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Labour market effects of reducing the gender gap in parental leave entitlements

Elena Del Rey[a,*], Maria Racionero[b], Jose I. Silva[c,d]

[a] Economics Department, Universitat de Girona, Carrer Universitat de Girona 10, Campus de Montilivi, Girona 17003, Spain
[b] Research School of Economics, Australian National University, H.W. Arndt Building 25A, ACT 2601 Canberra, Australia
[c] Economics Department, Universitat de Girona, Carrer Universitat de Girona 10, Campus de Montilivi, Girona 17003, Spain
[d] University of Kent, UK

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A B S T R A C T

We explore the effects of parental leave entitlements for mothers and fathers on wages and employment. We consider male and female workers who compete for the same jobs in a labour search and matching model with endogenous job search and leave take-up rates. We identify key theoretical effects and calibrate the model to simulate policy changes in France, Italy, Norway and Portugal. Reducing the gap in parental leave entitlements reduces gender wage gaps and increases gender employment rate gaps in these countries. Leave take-up rates increase with paid leave duration. In general, we find that job search intensity decreases when longer paid leave duration decreases wages.

1. Introduction

Despite convergence over time, substantial gender earnings and wage gaps persist in most countries. A large portion of the gender earnings and wage gaps has been attributed to the presence of children in the household, e.g.: Bertrand et al. (2010); Chung et al. (2017) and Kleven et al. (2019). If the presence of children plays a key role in explaining gender earnings and wage gaps family policies become potentially relevant tools to address them.

Parental leave regulations are indeed a central element of family policies in most OECD countries. They have expanded over time from narrow maternity leave to broader parental leave entitlements designed to support both working parents. Maternity and paternity leave is available to mothers and fathers, respectively, around the time of child-birth or adoption. Parental leave covers longer employment-protected periods. Parental leave can be either an individual right or a family entitlement. In an attempt to encourage the take-up of parental leave by fathers some countries reserve a portion of the leave to be taken exclusively by fathers. We refer to father-specific leave to encompass the paternity leave and the portion of the parental leave reserved for fathers. We classify the rest as mother-specific leave.[1]

The empirical literature on the effect of parental leave programs on female labour market outcomes is as yet inconclusive. However, leave duration seems to play a key role. Olivetti and Petrongolo (2017) conclude that leave entitlements over a year may be detrimental to female employment.[2] The evidence on the effects of father-specific leave is scarcer due to their more recent introduction and lower take-up rate.[3]

Despite the public policy debate and the empirical interest on the effects of parental leave programs, there are however surprisingly few theoretical contributions. Bastani et al. (2019) explore the efficiency enhancing role of mandatory parental leaves when workers can be career oriented or family oriented and firms are not allowed to offer differentiated contracts due to anti-discrimination legislation. They show that, in this context, a mandatory parental leave can be part of the socially optimal policy. In contrast, in a model where social norms concerning childcare activities arise endogenously from the most frequent behavior in the previous generation, Barigozzi et al. (2018) show that parental leave can reduce social welfare.

Erosa et al. (2010), Xiao (2020), and Del Rey et al. (2017) explore the effects of parental leave provisions in the presence of search and matching frictions. Erosa et al. (2010) consider three channels for parental leave effects - bargaining, redistribution and job creation -

[2] See also Ruhm (1998), Byker (2016); Del Rey et al. (2021); Lalive et al. (2014); Lalive and Zweimüller (2009).

[3] Farré and González (2019) provide a brief review of the literature on the effects of leave provisions for fathers. See also Patnaik (2019) for evidence of male take-up increasing when father-only leave increases.

* Corresponding author.
E-mail addresses: elena.delrey@udg.edu (E. Del Rey), maria.macionero@anu.edu.au (M. Racionero), jose.silva@udg.edu (J.I. Silva).

[1] See Section 2 (Institutional setting) for further details.

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within a relatively comprehensive model and explore, using simulations, the effects of leave policies on fertility, leave take-up and employment. Xiao (2020) proposes, and estimates using Finnish data, a search model with human capital accumulation, preferences for job amenities, and employer's statistical discrimination in wage offers and hiring. Del Rey et al. (2017) consider a simpler model that focuses on the job creation channel and explore, analytically and graphically, the effects of leave duration on wages and unemployment. They consider a single type of worker. This could correspond to a benchmark situation in which all workers are identical and treated the same regardless of gender, or alternatively to a situation with segmented markets. In reality, men and women often compete for the same jobs and firms are likely to take this into consideration when assessing the value of posting a vacancy. Leave entitlements targeted at either fathers or mothers are likely to affect both. Indeed, increasing the duration of father-specific leave has been frequently advocated as a labour market gender equalization measure, but there is hardly any theoretical analysis of the possible effects of this policy.

In order to explore the effects of parental leave entitlements for mothers and fathers we extend the labour search and matching model in Del Rey et al. (2017) to include two types of worker, males and females, who compete for the same jobs. Each individual can be jobless, working or on parental leave. We also consider endogenous job search intensity and endogenous leave take-up rates. We find that increases in type-specific leave duration have a positive direct effect on leave planning effort and hence take-up rates, and on job search intensity. In the case of job search intensity, however, there is a negative indirect effect through lower wages. Increases in type-specific leave duration have generally ambiguous effects on effective market tightness and wages. To provide further insights, we first explore the effects of changes in leave duration on equilibrium wages and effective market tightness for given job search intensity and leave take-up rates, and identify analytically the main mechanisms. We then allow search intensity and leave planning effort to vary and resort to simulations to assess the total impact of reducing gender gaps in leave entitlements.

We calibrate the model and simulate changes in leave duration for four different countries: France, Italy, Norway and Portugal. These countries display representative patterns in terms of total leave duration available to both parents and distribution of time institutionally allotted to each parent. To facilitate comparisons, we focus on full-rate equivalent weeks awarded to fathers and mothers, i.e. the length of the paid leave in weeks if it were paid at 100% of previous earnings. We simulate four different policy scenarios: 1) a benchmark scenario in which we eliminate the leave awarded to fathers and mothers in order to assess the contribution of parental leave policies to existing gender gaps; 2) an increase of 10 full-rate equivalent weeks of leave awarded to fathers; 3) a decrease of 10 full-rate equivalent weeks of leave awarded to mothers; and 4) a final scenario in which we divide the total full-rate equivalent weeks of leave currently available for both parents equally between mothers and fathers.

In the benchmark scenario, in which we eliminate the leave currently awarded to fathers and mothers, we find that gender wage gaps are reduced by 4.5 percentage points (henceforth pp) in Norway (from 12.8% to 8.3%), 1.0 pp in France (from 10.8% to 9.8%), 0.8 pp in Italy (from 5.3% to 4.5%), and 0.7 pp in Portugal (from 12.7% to 12.0%). Female employment rates fall in all four countries because effective separation rates increase when we eliminate job-protected leaves. Still, female job search intensity increases in France, Norway and Portugal following the resulting increase in wages.

An increase of 10 full-rate equivalent leave weeks awarded to fathers yields a dramatic percentage increase in male leave take-up rates in the four countries. However, in Italy and France, which start from very low male leave take-up rate levels, the effect on labour market outcomes is very small. In Norway and Portugal, higher male leave take-up rates result in more significant decreases in male wages and increases in effective market tightness. The increase in effective market tightness has a positive, although small, effect on female wages. Despite the direct positive effect of longer leave duration on male job search intensity, male job search intensity decreases in all cases due to a large decrease in male wages.

A decrease of 10 full-rate equivalent leave weeks awarded to mothers reduces the gender wage gap in all countries but the effects, although larger, remain small: from 10.8% to 10.2% in France, from 5.3% to 4.9% in Italy, from 12.8% to 11.4% in Norway, and from 12.7% to 11.9% in Portugal.

Section 2 provides an overview of parental leave policies in OECD countries, with special focus on our countries of interest. Section 3 presents the model. Section 4 derives the equilibrium equations. Section 5 analyses the effect of increasing type-specific leave duration in the benchmark case with exogenous job search intensity and leave take-up rates. Section 6 includes the calibration and simulation results, and Section 7 concludes.

2. Institutional setting

Almost all OECD countries provide a statutory entitlement to paid maternity leave. The United States, without national legislation on paid maternity leave, is the only notable exception.[4] According to the OECD Family Database (see Tables PF2.1.A and PF2.1.B), in 2018, the minimum duration is 6 weeks (Portugal) and the maximum duration is 43 weeks (Greece) with an average 18.1 weeks. Benefits range from 26.7 % (Ireland) to 100% of earnings (in 13 of the 36 countries, including Portugal). Norway provides 13 weeks of maternity leave paid at 94,2% of earnings, France 16 weeks paid at 90,4%, and Italy 21,7 weeks paid at 80%. About two thirds of OECD countries also offer paid paternity leave. This type of leave is usually shorter (between 0,4 weeks in the Netherlands and 5 weeks in Portugal) but well paid (100% in 14 out of the 25 countries offering paid paternity leave).

