefits (saving the employer from incurring the cost of a leave). The decision problem of a fertile female in this setting involves a new state variable e, denoting the number of periods of leave a female is entitled to. When a female gives birth, e is set at $\bar{e}$, the maximum number of periods of leave entitlements prescribed by the law. If the female takes a leave, next period e is set at $e' = \max\{e-1, 0\}$. If she does not take a leave, e is set at 0 (for convenience we denote this state as e_0).

We do not rule out the possibility of voluntary leaves. That is, females can negotiate with their employer, period by period, for a longer leave than the one guaranteed by the law. When a female is not entitled to take a mandatory leave ($e = e_0$), the functions defining the value of accept A, leave L, and reject R are the same as the ones described under the voluntary leaves arrangement. The same applies to the value of a job and the bargaining equation defining wages when working and on a (voluntary) leave. When a female is entitled

[21] Ruhm (1998, Table 1, page 297) reports the institutional arrangement of mandatory leaves for a set of European countries. The entitlements in Europe are financed through general payroll taxes imposed by the Government, with replacement wage rates that go from 60 percent in Greece to 100 percent in Germany, and duration ranging from 14 weeks in Ireland to 64 weeks in Sweden. The mandatory entitlement in the U.S. since 1993 allows for 12 weeks of unpaid leave.

to a leave, the equation defining the wage of a mandatory paid leave is given by

$$w_l^f(d,h,n,\upsilon,e) = \theta \; w^f(d_0,h,n-1,\upsilon,e_0).$$

The above recursive representation of the benefit of a paid leave has the advantage that we do not need to carry as a state variable the last wage received before taking a leave. We approximate this wage by the wage paid to a female in state $(d_0, h, n-1, \upsilon, e_0)$. The implicit assumptions are that the last time (or period) the female was working she had $n-1$ children, could not enjoy the value of staying at home with a child $d = d_0$, and had no entitlements.[22]

We allow for the possibility of side payments between the employer and the worker so that they both agree on whether to work, temporarily separate, or break the match. In particular, if the surplus is maximized when the match is destroyed, the firm will compensate the female for rejecting the job and losing the benefit entitlements. The bargaining equation determining the side payment, which we denote as w_r, satisfies

$$R(s) + w_r(s) - L(s) = \frac{\varepsilon}{1-\varepsilon}\left[-w_r(s) - J_l(s)\right],$$

where we use the compact notation $s = (d, h, n, \upsilon, e)$ to denote the state of the worker. When a female is entitled to a leave, the threat point is given by the value of a leave (which is higher than the value of reject). If the worker takes a leave, the value of a job for the firm is equal to J_l. If J_l is too negative, the employer may be willing to pay w_r to the worker so that the female rejects and obtains $R + w_r > L$, while the employer obtains $-w_r > -J_l(s)$. When a female is entitled to a leave, the value of a job is thus given by

$$J^f(s) = \max\left\{J_a^f(s), J_l^f(s), -w_r(s)\right\},$$

which can be negative. Since employers are forward looking, they take this possibility into

[22]Note that the above formula is an approximation (although a fairly accurate one in most cases) because it may occur that a female has two children without coming back to work while keeping the job match. Also, it may happen that the human capital may have changed after the last time a female worked. It is also worth emphasizing that because $d = d_0$ the benefit of a paid leave is independent of the current realization of υ.

account when negotiating wages with fertile females. It is also worth noting that if the surplus is maximized, when a female decides to work, and the worker is entitled to a leave, then the employer pays the worker a wage in order to induce the female to work. In this case, the threat point of the worker is given by the value of taking a leave since, in this state, the value of a leave weakly dominates the value of reject for the worker. Thus, the following equation is satisfied

$$A^f(s) - L^f(s) = \frac{\varepsilon}{1-\varepsilon}\left[J_a(s) - J_l(s)\right].$$

The previous discussion makes it clear that bargaining, together with the possibility of side payments, implies that the surplus of a match is always maximized. However, mandatory paid leaves may not be efficient from the viewpoint of a society. When leaves are centrally financed through tax revenues from the government, the benefits paid to females on leave may subsidize inefficient matches. To put it simply, a match that would be destroyed in the absence of leave entitlements may not be destroyed because the worker may require a large side payment w_r in order to give up the leave entitlement.

