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Abstract

We study the design of parental leave systems through the lens of an estimated model of parents' joint willingness to pay for parental leave. We estimate the model using Danish register data on almost 200,000 births combined with sharp variation in economic incentives created by the parental leave benefit system. The estimated model reproduces the empirical distribution of leave, including bunching at kinks in household budget sets and a large share of fathers taking little or no leave at all. We provide a menu of counterfactual policy simulations showing substantial interaction effects between earmarked leave, replacement rates and the duration of leave benefits. For example, introducing 9 weeks earmarked parental leave, as stipulated by a recent EU directive, with a low replacement rate increases the leave of fathers only slightly, while it reduces the leave of mothers significantly in our model. Finally, we discuss the efficiency costs of different policies aimed at increasing the parental leave of fathers.

JEL-Codes: J130, J220, H310, C540.

Keywords: parental leave, welfare reforms, intrahousehold allocation.

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1 Introduction

The arrival of children is one of the main drivers of labor market gender inequality (Angelov *et al.*, 2016; Lundborg *et al.*, 2017; Kleven *et al.*, 2019b,a), and part of the reason for the slow progress towards labor market gender equality in many developed countries over the past decades (Olivetti & Petrongolo, 2016; Blau & Kahn, 2017). This fact has spurred an increasing interest in welfare reforms that incentivize parents to share the burden of child rearing. Central among such policies is earmarked (non-transferable) parental leave, which has recently been mandated by law in all EU member countries (EU, 2019).[1] However, while earmarked parental leave may reduce labor market gender inequality, opponents of earmarked leave argue that such policies in effect restrict the choice set of parents and hence risk reducing both total parental leave and household welfare.

The arguments put forward by the opponents of earmarked leave reflect a gap in our understanding of how the broader design of parental leave benefits affects parents' division of parental leave and household welfare. A sizable literature studies partial elements of the parental leave system, such as the length of benefits (e.g., Lalive & Zweimüller, 2009; Dahl *et al.*, 2016), earmarked parental leave (see Footnote 1), and the replacement rate while on leave (e.g., Nielsen, 2009; Raute, 2019). However, from these empirical findings, it is difficult to arrive at a general understanding of welfare reforms that combines several of these features.

We study the broad design of parental leave benefit systems through the lens of an estimated model of parents' joint willingness to pay for parental leave. We analyze the parental leave use and efficiency costs associated with a menu of alternative combinations of the length and generosity of parental leave benefits and earmarked parental leave. To the best of our knowledge, we thus provide the first unified analysis of multi-dimensional parental leave reforms and the first step towards understanding the societal desirability of such reforms.

[1] Earmarked parental leave has already been implemented in, for example, Canada, Germany, Austria and Scandinavia (Ekberg *et al.*, 2013; Dahl *et al.*, 2014; Cools *et al.*, 2015; Patnaik, 2019).

We estimate the model using detailed register data and sharp variation in economic incentives created by the Danish parental leave benefit system. The Danish parental leave system combines transferable, but relatively low public benefits (average replacement rate is around 50%) with temporary and earmarked wage compensation partly provided by employers. This two-tier system creates discontinuities in the marginal cost of leave at which we find sharp bunching, consistent with a significant effect of economic incentives on the take-up of parental leave (Saez, 2010; Kleven, 2016). Carefully modeling the household-level incentives for parental leave division in Denmark allows us to back out the preferences of parents from the bunching created by these kinks in the household budget set.

The estimated model replicates the empirical distribution of parental leave well, both in terms of the observed bunching at the at kink points and in terms of the extensive margin. In particular, despite the often strong incentives for fathers to take parental leave, we find that a large share of parents choose the "gender stereotypical" allocation with zero parental leave to the father. In fact, we find that half of the parents in our sample are willing to pay at least 10% of household weekly earnings to avoid transferring one week of parental leave from the mother to the father.

We conduct several counterfactual policy simulations using the estimated model. First, we investigate how introducing earmarked parental leave affects parents while keeping remaining features of the Danish institutional settings fixed. We find that implementing the EU (2019) directive with 9 weeks of earmarked leave only increases the leave of fathers slightly while the leave taken by mothers is reduced significantly. Combined, households reduce the number of parental leave weeks by approximately 2 weeks and experience a utility loss worth roughly 1% of annual household income in our model.

However, we find important interaction effects between earmarked leave, the replacement rate when on benefits and the total length of leave benefit rights, which explain the modest response of fathers under the current Danish institutional setting. A higher replacement rate increases the behavioral responses of fathers to earmarked leave, and combining earmarked parental leave with higher replacement rates may fully undo the negative effects on household utility and the total duration of parental leave duration.

Finally, we use the model to discuss the efficiency costs of different policies aimed at raising fathers' use of parental leave. Using a standard measure of efficiency, our model provides the relevant estimates of the societal costs under the assumption that the societal costs and benefits are additively separable and that parents allocate parental leave efficiently. The in-sample simulations suggest that if total household leave is not a concern, the most efficient way to increase the fathers *share* of leave is to construct a less generous system with significant earmarked leave. Alternative policy goals that focus on the absolute *level* of fathers' or household's leave are most efficiently achieved by a more generous parental leave system with an extended period of parental leave benefits and a high replacement rate. In general, we find that earmarked parental leave is an efficient way to increase the leave of fathers.

Our paper relates to two strands of literature. First, we contribute to the empirical literature on parental leave reforms and, in particular, to the growing literature on the effects of earmarked parental leave (Ekberg *et al.*, 2013; Kluve & Tamm, 2013; Dahl *et al.*, 2014; Cools *et al.*, 2015; Avdic & Karimi, 2018; Andersen, 2018; Druedahl *et al.*, 2019; Farré & González, 2019; Patnaik, 2019; Olafsson & Steingrimsdottir, 2020). This literature studies the effects of earmarked leave on a number of outcomes, such as the division of household work, the gender wage gap, fertility and marriage stability using actual policy reforms. We complement these studies in two ways. First, we provide evidence on the effect on household utility, which is a key component in the assessment of the desirability of earmarked leave reforms. Second, by carefully modeling the institutional setting, we can relate the observed behavioral responses to the underlying changes in incentives. Hence, our study does not just provide behavioral responses to a particular reform but can serve as a guide for policy markers when designing parental leave systems more broadly.

Second, our approach relates to a growing literature that uses estimated economic models to analyze a broad set of counterfactual policy reforms. A paper closely related to ours, both in spirit and in methodology, is Chan (2013) who estimates a model of individual labor supply and investigates the labor supply effects of the Earned Income Tax Credit (EITC) in the US. Similarly, Blundell *et al.* (2016) analyze the UK tax and welfare system through a model of female labor supply. Similar "structural" approaches have, for example, been used to investigate the effect of pro-fertility policies on fertility and women's careers (Adda *et al.*, 2017), the effect of taxes on labor supply (see Keane, 2011, for a survey), the effect of social benefits on retirement of couples (van der Klaauw & Wolpin, 2008), and the effect of divorce laws (Voena, 2015). To the best of our knowledge, we provide the first analysis of counterfactual parental leave reforms.

The rest of the paper is organized as follows. Section 2 presents a model of parent's willingness to pay for parental leave together with a general formulation of a parental leave benefit system. Section 3 describes the Danish register data and institutional setting that we use to estimate the model in Section 4. In Section 5 we use the estimated model to investigate the in-sample effects of counterfactual policies. Finally, Section 6 concludes.

2 Model

In this section, we formulate a discrete choice model of the division of parental leave between mothers and fathers after a childbirth. The model includes a flexible parental leave benefit system and allows for rich heterogeneity in preferences for parental leave through both observed and unobserved household characteristics.

Parents of child i choose the amount of leave of the mother, $l_{i,m} \in \{0, 1, \dots\}$, and the father, $l_{i,f} \in \{0, 1, \dots\}$ that maximizes household utility, given by

$$U(l_{i,m}, l_{i,f}, y_i) = y_i + \sum_{j \in m,f} \left(\alpha_{i,j} l_{i,j} + \frac{1}{2} \beta_{i,j} l_{i,j}^2 \right) + \rho l_{i,m} \cdot l_{i,f}, \tag{1}$$

where y_i is disposable income and $\alpha_{i,j}$, $\beta_{i,j}$ and ρ for $j \in \{m, f\}$ measure the preferences for leave of each parent.

This specification implies that the couple's willingness to pay for an incremental increase in the leave of parent j is given by

$$MWP_{i,j} \equiv \frac{U(l_{i,j} + \triangle l_j, l_{i,-j}, y_i) - U(l_{i,j}, l_{i,-j}, y_i)}{\triangle l_j} = \alpha_{i,j} + \beta_{i,j} l_{i,j} + \rho l_{i,-j} + \frac{1}{2}\beta \triangle l_j, \quad (2)$$

which is linear in leave with $\alpha_{i,j}$ as the level parameter, $\beta_{i,j}$ as the slope in parent j's own leave, and ρ allows for the leave of the two parents to be complements or substitutes.

We allow the utility parameters to depend on parental characteristics through

$$\begin{aligned} \alpha_{i,j} &= \gamma_{\alpha,j} X_{i,j} + \varepsilon_{i,j}, \\ \beta_{i,j} &= \gamma_{\beta,j} X_{i,j}, \end{aligned} \quad (3)$$

where $X_{i,j}$ is a set of observed individual and household-level characteristics, and $\varepsilon_{i,m}$ and $\varepsilon_{i,f}$ are unobserved random utility parameters, which we assume follow a bi-variate normal distribution with mean zero, variances of σ_f^2 and σ_m^2 and covariance σ_{mf}.

Disposable household income is given as

$$y_i = (1 - \tau) \left(B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B}) + \sum_{j \in m,f} w_{i,j}(52 - l_{i,j}) \right), \quad (4)$$

where $w_{i,j}$ is the weekly earnings of parent j and τ is the income tax rate.[2] $B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B})$ is the parental leave benefits as a function of each parent's leave, relevant household information (Z_i), such as wage rates, and the institutional settings ($\mathcal{B}$), which we describe in detail below.

The model is intended to capture the main trade-offs parents face when allocating parental leave between them. For example, we want the model to be able to accurately describe the parents' *joint* allocation of parental leave. Thus, we model the amount of leave on the weekly level, which leads to a choice-set with $53^2 = 2,809$ discrete alternatives for a given

[2]We focus on the incentives created by the parental leave system and model the tax system as a simple proportional tax on total income. This simplification does not have significant implications for our results, as the complexity in the tax system is largely orthogonal to the complexity in the parental leave system. In our empirical application below, we set $\tau = 0.4$, which corresponds to the typical marginal tax on non-capital income in Denmark.

value of observed and unobserved household characteristics, Z_i, $X_{i,j}$ and $\varepsilon_{i,j}$, above.[3]

We have formulated the household decision problem as static to keep the estimation computationally tractable. The model incorporates dynamic considerations of parents into parents' willingness to pay for leave. Parents may, for example, be concerned with the consequences of parental leave on their future career (Rege & Solli, 2013; Johnsen *et al.*, 2020) due to losses in human capital (Adda *et al.*, 2017) or norms and signaling effects (Tô, 2018). This will reduce their willingness to pay for a given level of leave, which is captured in $\alpha_{i,j}$ and $\beta_{i,j}$. We probe the explanatory power of such extrinsic motives in Section 4by including potential wage growth and firm-level parental leave information in $X_{i,j}$, and we discuss the implications for counterfactual simulations in Section 5.

Finally, the model is unitarian in the sense that parents allocate parental leave optimally as if they were a single agreeing unit. Alternatively, household bargaining could be implemented through a collective model (see, e.g., Chiappori, 1992; Bourguignon & Chiappori, 1994) or as a non-cooperative model (e.g., Konrad & Lommerud, 2003). While such alternatives are interesting avenues for future research, we opt for the unitary model for simplicity.[4]

2.1 Parental Leave Benefit System

We formulate the parental leave benefit system in a flexible way, incorporating the key institutional details present in most developed countries, including Denmark. In particular, we allow parental leave benefits to be a non-linear function of the leave taken by both parents. As described in Section 3, the non-linear parental leave benefits in the Danish setting are created by a two-tier system that combines public parental leave benefits with wage compensation partly provided by firms, but the system could just as well be purely public or private.[5]

[3]Empirically, there is significant heaping around integer weeks, suggesting that weekly leave is a good approximation of the decision problem.

[4]Gobbi *et al.* (2018) estimate a collective model of parental leave use in Germany.

[5]The two-tier system created by the combination of public benefits and firm paid wage compensation is similar to the setting in many other countries, including some of US states (Goldin *et al.*, 2020).

The parental leave benefit system consists of the following policy parameters: *i)* a statutory benefit replacement rate as a share of pre-birth earnings (χ), *ii)* a benefits cap (κ), *iii)* leave earmarked to each parent $(\bar{e}_j)$, *iv)* the total number of household weeks of parental leave benefits including earmarked weeks and leave with full wage compensation $(\bar{p}_H)$, *v)* the number of weeks with full wage compensation for each parent ($\bar{z}_j$), and *vi)* the number of weeks with full wage compensation shared between the parents ($\bar{z}_H$).

Before discussing these economic incentives created by the parental leave system, we formally describe the institutional settings captured in $B(l_m, l_f; Z, \mathcal{B})$.[6] We assume throughout that parents maximize the amount of benefits they can receive for a given combination of leave. This implies that in situations where parents exhaust the shared leave components, they will allocate leave with benefits to the parent with the highest benefit level.

Denoting parent k as the parent with the highest weekly earnings, $w_k > w_{-k}$, we allocate any shared weeks with wage compensation ($\bar{z}_H$) between the parents and compute the used weeks with wage compensation for each parent as

$$z_k = \min(\bar{z}_k + \bar{z}_H, l_k), \tag{5}$$

$$z_{-k} = \min(\bar{z}_{-k} + r_z, l_{-k}), \tag{6}$$

where $r_z = \min(\bar{z}_k + \bar{z}_H - z_k, \bar{z}_H)$ is the shared weeks with wage compensation unused by the highest earning parent.

Similarly, we allocate the total parental leave benefits $(\bar{p}_H)$ (net of earmarked leave and leave with wage compensation) to the parent, k, with the highest weekly benefits, defined as

$$b_j = \min(\chi w_j, \kappa), \tag{7}$$

and compute the weeks with benefits for each parent as

$$p_k = \min(r_{p,k}, l_k - z_k), \tag{8}$$

[6] We drop child subscript i throughout this exposition to ease notation.

where $r_{p,k} = \bar{p}_H - z_k - \max(\bar{e}_{-k}, z_{-k})$ is the unused shared parental leave remaining for parent k after deducting leave with wage compensation and leave earmarked to parent $-k$. Leave with parental benefits to parent $-k$ is then given by

$$p_{-k} = \min(r_{p,-k}, l_{-k} - z_{-k}), \tag{9}$$

where $r_{p,-k} = \bar{p}_H - z_{-k} - \max(\bar{e}_{-k}, z_{-k} + p_k)$ is the remaining parental leave benefits for use by parent $-k$.

