# FIRMS AND POLICY INCIDENCE

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Abstract. I study the role of firms in the consequences of public policies that target workers and firms by developing a framework to incorporate firms into welfare analysis. Building on the existing sufficient statistics frameworks, I introduce heterogeneity across firms and involuntary unemployment caused by firms' employment decisions. The model can nest a wide variety of labor market frictions and firm-idiosyncratic responses to reforms. The framework rationalizes the use of the growing number of firm-level causal estimates of the effects of a policy to study its welfare impact. I apply the model to various reforms studied in the literature. Including the spillovers stemming from firm-level adjustments changes the welfare conclusions in most cases, suggesting a pivotal role of firms for the pass-through of many public policies.

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## 1. Introduction

A recent and growing literature has studied the welfare effects of individual-targeted policies using causal estimates of the effects of government reforms. The approach relies on sufficient statistics derived by theoretical models and estimated on the data. These frameworks focus on workers' responses to policy reforms, allowing for a limited role of firms. In particular, they do not explicitly account for the possibility of imperfectly competitive labor markets, where wages may have a firm-specific component, and where firm's employment decisions causing involuntary unemployment affect the welfare consequences of a reform. At the same time, a growing number of empirical papers has studied the effects of policies at the firm level, showing heterogeneous responses and spillovers across employees. This paper bridges the two strands of literature developing a sufficient statistics framework that uses firm-level estimates of the effects of public policies to investigate the importance of firm adjustments for welfare evaluations.

First, unlike previous work on sufficient statistics, I introduce firm heterogeneity. I allow for general equilibrium effects on wages that can be heterogeneous across firms, without explicitly modeling the firm's problem. Such heterogeneity becomes of primary importance in frictional labor markets where employers have wage-setting power and firm-idiosyncratic policy shocks are passed through to employees. My framework derives sufficient statistics to capture spillovers across employees within the same firm, without taking a stance on the source of labor market frictions or employees complementarities. As a consequence, the model allows for the indirect effect of a policy on workers who are not directly targeted by the government.

Second, I allow for involuntary unemployment caused by firms employment decisions. Similarly to what happens to wages, indirect effects on the probability of employment can arise within a firm. These employment responses contribute to the welfare consequences of a policy. I develop a method to derive boundaries on the utility cost of unemployment from estimates of the employment consequences of policy changes.

The welfare impact of a policy requires two elements. The first element is the causal impact of the policy on firm-level quantities and prices and its consequences for the government budget. It captures the redistribution of a policy's costs/benefits among incumbent workers. The second element is the cost of losing a job, determined by firm-level estimates of the policy's causal effect on employment. These estimates require an analysis of a policy's effects at the firm-level—where such dynamics play out—rather than at the individual level, which is often the focus in empirical contexts. Hence, I show how the growing number of firm-level estimates of the effects of government policies can be employed in welfare evaluations. I derive a new version of the marginal value of public funds (MVPF) to measure the ratio of willingness to pay to policy costs, extending the formula in Hendren and Sprung-Keyser (2020). The formula can parsimoniously nest a wide variety of relevant labor market frictions and policies, and can be applied to the existing estimates of firm-level spillovers. This allows me to provide new evidence on the relative desirability of different individual- and firm-targeted policies.

I apply the model to available estimates of the firm-level effects of policy changes and find two primary results. First, I find a MVPF of 1.02, 0.21 and 0.74 for payroll tax cuts (Saez, Schoefer, and Seim, 2019), cut in top income tax rates (Labanca and Pozzoli, 2019), and extension of parental leave (Brenøe et al., 2020), respectively. Second, I compare these results to what one would have obtained not accounting for firm-level responses, ignoring spillovers and firm-wide changes in wages that my model - unlike canonical sufficient statistics models - can account for. This generates different conclusions of 0.3 to 1. Benchmarked to estimates in Hendren and Sprung-Keyser (2020), these changes are comparable to moving from the most effective EITC expansion in 1986 ($MVPF = 1.2$) to the least effective job training programs for young workers such as JobStart and JobCorps ($MVPF = 0.4$). Such a sizable change suggests that firms are an important vector for the pass-through of public policies on welfare. I further show that the effects of firm-targeted policies on workers are pivotal for the MVPF of these reforms. For corporate tax changes ($MVPF = 1.04$) or ICT investment subsidies ($MVPF = 4.29$), the externality of firm decisions on wages affects the MVPF so that workers generate part of the willingness to pay for these policies, although they are not directly affected. Finally, I show that a firm's impact on normative evaluations mainly works through the fiscal externality of its behavior on the government budget, which is easy to estimate in the data.

This paper builds on the idea of deriving sufficient statistics for welfare analysis, debated by Chetty (2009a); Chetty (2009b) and previously adopted by Feldstein (1999). Hendren (2016) and Hendren and Sprung-Keyser (2020) provide a framework to show that causal estimates of the effects of a policy are sufficient to capture its welfare impact. They develop the concept of the MVPF that I discuss in my model. Hendren and Finkelstein (2020) review the MVPF framework and its applications.

The rest of the paper proceeds as follows. Section 2 sets up the model, and it derives expressions for the willingness to pay, and for the MVPF. Section 3 applies the model to existing papers discussing the role of firms in the welfare effects of various policies. Section 4 concludes.

## 2. The Model

I provide a definition of welfare in an economy with unemployment, populated by heterogenous individuals and firms. In this setting, I show how the welfare effect of a reform depends on the willingness to pay of three groups of individuals: incumbents, unemployed, and those who switch employment status because of the reform. I discuss producers' surplus and how to incorporate it in Section 2.6. The model does not require to explicitly solve the firm optimization problem or to take a stance on the sources of firm heterogeneity and labor market frictions.

2.1. **A Definition of Total Welfare.** The economy is populated by individuals of different types, indexed by $i$. There are $N_i$ individuals for each $i$, of whom $n_i^e$ are employed ($e$), while $n_i^u$ are unemployed ($u$). Individuals work in firms indexed by $j \in J$. Every individual has preferences over consumption ($x$) and activities ($\mathbf{L}$) that can be labor related. The model allows for an extensive margin of labor supply, as discussed more in details in Section 2.3.2. Preferences are represented by a utility function $u_i(x_i, \mathbf{L}_i)$. Each individual maximizes utility subject to a budget set $B$, experiencing indirect utility $V_i$:

$$V_i = \max_{x_i, \mathbf{L}_i \in B} u_i(x_i, \mathbf{L}_i)$$

The average utility of $i$ is a weighted average of the indirect utilities of employed and unemployed individuals of this type:

$$\bar{V}_i = \sum_j \frac{n_{ij}^e}{N_i} V_{ij}^e + \frac{n_i^u}{N_i} V_i^u$$

To measure total welfare in the economy, I use a vector of Pareto weights $\{\psi_i\}_{i \in I}$ to weight the average utilities. Total welfare therefore is

$$W = \sum_{i \in I} \psi_i N_i \bar{V}_i \tag{2.1}$$

2.2. **The Welfare Effect of a Policy Change.** The government can implement policies that cause marginal changes in the prices of activities (e.g. taxes) or in public spending. I add no assumption about the optimality of a given policy reform, but to implement the formulas I assume that the econometrician can observe the set of targeted individuals. I parametrize a policy change with $d\theta$—a perturbation of the *status quo* or the amount of upfront government spending on the policy (Hendren and Sprung-Keyser, 2020). The perturbation $d\theta$ can be either positive or negative to incorporate increases and decreases in taxes and public spending. I provide a parametrization of $d\theta$ in relation to the individual budget constraint in Section 2.3. For now, consider a policy reform $d\theta$ that causes a change in $\bar{V}_i$:

$$\frac{d\bar{V}_i}{d\theta} = \underbrace{\sum_j \frac{n_{ij}^e}{N_i} \frac{dV_{ij}^e}{d\theta}}_{\text{Utility change for incumbents}} + \underbrace{\frac{n_i^u}{N_i} \frac{dV_i^u}{d\theta}}_{\text{Utility change for unemployed}} + \underbrace{\sum_j \frac{\left(V_{ij}^e - V_i^u\right)}{N_i} \frac{dn_{ij}^e}{d\theta}}_{\text{Utility cost of unemployment}}$$

The expression is composed of three terms: *i*) the change in utility for incumbents; *ii*) the change in utility for the unemployed; and *iii*) the utility cost of unemployment, proportional to the change in employment and to the utility effect of a change in employment status.