In addition, a growing number of countries provide paid parental leave, which covers longer employment-protected periods and can be either a shareable family entitlement, an individual transferable entitlement or an individual non-transferable entitlement. Non-transferable entitlements are allocated to one or the other parent on a "use it or lose it" basis. Non-transferable quotas reserved for fathers remain relatively uncommon: only 12 countries in the OECD use them, ranging from 6 weeks paid at 62,9% of earnings in Finland to 52 weeks paid at 58,4% of earnings in Japan. The shareable entitlements are most often used by mothers. The OECD accordingly classifies the leave as "available to mothers" and "reserved for fathers". Taking into account the non-transferable entitlements reserved for mothers and the fact that mothers use most of the shareable entitlements, French mothers can enjoy up to 26 additional weeks of leave paid at an average of 13.7%, Italian mothers can enjoy up to 26 additional weeks paid at 30%, Norwegian mothers up to 78 weeks paid at 39,4% and Portuguese mothers 24,1 weeks paid at 59,6%.

Because payment rates vary across countries and types of leave, the OECD often provides entitlements in "full-rate equivalent" form.[5] We use full-rate equivalent duration as the basis for the simulations. In Figure 1 we represent the full-rate equivalent duration of leave available to mothers and reserved for fathers in France, Italy, Norway and Portugal, as well as the OECD and the EU-27 averages (34 and 40.4 weeks, respectively). France and Italy are below average (23.4 weeks and 26 weeks, respectively), Portugal around average (32.9 weeks) while Norway is significantly above average (52,4 weeks). In terms of leave al-

[4] Still, according to OECD (2016), some individual U.S states do provide income support to mothers during maternity leave through other disability insurance programs.

[5] The OECD Family Database defines the full-rate equivalent paid leave equal to the duration of leave in weeks times the payment rate (as per cent of average earnings) received by the claimant over the duration of the leave (see Tables PF2.1.A and PF2.1.B).

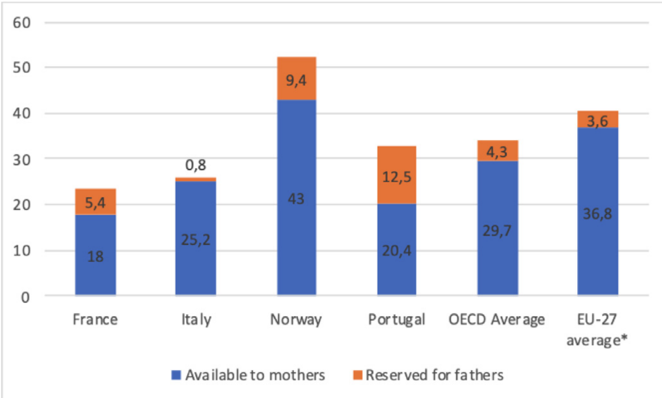

Fig. 1. Full Rate Equivalent Weeks of Statutory Paid Leave.

location for fathers relative to mothers, Italy with 3.1% is significantly below both the OECD and EU-27 averages (12.6% and 8.9%, respectively) while Norway (17.9%), France (23.1%) and Portugal (38%) are above average.

3. The model

The economy consists of a continuum of risk-neutral, infinitely lived workers and firms. There are two types of workers $i = \{m, f\}$ where m stands for male and f for female. The number of male and female workers N_m and N_f is given, with $N_m + N_f = 1$. Workers can be either employed or non-employed. If employed, they can either be working or on parental leave. Workers and firms discount future payoffs at a common rate r and capital markets are perfect. Time is continuous.

We denote the job search intensity of a type-i individual by s_i with $i = m, f$.[6] Note that each individual could choose a potentially different search intensity but in a symmetric Nash equilibrium all type-i individuals choose the same search intensity s_i.

There is a time-consuming and costly process of matching non-employed workers and job vacancies, which is captured by a standard constant-returns-to-scale matching function that is common for male and female workers (all compete for same jobs):

$$g(su, v) = g_o(su)^{\alpha} v^{(1-\alpha)}, \tag{1}$$

where $su = s_f u_f + s_m u_m$ represents the effective units of search by non-employed individuals in the economy, v is the number of vacancies, and α and g_o are the matching function parameters. The firm does not differentiate between both types of workers but search intensity is type specific. Then, type-i non-employed individuals find jobs at rate:

$$p(s_i, \widetilde{\theta}) = s_i \frac{g(su, v)}{su} = s_i g(1, \widetilde{\theta}). \tag{2}$$

where $\widetilde{\theta}$ is the effective labour market tightness:

$$\widetilde{\theta} = \frac{v}{su}. \tag{3}$$

The rate at which vacancies are filled is[7]

$$q(\widetilde{\theta}) = \frac{g(su, v)}{v} = g\left(\frac{1}{\widetilde{\theta}}, 1\right). \tag{4}$$

A job can be either filled or vacant. Before a position is filled, the firm has to open a job vacancy, incurring a flow cost c. A vacancy position is filled by each type of worker at the endogenous rate $q(\widetilde{\theta})\Omega_i$, where

$$\Omega_i = \frac{s_i u_i}{s_f u_f + s_m u_m}, \tag{5}$$

is the effective proportion of type-i individuals looking for a job. Filling the position yields a positive net value $(J_i - V)$ from the job creation process, where J_i and V stand for the value that the firm attributes to a filled and a vacant position, respectively. Note that $\Omega_m + \Omega_f = 1$.

Each firm has a constant-returns-to-scale production technology with labour as a unique production factor, generating an instantaneous profit equal to the difference between the constant labour productivity A_i and the labour cost w_i. Filled positions can be either destroyed at the constant job separation rate ρ_i or interrupted at the hazard rate $\tau(\varepsilon_i)$ if the worker moves to the status of parental leave. In the first case, the capital loss is represented by $(J_i - V)$, while the net capital loss when the worker is on parental leave is $(J_i - X_i)$, where X_i stands for the value that the firm attributes to the parental leave. Once the worker is on leave, the firm has a net productivity loss ψ_i until the individual returns to his/her job position at rate γ_i, generating value $J_i - X_i$.[8]

The values of the vacant (V_i), filled position (J_i) and worker on parental leave (X_i) are given by the following three expressions:

$$rV = -c + q(\widetilde{\theta})[\Omega_f(J_f - V) + \Omega_m(J_m - V)], \tag{6}$$

$$rJ_i = A_i - w_i - \rho_i(J_i - V) - \tau(\varepsilon_i)(J_i - X_i), \tag{7}$$

$$rX_i = -\psi_i + \gamma_i(J_i - X_i). \tag{8}$$

A non-employed type-i individual enjoys the actual or imputed income during non-employment b_i, finds a job at rate $p_i(s_i, \widetilde{\theta})$, which yields net value gain $(W_i - U_i)$. The non-employed type-i individual searches for a job with intensity s_i at a cost $\sigma(s_i)$ where

$$\frac{\partial \sigma(s_i)}{\partial s_i} > 0, \frac{\partial^2 \sigma(s_i)}{\partial s_i^2} \geq 0.$$

Type-i employed workers earn the endogenous wage w_i, and can either lose their jobs at the constant rate ρ_i or move to the status of parental leave at the rate $\tau(\varepsilon_i)$. $\tau(\varepsilon_i)$ represents the rate at which the parental leave is taken when a baby arrives and depends on a planning effort ε_i, interpreted as the effort put during leave planning to maintain productivity at work, with cost $\kappa(\varepsilon_i)$ where

$$\frac{\partial \kappa(\varepsilon_i)}{\partial \varepsilon_i} > 0, \frac{\partial^2 \kappa(\varepsilon_i)}{\partial \varepsilon_i^2} \geq 0.$$

An individual on parental leave enjoys the actual or imputed income during parental leave z_i and returns to her same job position at the hazard rate γ_i. The inverse of γ_i, $\delta_i = 1/\gamma_i$, represents the average period the individual is on parental leave, or duration of the leave, and is hence a policy parameter.

The values of the different worker status - non-employed (U_i), working (W_i) and on parental leave (L_i) - are given by the following expressions:

$$rU_i = b_i - \sigma(s_i) + p_i(s_i, \widetilde{\theta})(W_i - U_i), \tag{9}$$

$$rW_i = w_i - \kappa(\varepsilon_i) - \rho_i(W_i - U_i) - \tau(\varepsilon_i)(W_i - L_i), \tag{10}$$

$$rL_i = z_i + \gamma_i(W_i - L_i). \tag{11}$$

To close the model, we invoke two standard assumptions: free entry condition for vacancies and bilateral Nash bargaining over wages. The

[6] For instance, s_i can represent the number of applications submitted per non-employed individual as in Faberman and Kudlyak (2019).