3.2 Quantitative Experiments

The experiments below evaluate the effects of unpaid mandatory leaves of 1 period (one quarter) – which corresponds to the institutional arrangement in the U.S. after the passage of the 1993 F.M.L.A. and "European-style" mandatory leave policies involving 1 and 2 periods of fully-paid leaves (e.g., leaves that pay 100 percent of the wage of a female up to 3 or 6 months after giving birth). We also report the effects of long (up to a year) unpaid and paid leaves since several countries, such as Canada, have recently moved to leave entitlements of this long duration.

Before presenting the results, it is important to discuss the main channels through which parental leave policies affect equilibrium allocations and welfare in the model economy. First, these policies increase the threat point used in bargaining for females that have the option of taking a parental leave (bargaining channel). Second, parental leaves reduce the value of posting vacancies which, in general equilibrium, reduces the job finding rate (general equilibrium channel). When leaves are paid there is a third channel that works through the redistribution of resources from workers –taxpayers– to mothers on leave.

To isolate the effects of the general equilibrium channel, we simulate the effects of parental leave policies keeping fixed the job finding rate at the value of the benchmark economy. In addition to keeping constant the job finding rate, in a second experiment we eliminate the redistribution of resources across gender and education types induced by parental leave policies (redistributive channel). We find that parental leave policies have important effects on welfare. When leaves are paid and are of relatively long duration (6 months or more), the welfare effects are mostly driven by redistribution. Nonetheless, the general equilibrium and the bargaining channels have non-trivial effects on welfare. The bargaining channel is crucial for understanding the effects of parental leave policies on fertility, employment of mothers with young children, and the time that mothers spend at home with their newborn children. These decisions are mostly unaffected by the redistributive channel.

3.2.1 Main Findings

Mandatory leave policies have important effects on welfare, fertility decisions, labor market decisions of mothers that have just given birth, the time that mothers spend at home with their newly born babies, and on the employment of mothers with infants. Parental leaves do not have important consequences on the employment of fertile mothers.

Welfare We compute the welfare effects of mandatory leave policies as the amount of consumption required by a newborn individual to be indifferent between living a lifetime in the benchmark economy and in the mandatory-leaves economy being considered. Note that we compute a constant annual consumption compensation (expressed in terms of per capita GDP) which is applied for 45 years (45×4 periods). The results are reported in Table 8 by gender and education groups. Parental-leave policies lead to aggregate welfare losses. This should not be surprising as these policies distort the decision of keeping vs. destroying a match and the decision of whether to work or take a leave. The welfare effects differ substantially across gender and educational categories. The welfare of males falls because males pay taxes and face a lower job finding rate without benefiting from leave policies. The welfare gains of highly educated females are smaller than the welfare gains of less educated females. Females gain substantially with generous policies, but this benefit occurs at the expense of a reduction in the welfare of males. The fact that parental-leave policies have sizeable welfare-effects of opposite sign across genders suggests that these policies should affect resource allocation within the household.[23]

Table 8: Welfare of Newborns by Gender and Education

	Females				Males			
	Agg.	Edu1	Edu2	Edu3	Agg.	Edu1	Edu2	Edu3
Unpaid 1	-0.02	-0.04	-0.01	-0.05	-0.08	-0.06	-0.07	-0.12
Paid 1	0.15	0.22	0.22	-0.01	-0.50	-0.34	-0.45	-0.76
Paid 2	0.25	0.40	0.39	-0.07	-0.81	-0.56	-0.72	-1.22
Paid 4	0.33	0.58	0.54	-0.20	-1.28	-0.88	-1.15	-1.94

Notes: The numbers reported refer to annual consumption compensation for 45 years and are expressed as percentage of annual per-capita GDP of the benchmark economy.

Fertility Rates Mandatory leave entitlements have an impact on fertility rates. This result questions the often-used assumption in the empirical wage literature on the exogeneity of fertility rates. Mandatory leaves have two opposing effects on fertility rates. First, they reduce the cost of taking a leave borne by the worker which positively affects fertility. Second, since leave entitlements are conditioned on employment, mandatory leave policies raise the value of a job which negatively affects fertility. We find that the strength of these opposing effects differs systematically across education groups. Indeed, Table 9 shows that while the fertility rate of females with low education decreases monotonically with the generosity of entitlements, fertility rates of females in the second and third education category increase with entitlements. In particular, the fertility rate of females with high education increases from 1.55 under unpaid leaves to 1.76 under 2 period paid leaves. For all educational categories, fertility rates are the lowest in the benchmark economy (voluntary leaves).