Dividing each term by the marginal utility of income of the respective group of workers, I can recover the willingness to pay of every group. Specifically, $\lambda_i^u = \partial V_i^u / \partial y_i$ and $\lambda_{ij}^e = \partial V_{ij}^e / \partial y_i$ are the marginal utilities of income for unemployed and incumbents in firm $j$, respectively. Hence, $WTP_i^{\theta,u} = n_i^u \frac{dV_i^u}{d\theta} / \lambda_i^u$ and $WTP_{ij}^{\theta,e} = n_{ij}^e \frac{dV_{ij}^e}{d\theta} / \lambda_{ij}^e$ are the willingness to pay for policy $\theta$ of the unemployed and incumbents, while $WTP_{ij}^{\theta,s} = \left(V_{ij}^e - V_i^u\right) \frac{dn_{ij}^e}{d\theta} / \lambda_i^u$ is the willingness to pay of those who lose/find their job (i.e., switch employment status) in firm $j$. The policy effect on $\bar{V}_i$ is a function of these WTPs

$$\frac{d\bar{V}_i}{d\theta} = \frac{1}{N_i} \left( \lambda_i^u \sum_j WTP_{ij}^{\theta,s} + \sum_j \lambda_{ij}^e WTP_{ij}^{\theta,e} + \lambda_i^u WTP_i^{\theta,u} \right).$$

Hence, the welfare effect is

$$\frac{dW}{d\theta} = \tilde{\eta}^\theta WTP^\theta. \tag{2.2}$$

It is proportional to the average social marginal utility $\tilde{\eta}^\theta$ of those who are affected by the policy, and to the total willingness to pay for the policy defined as $WTP^\theta = \sum_j WTP_{ij}^{\theta,s} + \sum_j WTP_{ij}^{\theta,e} + WTP_i^{\theta,u}$.

The average social marginal utility is

$$\tilde{\eta}^\theta = \sum_i \frac{\eta_i^u \sum_j WTP_{ij}^{\theta,s} + \sum_j \eta_{ij}^e WTP_{ij}^{\theta,e} + \eta_i^u WTP_i^{\theta,u}}{WTP^\theta}, \tag{2.3}$$

where $\eta_i = \psi_i \lambda_i^k$ is the social marginal utility of income for an individual $i$ with employment status $k = u, e$, and it measures the social value of giving \$1 to this individual (Saez and Stantcheva, 2016). Hence, $\tilde{\eta}^\theta$ is the social value of giving \$1, on average, to those affected by the policy.

Equation (2.2) shows that, given $\tilde{\eta}^\theta$, $WTP^\theta$ must be quantified to evaluate the welfare effect of a policy. This is the focus of the next subsection.

2.3. **Total Willingness to Pay for a Policy Change.** To derive formulas for the total willingness to pay, I first define the individual budget constraint and describe how different government policies can affect it. I distinguish two types of activities in $\mathbf{L}$: activities that individuals are free to choose ($\mathbf{l}$) and activities that are taken as given ($\bar{\mathbf{l}}$). The former category may include labor in a firm and social security transfers; the latter may contain work hours if they are set by the employer and taken as given by the employee.

The government designs policies that affect three elements of the model: it can influence the prices of labor activities by changing policies $(\rho_i, \bar{\rho}_i)$ and can set a transfer $T_i$. A policy change $\theta$ targeting individuals $i$ shifts policy instruments $(\rho_{\mathbf{i}}, \bar{\rho}_{\mathbf{i}}, T_i)$. For instance, $d\rho_{is}/d\theta > 0$

represents an increase of policy $\rho_{is}$. Given government policies and prices, every agent faces a budget constraint that depends on their employment condition $k = e, u$

$$x_{ij}^{k} \leqslant (\mathbf{1} - \rho_i)\, \mathbf{w}_{ij}^{k} \mathbf{l}_{ij}^{k} + (\mathbf{1} - \bar{\rho}_i)\, \bar{\mathbf{w}}_{ij}^{k} \bar{\mathbf{l}}_{ij}^{k} + T_i + y_i. \tag{2.4}$$

For incumbents, $\left(\mathbf{w}_{ij}^{e}, \bar{\mathbf{w}}_{ij}^{e}\right)$ are the prices of labor activities earned by type $i$ in firm $j$. Importantly, the model allows for heterogeneity in wages across firms. $y_i$ is income unrelated to activities and can incorporate profit shares. Unemployed individuals face a similar budget constraint, but some of their labor activities $\mathbf{l}$ (e.g., labor in a firm) are equal to zero. Moreover, they face a common vector of prices $(\mathbf{w}_i^u, \bar{\mathbf{w}}_i^u)$, and all unemployed individuals $i$ choose the same vector of activities $\mathbf{L}_i^u$. From now on, I only focus on incumbents for the sake of brevity, but I show in Appendix A.2 how to include the unemployed. I also assume that consumption goods are produced under perfect competition. Section 2.6 discusses how to model producers' surplus, which will be important in the implementation of the formulas and to study firm-targeted policies.

The government transfers the following resources to incumbents $i$ in firm $j$:

$$t_{ij}^{e} = -\rho_{\mathbf{i}} \mathbf{w}_{ij}^{e} \mathbf{l}_{ij}^{e} - \bar{\rho}_{\mathbf{i}} \bar{\mathbf{w}}_{ij}^{e} \bar{\mathbf{l}}_{ij}^{e} + T_i.$$

A government reform changes these resources by an amount $dt_{ij}^{e}/d\theta$, which can be decomposed into a mechanical and a behavioral component. The former captures the mechanical effect of a policy on the government budget, which I define as $M_{ij}^{\theta,e} = -\sum_s w_{ijs}^{e} l_{ijs}^{e} \frac{d\rho_{is}}{d\theta} - \sum_r \bar{w}_{ijr}^{e} \bar{l}_{ijr}^{e} \frac{d\bar{\rho}_{ir}}{d\theta} + \frac{dT_i}{d\theta}$. The behavioral component is the externality on the government budget caused by the behavioral responses of workers and firms, which are $B_{ij}^{\theta,e} = -\sum_s \rho_{is} w_{ijs}^{e} \frac{dl_{ijs}^{e}}{d\theta} - \sum_s \rho_{is} \frac{dw_{ijs}^{e}}{d\theta} l_{ijs}^{e} - \sum_r \bar{\rho}_{ir} \bar{w}_{ijr}^{e} \frac{d\bar{l}_{ijr}^{e}}{d\theta} - \sum_r \bar{\rho}_{ir} \frac{d\bar{w}_{ijr}^{e}}{d\theta} \bar{l}_{ijr}^{e}$. As an example, if the government raises payroll taxes, the mechanical effect of the tax change is the amount of money collected when keeping the vector of activities at the pre-policy equilibrium, while the behavioral effect quantifies the resources that are lost because of changes in wages, workers' labor supply adjustments, and changes in working hours—if there are any.

The change in employment status of a subset of individuals $i$ also causes an externality on the government budget, which I define as $B_{ij}^{\theta,s} = \left(t_{ij}^{e} - t_i^{u}\right) \frac{dn_{ij}^{e}}{d\theta}$.

The policy's cost $C^\theta$ for the government is therefore a function of $dt_i^e/d\theta$ and $B_{ij}^{\theta,s}$:

$$C^{\theta} = \frac{dt^{\theta}}{d\theta} = \sum_i \sum_j \left( n_{ij}^{e} \frac{dt_{ij}^{e}}{d\theta} + \left(t_{ij}^{e} - t_i^{u}\right) \frac{dn_{ij}^{e}}{d\theta} \right). \tag{2.5}$$

Using this setup, in the next two subsections I derive formulas for the willingness to pay of incumbents, and for those who change employment status.

