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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, their aggregate effects in the economy are not well understood. To assess their quantitative impact, we develop a general equilibrium model of fertility and labor market decisions that builds on the labor matching 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. Leave policies have important effects on fertility, leave taking decisions, and employment. These effects are mainly driven by how the policy affects bargaining – young females anticipate future states with higher threat points induced by the policy. Because the realization of these states depend on the decisions of females to give birth and take a leave, leave policies effectively subsidize fertility and leave taking. We also find that generous 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.[1] 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 welfare 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 difficult to disentangle how these channels affect outcomes. Studies exploiting the 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 workers.[2] To the extent that is difficult to control for all relevant sources of 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.[3] These studies are also subject to limitations. First, these studies are likely to overstate the effects of parental leave policies as some countries have implemented other family policies such as child care at the same time they expanded the generosity of parental leaves. Second, countries may differ on dimensions that are difficult to control for in the regressions. Third, estimates are limited by small sample sizes and incomplete data.[4]

[1]These policies specify a minimum amount of leave time that a person is entitled to in order to care for a newborn child with job dismissal prohibited during pregnancy and a guaranteed job after the leave.

[2]See for instance, Dalto (1989) and Waldfogel (1997, 1998b).

[3]See for instance Ruhm and Teague (1997) and Ruhm (1998).

[4]See the discussion in Ruhm (1998).

In view of these difficulties, we find it useful to build a benchmark model in order to improve our understanding of the mechanisms that drive the effects of parental leave policies. We develop a framework that builds on the Mortensen and Pissarides (1994) matching model in several dimensions. Females make fertility decisions and derive utility from spending time with children after giving birth. Females may want to temporarily separate from a job to enjoy the utility value of staying at home 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.[5] In this framework, 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 reduces the job finding rate (general equilibrium channel). Third, paid parental leaves induce a redistribution of resources from workers –taxpayers– to mothers on leave (redistributive channel). In order to explore the quantitative significance of these channels, we calibrate the economy without parental leaves to data for the U.S. economy prior to the implementation of parental leave policies at the federal level in 1993.

Our quantitative analysis leads to three key findings. First, we find substantial effects of parental leave policies on steady-state welfare with these effects being 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. Parental leave policies lead to aggregate steady-state welfare losses because these policies subsidize inefficient matches and encourage too much leave taking by fertile females. Second, we find that the change in welfare of females is affected by the general equilibrium, redistribution, and bargaining channels operating in the model. However, when leaves are

[5]The assumption of efficient bargaining is adopted not because of its realism but because it offers a useful benchmark to evaluate the costs and the redistributive effects of parental leave policies.

paid and of relatively long duration, the welfare effects are mostly driven by the redistribution channel. Third, parental leave policies have non-trivial effects on fertility, employment, and the time that mothers spend at home with children. We also compare the effect of parental leave policies with two other policies that subsidize mothers: a subsidy to working mothers and a subsidy to staying at home mothers. While parental leave policies induce the strongest effects on allocations (fertility, employment, and time spent with children), the subsidy to working mothers leads to the highest welfare gains of females and the smallest welfare losses for males across the three policies considered.

Our paper is related to a large literature of calibrated models on the economics of the family.[6] Differently from many papers in this literature, we abstract from marriage issues and focus instead on labor-market decisions and temporary separations.[7] Our paper is closest to Erosa, et al. (2002). A critical distinction is that we allow for temporary separations between a worker and a job which is essential in capturing the economics of leave policies. Moreover, we model the demand side of the labor market to capture the general equilibrium effects induced by mandatory leave policies.[8]

The analysis proceeds as follows. In the next section, we present a model with voluntary leaves, calibrate it to U.S. data, and evaluate its main properties. Section 3 extends the analysis to mandatory leaves and performs experiments to understand the quantitative importance of bargaining, general equilibrium and redistributive channels. We also compare mandated leaves with other policies that subsidize mothers. We conclude in section 4.