[7] Note that

$$p(s_i, \widetilde{\theta}) = s_i \frac{g(su, v)}{su} = \frac{v}{su} s_i \frac{g(su, v)}{v} = s_i \widetilde{\theta} q\left(\widetilde{\theta}\right).$$

[8] Note that, while the loss associated with dispensing with a worker temporarily could be the same for men and women, the rate at which they come back to work, dependent on the length of the leave, generally differs.

free entry condition for vacancies, whereby firms open vacancies until the expected value of doing so becomes zero, implies

$$V = 0. \tag{12}$$

Since neither type-i workers nor employers can instantaneously find an alternative match partner in the labour market, and since hiring decisions are costly, a match surplus exists: $S_i = J_i + W_i - U_i$. To divide this surplus between the firm and the type-i worker, we assume wages are the result of bilateral Nash bargaining. The Nash solution is the wage that maximizes the weighted product of the type-i worker's and the firm's net return from the job match. The first-order condition yields the following equation:

$$(1-\beta_i)(W_i - U_i) = \beta_i J_i \tag{13}$$

where β_i and $1-\beta_i$ represent the bargaining power of the type-i worker and the firm, respectively.

4. Solving the model

4.1. Dynamics of employment

Individuals are either employed (e) or non-employed (u). When employed, individuals can be active (a) or on leave (l). Then the total amount of workers of type $i = m, f$ is

$$N_i = e_i + u_i, \tag{14}$$

with

$$e_i = a_i + l_i. \tag{15}$$

Given the effective labour market tightness $\widetilde{\theta}$, non-employment u_i, active employment a_i, and leaves l_i respectively evolve according to the following backward-looking differential equations:

$$\dot{a}_i = -\tau(\varepsilon_i)a_i + \gamma_i l_i - \rho_i a_i + p(s_i, \widetilde{\theta})u_i, \tag{16}$$

$$\dot{l}_i = \tau(\varepsilon_i)a_i - \gamma_i l_i, \tag{17}$$

$$\dot{u}_i = \rho_i a_i - p(s_i, \widetilde{\theta})u_i. \tag{18}$$

Active type-i workers can take a leave at rate $\tau(\varepsilon_i)$ or separate from the firm at rate ρ_i, but workers on leave return to work at rate γ_i and non-employed workers become employed at rate $p(s_i, \widetilde{\theta})$. Workers on job-protected leave cannot separate from the firm. Then, the number of workers on leave evolves according to the rate at which active workers take the leave $\tau(\varepsilon_i)$ and the rate at which workers on leave return to work γ_i. Finally, the change in non-employment depends on the rate ρ_i at which active workers separate from the firm, and the rate $p(s_i, \widetilde{\theta})$ at which non-employed workers find a job.

At equilibrium, $\dot{u}_i = \dot{a}_i = \dot{l}_i = 0$. Then, $\rho_i a_i = p(s_i, \widetilde{\theta})u_i$ and $\tau(\varepsilon_i)a_i = \gamma_i l_i$. From (14) and (15), and using $\delta_i = 1/\gamma_i$, we can write

$$\frac{\rho_i e_i}{1+\tau(\varepsilon_i)\delta_i} = p(s_i, \widetilde{\theta})(N_i - e_i) \tag{19}$$

Separations by the employed equal job findings by the non-employed. Since not all the employed can be separated, because a proportion of employed type- i workers are on job-protected leave, we denote the effective separation rate of employed type-i workers by

$$\widetilde{\rho}_i = \frac{\rho_i}{1+\tau(\varepsilon_i)\delta_i}. \tag{20}$$

The equilibrium employment level for $i = \{m, f\}$ is then

$$e_i = \frac{N_i p(s_i, \widetilde{\theta})}{p(s_i, \widetilde{\theta}) + \widetilde{\rho}_i} \tag{21}$$

and the employment rate $\hat{e}_i = e_i/N_i$ is

$$\hat{e}_i = \frac{p(s_i, \widetilde{\theta})}{p(s_i, \widetilde{\theta}) + \widetilde{\rho}_i}. \tag{22}$$

Note that leave duration affects the employment level of type-i workers both through the effect on effective market tightness $\widetilde{\theta}$ and the effect on the effective separation rate $\widetilde{\rho}_i$.

The effective proportion of workers of each type looking for a job (5) can be written

$$\Omega_i(s_f, s_m, e_f, e_m) = \frac{s_i(N_i - e_i)}{s_f(N_f - e_f) + s_m(N_m - e_m))}. \tag{23}$$

4.2. Job creation by firms

To obtain the value of a job filled by a type-i worker, J_i, we use (7) and (8):

$$J_i = \frac{(r+\gamma_i)(A_i - w_i) - \tau(\varepsilon_i)\psi_i}{r(r+\tau(\varepsilon_i)+\rho_i) + \gamma_i(\rho_i + r)}. \tag{24}$$

Note that the value of a job filled by a type-i worker decreases in wage w_i, leave take-up rate $\tau(\varepsilon_i)$ and hazard rate γ_i at which workers on leave come back to the same position (the inverse of leave duration δ_i), but is not directly affected by search intensity s_i or imputed income during parental leave z_i. We henceforth write $J_i(w_i, \varepsilon_i)$.

Equation (6) and free entry condition (12) imply that the equilibrium job creation condition is:

$$q(\widetilde{\theta})\left(\Omega_m(s_f, s_m, e_f, e_m)J_m(w_m, \varepsilon_m) + \Omega_f(s_f, s_m, e_f, e_m)J_f(w_f, \varepsilon_f)\right) = c. \tag{25}$$

4.3. Wage determination

Each type of worker independently negotiates her or his wage with the employer. At equilibrium, (13) is satisfied. To obtain $W_i - U_i$, we use (9), (10) and (11):

$$W_i - U_i = \frac{(r+\gamma_i)\left(w_i - \kappa(\varepsilon_i) - (b_i - \sigma(s_i))\right) + \tau(\varepsilon_i)\left(z_i - (b_i - \sigma(s_i))\right)}{\left(r + p(s_i, \widetilde{\theta})\right)\left(r + \tau(\varepsilon_i) + \gamma_i\right) + \rho_i(r+\gamma_i)}. \tag{26}$$

If we then plug (24) and (26) into (13) and simplify, we obtain a condition that implicitly determines the equilibrium wage for $i = \{m, f\}$ as a function of $\widetilde{\theta}$, s_i and ε_i, as well as the parameters of the model:

$$w_i = (1-\beta_i)\left[\kappa(\varepsilon_i) + b_i - \sigma(s_i)\right] + \beta_i\left[A_i + p(s_i, \tilde{\theta})J_i(w_i, \varepsilon_i)\right] + \frac{\tau(\varepsilon_i)}{r+\gamma_i}\begin{bmatrix}\beta_i\left(p(s_i, \tilde{\theta})J_i(w_i, \varepsilon_i) - \psi_i\right) \\ -(1-\beta_i)\left(z_i - (b_i - \sigma(s_i))\right)\end{bmatrix}. \tag{27}$$

We denote the term $\beta_i\left(p(s_i, \widetilde{\theta})J_i(w_i, \varepsilon_i) - \psi_i\right)$ net bargaining position of the worker and the term $(1-\beta_i)\left(z_i - (b_i - \sigma(s_i))\right)$ net bargaining position of the firm. The net bargaining position of the worker includes the worker bargaining power parameter β_i and the expected value of a worker for the firm $p(s_i, \widetilde{\theta})J_i(w_i, \varepsilon_i)$ net of the costs incurred when the worker takes a leave ψ_i. The net bargaining position of the firm includes the firm bargaining power parameter $(1-\beta_i)$ and the value of being employed for a worker taking a leave, represented by $z_i - (b_i - \sigma(s_i))$. Note that, as expected, a dominating net bargaining position of the worker contributes to higher wages and a dominating net bargaining position of the firm contributes to lower wages.

4.4. Choice of search intensity and leave planning effort

Each non-employed type-i individual chooses search intensity s_i to maximize rU_i, taking the average search intensities s_m and s_f and the other market variables as given. Each optimal s_i satisfies:

$$\frac{\partial p(s_i, \widetilde{\theta})}{\partial s_i}(W_i - U_i) = \frac{\partial \sigma(s_i)}{\partial s_i} \tag{28}$$

provided that $W_i - U_i > 0$. Otherwise, $s_i = 0$. Note that $W_i - U_i$ is given by (26).

Note that each individual chooses the search intensity taking the average search intensities as given, and in a symmetric Nash equilibrium all individuals of the same type choose the same search intensity. The search intensity of a type-i individual increases in w_i, $\widetilde{\theta}$ and leave duration δ_i.

Each employed type-i worker chooses leave planning effort intensity ε_i to maximize rW_i, taking other market variables as given. ε_i is interpreted as work arranging before taking the leave.[9] Each optimal ε_i satisfies:

$$\frac{\partial \tau(\varepsilon_i)}{\partial \varepsilon_i}(L_i - W_i) = \frac{\partial \kappa(\varepsilon_i)}{\partial \varepsilon_i} \tag{29}$$

provided that $(L_i - W_i) > 0$. Otherwise, $\varepsilon_i = 0$. Using (9), (10) and (11):

$$L_i - W_i = \frac{\left(r + p(s_i,\widetilde{\theta})\right)\left(z_i - \left(w_i - \kappa(\varepsilon_i)\right)\right) + \rho_i\left(z_i - \left(b_i - \sigma(s_i)\right)\right)}{\left(r + p(s_i,\widetilde{\theta})\right)\left(r + \tau(\varepsilon_i) + \gamma_i\right) + \rho_i\left(r + \gamma_i\right)} \tag{30}$$

Leave planning effort, and therefore leave take-up rates, decrease in w_i and $\widetilde{\theta}$, and increase in leave duration δ_i.