2.3.1. *The Willingness to Pay of Incumbents.* Invoking the envelope theorem, the willingness to pay of incumbents $i$ in firm $j$ is

$$WTP_{ij}^{\theta,e} = \underbrace{\frac{dt_{ij}^{e}}{d\theta}}_{\text{Effect on transfers}} + \underbrace{\sum_{s} l_{ijs}^{e} \frac{dw_{ijs}^{e}}{d\theta} + \sum_{r} \bar{l}_{ijr}^{e} \frac{d\bar{w}_{ijr}^{e}}{d\theta}}_{\text{Effect of price changes}} + \underbrace{\sum_{s} \rho_{is} w_{ijs}^{e} \frac{dl_{ijs}^{e}}{d\theta}}_{\text{Cost of behavioral responses}} + \underbrace{\sum_{r} \left( \frac{\frac{\partial u_i}{\partial \bar{l}_{ijr}^{e}}}{\lambda_{ij}^{e}} + \bar{w}_{ijr}^{e} \right) \frac{d\bar{l}_{ijr}^{e}}{d\theta}}_{\text{Utility effect of } \bar{\mathbf{l}} \text{ change}} . \tag{2.6}$$

I report the details about the derivation of Equation (2.6) in Appendix (A.1). As is well-known in the literature, because of an envelope argument the willingness to pay is a function of the mechanical effect of a policy. Importantly, changes in quantities and prices are sufficient to characterize the total willingness to pay. Hence, one does not need to study each firm's optimization problem. Only in the case of non-zero producers' surplus the model must take a stance on how to measure the producers' welfare (Section 2.6).

The formula can be rewritten as a combination of the change in government resources provided to the workers and the behavioral responses of the workers to the policy $\left\{\frac{dl_{ijs}^{e}}{d\theta}\right\}_s$. Recognizing a role to firms, my model emphasizes the importance of general equilibrium effects on wages and the utility effect of changes in $\bar{l}$, which depend on a vector of marginal utilities and on prices $\left\{\bar{w}_{ijr}^{e}\right\}_r$. These effects arise in frictional labor markets where the responses of wages and working hours can be heterogeneous across firms. Using the formula, the average firm-level change in the willingness to pay can be computed as $E_j\left(WTP_{ij}^{\theta,e}\right)$.

2.3.2. *The Willingness to Pay of the Individuals Changing Employment Status.* The willingness to pay of the individuals changing employment status depends on the utility cost of this switch. The model allows for an extensive margin of labor supply so that if employment-to-unemployment flows were voluntary there would be no utility cost from changes in employment. However, in the presence of involuntary unemployment, this utility cost measures how much individuals value their employment condition relative to unemployment.

A change in firm total employment can generate different worker flows: some workers may change employer (work-to-work), some others may become unemployed (work-to-unemployment). Since most empirical papers quantify total employment responses, but do not investigate work-to-work flows, I develop a method to provide an upper-bound to the cost of unemployment based only on the response of total employment, and on the earnings drop following a job loss.

The willingness to pay for a change in employment status is proportional to $\Delta V_{ij}^{u} = V_{ij}^{e} - V_{i}^{u}$, the difference in indirect utilities across the two employment statuses. I propose a simple way to evaluate $WTP^{\theta,s}_{ij}$, which relies on an approximation of $\Delta V^u_{ij}$. Specifically, I approximate $\Delta V^u_{ij}$ using a first-order Taylor approximation:

$$\Delta V^u_{ij} = V^e_{ij} - V^u_i \cong u_{i,x}\left(x^u_i, \mathbf{l}^u_i\right)\Delta x_{ij} + \sum_s u_{i,l_s}\left(x^u_i, \mathbf{l}^u_{is}\right)\Delta l_{ijs}.$$

Among the various labor activities, denote with $l^w$ the number of hours of paid labor in a firm so that $l^w = 0$ in the unemployment state. Importantly, labor activities can include search costs that individuals face when unemployed.

I focus on the extreme scenario where the observed firm-level employment response is entirely contributing to a work-to-unemployment flow so that no worker who looses their job moves to a different firm. In addition, I assume that the entire unemployment flow is involuntary. This scenario provides an upper bound on the utility cost of unemployment. Using the approximation above, the average firm-level willingness to pay for policy $\theta$ of the individuals who lose/find a job is

$$\begin{aligned}
(2.7) \qquad E_j\left[WTP^{\theta,s}_{ij}\right] &\cong E_j\left[\frac{1}{\lambda^u_i}\left[u^u_{i,x}\Delta x_{ij} + \sum_s u^u_{i,l_s}\Delta l_{ijs}\right]\frac{dn^e_{ij}}{d\theta}\right] \\
&= \underbrace{E_j\left[\Delta x_{ij}\frac{dn^e_{ij}}{d\theta}\right]}_{\text{Cost of Consumption Drop}} + \underbrace{\sum_s E_j\left[\frac{u^u_{i,l_s}}{\lambda^u_i}\,|_{l^w=0}\,\Delta l_{ijs}\frac{dn^e_{ij}}{d\theta}\right]}_{\text{Gain from Reduced Working Hours}},
\end{aligned}$$

where $\Delta x_i$ and $\Delta l_{is}$ represent the drops in individual consumption and labor activities for employees changing employment status. In particular, $E_j\left[\Delta x_{ij}\frac{dn^e_{ij}}{d\theta}\right]$ is the average firm-level drop in earnings of workers $i$ (including government transfers) caused by the job loss, which can be estimated in the data by looking at the earnings consequences of job losses.[1] The second line in Equation (2.7) exploits the fact that $u_{i,x}$ and $u_{i,l^w}$ are constant across $j$s.[2] The Equation also uses the identity $\lambda^u_i = u^u_{i,x}$ from the optimization problem of the unemployed.

Reduced working hours might reduce the utility cost of a job loss. Marginal utilities $\left\{\frac{u^u_{i,l_s}}{\lambda^u_i}\right\}_s$ are the hardest element of the formula to estimate in the data. In the standard case where agents derive utility from consumption and labor ($l^w$), $\frac{u^u_{i,l^w}}{\lambda^u_i}$ represents the marginal disutility of labor in consumption units of unemployed individual $i$ (i.e., how much an unemployed worker is willing to pay to avoid an extra hour of work). Search costs can also be included among these marginal utilities so that $\frac{u^u_{i,ls}}{\lambda^u_i}$ is the cost of searching for a job in consumption money. Unlike the marginal disutility of labor, search costs increase the cost of unemployment.

[1] Firms can often adjust employment along two main margins: layoffs and hires. In case of layoffs, $\widetilde{\Delta x}$ represents the cost of losing the job, which is proportional to the wage loss following the separation event. In the case of new hires, $\widetilde{\Delta x}$ is the gain from finding a job, which depends on the new hires' wage.

[2] They represent the marginal utilities of unemployed workers.

I take two alternative approaches to evaluate $\left\{\frac{u^u_{i,l^w}}{\lambda^u_i}\right\}_s$, and I use them to derive bounds on the willingness to pay for a change in employment status. First, in a model with only consumption and labor margins I assume that $\lim_{l^w_i \longrightarrow 0} \frac{u^u_{i,l^w}}{\lambda^u_i} = 0$ to derive an upper bound to the cost of unemployment. The latter would lead to a good approximation of the true utility cost if unemployed individuals—who are constrained at $l^w = 0$—had a close to zero marginal disutility from working, as would be the case without fixed costs of working. More in general, assuming $\lim_{l^w_i \longrightarrow 0} \frac{u^u_{i,l^w}}{\lambda^u_i} = 0$ provides an upper bound also in the presence of job search costs if they are accompanied by fixed costs of working.[3]

Second, I take the opposite approach by assuming that the benefit from lowering the number of hours worked fully compensates the utility cost from the loss in earnings. As a consequence, a job loss has no impact on utility. This approach provides a lower bound to the cost of unemployment and it is analogous to assuming that the change in total firm employment creates a work-to-work flow where every worker finds a new job identical to the one they had before the policy change. This approximation would also be correct if the observed unemployment was the result of an individual extensive margin choice such that unemployment is only voluntary.

I show in my empirical analysis that the boundaries on MVPFs determined by the proposed approximations are often tight.

2.4. **Firm-Level Policy Responses and Implementation.** This section discusses the estimates needed to implement the formulas derived above. I define them as the firm-level policy responses of quantities or prices $q$, which are

$$\overline{\frac{dq^e_i}{d\theta}} = E_j\left[n^e_{ij}\frac{dq^e_{ij}}{d\theta}\right]. \tag{2.8}$$

These responses are a policy-induced change in the total firm amount $Q_{ij} = n_{ij}q_{ij}$. Firm-level changes in employment and wages become crucial when labor markets are not perfectly competitive and worker-targeted policies generate firm-idiosyncratic policy shocks. The latter may depend on different concentrations of policy-targeted workers across firms, or on the fact that workers are heterogeneously affected by the policy. In all these cases, if firms have wage-setting power and the labor market is frictional (e.g. in presence of hiring or firing costs), wages change heterogeneously across firms. My model shows that the average firm-level wage and employment responses are sufficient for welfare.