Combining the above, we calculate total parental leave benefits as

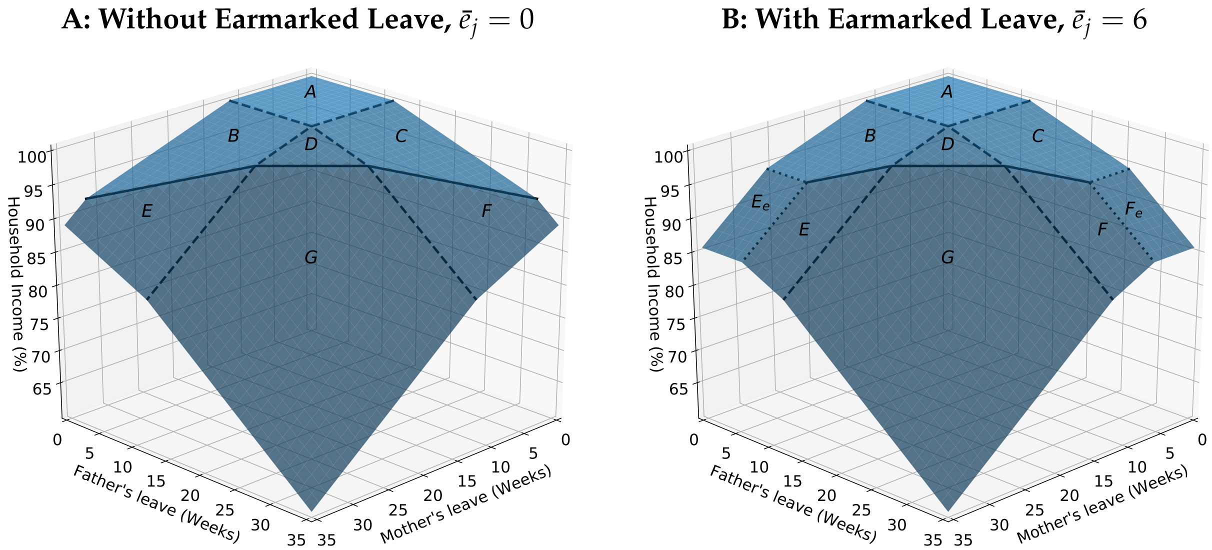
$$B = \sum_{j \in \{m,f\}} z_j w_j + p_j b_j. \tag{10}$$

We illustrate the resulting household budget sets in Figure 1 for $w_j = 1000$, $\bar{z}_j = 12$, $\bar{z}_H = 0$, $\bar{p}_H = 32$, $\chi = 1$, $\kappa = 580$ and $\bar{e}_j \in \{0, 6\}$. Thus, while the setup allows for general asymmetry in the parent-specific parameters, the example presented here is completely symmetric with respect to the mother and father. We plot household income, $y(l_m, l_f)$, relative to the no-leave income, $y(0, 0)$.

In Figure 1 Panel A, we divide the budget set into 7 segments depending on the economic incentives parents face. In segment A, where $(l_m, l_f) \in \{0, \ldots, 12\}^2$, household disposable income is unaffected by the number of weeks on leave since both parents receive full wage compensation for 12 weeks in this example. Hence, in this segment, the cost of an incremental increase in leave for both parents is $\Delta y / \Delta l_j = 0$.

Moving outside this plateau, the slopes of the budget set change discretely in multiple places. These kinks in the budget set are key to the identification of the model, as discussed in Section 4. In the segments C and D, the father has exhausted his wage compensation without the couple having exhausted their total public parental leave entitlement. Hence, in these segments the father will only be eligible for the lower parental leave benefits ($b_f = \min(\chi w_f, \kappa)$) and incremental increases in leave will reduce household income by the difference between his wage and the benefits net of taxes, $\Delta y / \Delta l_f = (1 - \tau)(b_f - w_f)$.

Figure 1: Examples of Household Budget Sets



Notes: The figure illustrates the household budget set, $y(l_m, l_f)$, as a function of leave of both parents. We report the budget set in percentages relative to taking no leave, $y(0,0)$. The budget sets are illustrated for a situation with $w_j = 1000$, $\bar{z}_j = 12$, $\bar{z}_H = 0$, $\bar{p}_H = 32$, $\chi = 1$, $\kappa = 580$ and $\bar{e}_j \in \{0,6\}$. Panel A has no earmarked parental leave, $\bar{e}_j = 0$, while Panel B include 6 weeks of earmarked leave to both parents, $\bar{e}_j = 6$.

Similarly, the incremental cost of parental leave for the mother in segments B and D is given by $\Delta y/\Delta l_m = (1-\tau)(b_m - w_m)$.[7]

The third kink arises due to the exhaustion of the parental leave benefits of $\bar{p}_H = 32$ weeks, indicated by the solid line in Figure 1. In segment G, the parents are no longer eligible for benefits, and hence, the incremental cost of leave for both parents is given by their full wage net of taxes, $\Delta y/\Delta l_j = -(1-\tau)w_j$.

The exhaustion of the public leave also creates kinks between segments B-E and C-F, but with slightly different changes in slopes. For example, in segment E the father has not exhausted his wage compensation despite the parents having exhausted their shared leave. Hence, when the father takes more leave, he will use parental leave benefits at the expense of the mother in order to take advantage of his wage compensation. This creates an incremental cost of leave for the father of $\Delta y/\Delta l_f = -(1-\tau)b_m$, and similarly, for the mother in segment G.

[7] Without the symmetry we would still have a jump in the marginal cost of leave for the mother when moving from A to C or B to D, but the size and position of these kinks would differ from those of the father.

In addition to the isolated marginal cost of leave of each parent, consider the marginal cost of reallocating leave from one parent to the other holding total household leave fixed. These costs are given by the difference between their marginal costs of leave. Consider, for example, segment B, where the father is still covered by wage compensation while the mother receives lower parental benefits. Hence, reallocating leave from the mother to the father in this segment will *increase* household income by $\Delta y/\Delta l_f - \Delta y/\Delta l_m = (1-\tau)(w_m - b_m)$, and as we show in Section 4, this is a common situation for Danish parents to be in.

In Figure 1 Panel B we illustrate a budget set with the same parameters as in Panel A except that $\bar{e}_j = 6$ weeks of leave is now earmarked each parent. This creates two additional segments, E_e and F_e, where the mother or the father take less than 7 weeks, respectively. These segments provide lower income than in the previous setting without earmarked leave and arise from the fact that total parental leave benefits, $\bar{p}_H$, can no longer be fully shared between parents.

In addition to the reduction in household income in segments E_e and F_e, the earmarked leave also changes the incremental cost of leave in two ways: First, in segment E_e the cost for the mother is now her full wage net of taxes, $\Delta y/\Delta l_m = -(1-\tau)w_m$, and similarly for the father in segment F_e. Second, in segment E_e, the leave of the father no longer rivals the leave of the mother, as she cannot use the leave with benefits even if he does not. This implies that the incremental cost of leave for the father is 0 in segment E_e, and similarly for the mother in segment F_e

As discussed above, the parental leave system creates a number of segments in which parents could increase their leave without reducing household income, or could even reallocate leave and *increase* household income. These segments are informative about parents' willingness to pay for parental leave to the extent we observe empirically (as we do) that parents are willing to forego contemporaneous income by allocating leave in a way that leaves money on the table. We use this information in the identification of the model parameters below.

3 Danish Data and Institutional Setting

3.1 Institutional Settings

During our sample period the Danish parental leave system provides a total of 52 weeks of leave divided into four parts: *i)* 4 weeks of pregnancy leave before the estimated date of delivery, *ii)* 14 weeks of maternity leave after birth, *iii)* 2 weeks of paternity leave within the first 14 weeks after birth, and *iv)* 32 weeks of shared parental leave of which none is earmarked.[8]

We focus on the division of the final 32 weeks of shared parental leave between mothers and fathers. As we show below, parents typically allocate most leave to the mother, and the marginal decision to transfer leave between parents is thus in the last half of the shared parental leave. Hence, we are effectively studying the allocation of parental leave when the child is typically 8–12 months old and the relative biological advantage of mothers in child rearing (e.g., due to breastfeeding) is less pronounced.

Parents have wide flexibility in when and how to use the 32 weeks of shared parental leave: They can take leave together, return to work fully or part time, postpone a proportion of the leave until the child is up to 8 years old and extend the leave by either 8 or 14 weeks.[9] However, parents must inform their employer about their planned leave well in advance and, thus, cannot take leave on a day to day basis.

While on any of the four types of leave, parents who are employed pre-birth are eligible for public benefits equivalent to unemployment benefits.[10] For a full-time employee (37 hours per week) benefits replace 100% of pre-birth earnings up to a benefit cap of EUR

[8]The public leave is assigned to parents per birth regardless of the number of children born. Hence, twin births do not trigger additional leave. See, e.g., Andersen (2018) for additional details of the Danish parental leave system.

[9]Extensions do not trigger more benefits but parents can choose to smooth their benefits over the total duration of leave.

[10]The employment criteria is roughly that the parent was working at least three out of four months. Employees are also covered by extended job protection during pregnancy and all types of parental leave, which implies that the employer must prove that a firing was fully motivated by other factors than the pregnancy or leave.

580 per week (2019-level, EUR 1 $\approx$ DKK 7.5).[11] Hence, the public benefits only replace hourly wages up to EUR 15.7, which is close to the effective minimum wage in the Danish labor market. Compared to an average hourly wage rate of EUR 30, the benefits offer an effective replacement rate of only 53%, which is low by European standards (OECD, 2019).

The low public replacement rate is partly offset by firm-provided wage compensation, which covers the gap between public benefits and the parent's former wage.[12] In most cases, the wage compensation does not cover the entire period of potential leave and cannot be transferred between parents. Hence, combined with the public parental leave benefits, the wage compensation creates budget sets similar to the ones presented in Section 2. In the notation of the general parental leave system presented in that section, the division of the shared parental leave benefits in the Danish system is characterized by $\chi = 1$, $\kappa = 580$, $\bar{e}_j = 0$, $\bar{p}_H = 32$ and $\bar{z}_j$ and $\bar{z}_H$ vary across parents. We will discuss the individual and shared wage, $\bar{z}_j$ and $\bar{z}_H$, compensation in detail below.

3.2 Data

We use administrative data for the full population in Denmark. The data combine several administrative registers (linked at the individual level via personal identification numbers) and contain detailed information on earnings and benefits received as well as demographic information. The data allow us to link individuals over time to other family members and workers to firms.

Our two main data sources are spell data on the use of parental leave available for parents of children born between 2008 and 2015 and monthly earnings data for the universe of

[11]For employees working less than full-time, the cap is scaled down proportionally. Parents on unemployment benefits pre-birth are also eligible for parental leave benefits, while parents, who have children while being on other types of benefits, such as cash or student benefits, typically will stay on these benefits.

[12]In practice, firms pay out the entire wage to employees when providing wage compensation and receive the public parental leave benefits as reimbursement from the state. For firms in the private sector, the wage compensation (the difference between the wages paid out and the public benefits) is, to a large extent, covered by parental leave funds organized by either the state or employer organizations, and hence, private firms are largely unaffected financially by having workers on parental leave (Brenøe *et al.*, 2020). During the period we consider, it is mandatory for firms to be a member and to contribute to a parental leave fund, but it is not mandatory for firms to actually provide wage compensation.

Danish employees starting in 2008. The spell data has information on the amount of leave benefits received by each parent-child observation, including whether the benefits have been paid out to the parent or to the employer. Benefits are paid to the employer when the employer provides wage compensation, as, in practice, employers pay the entire wage to employees when providing wage compensation and receive the public parental leave benefits as reimbursements from the state.

We compute the total number of parental leave weeks from the start and end dates of the spell and use the total benefits paid out to calculate individual replacement rates. With these replacement rates, we calculate the number of weeks with full wage compensation from the amount of benefits paid to the employer. Our measure of parental leave includes all full-time leave taken at most three years after childbirth.

We restrict our attention to parents who are in stable employment and not on public benefits in the 3 months leading up to the birth, except pregnancy related benefits. We consider each birth as a separate observation, but we exclude births of parents who have a subsequent child within 15 months. These restrictions leave us with just under 190,000 births as shown in Table 1.

Table 1: Sample Selection.

	Mothers	**Fathers**	**Births**
All Births 2008-2015	414,248	414,248	414,248
+ No Close Births	404,860	404,860	404,860
+ Parents in Stable Employment Pre-birth	266,367	296,847	215,935
+ Parents not on Benefits Pre-birth	254,260	276,653	196,578
+ Parents in Parental Leave Data	243,843	213,571	189,974
Final Sample			**189,974**

Notes: Close births are defined as parents having subsequent children within 15 months. Stable employment is defined as being continuously employed in the same firm in the 3 months prior to birth. Similarly, we exclude parents who are on non-birth related public benefits at some point during the 3 months prior to birth. Our sample is not significantly affected by considering a longer (e.g., 9 months) pre-birth period. Each observation is a parent(s)-child combination, and hence, parents may enter multiple times if they have more children and in each case fulfill the selection criteria.

Table 2 provides descriptive statistics for our final sample. Half of the parents are married, and fathers are, on average, 2 years older than mothers. Additionally, mothers are positively selected into the public sector, larger firms, and industries, in which both fathers and mothers take longer parental leave. Mothers have lower pre-birth weekly earnings on average, but are on a steeper part of their career trajectory, measured by the potential earnings growth. The potential earnings growth is computed from a Mincer regression of log earnings on education level, field of study and labor market experience, as described in the notes to the table.

Table 2: Descriptive Statistics

	Fathers			Mothers		
	P25	Mean	P75	P25	Mean	P75
Child Generation	2,009.00	2,011.38	2,013.00	2,009.00	2,011.38	2,013.00
Total Number of Children	1.00	1.80	2.00	1.00	1.80	2.00
Married	0.00	0.51	1.00	0.00	0.51	1.00
Age	30.00	33.22	36.00	28.00	31.09	34.00
Earnings						
Weekly Earnings (EUR)	955.22	1,273.33	1,424.42	795.19	993.30	1,127.37
Potential Earnings Growth	0.00	0.12	0.18	0.06	0.16	0.23
Replacement Rate	0.41	0.51	0.61	0.50	0.60	0.69
Earnings Share in Couple	0.50	0.55	0.61	0.39	0.45	0.50
Sector, Firm and Industry Characteristics						
Private Sector	1.00	0.79	1.00	0.00	0.46	1.00
Local Government	0.00	0.11	0.00	0.00	0.44	1.00
Central Government	0.00	0.10	0.00	0.00	0.10	0.00
Firm Size (Employees)	25.38	3,853.94	2,428.63	124.92	8,478.68	10,697.13
Median Weekly Earnings in Firm (EUR)	869.19	1,027.28	1,186.90	825.67	925.93	1,041.55
Median Male Leave in Industry	0.00	1.58	3.00	0.00	3.02	6.00
Median Female Leave in Industry	26.00	27.84	32.00	26.00	28.75	32.00

Notes: The table provides descriptive statistics for each parent-child observed. All variables are measured pre-birth and all monetary amounts are scaled to 2019 levels. We compute individuals' potential earnings growth as follows: First, we estimate a Mincer equation of log earnings on education level, field of study and labor market experience on a sample of men only. Second, using the estimated coefficients, we predict the log earnings for all parents in two situations: A) given their pre-birth education and experience, and B) given their pre-birth education and experience plus 5 years. The difference between A and B is our estimate of potential increase in log earnings over the next 5 years. Median leave is measured within 6-digit industry groups (740 groups).

3.3 Individual Rights to Wage Compensation

We do not observe the individual rights to wage compensation directly in the data, and hence, we need to impute these.

The Public Sector

For the public sector, the collective labor market agreements stipulate a common set of rules for all employees. These rules give both parents the right to 6 weeks of full wage compensation with an additional 6 weeks shared between them (the so-called 6-6-6 model). However, the latter 6 weeks of wage compensation are only shared between parents if they are both employed in the same public sub-sector (either the central or local government). If instead, for example, the father is employed in the central government (state) and the mother in the local government (e.g., municipalities) or private sector, the father can use the 6 shared weeks uncontested. Hence, in this case, he has an individual right to 12 weeks of wage compensation.[13] We use these rules directly to impute the rights to wage compensation of publicly employed parents based on register data on the employment sector of both parents.

The Private Sector

Compared to the public sector, there is significant variation in the individual rights to wage compensation among private sector employees. The variation is created by three overall factors: *i)* Differences in collective agreements applying to different employees, *ii)* Firms not covered by collective agreements, and *iii)* Employees that negotiate additional individual rights to wage compensation. Hence, we impute each individual's rights to wage compensation in two steps for private sector employees.