4.5. Equilibrium

An equilibrium is a set of male and female employment levels $\{e_m, e_f\}$, an effective vacancy-unemployment ratio $\widetilde{\theta}$, male and female wages $\{w_m, w_f\}$, male and female job search intensities $\{s_m, s_f\}$ and male and female leave planning efforts $\{\varepsilon_m, \varepsilon_f\}$ that simultaneously satisfy the employment level equations (21) for $i = \{m, f\}$, the job creation equation (25), the wage equations (27) for $i = \{m, f\}$, the optimal search intensity equations (28) for $i = \{m, f\}$ and the optimal leave planning effort equations (29) for $i = \{m, f\}$.

If we plug (20) into the employment level equation (21) for each i, and plug the resulting employment level equations for $i = \{m, f\}$ into (23) we can express the effective proportion of type-i individuals looking for a job as a function $\Omega_i\left(s_f, s_m, \varepsilon_i, \widetilde{\theta}\right)$ for $i = \{m, f\}$. The set of seven remaining equilibrium conditions can then be expressed as a function of seven endogenous variables (i.e. $\left\{\widetilde{\theta}, w_m, w_f, s_f, s_m, \varepsilon_m, \varepsilon_f\right\}$).

5. Effects of changing leave duration with exogenous job search intensity and leave planning effort

In order to provide insights into the mechanisms at stake we first take job search intensity and leave take-up rates as given and characterize the equilibrium wages and market tightness. We explore analytically the effects of changes in leave duration on equilibrium wages and effective market tightness for given search intensity and take-up rates. We then allow job search intensity and leave planning effort to vary, and resort to simulations to assess the total impact of reducing gender gaps in leave entitlements.

When search intensity and leave planning effort are given, an equilibrium is a set of male and female wages $\{w_m, w_f\}$ and effective market tightness $\widetilde{\theta}$ that simultaneously satisfy the job creation condition (25) and the wage equations (27) for $i = \{m, f\}$. In Figure 2 we represent this equilibrium graphically as in the one type of worker case (see Del Rey et al. (2017)). To do this, we let $w_f = \omega_f\left(\widetilde{\theta}\right)$ be the female wage that satisfies (27) with $i = f$ for each $\widetilde{\theta}$ and plug this function into (25). We thus obtain a job creation condition JC that is only a function of $\left\{w_m, \widetilde{\theta}\right\}$ and other given parameters:

$$\Omega_m\left(\widetilde{\theta}\right)J_m(w_m) + \Omega_f\left(\widetilde{\theta}\right)J_f\left(\omega_f\left(\widetilde{\theta}\right)\right) - \frac{c}{q\left(\widetilde{\theta}\right)} = 0. \tag{31}$$

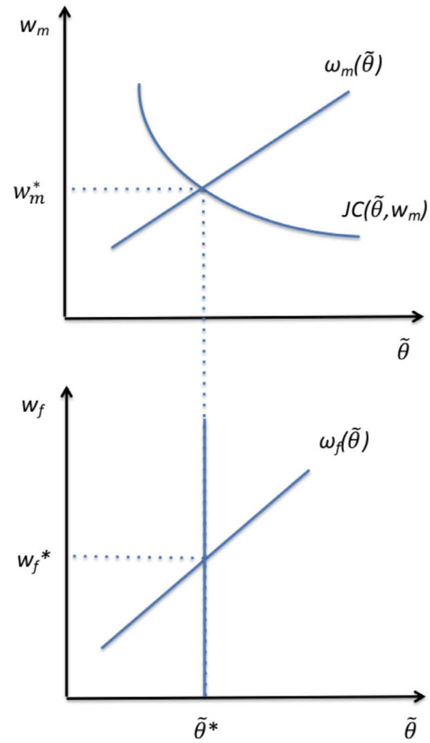

Fig. 2. Equilibrium wages and market tightness.

The intersection of the male wage equation (27) for $i = m$ and the new job creation condition (31) yields the equilibrium levels of w_m and $\widetilde{\theta}$ (w_m^* and $\widetilde{\theta}^*$ in the upper part of Figure 1). The equilibrium effective market tightness $\widetilde{\theta}^*$ can be then plugged into the female wage equation (27) for $i = f$ to yield the equilibrium female wage (w_f^* in the lower part of Figure 2).[10],[11]

To see how father-specific leave duration δ_m affects the equilibrium, we totally differentiate (31) with respect to w_m and δ_m for a given $\widetilde{\theta}$. We obtain:[12]

$$\left.\frac{dw_m}{d\delta_m}\right|_{JC} = -\frac{\left[\left[J_m - J_f\right]\frac{d\Omega_m}{d\delta_m} + \Omega_m \frac{dJ_m}{d\gamma_m}\frac{d\gamma_m}{d\delta_m}\right]}{\Omega_m \frac{dJ_m}{dw_m}}. \tag{32}$$

The second term in brackets in the numerator is negative, since, from (24):

$$\frac{dJ_i}{d\gamma_i} = \frac{\tau(\varepsilon_i)\left(r(A_i - w_i) + (\rho_i + r)\psi_i\right)}{\left(r(r + \tau(\varepsilon_i) + \rho_i) + \gamma_i(\rho_i + r)\right)^2} > 0. \tag{33}$$

and $d\gamma_i/d\delta_i < 0$, i.e. a male worker is less valuable to the firm when the duration of the father-specific leave increases. The sign of the first term in brackets in the numerator depends on $J_m - J_f$. If $J_m > J_f$ the first term is also negative since $d\Omega_m/d\delta_m < 0$ (since fathers on job-protected leave cannot be separated an increase in father-specific leave increases male employment and reduces the effective proportion of men looking for a job Ω_m). Hence, if $J_m > J_f$ the job creation curve (31) shifts downwards when δ_m increases: for any given effective market tightness $\widetilde{\theta}$, a

[9] See Houston and Marks (2003) for the empirical evidence related to the importance of workplace planning and support during pregnancy.

[10] Alternatively we can calculate first the joint determination of $\widetilde{\theta}^*$ and w_f^* and, then, the optimal wage for the male worker. The equilibrium is the same.

[11] In the model with one type of worker, either with parental leave or without, the job creation condition is downward sloping and the wage equation is upward sloping. In section 6 it will be shown that this property holds also in our calibrations and simulations, even when job search intensity and leave planning effort are determined endogenously.

[12] To see how mother-specific leave duration δ_f affects the equilibrium we need only interchange all the subindices m by f.

longer duration of the father-specific leave is associated with a lower wage. If $J_m < J_f$ the effect of an increase in δ_m on the job creation curve is ambiguous.

The effect of the increase in father-specific leave duration on the male wage equation (27) with $i = m$ is ambiguous. Letting

$$\Gamma = \frac{\frac{d\gamma_m}{d\delta_m}}{1 - \left(1 + \frac{\tau(\epsilon_m)}{r+\gamma_m}\right)\beta_m p\left(s_m, \widetilde{\theta}\right)\frac{dJ_m}{dw_m}} < 0, \tag{34}$$

we can write:

$$\left.\frac{dw_m}{d\delta_m}\right|_{\omega_m(\theta)} = \Gamma\left(1 + \frac{\tau(\epsilon_m)}{r+\gamma_m}\right)\beta_m p\left(s_m, \tilde{\theta}\right)\frac{dJ_m}{d\gamma_m} - \Gamma\frac{\tau(\epsilon_m)}{(r+\gamma_m)^2}\left(\begin{array}{c}\beta_m\left(p\left(s_m, \widetilde{\theta}\right)J_m - \psi_m\right) \\ -\left(1-\beta_m\right)\left(z_m - \left(b_m - \sigma\left(s_m\right)\right)\right)\end{array}\right). \tag{35}$$

The first term in (35) captures the direct effect of leave duration on the value to the firm of the job position filled by a male worker. This effect is negative, from (24) and (34), and therefore tends to shift the male wage curve downwards: the lower the effect on the value of the job position filled by a male worker, the lower the effect on his wage for a given $\widetilde{\theta}$. The sign of the second term hinges on the sign of the net wage bargaining position of the worker relative to that of the firm. If the net bargaining position of the worker is larger, a longer duration has a positive effect on the wage curve shifting it upwards (the final direction of the shift will thus be undetermined in this case). Conversely, if the net bargaining position of the firm is larger, a longer duration has a negative effect on the wage curve shifting it further downwards. Hence, an increase in father-specific leave duration can shift the male wage curve upwards only if the net bargaining position of the worker is very large.

The new equilibrium male wage and effective market tightness are determined by the point at which the new job creation and male wage equations cross. If the equilibrium effective market tightness increases (resp. decreases), so do female wages in the bottom part of Figure 2.