Stressing this heterogeneity, the model changes the focus of the sufficient statistics framework from individual responses to firm-level responses. Such interpretation suggests an estimation strategy that looks for externalities at the firm level - the focus of a growing number of empirical papers. In the existing attempts, firm-level responses of wages and employment

[3]This is valid as long as search costs do not exceed fixed costs of working, which is likely a reasonable assumption.

have been estimated by using policy variation across firms as opposed to across individuals (e.g. Saez, Schoefer, and Seim, 2019). Clearly, this reduced-form approach might not capture general equilibrium effects outside the firm - what Sarto (2018) refers to as a micro-global elasticity. General equilibrium effects would, however, be missed even by a more standard empirical strategy that compares individuals heterogeneously affected by the policy, ignoring the externalities that arise at the firm level. For instance, Saez, Schoefer, and Seim (2019) by comparing individuals heterogeneously affected by a drop in payroll taxes find no evidence of a passthrough to wages, while they show significant effects on wages when comparing firms with different shares of targeted employees.

Clearly, if the response to the policy is homogeneous across firms and there are no firm-level externalities, the firm-level responses described above are still sufficient for welfare and my model becomes closer to the canonical sufficient statistics frameworks, however accounting for involuntary unemployment.

Firm-level responses are also useful because they automatically account for the relative numerosity of different types of employees $i$ when multiple categories of workers are affected by the consequences of a reform. This will be crucial in the applications in section 3.

2.5. **Revisiting the MVPF.** The MVPF has been recognized as a useful tool for evaluating the welfare effects of a government policy. It measures the total individual willingness to pay for every dollar spent by the government on the policy and reads:

$$MVPF^{\theta} = \frac{WTP^{\theta}}{C^{\theta}}. \tag{2.9}$$

The numerator is the total marginal willingness to pay of all individuals. Using Equations (2.6) and (2.7), it can be written as a function of the firm-level responses described in Section 2.4. The denominator quantifies the policy cost for the government.

The MVPF of this model can be decomposed into four terms. I show this decomposition in the formula below for the special case where only incumbents are affected by the policy, and I derive the more general formula in Appendix A.2.

(2.10)

$$MVPF^{\theta} = \underbrace{\frac{1}{1+FE^{\theta}}}_{\text{Standard formula}} + \underbrace{\frac{\sum_i \overline{\Delta W_i^{\theta,e}}}{C^{\theta}}}_{\text{GE effect of price change}} + \underbrace{\frac{\sum_i \widetilde{\Delta x_i^e \frac{dn_i^e}{d\theta}}}{C^{\theta}}}_{\text{Cost of unemployment}} + \underbrace{\frac{\sum_i \sum_r \Delta U^e_{i,\bar{l}_r} \cdot \overline{\frac{d\bar{l}^e_{ir}}{d\theta}}}{C^{\theta}}}_{\text{Utility effect of } \bar{l} \text{ change}}.$$

The first term is familiar to the literature on sufficient statistics. $FE^{\theta}$ is the so-called fiscal externality. In the standard model, it represents the ratio between the behavioral impact on government budget and the policy's mechanical cost for the government. In this model, the fiscal externality has a similar interpretation and reads as

$$FE^{\theta}=\sum_{i}\frac{\overline{B_{i}^{\theta,e}}+\overline{B_{i}^{\theta,s}}}{\overline{M_{i}^{\theta,e}}}. \tag{2.11}$$

The mechanical effect in the denominator measures the resources that the policy mechanically raises from incumbents. The numerator captures the budget externalities caused by the behavioral responses of workers and firms. It takes into account the effect of behavioral responses on incumbents' budget and, because firms actively respond to the policy, the loss/gain in government revenues caused by firms' adjustments in employment.

The second term of Equation (2.10) measures the utility cost of price changes at the firm level, where $\overline{\Delta W_{i}^{\theta,e}}=\sum_{s}\left(1-\rho_{is}\right)\overline{\frac{dw_{is}^{e}}{d\theta}l_{is}^{e}}+\sum_{r}\left(1-\bar{\rho}_{ir}\right)\overline{\frac{d\bar{w}_{ir}^{e}}{d\theta}\bar{l}_{ir}^{e}}$. Thanks to an envelope argument, this term is proportional to the average change in prices $\mathbf{w}$. It captures price adjustments caused by general equilibrium dynamics within (or outside) the firm. For instance, firms could cut wages in response to higher payroll taxes or in response to an increased labor supply of incumbent employees, causing first-order effects on the willingness to pay for the policy. Although these responses can be heterogeneous across firms, firm-level average responses are sufficient for the reasons discussed in section 2.4.

The third term measures the utility cost of unemployment, which is proportional to the employment change and depends on the individual drop in consumption caused by a change in employment status $\widetilde{\Delta x_{i}^{e}\frac{dn_{i}^{e}}{d\theta}}=E_{j}[\Delta x_{ij}^{e}\frac{dn_{ij}^{e}}{d\theta}]$.[4]

Finally, the last term measures the utility effect of changes in activities $\bar{\mathbf{l}}$. Since workers take these activities as given, the marginal willingness to pay $\Delta U_{i,\bar{l}_{r}}=\overline{\frac{\partial u_{i}^{e}/\partial\bar{l}_{ir}^{e}}{\lambda_{i}^{e}}}+\left(1-\bar{\rho}_{ir}\right)\overline{\bar{w}_{ir}^{e}}$ is proportional to the direct utility effect $\partial u_{i}^{e}/\partial\bar{l}_{ir}^{e}$ and to the mechanical effect on utility of a change in $\bar{l}_{r}$, which is measured by the price of this activity.

2.6. **Incorporating Producer Surplus.** The baseline version of the model assumes perfect competition in the consumption goods market. However, producer surplus becomes particularly relevant when stressing firm-level externalities in response to reforms. One can include producers' surplus redefining total welfare as $\mathcal{W}=W+\psi^{p}P$, where $P$ is the total producer surplus and $\psi^{p}$ is the Pareto weight attached to producers.[5] $P$ is typically modelled as profits. Hence, if firms have wage setting power, it is sufficient to estimate the policy's mechanical effect on a firm's profits to measure the producers' willingness to pay.[6] On the other hand, $\frac{dP}{d\theta}$ determines the externality on the government budget if profits are taxed.[7]

[4]The formula assumed $\lim_{l_{i}^{w}\longrightarrow0}\frac{u_{i,l^{w}}^{u}}{\lambda_{i}^{u}}=0$ (Section 2.3.2).

[5]Some models assume that total welfare is the sum of individuals and producers surplus. This occurs if individuals have quasi-linear preferences and the government attaches the same Pareto weight to individuals and producers.

[6]Profits might be rebated to workers as dividends entering $y_{i}$ so that $y_{i}=f\left(P\right)$, and $f'\left(P\right)/\lambda$ is their willingness to pay for a change in profits. One must model $f\left(\cdot\right)$ to determine the policy's welfare effect.

[7]Other margins (e.g. investments) must be considered in the fiscal externality if they are taxed/subsidized.

The MVPF with producers' surplus must include the producers' willingness to pay in the numerator, which together with the producer's externality on the government budget would enter the $FE^{\theta}$ component in (2.10). To compute the total welfare effect of a policy, the formula for the social marginal welfare weight $\tilde{\eta}$ in Equation 2.3 must also be adjusted.

## 3. Firms' Impact on Welfare

In this section, I construct the MVPF for various policies, highlighting the firm-level responses that determine its components. I leave to Appendix A.3 all the details about the models and the formulas. I then compute the MVPFs using estimates from the literature and discuss the importance of firm-level externalities for welfare.

### 3.1. **Constructing the MVPF for Various Policies.**

3.1.1. *Changes in Labor Costs.* Saez, Schoefer, and Seim (2019) investigate the role of firms for the pass-through of taxes to wages using a payroll tax reform implemented in Sweden in 2007 that lowered payroll taxes for young workers. I apply my model to this reform, distinguishing two types of workers: young workers ($y$) and their coworkers ($c$). The willingness to pay of incumbents $i$ is

$$WTP_i^{\text{payroll},\,e} = \sum_j n_{ij}^e \left[ \left(1 - \tau^{\text{PIT}}\right) l_{ij}^w \frac{dw_{ij}}{d\theta} \right].$$

The latter depends on the change in the net wage caused by firms' wage policies in response to the reform. The authors show evidence of a firm-level redistribution of the surplus from lower payroll taxes, which generates spillovers on coworkers and a positive externality on the government budget. Firms also increase employment, which increases the utility of those who change their employment status. Estimates show that firms increase average net wages and employment by 0.79 and 1.92 percent, respectively, in response to a 1 percent decrease in labor costs. The willingness to pay also increases because the tax cut has a mechanical positive effect on producers' surplus proportional to the net wage bill on young workers.