[13] The 6-6-6 model was in effect between April 1st, 2008 and April 1st, 2015, which covers the bulk of our sample period. Starting April 1st 2015, the 6-6-6 model was replaced by a 6-7-6 model providing fathers with an additional week of wage compensation.

First, we assume that the parents we observe taking some leave without wage compensation must have first exhausted their individual right to wage compensation. For these parents, we assume that the observed leave with wage compensation in the data is equal to their individual rights. Formally, let l_i denote the leave taken, $\bar{z}_i$ the (unobserved) individual right to wage compensation, and z_i the observed weeks of leave with wage compensation for individual i. We then impose the natural assumption that $\bar{z}_i = z_i$ if $l_i > z_i$. We impute the individual right to wage compensation through individual exhaustion for around 35 percent of parents working in the private sector (see Table 3).

Second, for parents who do not exhaust their wage compensation ($l_i = z_i$), we know that $\bar{z}_i \geq z_i$. For these parents we impute $\bar{z}_i$ as the mode wage compensation among the co-worker parents who we observe with wage compensation weakly above parent i, and who exhaust their wage compensation.[14] Formally, that is

$$\bar{z}_i = \begin{cases} z_i & \text{if } l_i > z_i \\ \arg\max_{\bar{z}} f(\bar{z}| \underbrace{j \subset G_i}_{\text{Coworkers}}, \underbrace{l_j > z_j}_{\text{who exhaust with}}, \underbrace{z_j \geq z_i}_{\text{weakly more compensation}}) & \text{else} \end{cases} \quad (11)$$

where $f(\bar{z}|\cdot)$ is the empirical conditional probability function of weeks with wage compensation of co-workers in the same group, G_i, as individual i.[15]

Our preferred imputation of $\bar{z}_i$ is based on groups of co-workers defined as firm-year cells. However, as our imputation requires at least two co-workers who exhaust their wage compensation, there is a set of predominately smaller firms for which we cannot obtain an imputation at this disaggregated level. For the parents in this subset of firms, we define the co-worker group as industry-year cells.

In Table 3 we split the private sector sample according to the definition of co-worker group used to impute their individual right to wage compensation. For the third of fathers, who do not exhaust their benefits, we impute the right to wage compensation from within

[14] We allow for misclassified reimbursement claims by scaling down the mass with zero wage compensation by 50% when computing the mode.

[15] We illustrate our estimation strategy in Appendix Figure A.I.

firm-year cells, while the rest are identified from industry-year cells. The vast majority of mothers exhaust their benefits, and thus, we are able to identify their right to wage compensation directly from their observed amount of wage compensation.

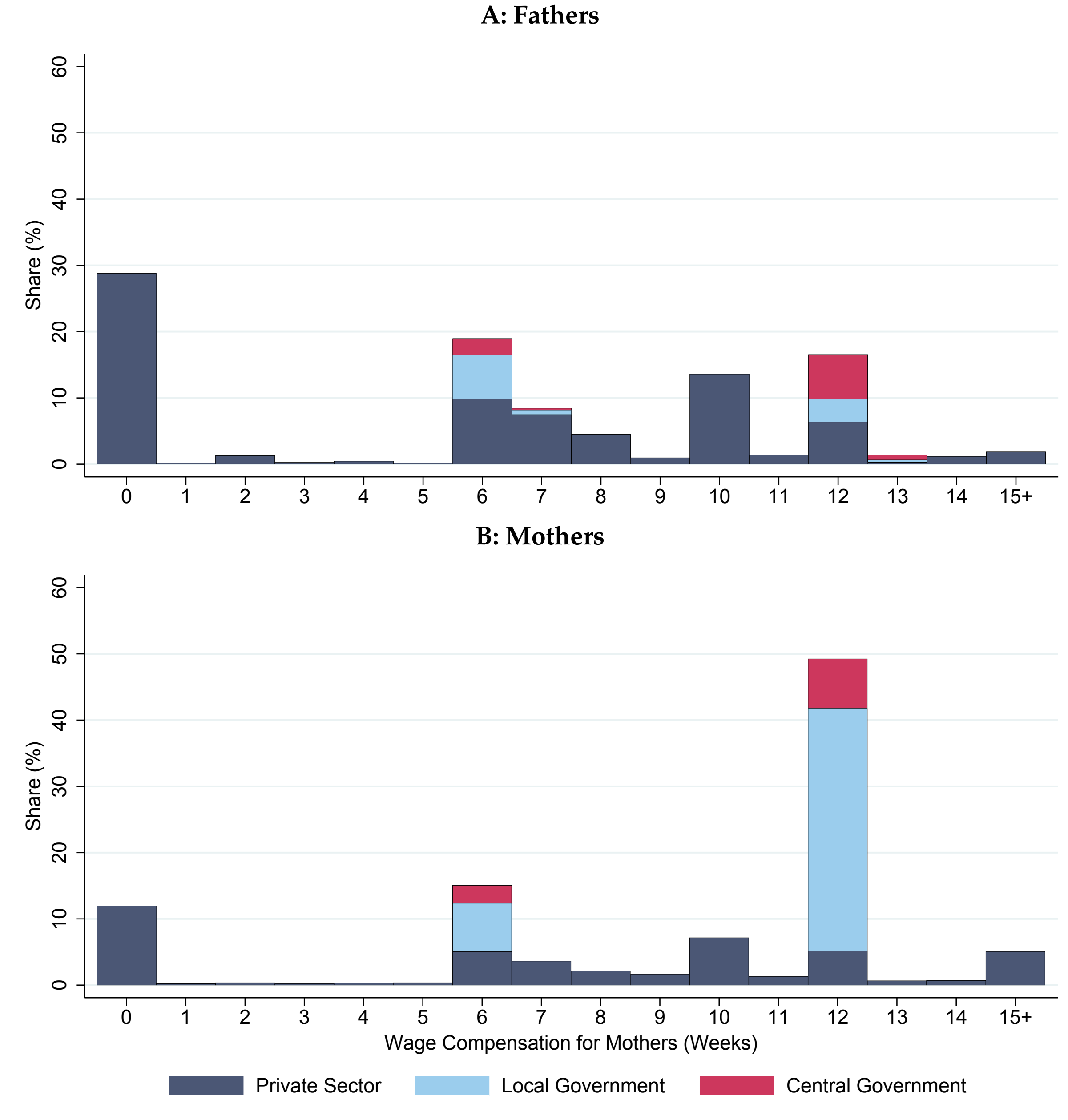
Table 3: Definition of Co-workers Used in the Private Sector Imputation

Share of Parents (%)	**Fathers**	**Mothers**	**Total**
Individual†	5.3	29.12	34.42
Within Firm	19.13	1.72	20.85
Within 6-Digit Industry (740 Groups)	36.12	1.58	37.7
Within 5-Digit Industry (127 Groups)	4.95	2.09	7.04
Total	**65.49**	**34.51**	**100.00**

Notes: The table shows the definition of co-workers used to impute the individual rights to wage compensation in the private sector. In all case we define co-worker groups as within year.
† Parents who exhaust their parental leave benefits.

In Figure 2 we show the distribution of individual rights to wage compensation based on the procedure described above. The figure reveals a marked difference in rights to wage compensation between fathers and mothers, with the distribution for mothers shifted significantly towards more weeks with wage compensation. Part of this difference is driven by the fact that mothers, to a larger extent, are employed in the public sector, but even within the private sector, mothers are more likely to work in firms offering more generous wage compensation.

Figure 2: Imputed Individual Rights to Wage Compensation



Notes: The figure shows the distribution of individual rights to wage compensation based on the imputation procedure described in Section 3.3. For the private sector we impute individual rights to wage compensation based on observed co-worker behavior, while for the public sector we base it on the sub-sectors in which the parents are employed. If parents are employed in the same public sub-sector (central or local government), they have 6 weeks of individual wage compensation and 6 weeks shared. The shared wage compensation is not shown in the figure, but we incorporate this in our analysis in Section 4 as explained in Section 2.

In Figure A.II in the Appendix, we assess the accuracy of the imputation method used for the private sector. We do so by applying the imputation method to parents in the public sector and compare the result to the rights stipulated in the collective labor market agreements. We find estimates consistent with the collective agreement rules for more than 90% of fathers and 70% of mothers. The larger fraction of measurement error for women is less of a problem in the empirical analysis, as, in most cases, women take more leave than is typically covered by wage compensation, and hence, the marginal incentives to take leave are largely unaffected by differences in their wage compensation.

4 Results

We estimate the model outlined in Section 2 using Maximum Likelihood in a Mixed Multinomial Logit Framework (MMNL) (McFadden & Train, 2000). Specifically, we assume that on top of the economic model outlined in Section 2, parents receive a leave-specific random taste shock, $\epsilon(l_{i,m}, l_{i,f})$. That, in turn, yields an associated value of choice as

$$v(l_{i,m}, l_{i,f}) = U(l_{i,m}, l_{i,f}; Z_i, X_i, \varepsilon_{i,m}, \varepsilon_{i,f}) + \epsilon(l_{i,m}, l_{i,f}),$$

where we assume that $\epsilon(l_{i,m}, l_{i,f})$ follows an Extreme Value Type I distribution.

With this assumption, the likelihood of observing a leave bundle given $Z_i, X_i, \varepsilon_{i,m}, \varepsilon_{i,f}$ is equal to the standard multinomial logit probabilities

$$P(l_{i,m}, l_{i,f} | Z_i, X_i, \varepsilon_{i,m}, \varepsilon_{i,f}) = \frac{\exp(U(l_{i,m}, l_{i,f}; Z_i, X_i, \varepsilon_{i,m}, \varepsilon_{i,f}))}{\sum_{k=0}^{52} \sum_{n=0}^{52} \exp(U(k, n; Z_i, X_i, \varepsilon_{i,m}, \varepsilon_{i,f}))}.$$

Integrating out the unobserved preference parameters $(\varepsilon_{i,m}, \varepsilon_{i,f})$ we obtain

$$P(l_{i,m}, l_{i,f} | Z_i, X_i) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} P(l_{i,m}, l_{i,f} | Z_i, X_i, \varepsilon_{i,m}, \varepsilon_f) \phi(\varepsilon_{i,m}, \varepsilon_{i,f}; \Omega) d\varepsilon_{i,m} d\varepsilon_{i,f},$$

where $\phi(\varepsilon_m, \varepsilon_f; \Omega)$ is the bi-variate normal probability density function with mean zero and covariance Ω.[16] We parameterize the covaraince matrix as $\Omega = TT'$ where $T =$

[16]In total, we use 49 Gaussian quadrature nodes/weights to approximate the integrals numerically.

$\begin{pmatrix} \tilde{\sigma}_f & 0 \\ \tilde{\sigma}_{mf} & \tilde{\sigma}_m \end{pmatrix}$ to ensure that the covariance matrix is always positive definite and report standard errors of the elements of Ω using the Delta method.

We estimate the parameters $\theta = (\gamma_{\alpha,m}, \gamma_{\alpha,f}, \gamma_{\beta,m}, \gamma_{\beta,f}, \rho, \sigma_m, \sigma_f, \sigma_{mf})$ with data on $i = 1, \ldots, n$ births as

$$\hat{\theta} = \arg\max_{\theta} \frac{1}{n} \sum_{i=1}^{n} \log \left(P(l_{i,m}, l_{i,f} | Z_i, X_i) \right).$$

4.1 Identification

The key parameters governing how parents respond to changes in the budget set are the slope parameters, β_j, and the interaction effect between the leave of the parents, ρ. We identity these parameters through an assumption on the underlying distribution of the preference shocks (ε_m,ε_f) in α_j. The key assumption is that the distribution of ε_m,ε_f is smooth. With this assumption, the overall distribution of parents' willingess to pay for parental leave is smooth, which translates into a smooth distribution of parental leave use in the absence of discontinuities in the parental leave benefit system, $B(\cdot)$. In contrast, kink points in the household budget set through $B(\cdot)$ will create mass points in the leave distribution (bunching) to the extent that parents respond to the changes in the marginal cost of leave. Hence, these mass points identify β_j and ρ. Specifically, we can think of β_j as being identified from the kinks created by the exhaustion of each parents' wage compensation, while kinks created by the shared parental leave identifies ρ. The fact that we allow β_j to vary with the characteristics of parents (X_j) captures heterogeneity in the responsiveness through the parameters $\gamma_{\beta,m}, \gamma_{\beta,f}$.

In turn, we identify the remaining model parameters, $\gamma_{\alpha,m}, \gamma_{\alpha,f}$ and σ_m,σ_f,σ_{mf}, from the variation in the joint parental leave use away from the kinks in the budget set together with the joint normality assumption.

In summary, identification in our model rests on the same key assumptions as in traditional bunching studies (Saez, 2010; Kleven, 2016). However, our structural approach allows us to handle the complexity of the parental leave system in terms of both the location and the magnitude of the discontinuities created by parents' wage compensation and the rivaling nature of the 32 weeks of shared parental leave.

4.2 Parameter Estimates and Model Fit

In Table 4 we list the covariates included in the estimation and report the estimated parameters. All variables except the dummies for sector and wage compensation, graduate school and child generation are standardized.

The first 3 rows control for selection into occupations with more or less wage compensation. The reference group, included in the constant, is the public sector. Conditional on the other covariates, being employed in the private sector with relatively few weeks of wage compensation implies a high level of willingness to pay for parental leave (positive effect on α), but also a steeper downward slope (negative effect on β), relative to the public sector. In contrast, privately employed parents with more than five weeks of wage compensation generally have a relatively lower level of willingness to pay for leave, but a slightly less negative slope, implying a higher responsiveness to changes in the marginal cost of leave.

Table 4: Estimation Results

	α_f	α_m	β_f	β_m
Constant	3.296	7.556	−0.315	−0.175
	(0.003)	(0.002)	(0.030)	(0.012)
Privately employed, <6 weeks compensation	1.138	1.096	−0.036	−0.027
	(0.002)	(0.002)	(0.016)	(0.028)
Privately employed, 6-9 weeks compensation	−1.078	0.060	0.025	−0.004
	(0.001)	(0.001)	(0.010)	(0.026)
Privately employed, >9 weeks compensation	−0.189	−0.703	0.006	0.015
	(0.001)	(0.002)	(0.018)	(0.039)
Age	−0.005	−0.028	0.003	0.002
	(0.079)	(0.040)	(1.159)	(0.090)
Child generation	0.020	0.090	−0.006	−0.003
	(0.008)	(0.008)	(0.110)	(0.198)
Weekly earnings	0.042	0.928	0.031	0.006
	(0.007)	(0.008)	(0.043)	(0.179)
Potential earnings growth	−0.008	−0.043	0.005	−0.001
	(0.003)	(0.003)	(0.029)	(0.083)
Graduate school	1.080	0.190	−0.024	−0.011
	(0.003)	(0.003)	(0.026)	(0.041)
Relative earnings share of mother	0.151	−0.170	−0.001	0.004
	(0.003)	(0.004)	(0.033)	(0.098)
Median parental leave of fathers in industry	0.898	0.108	−0.022	0.002
	(0.004)	(0.003)	(0.038)	(0.090)
Median parental leave of mothers in industry	−0.025	0.307	0.000	0.001
	(0.002)	(0.004)	(0.031)	(0.092)
σ_j^2	7.507	3.150		
	(0.021)	(0.016)		
σ_{fm}	2.599			
	(0.015)			
ρ	−0.100			
	(0.051)			
Number of births: 189,975				

Notes: Variables are defined in Table 2. All variables except the dummies for sector and wage compensation, graduate school and child generation are standardized to have mean 0 and standard deviation 1. Child generation is measured relative to 2008. Robust asymptotic standard errors are in brackets.