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. We assume that there is an equal

[6]For instance Aiyagari, et al. (2000), Regalia and Ríos-Rull (1999), Fernández and Rogerson (2001), Caucutt, et al. (2002), Da-Rocha and Fuster (2006), among many others.

[7]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).

[8]Our paper is also closely related to Bernal and Fruttero (2007) who 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.

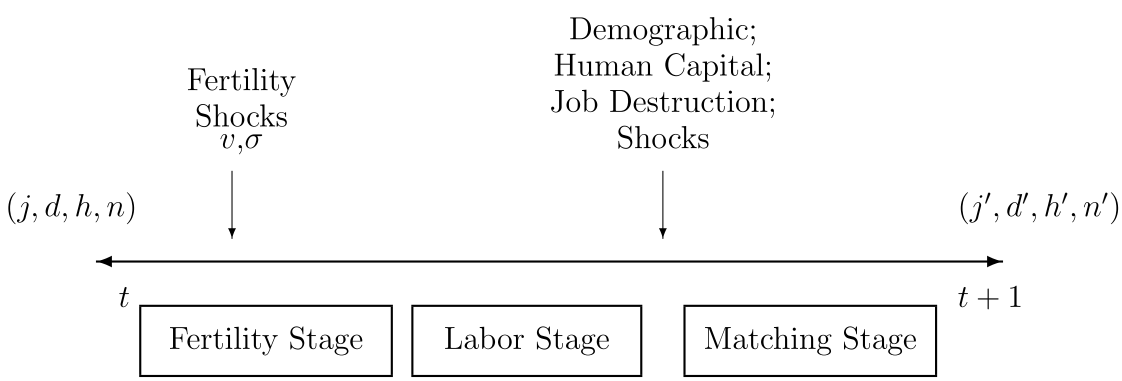
proportion of males and females. We model ex-ante heterogeneity across individuals to study the distributional effects of mandated leaves across education groups. Females face a constant probability ϕ of becoming non-fertile every period. People derive utility from consumption. In addition, females also 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 $W_j^f(d, h, n)$. 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 draws a fertility opportunity with probability σ. We let σ depend on the number of children a fertile female has at the beginning of the period and will be calibrated to match data on the distribution of children across women. 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 a normal distribution with mean μ_υ and variance σ_υ^2. Children are costly in terms of time and goods.[9] Each child reduces female labor supply (e.g., hours worked) in η units while working and costs ψ units of goods per period. These costs are incurred while the mother is fertile so when a female becomes non-fertile her children become adults and thus 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.



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

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

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

[9] 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.

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 enjoy the value of staying at home with children. 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 a 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,

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

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 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 cannot enjoy the value of staying at home, so that the realization of this value does not affect wages.[10] 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 other terms in equation (2) denote the expected discounted future utility where the superscript f (n) in the value function W indicates whether the female is fertile (non-fertile) and the subscript e (u) indicates whether the female is matched (unmatched) to a job. The inter-temporal discount factor is $\widehat{\beta}$ and the effective discount factor is $\beta = \widehat{\beta}(1-\rho)$, where $(1-\rho)$ is the survival probability.

A fertile female is 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 $\pi^a_{hh'}$. With probability $(1-\phi)\lambda$ 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 $\pi^r_{hh'}$. 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.

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

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

If a female stays at home, she receives the utility υd, but her labor income is zero. Note that

[10] Notice that if a female has given birth to n children, there are at most n periods in which 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.

the value of staying at home υ is enjoyed only if $d = 1$. Moreover, $d' = d$ so that she 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 becoming non-fertile, and human capital evolves according to π^r.

The value of being on leave L is given by,

$$\begin{aligned} L^f(d,h,n,\upsilon) &= w_f^l(d,h,n,\upsilon) + \upsilon d - \psi n + \gamma \log(1+n) \\ &+\beta(1-\phi)(1-\lambda)\sum_{h'} W_e^f(d,h',n)\pi_{hh'}^l \\ &+\beta(1-\phi)\lambda\sum_{h'} W_u^f(d,h',n)\pi_{hh'}^r \\ &+\beta\phi\left[(1-\lambda)\sum_{h'} W_e^n(h',n)\pi_{hh'}^l + \lambda\sum_{h'} W_u^n(h',n)\pi_{hh'}^r\right]. \end{aligned} \tag{4}$$

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 $\pi_{hh'}^l$ instead of $\pi_{hh'}^r$.