3.1.2. *Changes in Labor Supply Incentives.* Public policies that affect the labor supply of some workers are likely to trigger firms' responses, which in turn create spillovers on all incumbent workers.

**Cut in top income tax rates:** Firm production requires coordination between workers that might lead firms to pay a premium to the employees in order to reduce their discretion in choosing working hours. Labanca and Pozzoli (2019) document this phenomenon in the context of Danish firms and show its implications for the effect of a decrease in top income tax rates. I classify workers into two categories: top earners ($t$) and low earners ($l$). Suppose incumbents take the number of hours as given. The willingness to pay of incumbent $i$ is

$$WTP_i^{\text{top rate},e} = \sum_j n_{ij}^e \left[ -\bar{l}_{ij}^w w_{ij} \frac{d\tau_i}{d\theta} + \left( \frac{\frac{\partial u_i}{\partial \bar{l}_{ij}^w}}{\lambda_{ij}} + (1-\tau_i)\, w_{ij} \right) \frac{d\bar{l}_{ij}^w}{d\theta} \right].$$

It depends on the mechanical effect of the tax change, on the utility effect of the change in number of hours worked (proportional to the marginal disutility of labor), and on the mechanical effect of a change in hours worked. Labor hours decline following a decrease in top tax rates with an elasticity of $-0.047$ for top earners. Because of hours coordination, for a 1 percent decrease in hours worked by top earners, firms reduce low earners' work hours by 0.88. These spillovers influence the willingness to pay and the policy's cost for the government.

**Extension of parental leave:** Brenøe et al. (2020) study the short-run effects of a maternity leave of an employee on her coworkers and firm. Consider two groups of workers: women in fertile age ($f$) and coworkers ($c$). A paid leave policy provides a stipend (up to a certain number of months) to a woman who leaves her job around a pregnancy. The willingness to pay for introducing paid leave is

$$WTP_f^{\text{parental leave},e} = \sum_j \left[ (1-\tau^w) \left( l_{f,j} \frac{dw_{f,j}}{d\theta} + \frac{d\gamma}{d\theta} w_{f,j} l_{f,j}^l \right) \right]$$

where $\gamma$ is the replacement rate of the parental leave policy. I assume that there is full replacement so that $\gamma^l = 1$ and the government pays for the months on leave. The willingness to pay for $f$ workers depends on the effect of the policy on total earnings relative to a counterfactual without paid leave. I discuss alternative calibrations of the counterfactual in Appendix A.3. For coworkers, the willingness to pay depends on the change in their total earnings.[8] While $f$ workers see a replacement of their wage after the birth, coworkers experience a 1.7 percent increase in earnings. Moreover, firms hire more employees, increasing the willingness to pay for the policy and affecting the cost for the government.

3.1.3. *Firm-Targeted Policies.* The model also applies to the analysis of firm-targeted policies. I study the effect of local corporate taxes (Fuest, Peichl, and Siegloch, 2018) and a tax allowance on ICT investments (Gaggl and Wright, 2017). I calibrate my model assuming that there is only one type of workers, whose willingness to pay is proportional to the effect of the policies on wages and to the change in employment caused by a firm's decisions. Incumbents' wages decrease following increases in corporate tax rates, while the tax allowance leads firms to raise wages. I expand the total willingness to pay by including the effect of both policies on producers' surplus.

## 3.2. **Estimates.**

[8] I assume that workers are free to choose the working hours.

3.2.1. *Firm Responses Make a Difference.* Figure 1 compares the MVPFs estimated using the formulas discussed above to what one would find focusing on the workers directly targeted by the policy, as a benchmark for the canonical sufficient statistics approach. For all policies, the two MVPFs differ significantly: confidence intervals to the two estimates never overlap.[9] As I discuss below, firms redistribute the cost/benefit of the policies, creating spillovers on workers who are not directly affected by the policy change. This redistribution affects the willingness to pay of incumbents and causes externalities on the government budget that influence the cost of reforms. The difference between the two MVPFs ranges between 0.3 and 1 across policies. These numbers are comparable to moving from the most effective EITC expansion in 1986 ($MVPF = 1.2$) to the least effective job training programs for young workers such as JobStart and JobCorps ($MVPF = 0.4$) (Hendren and Sprung-Keyser, 2020). Hence, the spillovers caused by firm's responses and captured in my framework can completely reverse the normative evaluation of a policy, indicating a pivotal role of firms in the welfare effect of these reforms.

The MVPF of a cut in payroll taxes on young workers moves from -0.03 to 1.02 if firm-responses are included into the analysis. Producers surplus drives large part of the increase in WTP. The firm-level increase in wages for all incumbents also contributes to the WTP and reduces the cost of the reform relative to the case when only young workers are considered. Including these responses brings the policy from an MVPF below the one of the worst cash transfer in Hendren and Sprung-Keyser (2020) to being close to the average cash transfer.

Similarly, hours coordination within firms affects the fiscal cost of a cut in top income tax rates, causing a negative externality on the government budget. The MVPF without firm's responses is 0.73. After accounting for firms decreasing hours worked by low-paid employees when top earners decrease labor supply, the MVPF drops to 0.21. This result suggests that the top tax rate was likely not above the Laffer rate.

Firms responses also affect the MVPF of introducing a paid parental leave. The spillovers of firms' decisions on the coworkers increase the willingness to pay causing an increase in earnings and in the probability of being employed. For this reason, the MVPF increases from 0.41 to 0.74 when spillovers are considered.

As a robustness test, Table 1, column 3 shows how the MVPFs change when I assume no utility consequences of changes in employment. The formulas above relied on the assumption that $\frac{u^u_{i,l_s}}{\lambda^u_i} |_{l^w=0} = 0$. I simulate the extreme scenario where $\frac{u^u_{i,l_s}}{\lambda^u_i} |_{l^w=0}$ fully compensates the willingness to pay to avoid the loss in consumption. The estimates are only marginally affected, excluding that this approximation was driving the difference in the MVPFs presented above.

The analysis of firm-targeted policies provides further evidence of the importance of studying the effects of firms' behavior on the workforce. Corporate tax increases have a MVPF of 1.04: their negative effects on profits and wages cause a WTP larger than government revenues

[9]See Appendix B for details about the construction of confidence intervals.

(Figure 2). Tax allowances on ICT investments have a MVPF of 4.29 due to large effects on firm surplus and wages. Excluding the externality of firm decisions on wages, the MVPF would drop by 0.4 for ICT allowances, and would drop below 1 for corporate tax increases (Panel B), corroborating the importance of wages passthrough for welfare assessments.

3.2.2. *The Components of the MVPF.* Figure 3 exploits the decomposition in (2.10) to show that the fiscal externality and wage changes are the dominant components of the MVPF, determining more than 90 percent of the MVPF for all policies. This result implies that a firm's role in the welfare effects of a policy primarily works through the externalities on the government budget and on price adjustments rather than through the effects on employment or other marginal utilities.

## 4. Conclusion

This paper studies the importance of firms in normative analysis. I develop a new framework, which highlights the role of two welfare components that are often disregarded in the standard approach: the incumbents' willingness to pay for firm-level price changes, and the utility effect of changes in employment that are caused by adjustments in firms' employment decisions.

The framework provides guidance on how to employ the existing firm-level estimates of the effects of government reforms to evaluate welfare. I implement welfare formulas using estimates from the literature and I show that incorporating into the model the spillovers arising from firms' responses sizably changes the welfare conclusions. Although these estimates come from a limited number of contexts for which evidence exists and where publication bias might lead to an overestimation of a firms' role, the contribution of firms to the welfare impact of policies is likely relevant across various settings. Firms are an important channel for the pass-through of the effects of government reforms and therefore firm-level dynamics should be considered in welfare evaluations.