With endogenous job search intensity and leave planning effort, an increase in male leave duration δ_m will have a direct positive effect on s_m and ϵ_m as we mentioned in Section 4.4. New wages and effective market tightness resulting from our previous analysis will also affect s_m and ϵ_m. In turn, changes in s_m and ϵ_m will have an effect on the job creation and wage equations depicted in Figure 2. Given the large number of variables, we are unable to solve the model analytically and we proceed to calibrate the model for the economies of France, Italy, Norway and Portugal. In section 6, we illustrate the equilibrium before and after the simulated policy changes as in Figure 2.

6. Calibration and simulated results

6.1. Calibration

We calibrate the model in sections 3 and 4 at yearly frequency in order to match several empirical facts in the four economies. We consider individuals aged between 25 and 54 years old when the data is available because mothers in this age group are responsible for 99% of total births.[13]

Table 1 summarizes all the parameters (Block 1) and presents the steady state values of the endogenous variables (Block 2). It also includes six model's targets consistent with empirical evidence (Block 3).

Similar to Naval et al. (2020), we target the employment opportunity cost for parents claiming unemployment benefits and using childcare services (also knows as PTR) taken from the 2016 OECD Database. This indicator is calculated assuming that the jobseeker claims unemployment insurance and/or unemployment assistance benefits when s/he is out of work. A PTR of 100 means that the worker income will remain the same if she is separated from her job and remains jobless for one year, thus, a low work incentive, on contrary, a PTR of 0 indicates a high work incentive. The recipient is assumed to live in a two-earner family with a partner on 100% of average wages, with two children, and with no other dependents. We assume that the PTR is common to men and women, $b_f/w_f = b_m/w_m$.

Blatter et al. (2016) document that hiring costs average between one and two quarters of wage payments. Thus, we target the hiring cost parameter c to be consistent with one quarter of average wages, $\bar{w} = \frac{w_f e_f + w_m e_m}{e}$. Hence, $c/\bar{w} = 0.25$.

We target the total wage-adjusted labour productivity ratio $A/\bar{w}$. Since we normalize both productivities to 1 and use average wages, this target is common to women and men. We target the unadjusted hourly gender pay ratio w_m/w_f in 2016 for individuals aged between 25 and 54 using the 2016 Eurostat Database.

The duration of the paid leave available to mothers and reserved fathers $\delta_i = 1/\gamma_i$ is obtained from the 2016 OECD Family Database (see Tables PF2.1.A and PF2.1.B). For better comparability across countries, we consider the number of full-rate equivalent leave weeks (i.e. the equivalent number of weeks fully paid as percentage of wages).[14] Since we consider the number of full-rate equivalent weeks paid to mothers or reserved to fathers, we set $z_i/w_i = 1$.

To calculate the take-up rate for fathers and mothers $\tau_m(\epsilon_m)$ and $\tau_f(\epsilon_f)$ we use the following information. First, φ is the rate of births per woman aged 25 to 54. We take this information from the 2016 Eurostat Database and multiply it by the number of users/recipients of leave permits per birth who are men, ϑ_m, and the number of users/recipients of leave permits per birth who are women, ϑ_f, to obtain the take-up rates (See Chart PF2.2.B in the 2016 OECD Family Database).[15]

The annual interest rate r is set to be consistent with the annual long-term interest rate in each country in 2016. Petrongolo and Pissarides (2001) provide empirical support for a Cobb-Douglas matching function with constant returns to scale, and a plausible range for the empirical elasticity on unemployment between 0.5 and 0.7. Thus, we assume that $m(su, v) = \nu(su)^{\alpha}v^{1-\alpha}$ and set $\alpha = 0.6$ in all countries. We normalize the total working age population N to 1.

The employment rates $\hat{e}_m$ are taken from the 2016 OECD Database and calculated as proportion of the working age population. The gender annual job finding rates $p_i(s_i, \tilde{\theta})$ are calculated following Garda (2016) and using workers transition data from the 2016 Eurostat Database. In more detail, the job finding rate is equal to the transition of workers from joblessness to employment in year 2016 divided by the stock of jobless workers in year 2015. Jobless workers include both unemployed and inactive individuals.[16]

We assume that leave take-up rates are concave in leave planning effort, $\tau_i(\epsilon_i) = \varsigma_i\sqrt{\epsilon_i}$, and the leave planning costs are convex in leave planning effort, $\kappa_i(\epsilon_i) = \rho\epsilon_i^2$.[17] In turn, we normalize the female take-

[13] Considering all working age population would reduce the quantitative impact of the leave duration policy due to the very low birth rate. The on leave separation rate for individuals who are outside the 25-54 years old group is almost zero.

[14] In weeks, it is 18.8 (France), 25.2 (Italy), 45 (Norway) and 20.4 (Portugal) for mothers, and 5.6 (France), 0.4 (Italy), 9.8 (Norway) and 12.5 (Portugal) for fathers.

[15] Note that the number of women recipients of publicly-administered parental leave for each 100 live births in a year can be larger than 100 if the leave lasts longer than 1 year or is taken in several blocks over more than 1 year.

[16] Putting together both unemployed and inactive workers is not an unrealistic assumption since many European countries show high flows between inactivity and employment. For example, according to the Eurostat labour market flow statistics, 52% of ins to employment and 60% of outs from employment are from/to inactivity.

[17] Alternative degrees of concavity of the take up rate, $\tau_i(\epsilon_i)$ and the degree of convexity of the leave planning costs $\kappa_i(\epsilon_i)$, have significant effects on the size of the leave planning effort ϵ_i but not on other variables of the model.

Table 1
Calibrated parameters and variables.

	France	Italy	Norway	Portugal	Source
Block 1: Parameters					
Interest rate, r	0.0264	0.0384	0.0300	0.0552	OECD Database (2016)
Matching function elasticity, α	0.60	0.60	0.60	0.60	Petrongolo and Pissarides (2001)
Matching function scale, ν	0.2823	0.5727	0.5719	0.4439	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Female productivity, A_f	1.0	1.0	1.0	1.0	Normalization
Male productivity, A_m	1.0	1.0	1.0	1.0	Normalization
Total working age population, N	1.0	1.0	1.0	1.0	Normalization
Female working age population, N_f	0.510	0.5020	0.486	0.519	$N_f = N - N_m$
Male working age population, N_m	0.489	0.4980	0.514	0.481	Eurostat Database (2016)
Female full rate equivalent leave duration (years),$\delta_f = \frac{1}{\gamma_f}$	0.3615	0.4846	0.8654	0.3923	OECD Family Database (Chart PF2.1.A, 2016)
Male full rate equivalent leave duration (years), $\delta_m = \frac{1}{\gamma_m}$	0.1077	0.0077	0.1885	0.2404	OECD Family Database (Chart PF2.1.B, 2016)
Proportion of births by mother, φ	0.084	0.055	0.074	0.052	Eurostat Database (2016)
Female number of users of leave permits per birth, ϑ_f	0.533	0.541	1.491	1.078	OECD Family Database (Chart PF2.2.B, 2016)
Male number of users of leave permits per birth, ϑ_m	0.024	0.111	0.961	0.874	OECD Family Database (Chart PF2.2.B, 2016)
Costs during worker's leave, ψ	0.446	0.446	0.446	0.446	SHRM and Kronos (2014)
Female effective job separation rate, $\widetilde{\rho}_f$	0.1356	0.2188	0.1159	0.1279	Equation (20) for $i = f$
Male effective job separation rate, $\widetilde{\rho}_m$	0.117	0.1256	0.0967	0.1081	Equation (20) for $i = m$
Female workers bargaining power, β_f	0.5624	0.7561	0.7152	0.6614	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Male workers bargaining power, β_m	0.6731	0.7729	0.9120	0.9099	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Vacancy parameter, c	0.2195	0.2274	0.2289	0.2288	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Female employment opportunity cost (STR), b_f	0.3659	0.3531	0.2539	0.2616	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Male employment opportunity cost (STR), b_m	0.4054	0.3719	0.2866	0.2948	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Female on leave payment parameter, z_f	0.8315	0.8828	0.876	0.844	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Male on leave payment parameter, z_m	0.9213	0.9296	0.988	0.951	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Female search cost parameter, μ_f	0.1243	0.6744	0.4296	0.3478	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Male search cost parameter, μ_m	0.0716	0.4514	0.5625	0.3106	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Female take up rate parameter, ς_f	0.045	0.0300	0.1100	0.0560	$\tau_f(\varepsilon_f) = \varsigma_f \sqrt{\varepsilon_f}$
Male take up rate parameter, ς_m	0.0063	0.0284	0.1179	0.0551	$\tau_m(\varepsilon_m) = \varsigma_m \sqrt{\varepsilon_m}$
Planning effort cost parameter, ϱ	0.0001	0.0004	0.0043	0.0011	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Block 2: Variables					
Female job finding rate, $p_f(\widetilde{\theta}, s_f)$	0.409	0.3040	0.520	0.443	Garda (2016) and Eurostat Database (2016)
Male job finding rate, $p_m(\widetilde{\theta}, s_m)$	0.6280	0.4810	0.5390	0.528	Garda (2016) and Eurostat Database (2016)
Female employment rate, $\hat{e}_f$	0.754	0.585	0.807	0.776	Eurostat Database (2016)
Male employment rate, $\hat{e}_m$	0.844	0.793	0.845	0.830	Eurostat Database (2016)
Female employment level, e_f	0.3853	0.2937	0.5083	0.5186	$e_f = \hat{e}_m L_f$
Male employment level, e_m	0.4122	0.3949	0.4792	0.4967	$e_m = \hat{e}_m L_f$
Female jobless level, u_f	0.1257	0.2083	0.0992	0.1162	$u_f = L_f - e_f$
Male jobless level, u_m	0.0768	0.1031	0.0753	0.0818	$u_m = L_m - e_m$
Female share of jobless, Ω_f	0.5161	0.5772	0.5559	0.5438	$\Omega_f = 1 - \Omega_m$
Male share of jobless, Ω_m	0.4839	0.4228	0.4441	0.4562	$\Omega_m = \frac{u_m}{(u_m+u_f)}$
Effective labour market tightness, $\widetilde{\theta}$	1.0	1.0	1.0	1.0	Normalization
Female job search intensity, s_f	1.4488	0.5308	0.9425	0.9979	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Male job search intensity, s_m	2.2246	0.8399	0.9092	1.1893	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Female job search costs, $\sigma(s_f)$	0.2610	0.1897	0.3816	0.3098	$\sigma(s_f) = \mu_f s_f^2$
Male job search costs, $\sigma(s_m)$	0.3542	0.3184	0.4650	0.4384	$\sigma(s_m) = \mu_m s_m^2$
Female leave take up effort, ε_f	1.0	1.0	1.0	1.0	Normalization
Male leave take up effort, ε_m	0.1014	0.0447	0.3624	0.6663	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Female leave take-up rate, $\tau_f(\varepsilon_f)$	0.045	0.030	0.110	0.056	$\tau_f(\varepsilon_f) = \varphi\vartheta_f$