As the identification is based on the variation in the contemporary marginal cost of parental leave, our estimates capture both intrinsic preferences for parental leave as well as extrinsic motives, such as career concerns and norms. We probe the significance of such extrinsic motives by including two sets of controls in the estimation.

First, as proxies for career concerns, we find small negative, but significant effects on α of potential earnings growth for both fathers and mothers, while higher weekly earnings is correlated with a higher α for mothers. Both of these variables only have limited effects on the βs. Similarly, we find that a higher relative wage rate of the mother is correlated with a higher α for the father and lower for the mother. However, overall we find limited preference heterogeneity between parents with different earnings potentials.

Second, we include the median number of weeks of leave separately for fathers and mothers in the 6-digit industry group in which each parent works. These controls are intended to proxy for industry or firm norms, but may also reflect selection. We estimate positive and relatively large own-sex effects on α, implying that parents working in a sector with a relatively high median leave take-up of employees of the same sex tend to take longer leave. The industry median leave use of opposite sex employees has a much smaller effect and is negative for the father.

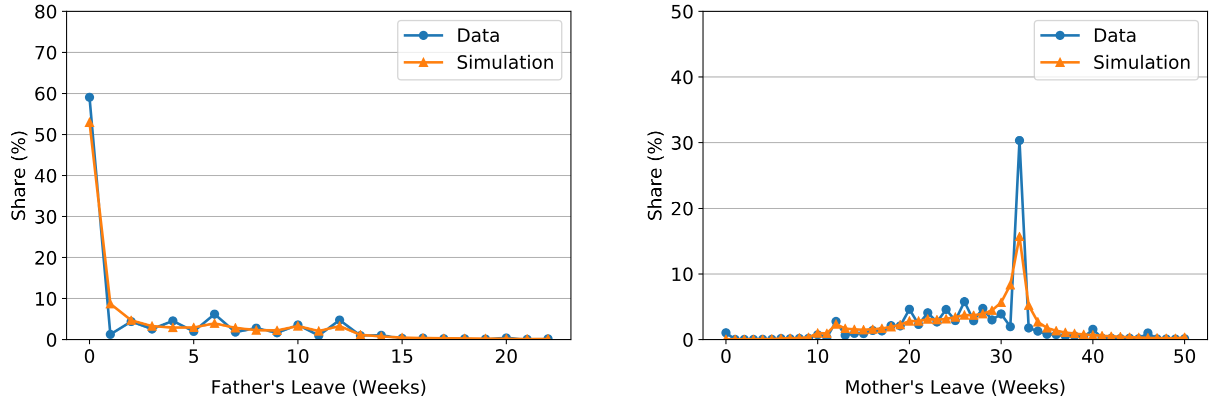
Finally, we estimate a significant positive covariance between fathers and mothers, consistent with assortative matching on preferences for parental leave, and a negative ρ implying that the leave periods of the two parents are substitutes.

In Figure 3 and Appendix Figure A.III, we compare the simulated parental leave from our model to the observed distributions of parental leave in the data. The estimated model reproduces the distributions very well. In particular, the model matches two salient features of the distributions. First, we reproduce the clear bunching at the exhaustion of wage compensation for both fathers (left figures) and mothers (right figures) and at the exhaustion of the 32 weeks of shared benefits.[17] The excess mass varies considerably across subsamples, and we match this heterogeneity as well.

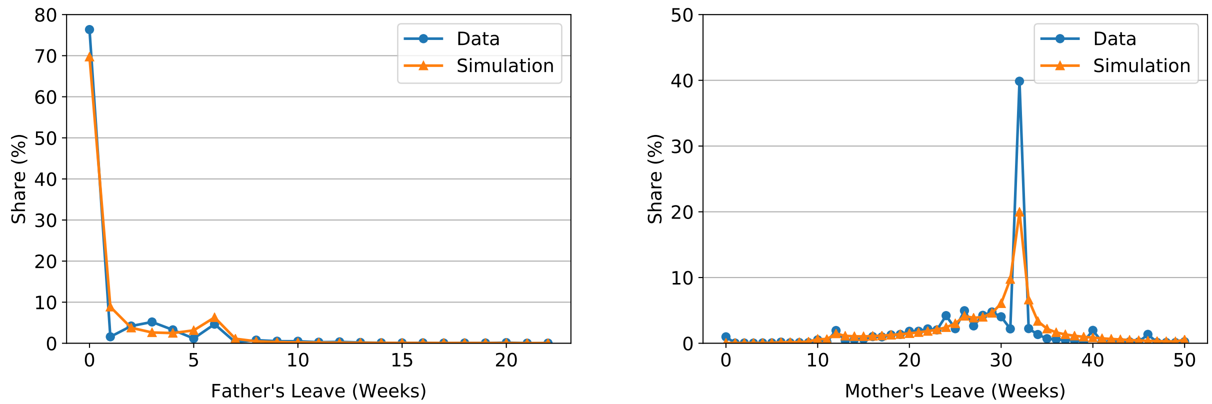
[17] The discrete choice model creates a small degree of smoothing in the leave distribution, which is why some of the excess mass is located on the weeks adjacent to the kink points.

Figure 3: Model Fit: Parental Leave Use

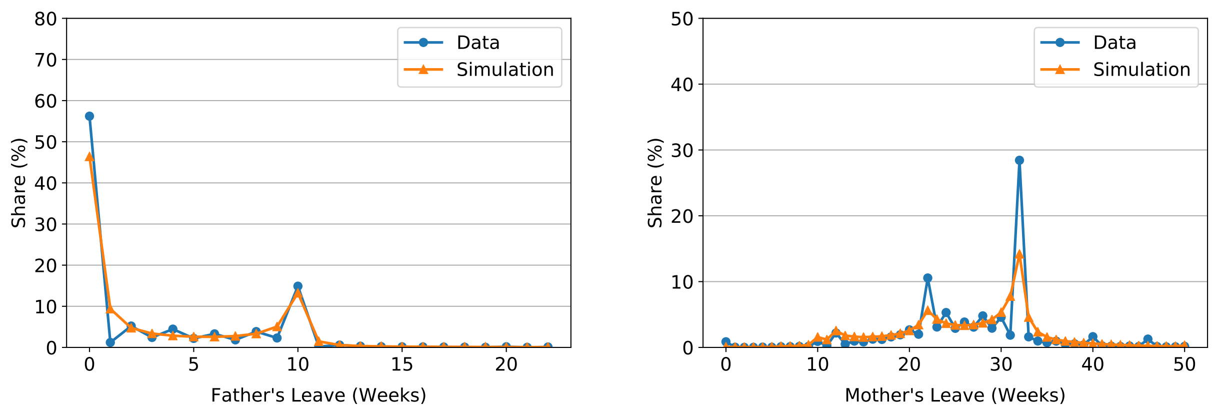
A: All Births



B: Father in Private Sector with 6 Weeks of Compensation



C: Father in Private Sector with 10 Weeks of Compensation

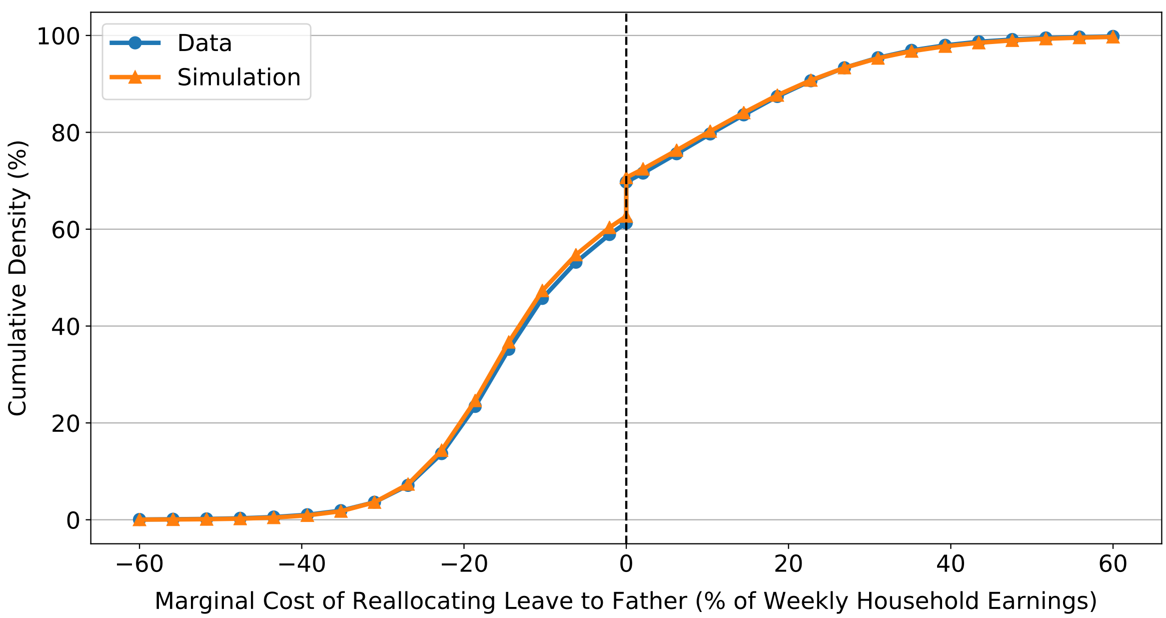


Notes: The figure shows the distributions of fathers' and mothers' parental leave split by the father's rights to wage compensation and sector. The simulated leave distributions are based on 200 random draws. We show the model fit for additional combinations of fathers' wage compensation and sector in Appendix Figure A.III.

Second, we reproduce the large share of fathers taking very little or no leave. As described in Section 2, in many cases, parents can increase contemporaneous household income by reallocating parental leave from the mother to the father when the father initially takes less leave than covered by individual wage compensation. Hence, while there may be many idiosyncratic motives for parents to allocate all parental leave to the mother, they might reveal a strong willingness to pay for this specific allocation.

We highlight this point in Figure 4, which shows the marginal cost of shifting one week of leave from the mother to the father. More than 60% of parents could increase household income by reallocating parental leave from the mother to the father. Furthermore, for the median household, reallocating parental leave to the father would, on the margin, increase household income by 10% of household earnings.[18]

Figure 4: Model Fit: Marginal Cost of Father's Leave.



Notes: The figure illustrates the marginal household cost of transferring one week of leave from the mother to the father in the data and simulated from the model. The marginal cost is calculated using the Danish benefit rules described in Sections 2 and 3, and expressed relative to the weekly household pre-birth earnings.

[18] The mass of parents with marginal costs of zero reflects two things. First, mothers with earnings at or below the benefits cap, and second, parents with shared wage compensation (parents working in the same public sub-sector). In both of these cases, household income is typically unaffected by reallocating leave from the mother to the father.

5 Counterfactual Policy Simulations

In this section, we use the model to simulate and evaluate the introduction of earmarked leave. We perform these in-sample simulations to make two points. First, we want to highlight the importance of the broader set of economic incentives facing parents when implementing earmarked parental leave. Second, we want to probe the efficiency costs of different parental leave reforms.

We define the efficiency of a reform as

$$\text{Efficiency} = \left(\bar{U}_{CF} - \bar{U}_{B}\right) - \left(\bar{C}_{CF} - \bar{C}_{B}\right), \tag{12}$$

where $\bar{U}_B$ and $\bar{U}_{CF}$ are the average household utilities in the baseline and counterfactual simulations, respectively, and $\bar{C}$ is the cost of the parental leave system given by the net transfers paid to parents.[19] Because the utility function is quasi-linear in income, we can directly interpret changes in household utility in a money-metric measure similar to the costs ($\bar{C}$). Hence, one way to interpret equation (12) is the change in household utility following a reform if we were to finance the parental leave system by lump sum taxation.[20]

Our model contains no explicit motive for governments to provide parental leave benefits. However, as we show in Appendix B, our definition of efficiency provides the relevant estimates of the societal costs under the assumption that the societal costs and benefits are additively separable and that parents allocate parental leave efficiently. Hence, the aim of our policy simulations is to study the behavioral effects and *efficiency cost* of a particular policy and not to rationalize the policy itself. The optimal policy design can then be achieved by balancing societal preferences for a particular allocation of parental leave with the efficiency costs implied by our model. This is similar to the welfare analyses in other

[19] See, e.g., Chan (2013) for a similar definition of the efficiency of a reform.

[20] We would arrive at a similar measure of efficiency in more realistic settings with distributional concerns, distortionary taxation and income effects (see, e.g., Kaplow, 2004). The intuition for this result is that once policy makers have set the available tax instruments to balance efficiency and distributional concerns, they will, on the margin, be indifferent between the different tax instruments, including lump sum taxes. By assuming quasi-linear utility and lump sum taxation, we avoid conflating our analysis with arbitrary distortions in other parts of the economy.

policy settings (Saez & Stantcheva, 2016; Goldin & Reck, n.d.).

The counterfactual simulations rely on the assumption that parents respond to reforms in the same way as they do to kinks in the budget set created by the parental leave system since we used that bunching variation to identify the model parameters. This is a standard external validity assumption and, while there may be reasons why parents would respond differently to reforms, we can validate the assumption by comparing our model predictions to observed responses to already implemented parental leave reforms.[21] We show in Appendix C that our model does a good job of predicting the medium-run effects of reforms in Norway, Sweden and Germany.

5.1 Earmarked Leave in the Current Danish Policy Setting

To illustrate how the introduction of earmarked leave changes the behavior of parents in our model, we start by presenting simulations of two earmarked leave reforms. Specifically, we simulate the effects of introducing either 1 week or 9 weeks of earmarked leave, while keeping all other policy parameters fixed. The latter of these reforms is interesting in its own right as it corresponds to the recently passed EU (2019) directive, which stipulates that all EU member states must implement 2 months of earmarked, non-transferable, parental leave to each parent no later than August 1, 2022. We implement earmarked leave by changing the household budget sets as illustrated in Section 2.

We present the effects of the two reforms in Figure 5. Considering first the small reform of 1 week earmarked leave, we see in Panel A that 7 percentage points of fathers shift from taking 0 to 1 week of parental leave. The response of mothers in Panel B is larger, where the model predicts an almost complete shift to the left of the mass round 32 weeks. The net effect of these changes is a reduction in total household leave as shown in Panel C. Considering the larger reform of 9 weeks earmarked leave, we find similar but more

[21] For example, we could imagine that the extrinsic motives captured in the estimated willingness to pay (see Section 2) depend on the overall policy environment, or that the wage compensation also functions as reference points for parents' leave use. The presence of such effects would imply that parents would respond either more or less than predicted by our model.

pronounced responses: Modest positive responses for men and larger negative responses for women, resulting in a reduction in total household leave.

However, as we show below, this result depends critically on the replacement rates that parents face. In our baseline setting, these replacement rates are often only around 50% once a parent has exhausted the wage compensation, and with longer periods of earmarked leave an increasing number of fathers would exhaust their wage compensation if they wanted to utilize all the earmarked leave.