This paper presents a framework that highlights, among other things, the role of unemployed or outsiders. Evidence on the effects of policies on this group of individuals is still scarce, mostly because of identification issues. More research is needed to quantify the importance of the dynamics involving these individuals for welfare analysis.

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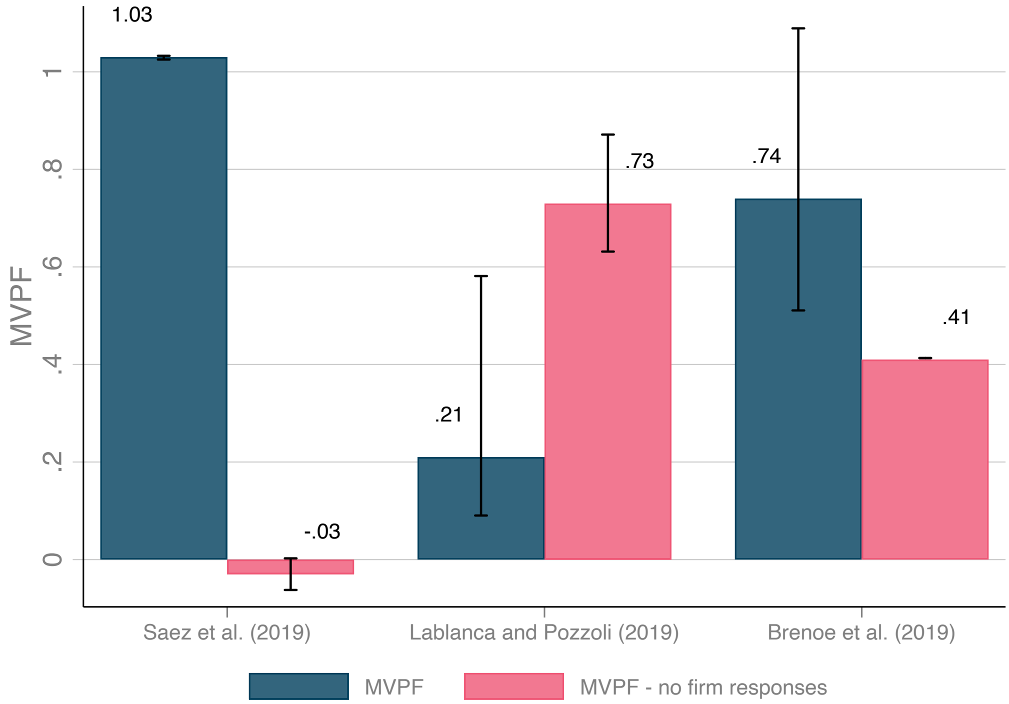
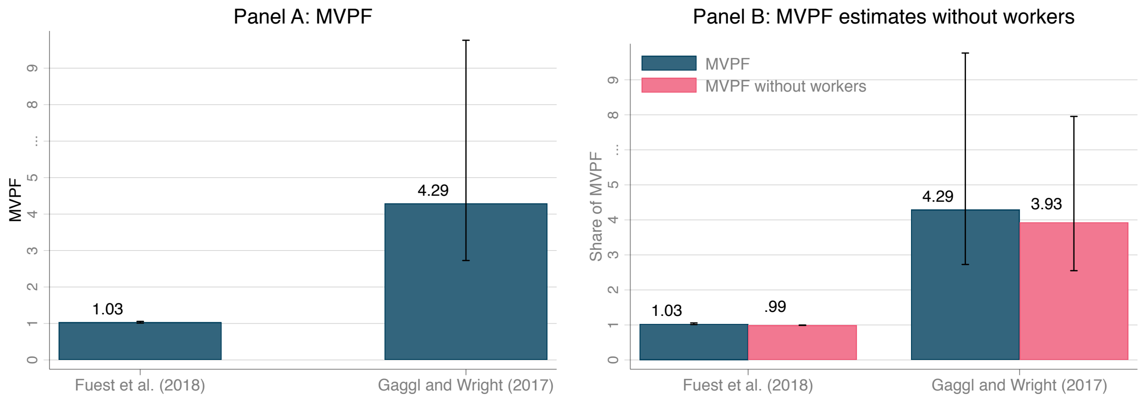
## Figures

Figure 1. MVPFs with and without firm's responses



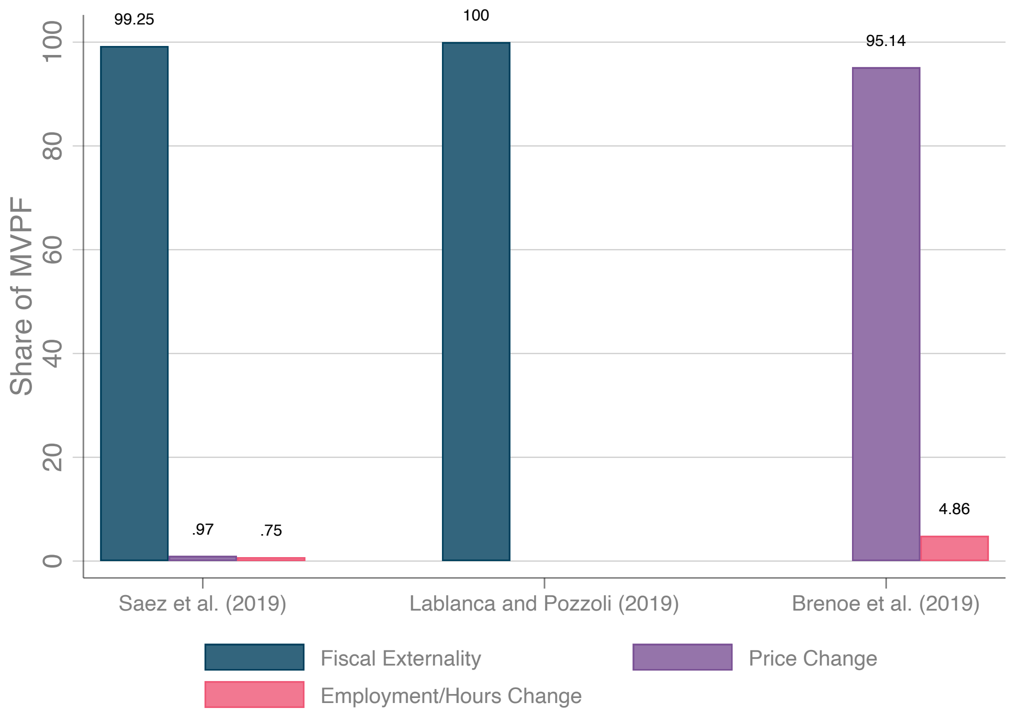

*Notes:* the Figure plots the MVPFs of different policies. For each policy the left bar reports the MVPF computed using the formulas described in Appendix A.3, where a firm's responses are included and I allow for spillovers on all incumbent workers. The right bar reports the MVPF estimated focusing on the workers who are directly targeted by the policy. All confidence intervals are 95% bootstrapped confidence intervals with adjustments discussed in Appendix B. All values are based on the calibrations described in Tables B.1 to B.2.

Figure 2. MVPF firm-targeted policies




*Notes:* the Figure plots the MVPFs for different firm-targeted policies. Panel A shows the MVPFs computed using the formulas described in Appendix A.3 and based on the calibrations described in Tables B.4 and B.5. All confidence intervals are 95% bootstrapped confidence intervals with adjustments discussed in Appendix B. Panel B compares the MVPFs showed in Panel A to those estimated by ignoring the passthrough of these policies on workers.

Figure 3. MVPF components




*Notes:* the Figure plots (for the policies in Figure 1) the percentage contribution to the MVPF of the components in formula (2.10). The first component is the so called fiscal externality, which represents the ratio between the behavioral impact on government budget and the mechanical cost of the policy for the government. It includes changes in producers' surplus that cause externalities on the government budget. The second component measures the utility cost of price changes at the firm-level and captures price adjustments caused by general equilibrium dynamics within the firm. The third component measures the utility cost of unemployment, which is proportional to the employment change and depends on the drop in consumption caused by a change in employment status. It also includes the utility effect of changes in activities that workers take as given. This component therefore includes all the terms that depend on marginal utilities that are hard to estimate and that one needs to approximate. All values are based on the formulas described in Appendix A.3 and on the calibrations described in Tables B.1 to B.2.