(*continued on next page*)

Table 1 (*continued*)

	France	Italy	Norway	Portugal	Source
Male leave take-up rate, $\tau_m(\epsilon_m)$	0.002	0.006	0.071	0.045	$\tau_m(\epsilon_m) = \varphi\vartheta_m$
Female leave take up costs, $\kappa_f(\epsilon_f)$	0.0006	0.0019	0.0040	0.0013	$\kappa_f(\epsilon_f) = \rho\epsilon_f^2$
Male leave take up costs, $\kappa_m(\epsilon_m)$	0.0000	0.0000	0.0001	0.0004	$\kappa_m(\epsilon_m) = \rho\epsilon_m^2$
Female wage, w_f	0.8315	0.8828	0.876	0.844	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Male wage, w_m	0.9213	0.9296	0.988	0.951	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Job filling rate, $q(\widetilde{\theta})$	0.2823	0.5727	0.550	0.5005	Equations (2), (28), (29) and (27) for $i = f, m$, equations (4),(25), and targets $\frac{b_i}{w_i}$, $\frac{z_i}{w_i}$, $\frac{c}{\bar{w}}$, $\frac{w_m}{w_f}$ and $\frac{A}{w}$
Block 3: Targets					
Employment opportunity cost rate, $\frac{b_m}{w_m} = \frac{b_f}{w_f}$	0.44	0.40	0.29	0.31	OECD Database
Female on leave payment rate, $\frac{z_f}{w_f}$	1.0	1.0	1.0	1.0	OECD Family Database (Chart PF2.1.A, 2016)
Male on leave payment rate, $\frac{z_m}{w_m}$	1.0	1.0	1.0	1.0	OECD Family Database (Chart PF2.1.B, 2016)
Hiring or vacancy costs, $\frac{c}{w}$	0.25	0.25	0.25	0.25	Blatter et al. (2016)
Gender wage gap, $\frac{w_m}{w_f}$	1.108	1.053	1.129	1.127	Eurostat Database (2016)
Wage adjusted labour productivity ratio, $\frac{A}{\bar{w}}$	1.142	1.100	1.273	1.096	Eurostat (Structural business statistics, 2016)

up planning effort $\epsilon_i = 1$. We also assume the presence of quadratic job searching costs and set $\sigma(s_i) = \mu_i s_i^2$.

The cost incurred by the firm during the worker's leave ψ is set using survey information related to the cost of employee absences presented in the Research Report of the Society for Human Resource Management (SHRM and Kronos, 2014). This study identified various costs associated with employee absences, including direct and indirect costs to organizations for unplanned, planned and extended paid time off. We use information from planned employee absences and consider both the direct costs (such as replacement and overtime costs) as well as the productivity loss (indirect cost) as a proxy of parental leave duration costs to the firm. According to this study, the direct costs and the productivity loss for a planed absence are equal to 29.4% and 15.2% of total payroll in Europe, respectively (see Tables 11 and 12 in the report). We sum up these two costs and set $\psi = 0.446$ in all countries, implying that the firm's costs during worker's leave represent around 44.6% of the worker's productivity.

The workers bargaining power β_i, wages w_i, the job filling rate $q(\widetilde{\theta})$, the male leave take-up effort ϵ_m, the job search intensity s_i, and parameters c, z_i, b_i, μ_i, ρ and ν, are obtained simultaneously by using the two job finding rates in equation (2), the job filling rate (4), the two optimal job search conditions (28), the job creation condition (25), the two leave planning effort conditions (29), the two wage equations (27), and the following targets: the gender wage ratio w_m/w_f, the hiring costs $c/\bar{w}$, the type-specific leave payment rates z_i/w_i, the net replacement rate (common to both types of worker) b_i/w_i, and the wage-adjusted labour productivity ratio $A/\bar{w}$.

Note that, according to this calibration, the male wage bargaining power β_m is higher than the female one β_f in all the economies. These calibrated results are in line with recent literature arguing that women are less likely to initiate bargaining with their employers and are less effective negotiators than men (see, for example, Card et al. (2015) for a discussion). Note also that the calibrated results show that, in contrast to the firm's cost during the worker's leave ψ, the worker's cost of planning the leave, $\kappa_i(\epsilon_i)$, is very small for both female and male workers. This however does not mean that workers do not incur any type of cost related to parental leave take-up, since firms transfer part of ψ to workers in the form of lower wages (see equation (24) and its effect on (27)).

6.2. Simulations: Reducing gaps in leave duration

We now explore the labour market effects of reducing gender gaps in leave duration. Tables 2 and 3 present our results. Table 2 presents the simulated results of the main variables while Table 3 presents the effects in the gender employment and wage gaps. To begin, in Block 1 of both tables, we eliminate the leave awarded to fathers and mothers in the benchmark calibrated equilibrium in order to assess the contribution of these policies to existing gender gaps. In Block 2 we depart from the benchmark in the calibration and increase the number of full-rate equivalent weeks awarded to fathers by 10 weeks. In Block 3, departing once again from the benchmark situation, we decrease the number of full-rate equivalent weeks awarded to mothers by 10 weeks. In Block 4, we add up the total number of full-rate equivalent weeks currently awarded to fathers and mothers and divide them equally between mothers and fathers.[3]

6.2.1. Eliminating parental leaves

In Block 1 in Table 2, we see that eliminating parental leaves increases wages and effective market tightness in all the countries. The value of both types of worker increases for the firm when we eliminate parental duration δ_i (Eq. (25)). Job search intensity also increases, reinforcing the positive effect on wages. Wage effects are more significant for mothers, because they enjoy longer leave periods in the benchmark situation. For example, female and male wages increase by 4.9% and 0.6% in Norway, respectively.

There are two opposing effects on employment (Eqs. (20)-(22)). On the one hand, an increase in effective market tightness has a positive effect on the employment of both types of worker. On the other hand, effective separation rates are larger without job-protected leaves. The latter effect dominates for women in all countries and men in Portugal, reducing the employment rate in these cases. For example, female and male employment rates decrease by 0.35 and 0.08 pp in Portugal, respectively. For men in France, Italy and Norway, the higher effective market tightness dominates, leading to higher male employment.

The contribution of leaves to the gender wage gap also varies largely (Block 1 in Table 3). Eliminating leaves reduces the gender wage gap by 4.5 pp in Norway (from 12.8% to 8.3%), 1.0 pp in France (from 12.8% to 8.4%), 0.8 pp in Italy (from 5.3% to 4.5%), and 0.7 pp in Portugal (from 12.7% to 12.0%). Thus, although the correlation is not perfect, the contribution of parental leaves to the gender wage gap is larger in the countries where a lower proportion of total available full-rate equivalent weeks are reserved for fathers (see Figure 1).

6.2.2. Increasing the duration of leaves awarded to fathers

In Block 2 in Table 2, a higher duration of the leave awarded to fathers reduces the value of the male worker to the firm (the derivative of Eq. (24)) with respect to δ_i is negative) and has a negative effect on job creation (Eq. (25)). Male wages are also negatively affected by the lower J_m and the lower job finding rate $p(s_i, \widetilde{\theta})$ resulting when $\widetilde{\theta}$ is lower

Table 2
Labour market effects of reducing gender leave gap (Variation Δ).