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 $V_u^f(d,h,n,\upsilon) = R^f(d,h,n,\upsilon)$.

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 $V_u^n(h,n) = R^n(h,n)$.

Males at the beginning of the period have 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

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

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

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 females. The output produced by a non-fertile female with human capital h satisfies

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

We introduce the possibility of exogenous productivity differences across gender and family status (ω_g, ω_f) 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.[11] In the calibration, exogenous productivity differences are chosen so that the model generates gender and family wage gaps similar to the ones observed in the U.S. economy.

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,

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

[11] Wages of mothers relative to wages of non-mothers and men will determine the tax rate needed to finance parental leave policies studied in the computational experiments in Section 3 of the paper.

where the value of an active job is given by

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

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 number of children next period is a random variable whose distribution depends on the realizations of 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.[12]

The value of a job temporarily on leave is

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

where C is the cost of maintaining the job and w_l^f is the wage when the female is on leave.

[12] 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.

The value of a job next period depends on fertility, demographic, and human capital shocks. Again, the policy function for birth decisions is used to forecast the probability distribution of the number of children during the next period.

The values of a job with a non-fertile female and a job with a 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,

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

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

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.[13] Moreover, the probability that a vacancy is matched with a worker

[13] This assumption is made to simplify the computation of equilibrium. Our quantitative findings suggest

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.[14] 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.[15] 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

that modeling a separate labor market for each education type is not likely to have important consequences for the results that we focus on, as mandatory leaves policies have a small impact on the decision of firms to post vacancies.

[14] 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.

[15] 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.

leave policies instituted by the F.M.L.A. in the U.S. of one quarter. The time preference parameter $\widehat{\beta}$ 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 of 45 years. Similarly, the probability of becoming non-fertile is selected to reproduce an expected fertile life of 20 years.[16] 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

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

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 $h(1,1,1) = h_E(1) \cdot h_G(1) \cdot h_S(1) = 1$. 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.[17]

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

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

[17] 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.

ease of computation, experience and tenure are measured in years and are restricted to take values in the set $\{0, 1, ..., 10\}$.[18] Since the model period is set to a quarter, we 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.[19] 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 $h_S(1) = 1$).[20] 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.[21]

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 (1996), 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 $k = 0.7776$.

The bargaining power of workers ε plays a key role in determining hiring costs. We

[18] 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 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).

[19] We make human capital evolve stochastically 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.

[20] 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).

[21] For instance, π^a is such that when an individual with human capital $h(j_E, j_G, j_S)$ works, 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.

choose $\varepsilon = 0.9$ which generates a vacancy cost over output close to 2% and an average cost of hiring a worker of 2.5% the output per worker.[22]

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

Table 1: Parameters Calibrated without Solving the Model

Parameter	Value
$\widehat{\beta}$ – 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

2.5.2 Calibration of Other Parameters

The remaining parameter values are selected by solving the model. We compute statistics from the model to compare with data targets. Then the parameter values are selected so that the model statistics match the 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, and the exogenous gender and family productivity gaps (ω_g, ω_f).[23] The values of these parameters are chosen so

[22]This hiring cost is consistent with the available empirical evidence, see for instance the discussion of this evidence in Hagedorn and Manovskii (2008).

[23]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

that the the model reproduces the targets for 12 statistics as described in Table 2. Finding an equilibrium in the model involves finding a non-employment to vacancy ratio so that the value of a vacancy is equal to zero. 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.

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	0.19
ω_f	0.046	Family wage gap	0.11
k	0.77	Probability of finding a job	0.66

We now discuss some of the choices of data targets. We target an aggregate fertility rate of 2.1. 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 which we use as another target.[24] We target a ratio of unemployment to vacancies of 1.32. Once this target is matched, and as our discussion of the calibration of k shows, the targets for $p = 0.66$ and $q = 0.87$ are automatically matched. Blau and

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.