## Tables

### Table 1. Marginal Value of Public Funds for Different Policies

| | MVPF (firm focus) | MVPF (targeted individuals only) | MVPF (no unemployment cost) |
|---|---|---|---|
| Payroll Tax Subsidy (Saez, Schoefer, and Seim, 2019) | 1.029<br>[1.025,1.033] | -.031<br>[-.062,.003] | 1.021<br>[1.018,1.024] |
| Decrease in top income tax rate (Labanca and Pozzoli, 2019) | .207<br>[.09,.581] | .728<br>[.631,.871] | .207<br>[.090,.581] |
| Paternal Leave (Brenøe et al., 2020) | .742<br>[.511,1.089] | .413<br>[.413,.413] | .706<br>[.480,1.045] |
| Increase in corporate tax rate (Fuest, Peichl, and Siegloch, 2018) | 1.035<br>[1.012,1.057] | NA | 1.035<br>[1.012,1.057] |
| Tax allowance on ICT investment (Gaggl and Wright, 2017) | 4.288<br>[2.727,9.765] | NA | 4.288<br>[2.727,9.765] |

*Notes:* the Table collects the values of MVPFs reported in Figures 1 and 2. All values are based on the formulas described in Appendix A.3 and on the calibrations described in Tables B.1 to B.5. All confidence intervals reported in parenthesis are 95% bootstrapped confidence intervals with adjustments discussed in Appendix B. Column 1 shows the MVPF that takes into account a firm's responses and allows for spillovers on all incumbent workers. Column 2 reports the MVPF that one would find focusing on the workers who are directly targeted by the policy. For this reason, the MVPFs are missing in column 2 for firm-targeted policies. Finally, column 3 shows the MVPFs under the assumption that there is no utility cost/benefit associated to changes in employment status. This robustness is motivated by the fact that the calibrations in column 1 assumed that $\frac{u^u_{i,l_s}}{\lambda^u_i} |_{l^w=0} = 0$ — an assumption that would be violated in case of a fixed utility cost of working. The values of the MVPFs in this column are very similar to those in column 1 for all the policies, suggesting that the assumption is not driving the main results.

## Appendix A. Appendix

A.1. **Derivation of the marginal willingness to pay.** The effect of a policy on the indirect utility of incumbent employees is

$$\frac{\frac{dV_{ij}^e}{d\theta}}{\lambda_{ij}} = \sum_s \frac{dV_{ij}^e}{dw_{ijs}^e}\frac{dw_{ijs}^e}{d\theta} + \sum_r \frac{dV_{ij}^e}{d\bar{w}_{ijr}^e}\frac{d\bar{w}_{ijr}^e}{d\theta} + \sum_s \frac{dV_{ij}^e}{d\rho_{is}}\frac{d\rho_{is}}{d\theta} + \sum_r \frac{dV_{ij}^e}{d\bar{\rho}_{ir}}\frac{d\bar{\rho}_{ir}}{d\theta} + \sum_r \frac{dV_{ij}^e}{d\bar{l}_{ijr}^e}\frac{d\bar{l}_{ijr}^e}{d\theta} + \frac{dV_{ij}}{dT_i}\frac{dT_i}{d\theta} \tag{A.1}$$

Using the envelope theorem

$$\frac{dV_{ij}^e}{dw_{ijs}^e} = \lambda_{ij}\left(1-\rho_{is}\right)l_{ijs}^e$$

$$\frac{dV_{ij}^e}{d\bar{w}_{ijr}^e} = \lambda_{ij}\left(1-\bar{\rho}_{ir}\right)\bar{l}_{ijr}^e$$

$$\frac{dV_{ij}^e}{d\rho_{is}} = -\lambda_{ij}w_{ijs}^e l_{ijs}^e$$

$$\frac{dV_{ij}^e}{d\bar{\rho}_{ir}} = -\lambda_{ij}\bar{w}_{ijr}^e \bar{l}_{ijr}^\rho$$

$$\frac{dV_{ij}^e}{d\bar{l}_{ijr}^\rho} = \frac{\partial u_i}{\partial \bar{l}_{ijr}^\rho} + \lambda_{ij}\left(1-\bar{\rho}_{ir}\right)\bar{w}_{ijr}^e$$

$$\frac{dV_{ij}^e}{dT_i} = \lambda_{ij}$$

By envelope theorem, behavioral responses do not have any first-order utility effect. The only behavioral response that affects the marginal willingness to pay is $\frac{d\bar{l}_{ijs}^\rho}{d\theta}$, which changes exogenously for incumbent workers. Substituting the terms derived above into (A.1) I get:

$$
\begin{aligned}
\frac{\frac{dV_{ij}^{e}(\theta)}{d\theta}}{\lambda_{ij}} &= \sum_{s}\left(1-\rho_{is}\right) l_{ijs}^{e} \frac{dw_{ijs}^{e}}{d\theta} + \sum_{r}\left(1-\bar{\rho}_{ir}\right) \bar{l}_{ijr}^{e} \frac{d\bar{w}_{ijr}^{e}}{d\theta} - \sum_{s} w_{ijs}^{e} l_{ijs}^{e} \frac{d\rho_{is}}{d\theta} - \sum_{r} \bar{w}_{ijr}^{e} \bar{l}_{ijr}^{e} \frac{d\bar{\rho}_{ir}}{d\theta} \\
&\quad + \sum_{r}\left[\frac{\frac{\partial u_{i}}{\partial \bar{l}_{ijr}^{e}}}{\lambda_{ij}} + \left(1-\bar{\rho}_{ir}\right)\bar{w}_{ijr}^{e}\right] \frac{d\bar{l}_{ijr}^{e}}{d\theta} + \frac{dT_{i}}{d\theta} \\
&= \frac{dt_{ij}^{e}}{d\theta} + \sum_{s} l_{ijs}^{e} \frac{dw_{ijs}^{e}}{d\theta} + \sum_{r} \bar{l}_{ijr}^{e} \frac{d\bar{w}_{ijr}^{e}}{d\theta} + \sum_{s} \rho_{is} w_{ijs}^{e} \frac{dl_{ijs}^{e}}{d\theta} + \sum_{r}\left(\frac{\frac{\partial u_{i}}{\partial \bar{l}_{ijr}^{e}}}{\lambda_{ij}} + \bar{w}_{ijr}^{e}\right) \frac{d\bar{l}_{ijr}^{e}}{d\theta}
\end{aligned}
$$

The same procedure applied to unemployed individuals delivers the following formula

$$
\frac{\frac{dV_{i}^{u}(\theta)}{d\theta}}{\lambda_{i}^{u}} = \frac{dt_{i}^{u}}{d\theta} + \sum_{s} l_{is}^{u} \frac{dw_{is}^{u}}{d\theta} + \sum_{s} \bar{l}_{is}^{u} \frac{d\bar{w}_{is}^{u}}{d\theta} + \sum_{s} \rho_{is} w_{is}^{u} \frac{dl_{is}^{u}}{d\theta} + \sum_{s}\left(\frac{\frac{\partial u_{i}}{\partial \bar{l}_{is}^{u}}}{\lambda_{i}^{u}} + \bar{w}_{ijr}^{u}\right) \frac{d\bar{l}_{is}^{u}}{d\theta}
$$

## A.2. **Derivation of the MVPF.**

A.2.1. *Decomposing the MVPF.* In this section I derive the MVPF decomposition in equation (2.10). I define the mechanical and behavioral responses as follows:

$$\overline{M_i^{\theta,e}} = -\sum_s \overline{w_{is}^e l_{is}^e}\frac{d\rho_{is}}{d\theta} - \sum_r \overline{\bar{w}_{ir}^e \bar{l}_{ir}^e}\frac{d\bar{\rho}_{ir}}{d\theta} + \overline{n_i^e}\frac{dT_i}{d\theta} \tag{A.2}$$

$$\overline{B_i^{\theta,e}} = -\sum_s \rho_{is}\overline{w_{is}^e\frac{dl_{is}^e}{d\theta}} - \sum_s \rho_{is}\overline{l_{is}^e\frac{dw_{is}^e}{d\theta}} - \sum_r \bar{\rho}_{ir}\overline{\bar{w}_{ir}^e\frac{d\bar{l}_{ir}^e}{d\theta}} - \sum_r \bar{\rho}_{ir}\overline{\bar{l}_{ir}^e\frac{d\bar{w}_{ir}^e}{d\theta}} \tag{A.3}$$