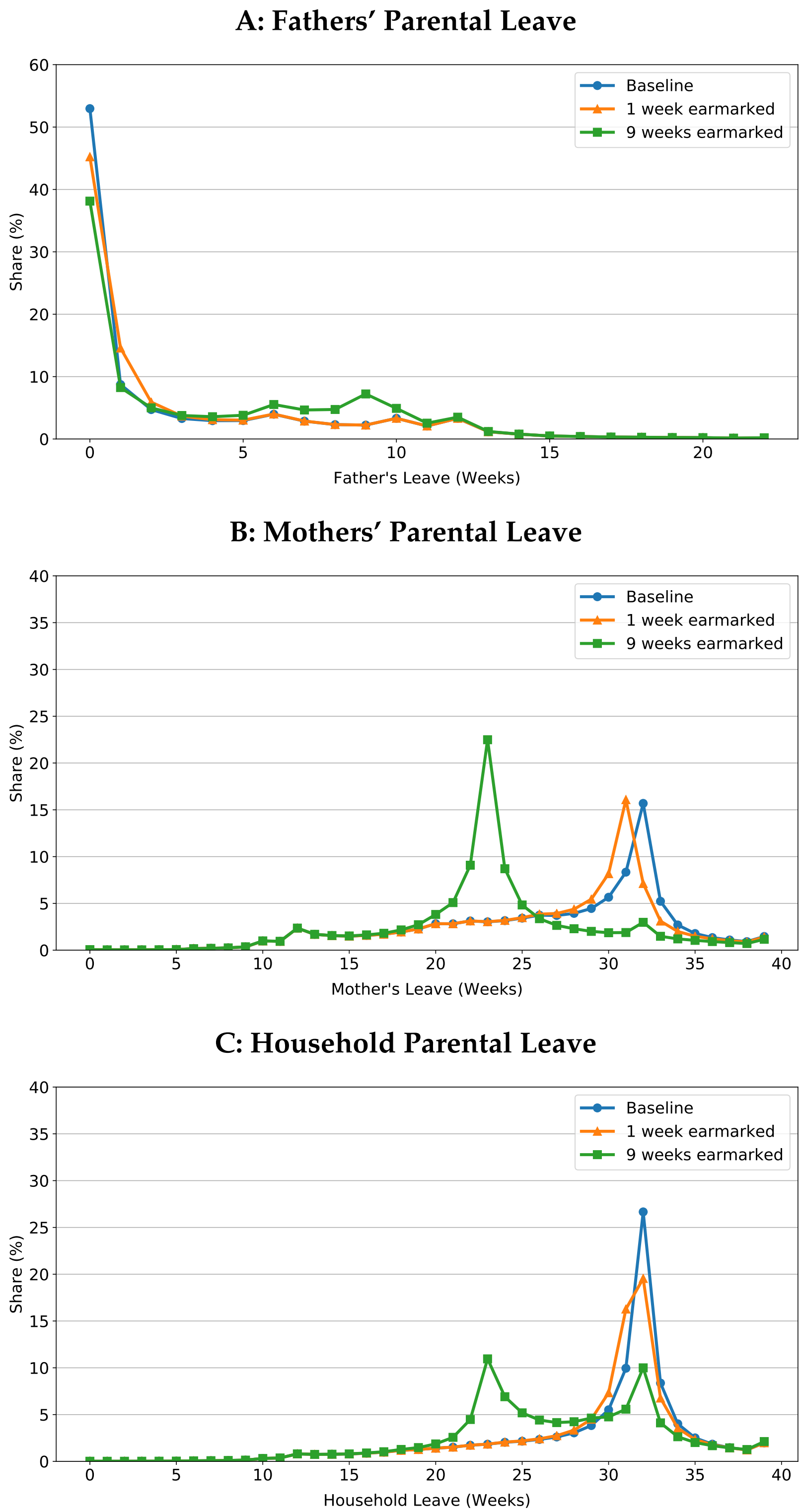
In Table 5 we show the simulated changes in average parental leave and labor earnings of mothers and father together with changes in household income, utility and efficiency from the two reforms. For each reform we break up the total effect into a mechanical effect, where we hold leave and labor supply fixed, and a behavioral effect. Panel A shows the effects of introducing 1 week of earmarked leave and Panel B the effect of 9 weeks of earmarked leave.

The mechanical effects of both reforms are reductions in the (net) transfers reflecting the reductions in parental leave benefits. Due to quasi-linear preferences, these reductions carry over directly to household utility. In contrast, the mechanical effect on efficiency is zero as the reduction in household utility is offset by the lower net transfers paid out by the government.

The behavioral responses of parents partly mitigate the mechanical effects by shifting leave from the mother to the father. For both reforms, fathers increase their leave by less than half of the reduction in the leave of mothers, and hence, the reforms lead to a reduction in household leave as also illustrated in Figure 5. The mirror image of the reduction in leave is an increase in household labor supply.[22] In addition, the change in behavior also increases net transfers due to the shift from the (post-reform) unpaid leave of mothers to fathers, who either receive wage compensation or public benefits. For both reforms, these effects more than counter the mechanical reduction in household income.

[22]The effect of the change in labor supply on household labor earnings is muted by the higher average weekly earnings of fathers, who now work slightly less.

Figure 5: Policy Simulations: Implementing Earmarked Leave



Notes: The figure shows the simulated leave distributions in three different policy settings: 1) with no earmarked leave (baseline), 2) 1 week earmarked leave to both parents 3) 9 weeks of earmarked leave. In all simulations we keep the 32 weeks of public parental and individual wage compensation fixed. The simulations are based on 200 random draws.

Table 5: Policy Simulations: Welfare Effects of Earmarked Leave

		A: 1 Week Earmarked Leave			**B: 9 Weeks Earmarked Leave**		
		Changes from Baseline					
	Baseline	Mechanical	Behavioral	Total	Mechanical	Behavioral	Total
Parental Leave (Weeks)							
(1) Total	30.178	0.000	-0.171	-0.171	0.000	-2.106	-2.106
(1a) Fathers	3.025	0.000	0.108	0.108	0.000	1.185	1.185
(1b) Mothers	27.153	0.000	-0.279	-0.279	0.000	-3.291	-3.291
Labor Earnings (EUR 1,000)							
(2) Total	87.159	0.000	0.126	0.126	0.000	1.666	1.666
(2a) Fathers	61.851	0.000	-0.129	-0.129	0.000	-1.422	-1.422
(2b) Mothers	25.308	0.000	0.255	0.255	0.000	3.088	3.088
Household Income, Utility and Welfare (EUR 1,000)							
(3) Net transfers	-21.315	-0.087	-0.013	-0.100	-1.439	0.025	-1.413
(3a) Transfers	22.580	-0.144	0.062	-0.082	-2.398	1.153	-1.245
(3b) Taxes	43.896	-0.058	0.075	0.018	-0.959	1.127	0.168
(4) Income (2+3)	65.844	-0.087	0.113	0.026	-1.439	1.691	0.253
(5) Utility	86.403	-0.087	0.020	-0.067	-1.439	0.542	-0.897
(6) Efficiency	107.718	0.000	0.033	0.033	0.000	0.517	0.517

Notes: The table shows simulated average effects from two hypothetical reforms. Panel A shows the effect of introducing 1 week of earmarked parental leave to each parent, while in Panel B we increase the earmarked leave to 9 weeks. The mechanical effect is calculated as the effect from changing the parental leave system while keeping the labor supply and parental leave of parents fixed at the baseline levels. The total effect is calculated by letting households re-optimize under the new regimes, and the behavioral effect is the difference between the mechanical and total effects. Transfers include both public transfers and the wage compensation formally pay for by firms. The assumption of quasi-linear preferences implies that we can directly interpret the effect on household utility as a money-metric effect.

Turning to household utility, the behavioral responses only have a second order effect and for small reforms the behavioral effect on household utility would to a first approximation be zero. Hence, the mitigating effect on household utility is generally smaller than the effect on household income. However, as the reforms we consider become larger, the behavioral effects become non-negligible: The relative size of the behavioral effect increases from 25% of the mechanical effect in Panel A to 40% in Panel B. Combining the mechanical and behavioral effects, we estimate a reduction in household utility corresponding to around EUR 800 or 1.2% of the baseline household income resulting from the introduction of 9 weeks of earmarked leave.

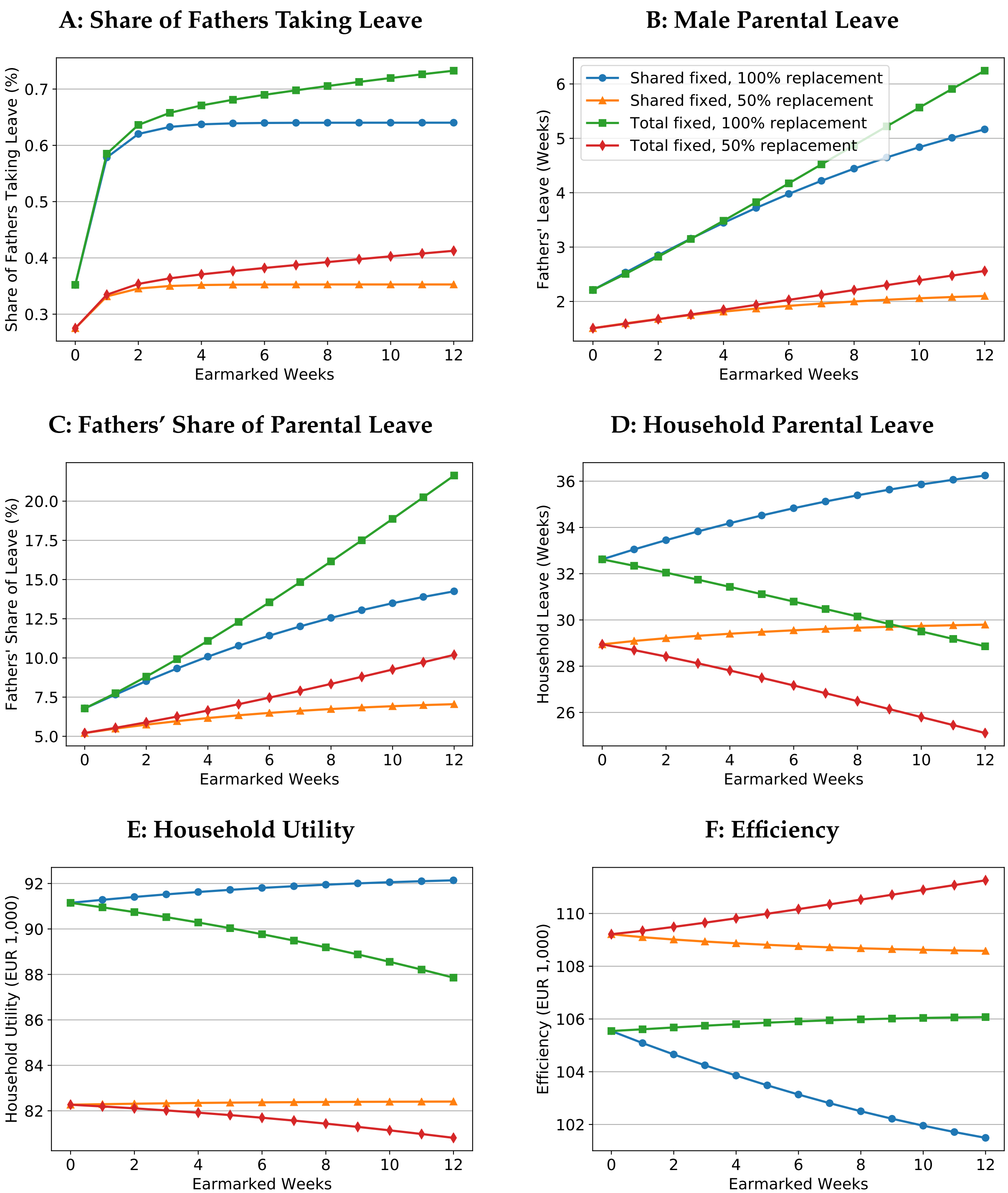
Finally, we find that both reforms have small positive effects on efficiency. This reflects that both reforms push parents' use of parental leave closer to what they would choose without parental leave subsidies (i.e., reduce household leave), and increase their labor supply.

5.2 Interaction Effects with Replacement Rates and Total Leave

Above, we considered the effects of introducing earmarked leave, while keeping the replacement rates and total leave duration in the parental leave system fixed. Next, we explore the effects when considering a menu of different combinations of these policy parameters.

In Figure 6. we show the simulated average outcomes as a function of the number of earmarked weeks under 4 different policy settings: Either low (50%) or high (100%) replacement rates combined with earmarked leave either taken from the initial 32 weeks of shared leave (referred to as "fixed total leave") or added to the total leave (referred to as "fixed shared leave"). Considering the (red) scenario with a low replacement rate with fixed total leave, we find effects similar to the ones presented above. The effect on fathers' leave-taking is modest, both on the extensive margin (Panel A) and on the average number of weeks on parental leave (Panel B), while total household leave (Panel D) and utility (Panel E) decrease.

Figure 6: The Effects of Earmarked Leave under Different Policy Settings



Notes: The figure shows the simulated outcomes of different parental leave policies. In these simulations we remove the heterogeneity in individual replacement rates and implement a uniform replacement rate for both parents and for the entire duration of public parental leave. In the simulations with fixed total leave we keep the total leave at 32 weeks and let the earmarked leave reduce the shared leave. In the simulations with fixed shared leave we expand the total leave by the number of earmarked weeks provided to the father.

However, these results depend critically on the replacement rates in the parental leave system. Considering the (green) scenario with a 100% replacement rate, the effect of 12 weeks earmarked leave is an increase in the share of fathers taking leave to around 75%. More than twice the change in fathers' take-up of parental leave in the low replacement rate scenario. Similarly, we find a much stronger increase in fathers' average number of weeks on parental leave, and thus, their share of total household leave (Panel C). Total household leave and utility still decreases in this scenario but from higher levels.

Next, we consider the (orange and blue) scenarios where the leave earmarked to fathers is added on top of the existing shared leave of 32 weeks. This expansion of total parental leave has two effects. First, it loosens the rivaling nature of the shared parental leave, and hence, fathers who use all of the earmarked leave will be more likely to also use some of the shared leave as it is now more abundant. However, the second and, here, dominating effect is a reduction in fathers' willingness to pay for parental leave through the substitutability with the leave of the mother.

We can compare these changes in outcomes to the effects on household utility and social welfare. Naturally more generous parental leave systems raise household utility, while earmarked leave reduces household utility when it is not accompanied by expansions in total leave.[23] Efficiency is reduced to the extent to which parents respond to the larger subsidies for parental leave.

5.3 Probing the Efficiency of Parental Leave Reforms

Finally, we can use the model to find the efficient set of policy parameters for a particular set of policy objectives, and compare the trade-off between different objectives.

To illustrate, in Table 6 we show four examples of efficient policies. In each example, we select the combination of *i)* weeks of earmarked *ii)* replacement rates, and *iii)* total benefit weeks, that minimize the efficiency loss of the parental leave system while achieving a

[23] The reduction in household utility could alternatively be countered by making the parental leave system more generous in other dimensions.

particular division of parental leave.[24] In columns A and C, we consider a case in which the policy objective is to incentivize fathers to take a least 15% of the household leave, while the objective in columns B and D is for the father to take a minimum of 6 weeks leave. In Columns C and D, we add the additional constraint that household leave must not fall below 30 weeks. This additional restriction could be motivated by, e.g., child care availability or other considerations.

Increasing the *relative* share of leave to fathers (in column A) can be achieved both by increasing the leave of fathers and by decreasing the leave of mothers, and the efficiency-maximizing policy parameters in column A reflect these two channels. Specifically, we find that the efficient policy mix is to earmark a significant part of the parental leave and to reduce the general generosity of the system (few weeks of benefits with a low replacement rate).

The intuition for this result is that a higher number of earmarked weeks incentivizes fathers to take more leave. The effect of earmarked leave on fathers' leave use is increasing in the replacement rate (see Figure 6). However, as a higher replacement also increases the leave of mothers (thus reducing the relative share of leave taken by fathers), the policy goal can be achieved most efficiently with the maximum number of earmarked weeks and a lower replacement rate.[25]

An absolute goal of fathers taking at least 6 weeks of leave (in column B) removes part of the motivation for a lower replacement rate because this cannot be achieved through a reduction in the leave of mothers. Therefore, the efficient policy mix includes a significantly higher replacement rate compared to column A. In terms of efficiency, the change in the policy objective creates an additional loss of approximately EUR 3,000 per birth on average.