[23] Extending this framework to model household decisions is a non-trivial task that we leave for future research.

Table 9: Fertility Rates by Education

	Aggregate	Edu1	Edu2	Edu3
Benchmark	2.11	2.43	2.24	1.54
Unpaid 1	2.14	2.47	2.27	1.55
Unpaid 4	2.15	2.47	2.30	1.57
Paid 1	2.18	2.46	2.30	1.69
Paid 2	2.20	2.45	2.32	1.76
Paid 4	2.23	2.43	2.33	1.85

Labor Market Decisions of Females Giving Birth Mandatory leaves reduce the proportion of females giving birth who reject jobs and increase the proportion of mothers who take a leave after giving birth. Interestingly, these effects are much stronger when leaves are paid. Whereas in the economy with 4 periods unpaid leaves (Unpaid 4) 39% of females reject a job and 22% of females take a leave after giving birth, in the economy with 1 period paid leaves (Paid 1) there are no females quitting their jobs and 85% of them take a leave (see Table 10). The fraction of females taking a leave increases to 92% and to 96% when the length of paid leaves increases to six months and to a year, respectively.

Table 10: Labor-Market Decisions

	Accept	Reject	Leave
Benchmark	0.38	0.51	0.11
Unpaid 1	0.39	0.39	0.22
Unpaid 4	0.38	0.37	0.25
Paid 1	0.15	0.00	0.85
Paid 2	0.08	0.00	0.92
Paid 4	0.04	0.00	0.96

Time Spent at Home with Children An important question is whether mandatory leaves increase the time that mothers spend at home with children. Proponents of mandatory leaves argue that these policies can benefit the health of children by facilitating breast feeding and by enhancing cognitive development.[24] Ruhm (2000) finds some empirical support for a positive impact of parental-leave policies on children's health in Europe – a 10 week extension of mandatory leaves decreases infant mortality between 1 and 2 percent. We use the model to quantify the impact of mandatory leaves on the time that mothers spend at home with children. Since these policies are designed to encourage females to spend time at home with their babies, we focus on the behavior of mothers with infant children (see Table 11). Consistently with our findings on the labor market decisions of females giving birth, we find that unpaid parental leaves have a small impact on the time that mothers spend with their children. Comparing the benchmark economy with an economy with 2 periods unpaid leaves (Unpaid 2), we find that in both economies 30% of mothers spend less than 1 quarter with their children and 52% spend at least 2 quarters. In the economy with 2 periods paid leaves (Paid 2), however, the fraction of mothers spending less than a period with their children is 7% and the fraction of mothers spending 2 or more periods at home is 80%. When the economy has a year of paid mandatory leaves, 87% of mothers spend at least 2 quarters with their children after giving birth and 71% of mothers spend at least an year with their children. We conclude that *paid* parental leave can be a very effective tool to encourage mothers to spend time with their children after giving birth.

Table 11: Distribution of Number of Periods at Home with Newborns

	% of Mothers by Number of Periods				
	0	1	≥ 2	≥ 3	≥ 4
Benchmark	30	18	52	42	35
Unpaid 1	31	27	42	35.8	31
Unpaid 2	30	19	51	35.5	31
Paid 1	12	72	16	11	9
Paid 2	7	13	80	14.5	11
Paid 4	3	10	87	79	71

Employment The employment to population ratio of mothers with infants increases substantially with the generosity of the entitlements, specially for the first two educational

[24]See for instance Ruhm (2000) and the references therein.