[24] 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 the 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.

Kahn (2000) report a gender wage ratio of 0.81 when adjusting for age, education, and experience differences between individuals in the sample. 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. As a result we target a family wage gap of 0.11. 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. 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. 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.

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	19.7
Fraction of age-40-women with 3 children	18.2	17.7
Gender wage gap	0.19	0.19
Family wage gap	0.11	0.11
Probability of finding a job (p)	0.66	0.70

Empirical evidence establishes a close connection between fertility and labor turnover, for instance, Phipps, et al. (2001) document that 90% of career interruptions of women are related to childbirth. 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 children across females. Table 4 reports the distribution of children across women between 40 and 44 years of age in the U.S. data (see Bachu and O'Connell, 2000) with the distribution of children across non-fertile females in the benchmark economy (e.g., women that have completed their fertility stage). The model is able to generate a reasonable distribution of number of children across females.[25]

[25]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

Table 4: Distribution of Number of Children across Women

	Data	Model
No child	19.0	19.7
One child	17.3	16.7
Two children	35.8	25.6
Three children	18.2	17.7
4 children or more	9.6	20.3

Note: The column Data refers to women 40-44 years of age and Model refers to non-fertile females

2.6.2 Other Implications

We explore implications of the theory in dimensions which were not targeted in the calibration.

Employment, Fertility, and Labor Turnover by Education Employment levels increase and fertility rates decrease with the level of education both in the model and the data. The pattern between fertility and employment by education groups is broadly captured by the model, although the model generates larger differences in employment across education groups than in the data (see Table 5).

Table 5: Fertility and Fertile Females Employment

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

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.

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 large for females with lower education levels. These implications of the model are broadly consistent with data.[26]

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

Another way to evaluate the impact of fertility on labor-market decisions is to consider the labor-market decisions of females giving birth. These decisions differ systematically across education groups. Whereas the percentage of women who reject a job after giving birth is 73% for low education women, this percentage is only 10% for females with high education (see Table 6).[27]

Wage Gaps by Education The gender and family wage ratios in the model are 0.81 and 0.89 as targeted in the calibration procedure.[28] Gender and family wage ratios in the model

[26] Using panel data from the NLSY, Erosa et al. (2009b) 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.

[27] Note that in all educational categories there is a non-negligible fraction of females taking leaves of at least one period even though leaves are costly for them. 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 to assess the impact of mandatory leaves.

[28] 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. Since people in

differ across education groups because fertility and labor market decisions vary with the level of education. Table 7 shows that the gender and family wage ratios are lower for less educated females, though the differences are not quantitatively large. This result is broadly consistent with data.[29]

To understand how human capital accumulation affects wage ratios in our model, we isolate the contribution of the exogenous components of wage differences. We approximate the exogenous gender ratio by $(1-\omega_g)(1-\bar{n}\omega_f)$ and the exogenous family wage ratio by $(1-\bar{n}\omega_f)$, where $\bar{n}$ is the fertility rate of the relevant educational group. In aggregate, the gender wage ratio is 0.81 while the related exogenous ratio is 0.80. In turn, the family wage ratio is 0.89 and the exogenous family 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 were substantial, females would find it optimal not to destroy job matches and perhaps even not to have children. In other words, in the model non-working mothers are systematically selected from the group of females with low tenure capital, and thus permanent separations have a small impact on human capital.[30] This selection effect is particularly strong for females of low education, who 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). Since the females working are self-selected among the ones with high tenure capital,

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).

[29] Erosa et al. (2009b) 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.

[30] 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.

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

the gender wage ratio is higher than the exogenous wage ratio for the low education group (.81 versus .78). The selection effect is small for females of high education as they have similar employment ratios as males, which explains why the gender wage ratio is equal to the exogenous gender wage ratio for this group of females.