Finally, adding a requirement that average household leave must not fall below 30 weeks (columns C and D), the optimal policy features additional incentives for households to

[24]For simplicity, we restrict the set of policy parameters to the sub-set also considered in Section 5.2. In a full policy analysis, we could allow for any joint non-linear replacement rate schedule and benefit cap for men and women.

[25]With 26 benefit weeks, the maximum number of earmarked leave week to each parent is 13.

increase total leave. In columns B and D, this is most efficiently achieved by raising both the replacement rate and the number of total benefit weeks together with a significant part of leave earmarked to each parent.

Table 6: Examples of Optimal Parental Leave Settings under Different Objectives.

	A	**B**	**C**	**D**
Objectives:	Fathers' share of leave: $\geq$ 15%	Fathers' leave: $\geq$ 6 weeks	Fathers' share of leave: $\geq$ 15% Household leave: $\geq$ 30 weeks	Fathers' leave: $\geq$ 6 weeks Household leave: $\geq$ 30 weeks
Optimal Policy Parameters:				
Earmarked Weeks	13	14	15	16
Replacement Rate	0.68	0.89	0.89	0.93
Total Benefits Weeks	26	28	38	38
Outcomes:				
Fathers' Leave (Weeks)	4.05	6.06	5.48	6.09
Fathers' Share of Leave (%)	15.38	21.49	15.71	17.50
Household Leave (Weeks)	23.73	25.58	30.11	30.03
Household Utility (EUR 1,000)	81.04	83.84	87.35	87.63
Efficiency (EUR 1,000)	111.32	108.68	106.11	105.66

Notes: The table shows the combination of *i)* weeks of earmarked *ii)* replacement rates, and *iii)* total benefit weeks that maximize the efficiency of the parental leave system, subject to satisfying the policy objectives in each column. We find the efficiency-maximizing combination by a grid-search over total benefit weeks from 26 to 44 weeks, earmarked weeks from 5 to 16, and 15 replacement rates from 50% to 100%.

6 Conclusion

In this paper, we estimate a novel model of parents' division of parental leave to advance our understanding of how the broader design of parental leave benefits affects the behavior of parents and household welfare. We estimate the model using detailed Danish register data and multiple kinks in the household budget set created by the parental leave benefit system. The estimated model replicates several key features of the joint distribution of parental leave. In particular, the model matches the fact that a substantial share of fathers take no parental leave and the substantial bunching around kinks in the household budget created by Danish parental leave benefits system.

Counterfactual policy simulations reveal several interesting results. First, we find that implementing the EU (2019) directive with 9 weeks of earmarked leave to each parent leads to a reduction in the total household leave and household utility. This result reflects that the direct effect of earmarked leave is reductions in parental leave benefits to households and in the incentives for mothers to take parental leave. In contrast, the incentives for fathers to take up the earmarked leave are primarily driven by the removal of the rivaling nature of the shared parental leave, and with low replacement rates (as in the current Danish system) we find that the incentives are insufficient to outweigh the reduction in parental leave taken by mothers.

Second, we find important interaction effects between earmarked leave, the replacement rate when on benefits and the total length of leave benefit rights. A higher replacement rate increases the behavioral responses of fathers to earmarked leave, and combining earmarked parental leave with higher replacement rates may fully undo the negative effects on household utility and total leave taken.

Finally, we use the model to probe the efficiency costs of various parental leave systems, given different policy objectives. Using a standard measure of efficiency, our model provides the relevant estimates of the societal costs under the assumption that the societal costs and benefits are additively separable and that parents allocate parental leave efficiently. We find that a policy objective of incentivizing fathers to take 15% of the household parental leave is most efficiently achieved with a relatively large number of earmarked weeks and a less generous replacement rate and total leave. Alternative policy objectives focusing on the level of fathers' (or household leave) lead to a policy mix with higher replacement rates and and longer parental leave benefit periods. While the assumptions of additive separability and efficient intra-household allocation of leave are restrictive, our framework is a natural first step towards a full welfare evaluation of parental leave reforms. Future research can thus extend our analysis in several directions. Allowing for dynamic considerations and intra-household bargaining are two particularly interesting avenues for future research.

References

ADDA, JÉRÔME, DUSTMANN, CHRISTIAN, & STEVENS, KATRIEN. 2017. The Career Costs of Children. *Journal of Political Economy*, **125**(2), 293–337.

ANDERSEN, SIGNE HALD. 2018. Paternity Leave and the Motherhood Penalty: New Causal Evidence. *Journal of Marriage and Family*, **80**(5), 1125–1143.

ANGELOV, NIKOLAY, JOHANSSON, PER, & LINDAHL, ERICA. 2016. Parenthood and the Gender Gap in Pay. *Journal of Labor Economics*, **34**(3), 545–579.

AVDIC, DANIEL, & KARIMI, ARIZO. 2018. Modern Family? Paternity Leave and Marital Stability. *American Economic Journal: Applied Economics*, **10**(4), 283–307.

BLAU, FRANCINE D., & KAHN, LAWRENCE M. 2017. The Gender Wage Gap: Extent, Trends, and Explanations. *Journal of Economic Literature*, **55**(3), 789–865.

BLUNDELL, RICHARD, DIAS, MONICA COSTA, MEGHIR, COSTAS, & SHAW, JONATHAN M. 2016. Female Labour Supply, Human Capital and Welfare Reform. *Econometrica*, **84**(5), 1705–1753.

BOURGUIGNON, FRANÇOIS, & CHIAPPORI, PIERRE-ANDRÉ. 1994. The Collective Approach to Household Behaviour. *Chap. 3, pages 70–84 of:* BLUNDELL, RICHARD, PRESTON, IAN, & WALKER, IAN (eds), *The Measurement of Household Welfare*. Cambridge University Press.

BRENØE, ANNE A., CANAAN, SERENA, HARMON, NIKOLAJ A., & ROYER, HEATHER. 2020. *Is Parental Leave Costly for Firms and Coworkers?* NBER Working Paper No. 26622.

BÜNNING, MAREIKE. 2015. What Happens after the Daddy Months? Fathers' Involvement in Paid Work, Childcare, and Housework after Taking Parental Leave in Germany. *European Sociological Review*, **31**(6), 738–748.

CHAN, MARC K. 2013. A Dynamic Model of Welfare Reform. *Econometrica*, **81**(3), 941–1001.

CHIAPPORI, PIERRE-ANDRÉ. 1992. Collective Labor Supply and Welfare. *The Journal of Political Economy*, **100**(3), 437–467.

COOLS, SARA, FIVA, JON H., & KIRKEBØEN, LARS J. 2015. Causal Effects of Paternity Leave on Children and Parents. *Scandinavian Journal of Economics*, **117**(3), 801–828.

DAHL, GORDON B., LØKEN, KATRINE V., & MOGSTAD, MAGNE. 2014. Peer Effects in Program Participation. *American Economic Review*, **104**(7), 2049–2074.

DAHL, GORDON B., LØKEN, KATRINE V., MOGSTAD, MAGNE, & SALVANES, KARI VEA. 2016. What Is the Case for Paid Maternity Leave? *Review of Economics and Statistics*, **98**(4), 655–670.

DRUEDAHL, JEPPE, EJRNÆS, METTE, & JØRGENSEN, THOMAS H. 2019. Earmarked Paternity Leave and the Relative Income Within Couples. *Economics Letters*, **180**, 85–88.

EKBERG, JOHN, ERIKSSON, RICKARD, & FRIEBEL, GUIDO. 2013. Parental Leave - A Policy Evaluation of the Swedish "Daddy-Month" Reform. *Journal of Public Economics*, **97**(1), 131–143.

EU. 2019. *Directive of the European Parliament and of the Council on Work-Life Balance for Parents and Carers*.

FARRÉ, LÍDIA, & GONZÁLEZ, LIBERTAD. 2019. Does Paternity Leave Reduce Fertility? *Journal of Public Economics*, **172**, 52–66.

GOBBI, PAULA E., PARYS, JULIANE, & SCHWERHOFF, GREGOR. 2018. Intra-household allocation of parental leave. *Canadian Journal of Economics*, **51**(1), 236–274.

GOLDIN, CLAUDIA, KERR, SARI PEKKALA, & OLIVETTI, CLAUDIA. 2020. *Why Firms Offer Paid Parental Leave: An Exploratory Study*. NBER Working Paper No. 26617.

GOLDIN, JACOB, & RECK, DANIEL. Optimal Defaults with Normative Ambiguity. *The Review of Economics and Statistics*. Forthcoming.

JOHNSEN, JULIAN V., KU, HYEJIN, & SALVANES, KJELL G. 2020. *Competition and Career Advancement: The Hidden Costs of Paid Leave*. IZA Working Paper No. 13596.

KAPLOW, LOUIS. 2004. On the (Ir)Relevance of Distribution and Labor Supply Distortion to Government Policy. *Journal of Economic Perspectives*, **18**(4), 159–175.

KEANE, MICHAEL P. 2011. Labor Supply and Taxes: A Survey. *Journal of Economic Literature*, **49**(4), 961–1075.

KLEVEN, HENRIK JACOBSEN. 2016. Bunching. *Annual Review of Economics*, **8**(1), 435–464.

KLEVEN, HENRIK JACOBSEN. 2021. Sufficient Statistics Revisited. *Annual Review of Economics*, **13**.

KLEVEN, HENRIK JACOBSEN, LANDAIS, CAMILLE, POSCH, JOHANNA, STEINHAUER, ANDREAS, & ZWEIMÜLLER, JOSEF. 2019a. Child Penalties across Countries: Evidence and Explanations. *AEA Papers and Proceedings*, **109**, 122–126.

KLEVEN, HENRIK JACOBSEN, LANDAIS, CAMILLE, & SØGAARD, JAKOB EGHOLT. 2019b. Children and Gender Inequality: Evidence from Denmark. *American Economic Journal: Applied Economics*, **11**(4), 181–209.

KLUVE, JOCHEN, & TAMM, MARCUS. 2013. Parental Leave Regulations, Mothers' Labor Force Attachment and Fathers' Childcare Involvement: Evidence from a Natural Experiment. *Journal of Population Economics*, **26**(3), 983–1005.

KONRAD, KAI A., & LOMMERUD, KJELL ERIK. 2003. The Bargaining Family Revisited. *Canadian Journal of Economics*, **33**(2), 471–487.

LALIVE, RAFAEL, & ZWEIMÜLLER, JOSEF. 2009. How does Parental Leave Affect Fertility and Return to Work? Evidence from Two Natural Experiments. *Quarterly Journal of Economics*, **124**(3).

LUNDBORG, PETTER, PLUG, ERIK, & RASMUSSEN, ASTRID WÜRTZ. 2017. Can Women Have Children and a Career? IV Evidence from IVF Treatments. *American Economic Review*, **107**(6), 1363–1402.

MCFADDEN, DANIEL, & TRAIN, KENNETH. 2000. Mixed MNL Models for Discrete Response. *Journal of Applied Econometrics*, **15**(5), 447–470.

NIELSEN, HELENA SKYT. 2009. *Causes and Consequences of a Father's Child Leave: Evidence from a Reform of Leave Schemes*. IZA Discussion Paper No. 4267.

OECD. 2019. *OECD Family Database*.

OLAFSSON, ARNA, & STEINGRIMSDOTTIR, HERDIS. 2020. How Does Daddy at Home Affect Marital Stability? *The Economic Journal*, **130**(629), 1471–1500.

OLIVETTI, CLAUDIA, & PETRONGOLO, BARBARA. 2016. The Evolution of Gender Gaps in Industrialized Countries. *Annual Review of Economics*, **8**(1), 405–434.

PATNAIK, ANKITA. 2019. Reserving Time for Daddy: The Consequences of Fathers' Quotas. *Journal of Labor Economics*, **37**(4), 1009–1059.

RAUTE, ANNA. 2019. Can Financial Incentives Reduce the Baby Gap? Evidence from a Reform in Maternity Leave Benefits. *Journal of Public Economics*, **169**, 203–222.

REGE, MARI, & SOLLI, INGEBORG F. 2013. The Impact of Paternity Leave on Fathers' Future Earnings. *Demography*, **50**(6), 2255–2277.

SAEZ, EMMANUEL. 2010. Do Taxpayers Bunch at Kink Points? *American Economic Journal: Economic Policy*, **2**(3), 180–212.

SAEZ, EMMANUEL, & STANTCHEVA, STEFANIE. 2016. Generalized Social Marginal Welfare Weights for Optimal Tax Theory. *American Economic Review*, **106**(1), 24–45.

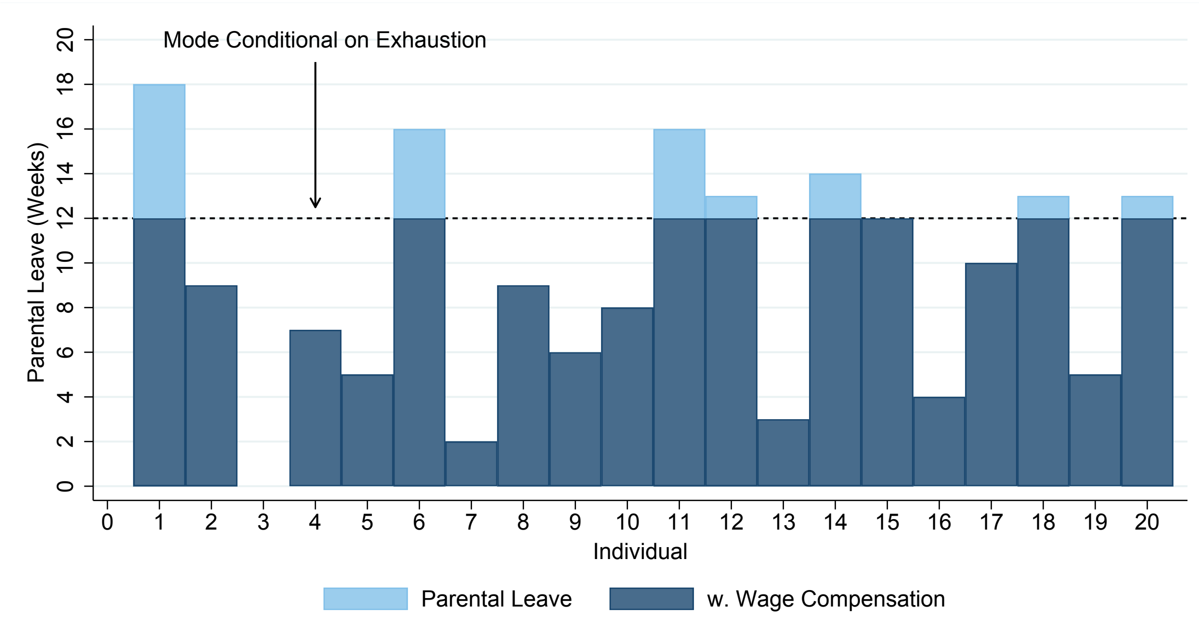
TÔ, LINH T. 2018. *The Signaling Role of Parental Leave*. Working Paper.

VAN DER KLAAUW, WILBERT, & WOLPIN, KENNETH I. 2008. Social Security and the Retirement and Savings Behavior of Low-Income Households. *Journal of Econometrics*, **145**(1-2), 21–42.

VOENA, ALESSANDRA. 2015. Yours, Mine, and Ours: Do Divorce Laws Affect the Intertemporal Behavior of Married Couples? *American Economic Review*, **105**(8), 2295–2332.