categories (see Table 12). While in the benchmark economy the employment ratios of mothers with infants are .26, .48 and .77 for the education groups 1, 2, and 3, respectively, in the economy with two period leaves the employment ratios are .64, .71, and .82. Nonetheless, parental leaves have a small effect on the employment ratio of fertile females. The employment ratio of fertile females in the lowest educational category increases with the generosity of entitlements. Moreover, the employment level of mothers with infants is higher than that of fertile females when leaves are paid, suggesting that mothers with low education postpone breaking the job match until the end of their leave entitlement. The employment ratios of fertile females of the two highest education categories decreases with the generosity of leaves, which is explained by the increase in the fertility rates of these females. Overall, we find that the employment rate of mothers (not just mothers with infants) is not affected much by parental leave policies. This finding implies that the job reinstatement guarantee associated to these policies does not play an important role, which follows from the fact that the job finding rate in our baseline economy is quite high (70% per period).[25]

Table 12: Employment-to-Population Ratios by Education

	Fertile			Mothers with Infants		
	Edu1	Edu2	Edu3	Edu1	Edu2	Edu3
Benchmark	0.49	0.72	0.84	0.26	0.48	0.77
Unpaid 1	0.48	0.72	0.84	0.27	0.55	0.81
Unpaid 4	0.48	0.71	0.83	0.27	0.59	0.81
Paid 1	0.51	0.71	0.83	0.55	0.66	0.81
Paid 2	0.52	0.69	0.83	0.64	0.71	0.82
Paid 4	0.53	0.69	0.83	0.72	0.76	0.83

[25]Mandatory leaves have a small impact on the employment of males because these policies have a small impact on the decision of firms to post vacancies. This result is explained by the low tax rate needed to finance parental leave policies. For instance, the tax rate on labor income in the economy with two-period leaves is equal to 1.37 percent.

3.2.2 Understanding the Relative Importance of Bargaining, General Equilibrium, and Redistribution Channels

In our model economy, parental leave policies affect equilibrium allocations through the bargaining, general equilibrium, and redistributive channels. To evaluate the relative importance of these channels we compare equilibrium allocations and welfare between the benchmark economy and an economy with 4 periods paid leaves (Paid 4). To isolate the general equilibrium effect, we simulate the effects of a 4 periods paid parental leave policy keeping fixed the job finding rate at the level in the benchmark economy. In order to assess the role of the redistributive channel, we also simulate the effects of this policy when there is no redistribution across gender and education types. To eliminate the redistribution across genders, we simulate an economy in which paid parental leaves are financed by only taxing female workers. To eliminate the redistribution across education groups, we simulate an economy in which the tax rate to finance parental leaves varies across education categories, ensuring that for each education group the aggregate tax revenue is equal to aggregate benefits collected.

The results of these experiments are reported in Table 13.[26] Note that the general equilibrium channel is driven by the fact that parental leave policies reduce the profits of firms, making it less profitable for firms to post vacancies and reducing the job finding rate for workers. While the job finding rate is .701 in the baseline economy, it is .679 in the economy with four-period paid leaves. If the job finding rate (p) is fixed at the value in the baseline economy, the welfare gain (permanent consumption compensation) of a four-period paid leave increases from 0.33% to 0.58% of GDP (compare columns 2 and 3 in Table 13). Thus, the general equilibrium channel has important effects on welfare. When p is fixed and there is no redistribution, the welfare gain of a newborn female decreases from 0.58% to −0.34%. (compare column 3 and 4 in Table 13). Eliminating the redistribution implied by a 4 periods parental leave decreases the aggregate welfare of newborn females by 0.92% of GDP.

The bargaining channel can be assessed by examining the effects of the policy once the

[26]For ease of exposition, the table reports results aggregated across education types.

Table 13: Decomposition of Effects of Four Periods Paid Leaves

	Benchmark	Paid 4	$p = 0.7$	No Redist. and $p = 0.7$
Empl. Mothers with Infants	0.44	0.76	0.76	0.76
Empl. Fertile	0.66	0.66	0.66	0.64
Fertility	2.11	2.23	2.23	2.26
Welfare	0	0.33	0.58	-0.34
Cost leaves/GDP	0.016	0.36	0.36	0.36
% Pop on leave	0.11	2.4	2.42	2.42

redistribution and general equilibrium effects have been eliminated (e.g. comparing columns 1 and 4 in Table 13). This channel accounts for a reduction in welfare of 0.34%. At a first glance, this result might seem surprising: Since parental leave policies increase the threat point of females, one may expect that the bargaining channel should increase welfare of females. However, it is important to keep in mind that parental leaves have an additional effect on bargaining outcomes: By subsidizing leave taking, these policies reduce the surplus of a match between a female and a job, which negatively affects the welfare of females.