3 Mandatory Leaves

In this section, we consider an economy with an institutional arrangement that entitles females to take maternity leave after giving birth. The objective is to study the aggregate and distributional impact of mandatory parental leaves on outcomes.

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. 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.[31]

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. 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 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.[32]

[31] 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.

[32] 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.

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 $s = (d, h, n, v, e)$ 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 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

We evaluate the effects of a 1-period unpaid parental leave policy which corresponds to the institutional arrangement in the U.S. after the passage of the 1993 F.M.L.A. and "European-style" parental leave policies involving 1 and 2 periods of fully-paid leaves (e.g., leaves that pay 100 percent of the wage). 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.

3.2.1 Main Findings

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.[33]

Table 8: Welfare 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

Note: 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. Compared to the benchmark economy, mandatory leave policies increase fertility in aggregate as well as by education groups (see Table 9). One exception is the fertility rate of females in the lowest education group with a 4-period paid leave which is roughly the same as in the benchmark economy. Interestingly, for this group of females with leave policies, the fertility rate decreases with the generosity of leave entitlements. To understand this result, we note that 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 of workers who are matched with a job. Second, mandatory leave policies encourage unmatched workers to postpone fertility decisions until they are matched with a firm, thereby reducing the fertility of non-employed workers. This effect is particularly important for females in the lowest education group since this group has the lowest employment rate.[34]

Labor Market Decisions of Females Giving Birth Mandatory leaves reduce the proportion of females giving birth who reject jobs and increase the proportion taking leaves.

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

[34]The fraction of unmatched fertile females that give birth decreases from 2.7 in the benchmark economy to 2.6 in the economy with 4-period paid leaves.

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
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

Interestingly, these effects are much stronger when leaves are paid. Whereas in the economy with 1 period unpaid leaves (Unpaid 1) 22% of females giving birth decide to take a leave and 39% reject a job, in the economy with 1 period paid leaves (Paid 1) 85% of mothers take leaves and there are no mothers rejecting jobs (see Table 10). The percentage of females giving birth taking leaves increases to 92% and to 96% when the length of paid leaves increases to 2 and 4 periods.

Table 10: Labor-Market Decisions of Females Giving Birth

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

Employment vs. Work Parental-leave policies introduce a distinction between employment and work since these policies encourage females to take leaves. This distinction may be relevant for wages of females if more work leads to more human capital accumulation on the job (see Erosa, et al. (2009b) for a quantitative assessment of this channel in the U.S. economy). Therefore, it is of interest to quantify the impact of mandatory leave policies on the working decision of females. Table 11 shows the working and employment-to-population ratios for fertile females and for mothers with infants. Whereas in the benchmark economy 44% of mothers with infants are employed and 41% are working, in the economy with six-months-paid mandatory leaves (Paid 2), 71% of mothers with infants are employed, and only 22% are working. Hence, mandatory leaves increase the employment of mothers with infants because of greater leave taking. Overall, we find that the employment rate of fertile females is not affected much by parental leave policies. This finding implies that the job reinstatement guarantee associated with 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).[35]

Table 11: Ratios of Employment and Working to Population (%)

	Fertile Females		Mothers with Infants	
	Employment	Working	Employment	Working
Benchmark	66.4	66.0	44.1	40.7
Unpaid 1	66.0	65.3	47.8	41.3
Paid 1	66.6	63.0	64.4	29.5
Paid 2	66.4	61.0	70.6	21.6
Paid 4	66.6	58.6	76.1	13.2

Note: Employment includes all matched individuals (working and on leave), whereas Working excludes those on leave.