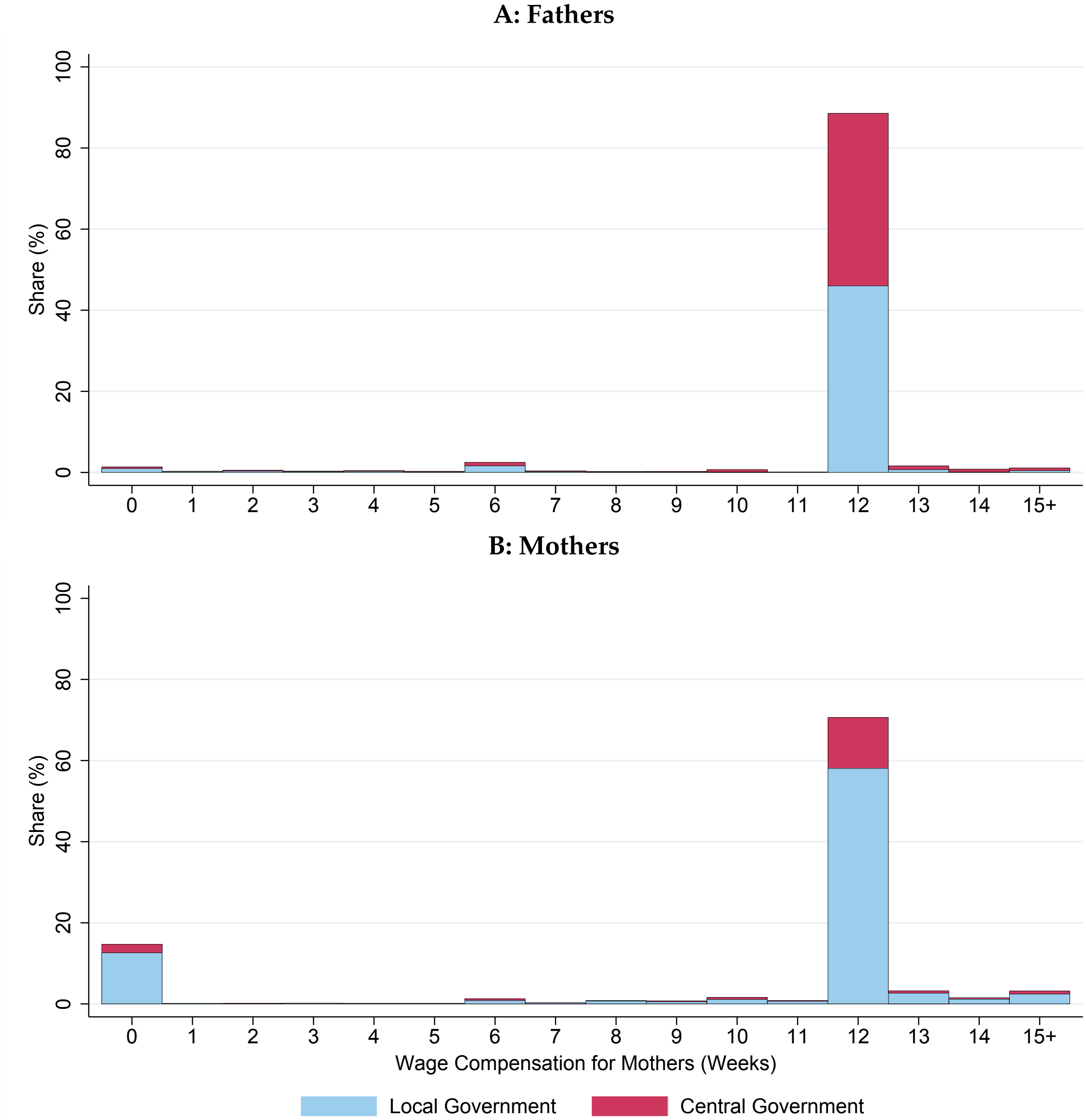
A Supplementary Figures

Figure A.I: Illustration of the Imputation of Individual Wage Compensation



Notes: The figure illustrates our imputation procedure for individual rights to wage compensation during parental leave ($\bar{z}_i$) in a hypothetical group of 20 co-workers who have a child in a given year. In the illustration, we assume that all co-workers have the right to 12 weeks of wage compensation and our goal is to estimate this number based on the co-workers' observed leave taking l_i and wage compensation $z_i \leq l_i$. As we do not observe the full right to wage compensation for individuals, who do not exhaust their wage compensation $(l_i = z_i)$, we estimate $\bar{z}_i$ as the mode of z_i for the parents who exhaust $(l_i > z_i)$ as described in equation (11).

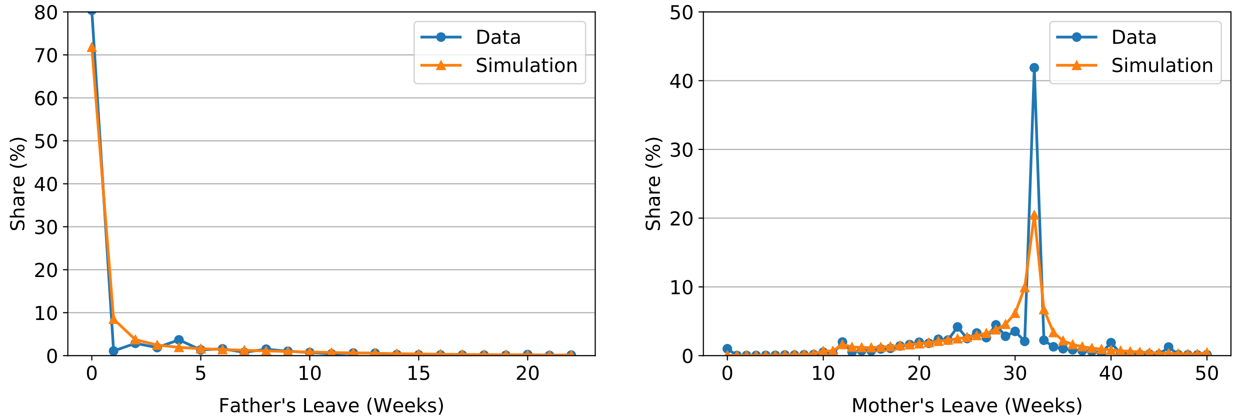
Figure A.II: Applying Our Private Sector Imputation to the Public Sector



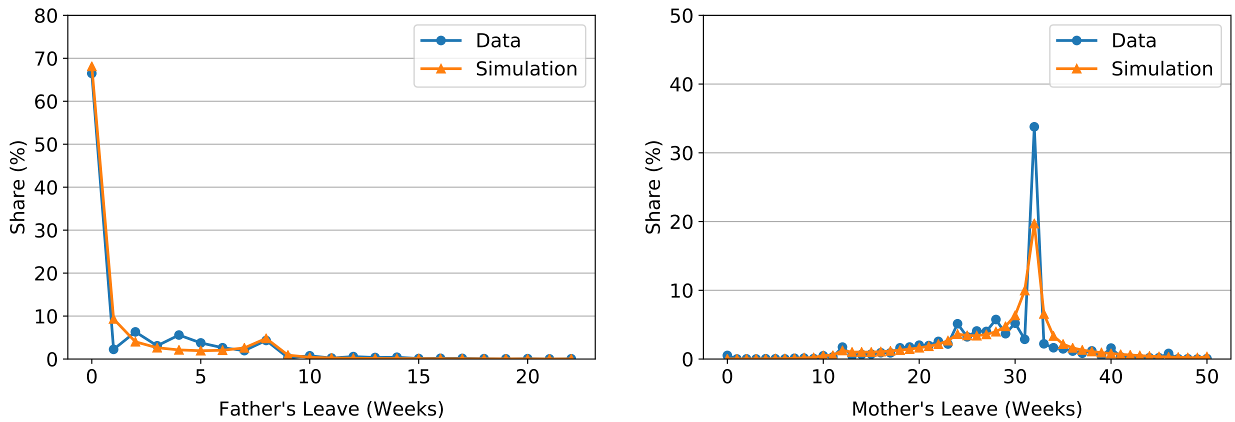
Notes: The figure shows the results from applying our procedure for imputing individual rights to wage compensation to public sector employees. Estimates consistent with the public sector collective agreements are 6/12 for mothers and fathers before April 1, 2015 and 7/13 for fathers after April 1, 2015. Our private sector estimation procedure will never identify the exact 6/12 and 7/13 split as it depends on the sub-sector in which the partner is employed, as described in section 3, and because we do not use spousal information in the imputation.

Figure A.III: Model Fit: Actual and Simulated Parental Leave Use

A: Father in Private Sector with 0 Weeks of Compensation



B: Father in Private Sector with 8 Weeks of Compensation



C: Father in Private Sector with 12 Weeks of Compensation

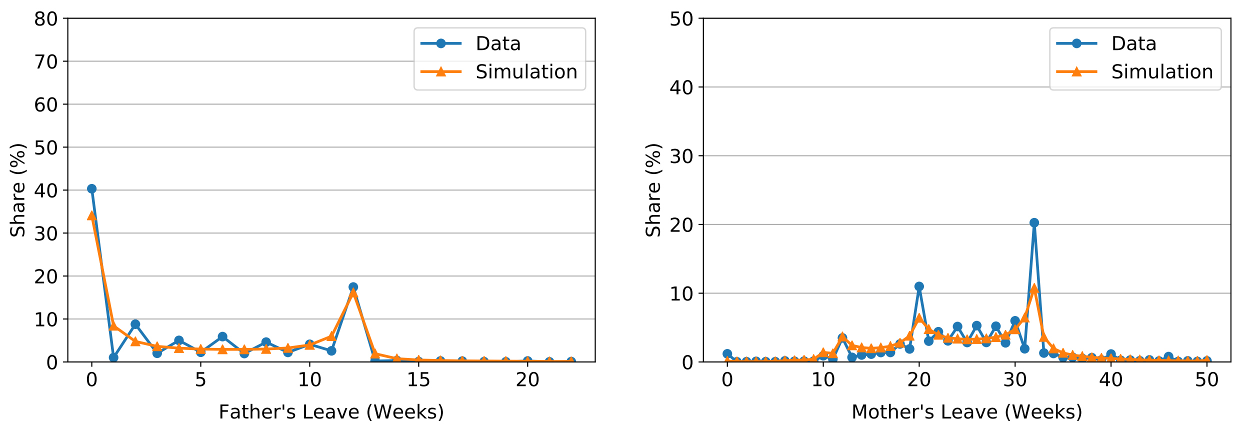
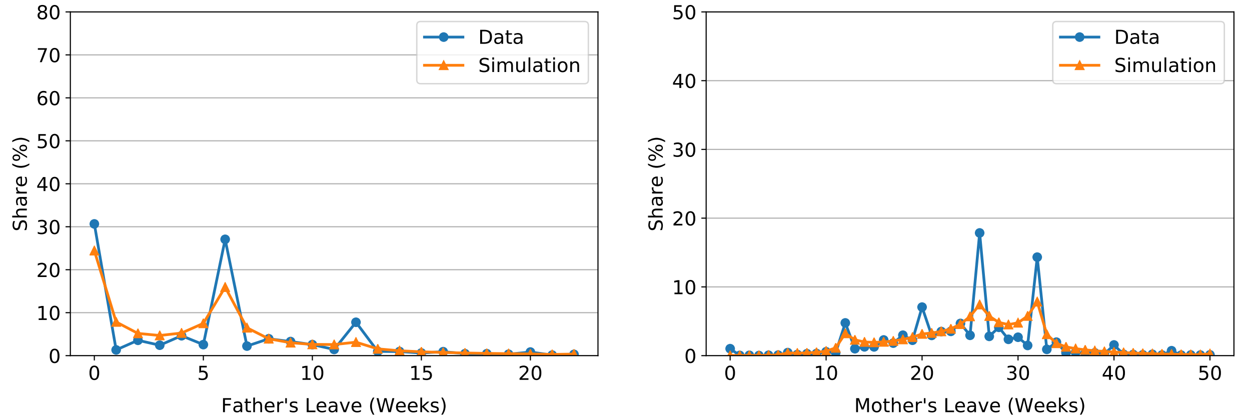
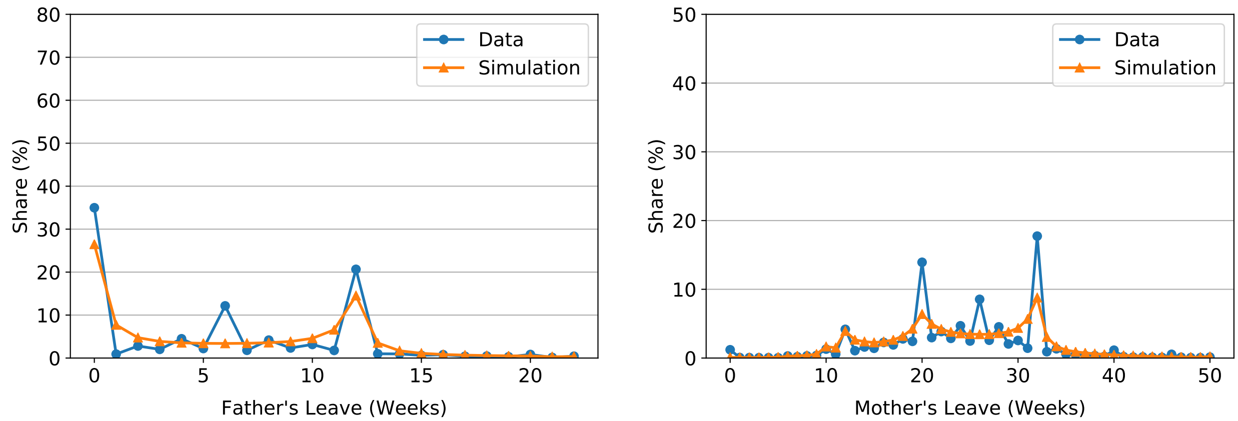


Figure A.III: Model Fit: Actual and Simulated Parental Leave Use - Cont.

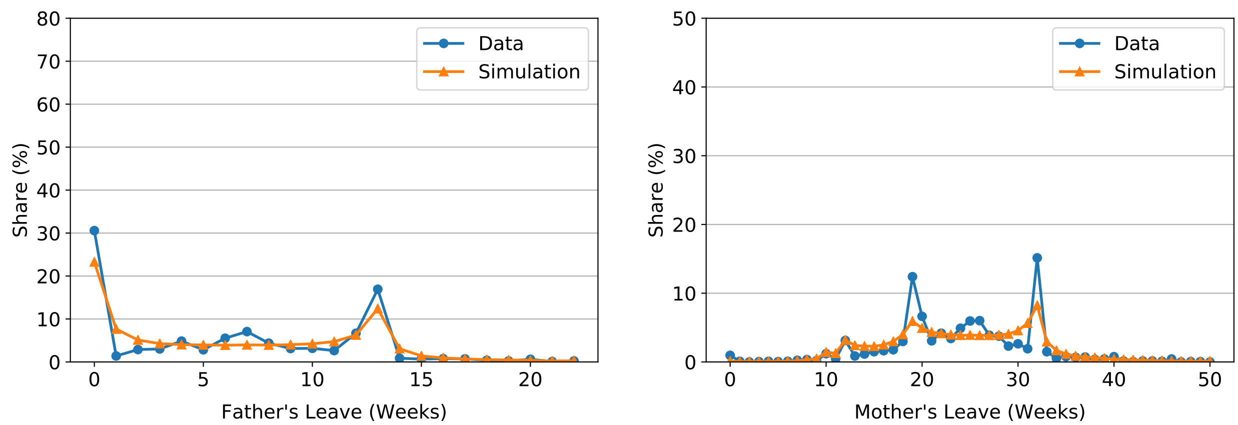
D: Father in Public Sector with 6 Weeks of Compensation



E: Father in Public Sector with 12 Weeks of Compensation



F: Father in Public Sector with 13 Weeks of Compensation



Notes: The leave distributions simulated from the model are based on 200 random draws of $(\varepsilon_w, \varepsilon_m)$ together with a uniform draw to determine the optimal leave from the choice-probabilities.

B Probing the Welfare Effects of Parental Leave Reforms

In this appendix, we formalize the points about the welfare effects of earmarked parental leave made in Section 5. Specifically, we show under which assumptions the efficiency costs defined in Section 5 are relevant for policy evaluations.