Table 14: Effects of the Bargaining Channel

	Benchmark	Unpaid 1	Paid 1	Paid 2	Paid 4
Empl. Mothers with Infants	0.44	0.47	0.65	0.71	0.76
Welfare	0	0.036	-0.17	-0.20	-0.34
Cost leaves/GDP	0.016	0.029	0.16	0.24	0.36
% change wage newborn female	0	-0.38	-0.51	-1.04	-1.83

Note: All the policy experiments assume $p = 0.7$ and no redistribution across types. In this way, the effect of changes in bargaining can be isolated.

To visualize the interplay of these two effects on bargaining outcomes, Table 14 compares economies that differ on parental leave policies but have a common job finding rate (equal to the one in the baseline economy) and no redistribution across types. Notice that the aggregate welfare of a newborn female is higher in the economy with 1 period unpaid parental leave than in the baseline economy, a result that follows from the higher threat point of females in the economy with 1 period unpaid leaves. However, we find that more generous parental leave policies imply –when redistributional effects are eliminated– a lower aggregate welfare of females. This result is explained by the decrease in the surplus associated to leaves of long duration. Notice that paid mandatory leave policies of long duration impose important costs on firms: The aggregate cost of leaves in the economy with 4 periods paid leaves is 0.36% of GDP. In anticipation of these costs, firms and females negotiate a reduction on the wage paid to females with no children: We find that the wage of a newborn female with no children is on average (across all possible human capital levels) 2.0% lower than in the baseline economy.

Table 15 summarizes how the three channels contribute to the welfare effects of mandatory leaves policies.[27] In the case of a 1 period unpaid leave policy, we find that the general equilibrium channel reduces aggregate welfare of females (consumption compensation) by 0.06 percentage points and that the bargaining channel increases welfare by 0.04 percentage points, thereby leading to an overall welfare loss of 0.02% of GDP. (Notice that when leaves are unpaid, the redistribution channel is not operative.) In the case of a 4 periods paid parental leave policy, the general equilibrium and the bargaining channel reduce welfare of newborn females by 0.25 and 0.34 percentage points, respectively. These negative effects on welfare are more than compensated by a welfare gain of 0.92% of GDP due to the redistribution channel.

Table 15: Decomposition of Welfare Effects

	General Eq.	Redistribution	Bargaining	Total
Unpaid 1	-0.06	0	0.04	-0.02
Paid 1	-0.08	0.39	-0.16	0.15
Paid 2	-0.15	0.60	-0.20	0.25
Paid 3	-0.20	0.77	-0.26	0.31
Paid 4	-0.25	0.92	-0.34	0.33

Table 13 reveals an interesting finding: The redistributive channel is not important for understanding the effects of parental leave policies on fertility, leave taking decisions, and

[27]The welfare measure is the same as the one in Table 8.

employment rate of mothers with infants. To fix ideas, consider the effects of parental leave policies on the employment rate of mothers with infants. A 4 periods parental leave policy increases this statistic by 32 percentage points: From 44% in the benchmark economy (column 1) to 76% with 4 periods paid leaves (column 2). The impact of this policy on the employment rate of mothers with infant does not vary when the job finding rate is kept fixed (column 3) and when the redistribution across types is eliminated (column 4). Hence, the increase in the employment of mothers is entirely driven by the bargaining channel. This can also be seen in Table 14 which shows how the employment rate of mothers with infants varies as the threat point of females increases. A similar reasoning, reveals that the general equilibrium and the redistributive channel do not have important consequences on the fertility rate, percentage of females on leave, fraction of women on leave for four periods, and the resources spent by firms to keep the jobs of workers on leave. Hence, the changes in these statistics are also driven by the bargaining channel.

We conclude that changes in the threat point of females giving birth drive the impact of parental leave policies on fertility and leave taking behavior: Young females anticipate that there are some states in the future in which their threat point in bargaining will be higher. Because the realization of these states depend on the decisions of females to give birth and take a leave, the change in the threat point induced by parental leaves subsidizes fertility and leave taking.