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

In the model, 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 economies with parental leave policies. To isolate the general equilibrium effect, we simulate an economy with a parental leave policy keeping fixed the job finding rate of the

[35]Mandatory leave policies have a small impact on the employment of males because these policies have a small effect on the decision of firms to post vacancies. This result is explained by the low tax rate needed to finance parental leaves. For instance, the tax rate on labor income in the economy with 2-period paid leave is equal to 1.37 percent.

benchmark economy. We also simulate the effects of policies when there is no redistribution across gender and education types. To eliminate the redistribution effect across genders, we assume that parental leaves are financed with taxes on female workers. To eliminate the redistribution effect across education groups, we assume that 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 bargaining channel can be assessed by examining the effects of the policy once the redistribution and general equilibrium effects have been eliminated. The results of these experiments are summarized in Table 12 for an economy with 4 periods paid leaves.[36] We find that the effect of paid parental leave policies on welfare of females is determined by the important contribution of all three channels. However, the effect of these policies on fertility and employment is mainly driven by the bargaining channel.

If the job finding rate (p) is fixed at the value in the baseline economy, the welfare gain (permanent consumption compensation) of a 4-period paid leave increases from 0.33% to 0.58% of GDP (compare columns 2 and 3 in Table 12). Thus, the general equilibrium channel has important effects on welfare. When the redistributive effects of the policy are eliminated, the welfare gain of a newborn female decreases from 0.58% to -0.34% of GDP (compare columns 3 and 4 in Table 12). Hence, the redistributive channel generates an increase in welfare of 0.92% of GDP. The bargaining channel is assessed by examining the effects of the policy once the redistribution and general equilibrium effects have been eliminated, and it accounts for a reduction in welfare of 0.34% of GDP. That the bargaining channel implies a reduction in welfare may seem surprising at first glance. Since parental leave policies increase the threat point of females, we may expect that the bargaining channel should increase welfare of females. However, parental leaves have an additional effect on bargaining outcomes – by subsidizing leave taking these policies reduce the surplus of a match which negatively affects the welfare of females.

To better assess the importance of these two effects –changes in threat point and surplus of

[36]For ease of exposition, the table reports results aggregated across education types. For the welfare effects of parental leave policies of length other than 4 periods, see Erosa et al. (2009a).

Table 12: Decomposition of Effects of a 4-Period Paid Leave

	Benchmark	Paid 4	$p = 0.7$	No Redist. and $p = 0.7$
Welfare of Females (% of GDP)	–	0.33	0.58	-0.34
Employment of Mothers with Infants	0.44	0.76	0.76	0.76
Employment Fertile Females	0.66	0.66	0.66	0.64
% of Population on Leave	0.11	2.40	2.42	2.42
Fertility	2.11	2.23	2.23	2.26
Cost of Leaves/GDP	0.02	0.36	0.36	0.36

Note: The third column is an economy with no general equilibrium effects while the fourth column is an economy with no general equilibrium and no redistribution effects.

matches– on bargaining outcomes, Table 13 compares economies that differ on the generosity of parental leave policies. Each of these economies abstracts from general equilibrium and redistribution effects. Welfare of females is higher in the economy with 1-period unpaid leaves than in the benchmark economy, a result that follows from the higher threat point of females with the mandated leave. However, more generous leave policies imply lower aggregate welfare of females due to the bargaining channel, a result that follows from the decrease in the surplus of matches 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-period 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 – the wage of a newborn female with no children is on average (across all possible human capital levels) 2% lower than in the benchmark economy.

The discussion above underscores that parental leave policies redistribute resources across females with different number of children. To assess this effect, we simulate the economy to compute discounted lifetime utility for a cohort of females. We then compare the average ex-post utility for various groups of females according to the number of the children they bear during their lifetime. We perform these computations for the benchmark economy and for the economy with a 4-period paid mandatory leave. We find that this policy induces an important redistribution of resources across females with different number of children. Whereas females with 0 and 1 children face welfare losses of 0.7% and 0.2%, females with 2 or more children exhibit a welfare gain of 0.9% of GDP.[37]

Table 13: Effects of the Bargaining Channel

	Benchmark	Unpaid 1	Paid 1	Paid 2	Paid 4
Welfare of Females (% of GDP)	–	0.04	-0.17	-0.20	-0.34
Employment of Mothers					
with Infants	0.44	0.47	0.65	0.71	0.76
Cost of Leaves/GDP	0.02	0.03	0.16	0.24	0.36
Wage of Newborn Female					
(% change)	–	-0.38	-0.51	-1.04	-1.83

Note: All the policy experiments assume $p = 0.7$ and no redistribution across types so the effect of changes in bargaining is isolated.