To make these points, we consider an extended version of the model in Section 2. Specifically, we treat the choice of leave as continuous and model household utility as

$$U(l_{i,m}, l_{i,f}, \tilde{l}, y_i) = y_i + v(l_{i,m}, l_{i,f}, \tilde{l}), \tag{13}$$

which, similar to equation (1) in Section 2, is quasi-linear in disposable income (y_i). We allow for a more general functional form in the utility from parental leave, $v(l_{i,m}, l_{i,f}, \bar{l})$, where we allow for interaction effects between parents' individual leave $(l_{i,j})$ and leave of all other parents $(\tilde{l})$, which we, for example, can interpret as a norm effect. We assume that the marginal utility of leave is declining $\left(\frac{\partial^2 v(l_{ij}, l_{i-j}, \tilde{l})}{\partial^2 l_{ij}} < 0\right)$.

Parents maximize utility subject to the budget constraint

$$y_i = B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B}) + \sum_{j \in m,f} w_{i,j}(52 - l_{i,j}), \tag{14}$$

which is similar to equation (4) in Section 2 except that we set the income tax to zero for simplicity. The parameter $\mathcal{B}$ captures the overall policy setting that we can affect through reforms. We assume that $B(\cdot)$ is differentiable in $\mathcal{B}$.

The total governmental expenditure on the parental leave system is given by

$$Q = \sum_i B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B}). \tag{15}$$

Household optimization yields the first-order condition

$$\frac{dU(l_{i,m}, l_{i,f}, \bar{l}, y_i)}{dl_{i,j}} = 0 \Leftrightarrow \frac{\partial v(l_{i,m}, l_{i,f}, \tilde{l})}{\partial l_{i,j}} = \underbrace{w_{i,j} - \frac{\partial B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B})}{\partial l_{i,j}}}_{MC_{i,j}(l_{i,m}, l_{i,f}; Z_i, \mathcal{B})}, \tag{16}$$

which implicitly defines individual parental leave $(l_{i,j})$ as a function of the marginal cost of leave (MC) and the leave taken by the partner $(l_{i,-j})$, and all other parents $(\tilde{l})$.

Welfare Effects of Parental Leave Reforms

To investigate the welfare effects of parental leave reforms, we introduce a notion of social welfare, modeled as

$$W(\mathcal{B}) = \sum_i U(l_{i,m}, l_{i,f}, \tilde{l}, y_i) - Q + g(\tilde{l}), \tag{17}$$

which is the sum of parents' utility, the expenditure for on parental leave system, and a social utility component from aggregate use of parental leave, $g(\tilde{l})$.[26] The social utility component could, for example, reflect desirable effects of fathers' parental leave on overall gender inequality or other outcomes over and above what parents take into account in their optimization.

Considering a reform that changes the institutional setting from $\mathcal{B}_0$ to $\mathcal{B}_1$, we obtain a change in welfare of

$$W(\mathcal{B}_1) - W(\mathcal{B}_0) = \int_{\mathcal{B}_0}^{\mathcal{B}_1} \frac{dW(\mathcal{B})}{d\mathcal{B}} d\mathcal{B}, \tag{18}$$

where

$$\frac{dW(\mathcal{B})}{d\mathcal{B}} = \sum_i \frac{dU(l_{i,m}, l_{i,f}, \tilde{l}, y_i)}{d\mathcal{B}} - \frac{dQ}{d\mathcal{B}} + \frac{\partial g(\tilde{l})}{\partial \tilde{l}} \frac{d\tilde{l}}{d\mathcal{B}}. \tag{19}$$

Using the Envelope Theorem, we can obtain

$$\frac{dU(l_{i,m}, l_{i,f}, \tilde{l}, y_i)}{d\mathcal{B}} = \frac{\partial B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B})}{\partial \mathcal{B}} + \frac{\partial v(l_{i,m}, l_{i,f}, \tilde{l})}{\partial \tilde{l}} \frac{d\tilde{l}}{d\mathcal{B}}, \tag{20}$$

[26] We normalize the marginal cost of public funds to 1. As utility in our model is quasi-linear in income, the marginal cost of public funds would indeed be 1 if we financed the changes in the parental leave system with lump sum taxes. However, a marginal cost of public funds of 1 holds in much more general settings (see, e.g., Kaplow, 2004).

and the effect of the public expenditure on parental leave is given by

$$\frac{dQ}{d\mathcal{B}} = \sum_i \left[\frac{\partial B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B})}{\partial \mathcal{B}} + \sum_{j \in m,f} \frac{\partial B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B})}{\partial l_{i,j}} \frac{dl_{i,j}}{d\mathcal{B}} \right]. \tag{21}$$

Combining equations (18)-(21), we can write the welfare effect of a parental leave reforms as

$$\frac{dW}{d\mathcal{B}} = \underbrace{-\sum_i \sum_{j \in m,f} \frac{\partial B(l_{i,m}, l_{i,f}; Z_i, \mathcal{B})}{\partial l_{i,j}} \frac{dl_{i,j}}{d\mathcal{B}}}_{\text{Behavioral Budget Effect}} + \underbrace{\sum_i \frac{\partial v(l_{i,m}, l_{i,f}, \tilde{l})}{\partial \tilde{l}} \frac{\partial \tilde{l}}{d\mathcal{B}}}_{\text{Externality}} + \underbrace{\frac{\partial g(\tilde{l})}{\partial \tilde{l}} \frac{d\tilde{l}}{d\mathcal{B}}}_{\text{Additional Motive}} . \tag{22}$$

The above result is, broadly speaking, standard in Public Economics (Kleven, 2021). From the parents' perspective (equation 20), a marginal reform affects utility through two channels: i) the mechanical effect on their budget and ii) potential externalities from changes in overall parental leave-taking through $\tilde{l}$. The externality channel carries over to social welfare in equation (22), while the mechanical effect is cancelled out by the mechanical effect on the public expenditure, leaving only the behavioral effect.[27]

Our definition of efficiency costs in equation (12) in the main text captures the direct effect of reforms on parents' utility (first term on the right hand side of equation 20) and the effect on public expenditure (equation 21). With accurate estimates of the reform effects, $\frac{dl_{i,j}}{d\mathcal{B}}$, this is exactly the first term in equation (22). In a full policy evaluation, these efficiency costs should be balanced against the potential benefits (two last terms in equation 22), which can take very general forms as long as they are external to the parents' optimization problem.

[27]The terms behavioral and mechanical effects in this section refer to marginal reforms only and differ from the terms in Section 5.1 in the main text when considering large reforms. To see this, note that optimal $l_{i,j}$ is a function of $\mathcal{B}$, and hence, $\int_{\mathcal{B}_0}^{\mathcal{B}_1} \sum_i \frac{\partial B(l_{i,m}(\mathcal{B}), l_{i,f}(\mathcal{B}); Z_i, \mathcal{B})}{\partial \mathcal{B}} d\mathcal{B} \neq \int_{\mathcal{B}_0}^{\mathcal{B}_1} \sum_i \frac{\partial B(l_{i,m}(\mathcal{B}_0), l_{i,f}(\mathcal{B}_0); Z_i, \mathcal{B})}{\partial \mathcal{B}} d\mathcal{B}$, which is the definition of the mechanical effect used in Section 5.1. The difference between the two terms is the second-order effect referred to in Section 5.1, which becomes large when the difference between $\mathcal{B}_0$ and $\mathcal{B}_1$ becomes large.

C Comparing Our Simulations with Past Earmarked Leave Reforms

In this appendix we compare our model simulations to the past reforms that introduced earmarked parental leave in other countries. Specifically, we simulate the Norwegian 1993-reform, the Swedish 1995-reform and the German 2007-reform and compare our model predictions for fathers' take-up of parental leave to the observed behavioral changes after the reform.

For each reform we implement the key elements of the policy setting before and after the reform. These include leave duration, replacement rate and benefit cap. However, it is important to note the formal policy setting only partly shapes the incentives that face parents. In particular, the incentives facing parents are also formed by earnings distributions of men and women, which we keep fixed in our data.[28] For this reason, and differences in sample selection and measurement of parental leave, we should not expect our model to match the observed behavior in countries exactly. That said, our model does a good job of predicting the changes in behavior following the introduction of earmarked leave (see Table A.I).

The Norwegian 1993-Reform

The Norwegian 1993-reform increased total parental leave from 35 to 42 weeks and earmarked leave from 0 to 4 weeks, while keeping the replacement rate of 100% and benefit cap of NOK593,000 per year or €1,110 per week (2019-level) fixed. However, most public and private employers top up benefits so that income is fully compensated (Dahl *et al.*, 2014), and hence, we treat the cap as non-binding. The totalparental leave is measured from the birth of the child, and hence, we subtract 14 weeks to make it comparable with our model.

[28] As we note in Table A.I, we scale the benefit caps for Germany and Sweden to reflect lower earnings levels in these countries.

The Norwegian 1993-reform is studied by Rege & Solli (2013), Dahl *et al.* (2014) and Cools *et al.* (2015). Cools *et al.* (2015) report a pre-reform share of fathers taking parental leave of around 5%, which jumps to around 25% immediately after the reform. In the following 3 years there is a relatively sharp increase that brings the share up to 40%, and there after there is a more modest increase to just below 60% 10 years after the reform. Of course, the longer run changes in fathers' parental leave use could also reflect gradual changes in preferences and may not necessarily be driven solely by the reform.

In Rege & Solli (2013) and Dahl *et al.* (2014) the long run effects are larger as they report a take-up share that is around 10 percentage points higher in years 3 and 10. The difference is likely due to stricter sample selection in Rege & Solli (2013) and Dahl *et al.* (2014), who only include full-time workers in their analysis. Our sample selection lies somewhere between that of Rege & Solli (2013) and Dahl *et al.* (2014) and that of Cools *et al.* (2015).

Our model predicts a 34 percentage points increase in the share of fathers taking parental leave from a pre-reform level of 40% to 74% post-reform. Hence, our model accurately predicts the 3-year reform effect and the level of take-up measured closer to our data window (2008-2015). Based on our model, we would interpret the observed 3-year change in fathers' take-up of parental leave as the pure reform effect, while the more gradual subsequent development is due to other factors that are also present in our data.

Turning to the change in the average length of male parental leave, Cools *et al.* (2015) report an increase of 8 days from a pre-reform level of 2 days. We estimate a significantly larger effect of 1.9 weeks, which can be partly explained by the higher pre-reform level of take-up in our model. The higher level of take-up implies that more fathers respond on the intensive margin, driving larger changes in the average length of parental leave.

The Swedish 1995-Reform

The Swedish 1995-reform introduced 4 weeks of earmarked leave and reduced the replacement rate from 90% to 80%, while keeping the total leave fixed at 360 days (corresponds to

37 in our setting).[29] Parental leave benefits were capped at SEK1,006 per day or €690 per week (2019-level). However, the earnings levels in Sweden are significantly lower than in Norway and Denmark (partly due to higher social security contributions). According to Eurostat, the median gross hourly earnings is about 2/3 of the level in Denmark and Norway, and therefore, we scale the benefit cap by 3/2 to €1,035.[30]

The Swedish 1995-reform is studied by Ekberg *et al.* (2013) and Avdic & Karimi (2018). Ekberg *et al.* (2013) report an increase in the average length of male parental leave of 14 days, from 30 days pre-reform to 44 days after. The same increase is found in Avdic & Karimi (2018), but from a pre-reform level of 35 days. Ekberg *et al.* (2013) also report an increase in the share of fathers taking leave from 46.3% to 82.3%.

Compared to the observed changes in male parental leave use, our model simulations predict significantly smaller reform effects. We predict an increase in the average length of 0.6 of a week from a pre-reform level of 2.7 weeks, and a 19 percentage point increase in the share of fathers taking leave from 28% pre-reform. Hence, our model produces effects that are essentially half the size of the actually changes. However, part of this difference can be explained by the fact that both Ekberg *et al.* (2013) and Avdic & Karimi (2018) measure parental leave taken up to 8 years after birth, while we, as in the Norwegian studies, only measure up to 3 years after birth. As reported in Ekberg *et al.* (2013), a significant share of the effect is due to larger male take-up after the 3rd year and, in particular, during holidays.

The German 2007-Reform

The German 2007-reform was significant in the sense that it almost halved total parental leave from 24 to 14 months, of which 2 were earmarked to the father, while benefits were increased from means-tested €300 per month to 67% replacement of past earnings capped at €1,800 per month or €415 per week (2019-level). Similar to the Swedish reform, we scale the benefit cap by 3/2 to account for the lower earnings level in Germany.

[29] In addition, parents can take 90 days of parental leave with flat rate of 60 SEK/day.

[30] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Earnings_statistics

The German 2007-reform is studied by Kluve & Tamm (2013) and Bünning (2015), but neither of them provide their own estimates of the changes in fathers' parental leave use. Kluve & Tamm (2013) find no significant changes in fathers' involvement in childcare or employment within the first 2 years after the birth of the child, but Bünning (2015) cites figures from the German Statistisches Bundesamt that the share of fathers who took parental leave increased from 3.5% in 2006 to 21% in 2008 and to 30% in 2012.

Compared to the numbers cited by Bünning (2015) our model has difficulties in matching the very low pre-reform take-up by fathers. We predict a 24% share compared to the 3.5% cited above. Our interpretation of this discrepancy is that the German pre-reform setting with very long total leave and low benefits is too far from the variation we used to identify our model. In contrast, the post-reform is closer to the baseline setting in our model and here we predict a level of take-up (40%) that is closer to numbers cited by Bünning (2015).

Table A.I: Comparing Our Simulations with Past Earmarked Leave Reforms

Reform	**Pre-Reform Setting**[1)]	**Post-Reform Setting**[1)]	**Simulated Change**	**Observed Change**
Norway 1993	100% replacement No benefit cap[2)]	100% replacement No benefit cap[2)]	34pp increase in the share of fathers taking leave from 33% pre-reform.	22pp increase after 1 year, 37pp after 3 years, and 55pp after 10 years from 3% pre-reform.
	21 weeks total leave 0 weeks earmarked	28 weeks total leave 4 weeks earmarked	1.8 weeks increase in the avg. length of male parental leave from 4.1 weeks pre-reform.	8 days (1.15 weeks) increase after 1 year from 2 days pre-reform.
Sweden 1995	90% replacement €1,035 benefit cap[3)]	80% replacement €1,035 benefit cap[3)]	17pp increase in the share of fathers taking leave from 26% pre-reform.	36pp increase after 1 year from 46% pre-reform.
	37 weeks total leave 0 weeks earmarked	37 weeks total leave 4 weeks earmarked	0.4 week increase in the avg. length of male parental leave from 3.4 weeks pre-reform.	14 days (2 weeks) increase after 1 year from 30 days pre-reform.
Germany 2007	100% replacement €100 benefit cap[3)]	80% replacement €625 benefit cap[3)]	16pp increase in the share of fathers taking leave from 21% pre-reform.	18pp increase after 1 year and 26pp after 3 years from 3.5% pre-reform.
	90 weeks shared leave 0 weeks earmarked	47 weeks total leave 9 weeks earmarked	1.2 weeks increase in the avg. length of male parental leave from 1.3 weeks pre-reform.	

Notes: 1) As our model focuses on the shared parental leave that follows the 14 weeks of maternity leave, we subtract 14 weeks from the available parental leave in the other countries. 2) Norway has an official cap of €1,070 per week. However, most public and private employers top up benefits so that income is fully compensated (Dahl *et al.*, 2014). Hence we treat the cap as non-binding. 3) We scale the benefit caps in Sweden and Germany by 3/2 to adjust for the lower earnings levels in these countries. The 3/2 scaling reflects the relative median gross hourly earnings in 2019 between the countries measured by Eurostat. pp = percentage points.