3.2.3 Parental Leave Policies vs. Other Subsidies to Mothers

We compare parental leave policies with two other policies that also subsidize fertile female with children. We assume that fertile females receive a fixed amount per child and that the subsidy is either contingent on the decisions to work or to stay at home: While in the first case the subsidy is only collected by fertile females who work, in the second case the subsidy is received by females who stay at home. Moreover, the subsidy is financed by taxing labor earnings of all individuals in the economy and the tax rate is set equal to the one in the economy with paid parental leave policies of 2 periods (Paid 2). The amount of the per child subsidy is determined so that in equilibrium the government budget is balanced.

Table 16: Comparing Two-Period Paid Leave with Other Subsidies to Mothers

	Benchmark	Paid 2	Work-Subsidy	Home-Subsidy
Empl. Mothers with Infants	0.44	0.70	0.50	0.38
Empl. Fertile	0.66	0.66	0.76	0.56
Fertility	2.11	2.2	2.15	2.20
Welfare Females	0	0.25	0.78	-0.26
Welfare Males	0	-0.81	-0.07	-1.36
Job Finding Rate (p)	0.70	0.69	0.75	0.65

We find that the employment of fertile females varies substantially across the economies considered (see Table 16). While the employment of fertile female increases from 66% in the benchmark economy to 76% in the economy with work-subsidies, it is not affected by a 2 periods paid parental leave. However, the parental leave policy has a much stronger effect on the employment of mothers with infants: Whereas this statistic increases by 26 percentage points with parental leaves, it rises by 6 percentage points with work subsidies. The subsidy to stay at home reduces both the employment of fertile females and of mothers with infants. While the fertility rate increases with the three policies considered, the increase is much lower in the case of the policy that subsidizes work.

Table 17 reveals that the policies that subsidize either working mothers or mothers who stay at home have very little impact on the time that mothers spent at home after giving birth. This stands in contrast to the paid leave policy which reduces the fraction of mothers that stay less than 1 period with their children from 0.30 in the baseline economy to 0.067 and increases the fraction of mothers that stay 2 periods with their children from .10 in the baseline economy to .66.

Regarding welfare, it is interesting that the policy that subsidizes working mothers leads to the biggest welfare gains for females and the smallest welfare losses for males across the three policies considered (see Table 16). The policy that impacts more negatively on the welfare of both males and females is the one that subsidizes staying at home. In understanding these results, it is important to keep in mind that, unlike parental leave policies, work subsidies are not costly for the firm to implement. Working subsidies lead firms to post more

Table 17: Time Spent with Children under Alternative Subsidies

% of Mothers by Number of Periods			
	0	1	2
Benchmark	30	17	10
Paid 2	6.7	13	66
Work-Subsidy	32	19	11
Home-Subsidy	27	16	9.0

vacancies, increasing the job finding rate from .70 in the baseline economy to .75 and, hence, improving the welfare of all agents in the economy.

Finally, Table 18 shows that the policy that subsidizes work increases the average human capital of females, with this effect being more important for females with the lowest level of education. By stimulating female employment, this working subsidies increase the human capital accumulated by females. On the other hand, parental leaves decrease the human capital of females. This finding should not be surprising: Parental leaves have a small effect on the overall employment rate of mothers. Moreover, because in the benchmark economy the females with high specific human capital choose not to interrupt their careers (see the discussion on Section 2.6.2), there is not much role for parental leave policies to protect females giving birth from losing specific human capital (see also Erosa et al. 2002). Finally, having found that work subsidies increase human capital of females, it is interesting that this policy leads to a small *increase* in the gender wage gap. This is due to a selection effect that drives down the average human capital of employed females.

Table 18: Percentage Change in Human Capital Relative to Benchmark.

	Agg.	Edu1	Edu2	Edu3
Paid 2	-0.66	-0.68	-0.80	-0.59
Work-Subsidy	0.53	1.43	0.43	0.05
Home-Subsidy	-1.045	-1.87	-1.50	-0.28

4 Conclusions

This paper builds a quantitative theory of labor-market and fertility decisions that is successful in matching U.S. data regarding employment, wages, and fertility rates both at the aggregate level and across gender and education groups. We build on the labor-market theory of Mortensen and Pissarides (1994). We extend this basic framework in three dimensions: First, we model male and female workers, where females make fertility decisions. Second, we model human-capital accumulation on the job in the form of general and specific human capital. Third, we model temporary job separations of female workers due to childbirth. We consider two institutional arrangements for temporary job separations: voluntary and mandatory leaves. We use our theory to quantify the impact of mandatory-leave entitlements on fertility, employment, welfare, and wages in the aggregate and across education and gender groups.