Our results also reveal that the effects of parental leave policies on fertility, leave taking decisions, and employment of mothers with infants are mostly driven by the bargaining channel and not the general equilibrium or redistribution channels. Changes in the threat point of females giving birth drive the impact of parental leave policies on fertility and leave taking behavior.[38] Young females anticipate that there are some states in the future in which their threat point in bargaining will be higher and 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 effectively 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 females with young children. We assume that fertile females receive a fixed subsidy amount per child that

[37] We do not report welfare for females with only 2 children as the size of this group and their average human capital change quite significantly across steady states, making ex-post welfare comparisons difficult. Since the measures of females with 0, 1, and 2 or more children do not vary much across steady states, we aggregate results for these groups of females.

[38] While these statistics vary substantially with the generosity of parental leaves (see Table 13) , they vary little with the job finding rate -general equilibrium- and when the redistributive channel is shut down (see Table 12)

is either contingent on the decision to work or the decision to stay at home. The subsidy is financed by a tax on labor earnings of all individuals in the economy and is set equal to the tax in the 2-period paid leave economy (Paid 2). The amount of the subsidy per child is determined so that in equilibrium the government budget is balanced.

Table 14: Comparing 2-Period Paid Leaves with Other Subsidies to Mothers

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

Table 14 summarizes our results. We find that the employment of fertile females varies substantially across the economies considered. 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 period paid parental leave. However, the parental leave policy has a much stronger effect on the employment of mothers with infants – an increase of 26 percentage points with parental leaves and an increase of only 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. 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. The policy that impacts more negatively on the welfare of both males and females is the one that subsidizes staying at home. Unlike parental leave policies, work subsidies are not costly for the firm. Working subsidies lead firms to post more vacancies, increasing the job finding rate from .7 in the baseline economy to .75 and hence, improving the welfare of all agents in the economy.[39]

Proponents of mandatory leaves argue that these policies can benefit the health of children by facilitating breast feeding and by enhancing cognitive development.[40] Table 15 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 at home with their children from 30% in the benchmark economy to 7% and increases the fraction of mothers that stay 2 periods with their children from 10% in the benchmark economy to 66%.

Table 15: Time Spent with Children under Alternative Policies

(Percentage of Mothers)			
	Periods		
	0	1	2
Benchmark	30	17	10
Paid 2	7	13	66
Work-Subsidy	32	19	11
Home-Subsidy	27	16	9

4 Conclusions

We built a general equilibrium theory of labor-market and fertility decisions to study the economic impact of two alternative institutional arrangements for temporary job separations: voluntary and mandatory leaves. We used this theory to quantify the impact of mandatory leave entitlements on outcomes. We found 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. Parental leave policies lead to aggregate steady-state welfare losses

[39] In Erosa et al. (2009a) we discuss the effects of these subsidies on human capital accumulation.

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

because these policies subsidize inefficient matches and encourage too much leave taking by fertile females.

These findings should be interpreted in the context of our model where firms and employees can efficiently negotiate voluntary leaves. 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. In practice, it may be that market imperfections such as asymmetric information or contracting problems limit the ability of market forces in the United States to provide voluntary leaves. As a result, government regulation may play a role in increasing the surplus in job matches and mitigating human capital losses by females that permanently break job matches in order to spend time at home with children. Moreover, there is some empirical evidence that parental leaves improve pediatric health.[41] This may provide a rationale for parental leave policies if parents discount the future more heavily than socially optimal (because of borrowing constraints), if parents only pay a fraction of health costs (which are partly covered by medical insurance), or if parents ignore some negative health externalities imposed on other children.

Our work can be extended in a number of dimensions. Private information on 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 individual'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. Our framework is also suitable for studying parental leave policies in conjunction with other labor-market institutions that may affect female labor supply 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.

[41] See for instance Ruhm (2000).

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