Block 1: $\delta_m = \delta_f = 0$

Variable	France	Italy	Norway	Portugal
$\Delta\delta_f$	-18.8 weeks	-25.2 weeks	-45 weeks	-20.4 weeks
$\Delta\delta_m$	-5.6 weeks	-0.4 weeks	-9.8 weeks	-12.5 weeks
$\Delta\tilde{\theta}$	0.42%	0.11%	3.29%	0.68%
Δs_f	0.33%	0.17%	1.98%	0.45%
Δs_m	0.04%	0.01%	0.48%	0.23%
$\Delta\tau_f(\varepsilon_f)$	-100%	-100%	-100%	-100%
$\Delta\tau_m(\varepsilon_m)$	-100%	-100%	-100%	-100%
Δw_f	0.89%	0.74%	4.92%	1.16%
Δw_m	0.02%	0.01%	0.63%	0.49%
$\Delta\hat{e}_f$	-0.21 pp	-0.30 pp	-0.92 pp	-0.25 pp
$\Delta\hat{e}_m$	0.02 pp	0.01 pp	0.06 pp	-0.08 pp

Block 2: $\uparrow \delta_m$

Variable	France	Italy	Norway	Portugal
$\Delta\delta_f$	-	-	-	-
$\Delta\delta_m$	10 weeks	10 weeks	10 weeks	10 weeks
$\Delta\tilde{\theta}$	0.00%	-0.03%	0.39%	0.34%
Δs_f	0.00%	0.00%	0.04%	0.04%
Δs_m	-0.01%	-0.06%	-0.30%	-0.17%
$\Delta\tau_f(\varepsilon_f)$	0.00%	0.00%	0.00%	0.00%
$\Delta\tau_m(\varepsilon_m)$	40.00%	195.0%	25.35%	20.89%
Δw_f	0.00%	-0.00%	0.02%	0.01%
Δw_m	- 0.02%	-0.16%	-0.94%	-0.58%
$\Delta\hat{e}_f$	0.00 pp	-0.05 pp	0.03 pp	0.02 pp
$\Delta\hat{e}_m$	0.01 pp	0.05 pp	0.24 pp	0.17 pp

Block 3: $\downarrow \delta_f$

Variable	France	Italy	Norway	Portugal
$\Delta\delta_f$	-10 weeks	-10 weeks	-10 weeks	-10 weeks
$\Delta\delta_m$	-	-	-	-
$\Delta\tilde{\theta}$	0.26%	0.05%	0.98%	0.57%
Δs_f	0.21%	0.09%	0.57%	0.29%
Δs_m	0.02%	0.01%	0.09%	0.05%
$\Delta\tau_f(\varepsilon_f)$	-22.0%	-15.0%	-7.27%	-19.64%
$\Delta\tau_m(\varepsilon_m)$	0.00%	0.00%	0.00%	0.00%
Δw_f	0.57%	0.36%	1.36%	0.69%
Δw_m	0.01%	0.01%	0.01%	0.01%
$\Delta\hat{e}_f$	-0.13 pp	-0.15 pp	-0.23 pp	-0.13 pp
$\Delta\hat{e}_m$	0.02 pp	0.01 pp	0.06 pp	0.04 pp

Block 4: $\delta_m = \delta_f > 0$

Variable	France	Italy	Norway	Portugal
$\Delta\delta_f$	-6.6 weeks	-12.4 weeks	-17.6 weeks	-4.0 weeks
$\Delta\delta_m$	6.6 weeks	12.4 weeks	17.6 weeks	4.0 weeks
$\Delta\tilde{\theta}$	0.18%	0.03%	2.42%	0.37%
Δs_f	0.14%	0.09%	1.06%	0.14%
Δs_m	0.01%	-0.07%	-0.44%	-0.04%
$\Delta\tau_f(\varepsilon_f)$	-13.11%	-19.67%	-14.00%	-6.79%
$\Delta\tau_m(\varepsilon_m)$	30.00%	215.00%	38.45%	9.33%
Δw_f	0.38%	0.44%	2.27%	0.30%
Δw_m	-0.01%	-0.22%	-1.72%	-0.22%
$\Delta\hat{e}_f$	-0.09 pp	-0.18 pp	-0.35 pp	-0.04 pp
$\Delta\hat{e}_m$	0.02 pp	0.07 pp	0.54 pp	0.08 pp

(Eq. (27)). Male job search intensity, initially positively affected by the longer leave duration, decreases by the effect of the lower male wage (by 0.01% in France, 0.06% in Italy, 0.30% in Norway and 0.17% in Portugal). This negative effect on job search intensity further reinforces the reduction in wages. Finally, despite the 40% and 195% increase in male leave take-up rates in France and Italy, respectively, the final effect of this variable is small due to the low initial male take-up rates in these countries.[18]

Figure 3, panels (a) and (b), depicts the original equilibrium and the one resulting from the policy change in France and Italy. In France, the downward shift in both job creation and the male wage curves results in a male wage 0.02% lower, no change in effective market tightness and therefore no change in the female wage. In Italy, the shift in job creation slightly dominates resulting in a male wage 0.06% lower and lower effective market tightness, but the reduction is so small that it has negligible effects on female wages.

Finally, in Norway and Portugal, the increase in leave duration awarded to fathers has positive effects on effective market tightness because the decrease in male wages (0.94% and 0.58%, respectively) is large enough to compensate for the other negative effects and still make job creation attractive (Eq. (24)). The higher effective market tightness increases female wages. The resulting reduction in the gender wage gap (Block 2 in Table 3) is nil in France, 0.2 pp in Italy, 1.0 pp in Norway and 0.7 pp in Portugal.

Effects on employment are more involved. From Eqs. (20)-(22), the increased duration and higher leave take-up rate of male workers reduces the effective separation rate and increases the male employment rate. Also, the higher effective market tightness $\tilde{\theta}$ resulting in Norway and Portugal increases the job finding rate with a positive effect on the employment rate of all workers. In all the countries considered, the gender employment rate gap increases (0.01 pp in France, 0.10 pp in Italy, 0.21 pp in Norway and 0.14 pp in Portugal, see Table 3). The reduction in the effective market tightness in Italy reduces female employment by 0.05 pp. The opposite happens in Norway, where the effective market tightness increases.

6.2.3. *Decreasing the duration of leaves awarded to mothers*

In Block 3 of Tables 2 and 3 we analyse the effect of decreasing the number of full-rate equivalent weeks awarded to mothers by 10 weeks. This has similar qualitative effects in all countries. The effective market tightness $\tilde{\theta}$ increases, and female wages increase. This can be explained, first, by the increase in the value of the female worker to the firm that shifts the job creation curve upwards (Eq. (25)). Female wages are also positively affected by the higher J_f and the higher job finding rate $p\left(s_i, \tilde{\theta}\right)$ resulting when $\tilde{\theta}$ is larger (Eq. (35)). Male wages, affected only by the latter effect, increase only slightly. This happens in all countries with different levels of intensity. For example, in Norway, where female wage and employment effects are largest, effective market tightness increases by 0.98%, female wages by 1.36% and male wages by 0.01%.

The reduced duration of leaves awarded to mothers reduces female take-up rates as expected from Eq. (29). This also contributes to higher wages and effective market tightness through higher value of a female worker to the firm. To continue with the example of Norway, female leave take-up rates decrease by 7.27%.

Finally, although we could expect a negative effect of reduced mother-specific leave duration on female search intensity from Eq. (28), we observe in contrast a slight increase. This suggests that the positive effect of reduced leave duration on female wages plays an important role on the choice of female job search intensity (Eqs. (28) and (26)). Similarly, the positive but smaller effect on male job search intensity stems from the higher job finding rate resulting from the increase in $\tilde{\theta}$. Norway has again the largest effect: an increase in female search intensity of 0.57%. The reason why effects are largest in Norway is that female take-up rates are lager to begin with: 0.11 versus 0.056 in Portugal, or 0.03 in Italy (see Table 1). At the same time, these relatively small figures suggest limited effects of changing leave duration on labour market outcomes.

Once again, effects on employment are more involved (see Table 3). From Eqs. (20)-(22), the reduced mother-specific leave duration in-

[18] A few papers have documented large effects on take-up in California, Norway, Spain, Sweden and Quebec (Bartel et al. (2018); Cools et al. (2015); Dahl et al. (2014); Ekberg et al. (2013); Farré and González (2019); Patnaik (2019)). Farré and González (2019) explore the effects of the introduction of two weeks paid paternity leave in Spain in 2007. They find an increase of around 400% in the take-up rate of fathers.