We find that mandatory-leave policies lead to substantial redistributions across people in terms of steady-state welfare and lead to changes in fertility and employment ratios. The introduction of parental-leave policies leads to aggregate (steady-state) welfare losses because these policies subsidize inefficient matches and encourage too much leave taking by fertile females. However, we stress that this last finding should be interpreted with care: In our framework firms and employees can efficiently negotiate voluntary leaves. Hence, to match the low fraction of women taking parental leaves in the U.S. prior to the passage of the FMLA, our calibration implies that the cost of leave entitlements should be high relative to the benefits. Alternatively, it may be that market imperfections such as asymmetric information or limits to contracting may have limited the ability of the market forces in the U.S. to provide voluntary leaves. In this case, government regulation may play a role in increasing the surplus in job matches and mitigating human capital losses by females that were forced to permanently break job matches in order to spend time at home with their children. Moreover, there is some empirical evidence that parental leaves improve pediatric health (see Ruhm (2000)). This may provide a rationale for parental leave policies if parents discount the future more heavily than socially optimal (say because of borrowing constraints), or only pay a fraction of health costs (which are partly covered by medical insurance), or there are some negative health externalities imposed on other children that parents ignore.

Our work can be extended in a number of dimensions. Private information on people's preferences towards family leaves may lead to an under-provision of parental leaves; therefore, it would be relevant to consider a framework with asymmetric information about people's preferences regarding the value of time spent with children, and how this positive role for parental-leave policies interact with the negative effects in the labor market. Finally, our framework is suitable for studying parental-leave policies in conjunction with other labor-market institutions that may affect the female labor supply in important ways (such as the availability of part-time jobs, child-care policies, firing costs and other employment-protection policies). We leave these important extensions of the model for future research.

A Appendix

In this appendix we present the laws of motion of the different demographic groups and of the aggregate population in our model. Since individuals make fertility decisions, the population growth rate is endogenous. Below we show how the population growth rate is determined in a steady-state equilibrium.

Distributions of Households The population is composed of males, fertile females, non-fertile females, and children. We denote the mass of each of these demographic groups by m, f, nf, and ch, respectively, and the fraction of fertile females that give birth by B_t. The laws of motion of the population of each of the demographic groups are as follows:

$$
\begin{aligned}
ch_{t+1} &= (1-\phi)(ch_t + B_t f_t), \\
m_{t+1} &= (1-\rho)m_t + \frac{1}{2}\phi\left(ch_t + B_t f_t\right), \\
f_{t+1} &= (1-\rho)(1-\phi)f_t + \frac{1}{2}\phi\left(ch_t + B_t f_t\right), \\
nf_{t+1} &= (1-\rho)nf_t + (1-\rho)\phi f_t.
\end{aligned}
$$

The mass of children at date $t+1$ is given by the fraction of children $(ch_t + B_t f_t)$ that do not become adults at date t (because the mother does not become non-fertile). We assume that half of all newborn children are females in order to keep the gender distribution of the adult population constant over time.

We denote by X_f the distribution of states (j, d, h, n) across fertile females at the beginning of the period. X_{nf} denotes the distribution of states (j, h, n) across non-fertile females and X_m denotes the distribution of states (j, h) across males at the beginning of the period. Therefore, we can define the fraction of fertile females that give birth as

$$
B_t = \int_{j,d,h,n,\upsilon} b_j(d, h, n, \upsilon) X_f(j, d, h, n) dF(\upsilon).
$$

Population Growth Rate The total population next period equals the population in the current period plus the newborn children minus the number of deaths, that is,

$$P_{t+1} = P_t + f_t B_t - \rho P_t,$$

where P_t denotes the population at period t, $P_t = m_t + n f_t + f_t + ch_t$. In a steady state, the rate of growth of population, g, is constant; that is, $P_{t+1} = (1+g)P_t$ and, thus,

$$gP_t = f_t B_t - \rho P_t.$$

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