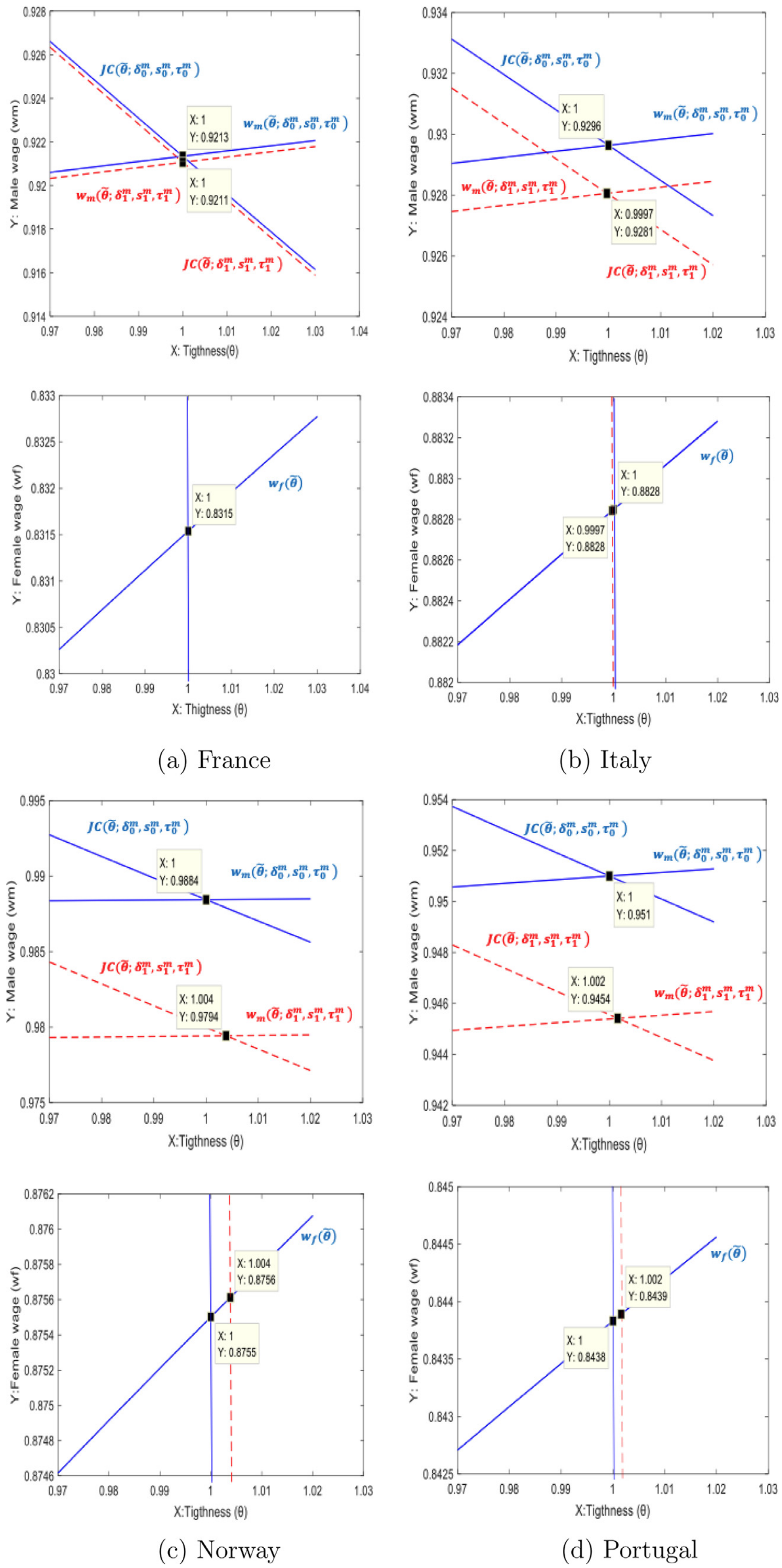

Fig. 3. Effect of increased duration of father-specific leave.

Table 3
Gender wage and employment gap effects of reducing gender leave gap.

Block 1: $\delta_m = \delta_f = 0$

	δ_m, δ_f (years)		$\hat{e}_m - \hat{e}_f$ (% points)		$(\frac{w_m}{w_f} - 1) \times 100\%$	
Country	benchmark	$\delta_m = \delta_f$	benchmark	$\delta_m = \delta_f$	benchmark	$\delta_m = \delta_f$
France	0.108, 0.362	0.000	8.90	9.13	10.80%	9.80%
Italy	0.008, 0.200	0.000	20.80	21.11	5.30%	4.50%
Norway	0.189, 0.865	0.000	3.80	4.78	12.80%	8.30%
Portugal	0.240, 0.392	0.000	5.40	5.57	12.70%	12.00%

Block 2: ↑ δ_m

	δ_m (years)		$\hat{e}_m - \hat{e}_f$ (% points)		$(\frac{w_m}{w_f} - 1) \times 100\%$	
Country	benchmark	after	benchmark	after	benchmark	after
France	0.108	0.300	8.90	8.91	10.80%	10.80%
Italy	0.008	0.200	20.80	20.90	5.30%	5.10%
Norway	0.189	0.381	3.80	4.01	12.80%	11.80%
Portugal	0.240	0.433	5.40	5.54	12.70%	12.00%

Block 3: ↓ δ_f

	δ_f (years)		$\hat{e}_m - \hat{e}_f$ (% points)		$(\frac{w_m}{w_f} - 1) \times 100\%$	
Country	benchmark	after	benchmark	after	benchmark	after
France	0.362	0.169	8.90	9.05	10.80%	10.20%
Italy	0.485	0.292	20.80	20.96	5.30%	4.90%
Norway	0.865	0.673	3.80	4.09	12.80%	11.40%
Portugal	0.392	0.200	5.40	5.57	12.70%	11.90%

Block 4: $\delta_m = \delta_f > 0$

	δ_m, δ_f (years)		$\hat{e}_m - \hat{e}_f$ (% points)		$(\frac{w_m}{w_f} - 1) \times 100\%$	
Country	benchmark	$\delta_m = \delta_f$	benchmark	$\delta_m = \delta_f$	benchmark	$\delta_m = \delta_f$
France	0.108, 0.362	0.1169	8.90	9.01	10.80%	10.40%
Italy	0.008, 0.200	0.1250	20.80	21.05	5.30%	4.60%
Norway	0.189, 0.865	0.0953	3.80	4.69	12.80%	8.40%
Portugal	0.240, 0.392	0.1076	5.40	5.52	12.70%	12.10%

creases the female effective separation rate and reduces the female employment rate. Also, the higher effective market tightness $\widetilde{\theta}$ increases the job finding rate and this has a positive effect on the female employment rate. In all the countries considered, the former effect dominates, yielding reductions of the female employment rate from 0.13 pp (France) to 0.23 pp (Norway). The effect on the male employment rate stems from the higher effective market tightness $\widetilde{\theta}$ and is hence positive, although much smaller.

Overall, the reduction of 10 full-rate equivalent leave weeks awarded to mothers reduces the gender wage gap in all countries considered (Table 3). The reduction is of 0.6 pp in France, 0.4 pp in Italy, 1.40 pp in Norway and 0.8 pp in Portugal. However, the gender employment rate gap increases by 0.15 pp in France, 0.16 in Italy, 0.29 in Norway and 0.17 in Portugal.

6.2.4. *Equalizing the duration of leaves awarded to fathers and mothers*

In Block 4 of Tables 2 and 3 we eliminate the gap in leave duration by adding up the full-rate equivalent weeks currently awarded to fathers and mothers and dividing them equally among them. Thus, we increase father-specific leave duration and decrease mother-specific leave duration simultaneously. The sign of the effects is as expected from the combination of the previous exercises: female leave take-up rates decrease and male leave take-up rates increase dramatically. Effective market tightness increases in all countries (as much as 2.42% in Norway). Female wages increase and male wages decrease resulting in smaller gender wage gaps (Table 3). The size of the reduction depends on the number of weeks involved in the reform. The effect is largest in Norway, where the duration of the leave transferred from mothers to fathers is of 17.6 weeks and the gender wage gap decreases by 4.4 pp. In France and Portugal, where the number of weeks transferred is of 6.6 and 4 weeks, respectively, gender wage gaps decrease by only 0.4 pp and 0.60 pp. Gender employment gaps increase in all countries.

7. Concluding remarks

We have explored the effects of mother-specific and father-specific leave entitlements on gender wage and employment gaps in a labour search and matching model with parental leave and two types of workers, males and females, who compete for the same jobs. We have accounted for endogenous job search intensity and endogenous leave take-up rates.

An increase in type-specific leave duration has ambiguous effects on effective market tightness, wages, job search intensities and leave take-up rates. To shed some light on the mechanisms at stake, we first explored analytically the effect of leave duration on effective market tightness and wages taking search intensities and take-up rates as given. We thus identified two key mechanisms: a negative effect on the value of the job position that shifts both job creation and targeted worker wage curves downwards, and an either positive or negative effect on the targeted worker wage curve that depends on his or her net bargaining position. To account for the effect of changes in leave duration when search intensity and leave take-up rates are endogenous, we calibrated the model and simulated parental leave duration changes for four selected countries: France, Italy, Norway and Portugal. Despite significant differences in parental leave policies, the four countries display similar patterns. In most cases, an increase in the duration of either type-specific leave shifts the job creation and the targeted worker wage curves downwards. Thus, the wage of the targeted worker falls but effective market tightness, and the wage of the other worker, can increase. Leave take-up rates increase and search intensity of each type falls when the wage of that type falls.

Employment turns out to be quite responsive to the changes in the effective separation rate. Longer leave duration in effect protects workers' employment and increases employment rates of targeted workers. In general, we find that job search intensity decreases when longer leave duration decreases wages.

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