$$\overline{B_i^{\theta,s}} = \left(\overline{t_i^e} - t_i^u\right)\overline{\frac{dn_i^e}{d\theta}} \tag{A.4}$$

where $\overline{w_{is}^e l_{is}^e}$, $\overline{\bar{w}_{ir}^e \bar{l}_{ir}^e}$ are averages in total earnings from various activities across firms. $\overline{M_i^{\theta,e}}$ is the mechanical effect of the policy on the government budget. $\overline{B_i^{\theta,e}}$ is the externality on the government budget of incumbents' and firms' behavioral responses. $\overline{B_i^{\theta,s}}$ is the externality on the government budget of a firm's employment response. Assuming that $\frac{u_{i,l_s}^u}{\lambda_i^u}\,|_{l^w=0} = 0$, the utility consequence of employment responses is $\widetilde{\Delta c_i^e \frac{dn_i^e}{d\theta}}$ (Section 2.3.2). The average firm-level cost of policy change $d\theta$ is $C^\theta = \sum_i \left(\overline{M_i^{\theta,e}} + \overline{B_i^{\theta,e}} + \overline{B_i^{\theta,s}}\right)$. Hence, the MVPF is

$$\begin{aligned} MVPF^\theta &= \sum_i \frac{\overline{M_i^{\theta,e}} + \sum_s (1-\rho_{is})\overline{\frac{dw_{is}^e}{d\theta}l_{is}^e} + \sum_r (1-\bar{\rho}_{ir})\overline{\frac{d\bar{w}_{ir}^e}{d\theta}\bar{l}_{ir}^e} + \widetilde{\Delta c_i^e \frac{dn_i^e}{d\theta}} + \sum_r \left(\frac{\overline{\frac{\partial u_i^e}{\partial \bar{l}_{ir}^e}}}{\lambda_i^e} + (1-\bar{\rho}_{ir})\,\overline{\bar{w}_{ir}^e}\right)\cdot \overline{\frac{d\bar{l}_{ir}^e}{d\theta}}}{\overline{M_i^{\theta,e}} + \overline{B_i^{\theta,e}} + \overline{B_i^{\theta,s}}} \\ &= \frac{1}{1+FE^\theta} + \sum_i \frac{\Delta \overline{W_i^{\theta,e}}}{C_i^\theta} + \sum_i \frac{\widetilde{\Delta c_i^e \frac{dn_i^e}{d\theta}}}{C_i^\theta} + \sum_i \frac{\sum_r \Delta U_{i,\bar{l}_r}^e \cdot \overline{\frac{d\bar{l}_{ir}^e}{d\theta}}}{C_i^\theta} \end{aligned}$$

The second line of the formula above is exactly equation (2.10), where $FE^\theta = \sum_i \frac{\overline{B_i^{\theta,e}}+\overline{B_i^{\theta,s}}}{\overline{M_i^{\theta,e}}}$, $\overline{\Delta W_i^{\theta,e}} = \sum_s (1-\rho_{is})\overline{\frac{dw_{is}^e}{d\theta}l_{is}^e} + \sum_r (1-\bar{\rho}_{ir})\overline{\frac{d\bar{w}_{ir}^e}{d\theta}\bar{l}_{ir}^e}$, and $\Delta U_{i,\bar{l}_r}^e = \frac{\overline{\partial u_i^e/\partial \bar{l}_{ir}^e}}{\lambda_i^e} + (1-\bar{\rho}_{ir})\,\overline{\bar{w}_{ir}^e}$.

A.2.2. *The MVPF including unemployed individuals.* I derive here a formula for the MVPF that also includes the unemployed. The total cost $C^\theta$ of the policy in this case is a function of the different $dt_i/d\theta$s so that

$$C^{\theta}=\frac{dt^{\theta}}{d\theta}=\sum_{i}\left[\sum_{j}\left(n_{ij}^{e}\frac{dt_{ij}^{e}}{d\theta}+\left(t_{ij}^{e}-t_{i}^{u}\right)\frac{dn_{ij}^{e}}{d\theta}\right)+n_{i}^{u}\frac{dt_{i}^{u}}{d\theta}\right] \tag{A.5}$$

Where $\frac{dt_i^u}{d\theta}$ is the change in the resources transferred to the unemployed. The mechanical and behavioral externalities on the government budget that involve the unemployed are

$$\overline{M_{i}^{\theta,u}}=-\sum_{s}\overline{w_{is}^{u}l_{is}^{u}}\frac{d\rho_{is}}{d\theta}-\sum_{r}\overline{\bar{w}_{ir}^{u}\bar{l}_{ir}^{u}}\frac{d\bar{\rho}_{ir}}{d\theta}+\frac{dT_{i}}{d\theta} \tag{A.6}$$

$$\overline{B_{i}^{\theta,u}}=-\sum_{s}\overline{\rho_{is}w_{is}^{u}}\overline{\frac{dl_{is}^{u}}{d\theta}}-\sum_{s}\overline{\rho_{is}l_{is}^{u}}\overline{\frac{dw_{is}^{u}}{d\theta}}-\sum_{r}\overline{\bar{\rho}_{ir}\bar{w}_{ir}^{u}}\overline{\frac{d\bar{l}_{ir}^{u}}{d\theta}}-\sum_{r}\overline{\bar{\rho}_{ir}\bar{l}_{ir}^{u}}\overline{\frac{d\bar{w}_{ir}^{u}}{d\theta}} \tag{A.7}$$

Where $\overline{w_{is}^u l_{is}^u}$ and $\overline{\bar{w}_{ir}^u \bar{l}_{ir}^u}$ are individual average value of total earnings from different activities; while $\left\{\overline{\frac{dl_{ik}^u}{d\theta}}\right\}_{k=s,r}$ and $\left\{\overline{\frac{dw_{ik}^u}{d\theta}}\right\}_{k=s,r}$ are the individual-level changes in labor activities and prices for the unemployed. To operationalize the formulas and exploit firm-level estimates I also rescale the responses of the unemployed by the number of firms, accounting for the number of unemployed $n_i^u$. Hence, the average firm-level cost of a policy change $d\theta$ is

$$C^{\theta}=\sum_{i}\left(\overline{M_{i}^{\theta,e}}+\frac{n_{i}^{u}}{|J|}\overline{M_{i}^{\theta,u}}+\overline{B_{i}^{\theta,e}}+\frac{n_{i}^{u}}{|J|}\overline{B_{i}^{\theta,u}}+\overline{B_{i}^{\theta,s}}\right)$$

The MVPF including the three groups of workers is therefore:

$$\begin{aligned} MVPF^{\theta}&=\frac{1}{1+FE^{\theta}}+\sum_{i}\frac{\overline{\Delta W_{i}^{\theta,e}}+\overline{\Delta W_{i}^{\theta,u}}}{C_{i}^{\theta}}\\ &\quad+\sum_{i}\frac{\widetilde{\Delta c_{i}^{e}\frac{dn_{i}^{e}}{d\theta}}}{C_{i}^{\theta}}+\sum_{i}\frac{\sum_{r}\Delta U_{i,\bar{l}_{r}}^{e}\cdot\overline{\frac{d\bar{l}_{ir}^{e}}{d\theta}}+\sum_{r}\Delta U_{i,\bar{l}_{r}}^{u}\cdot\overline{\frac{d\bar{l}_{ir}^{u}}{d\theta}}}{C_{i}^{\theta}} \end{aligned} \tag{A.8}$$

Where the definition of fiscal externality is now updated to include the behavioral and mechanical externalities regarding the unemployed. Specifically, $FE^{\theta}=\sum_i \frac{\overline{B_i^{\theta,e}}+\overline{B_i^{\theta,s}}+\frac{n_i^u}{|J|}\overline{B_i^{\theta,u}}}{\overline{M_i^{\theta,e}}+\frac{n_i^u}{|J|}\overline{M_i^{\theta,u}}}$. Analogously, I update the second term of the MPVF to include $\overline{\Delta W_i^{\theta,u}}=\frac{n_i^u}{|J|}\sum_s \overline{\frac{dw_{is}^u}{d\theta}l_{is}^u}+\frac{n_i^u}{|J|}\sum_r\left(\overline{\frac{d\bar{w}_{ir}^u}{d\theta}\bar{l}_{ir}^u}\right)$, and the last term to include $\Delta U_{i,\bar{l}_r}^u=\frac{n_i^u}{|J|}\left[\overline{\frac{\partial u_i^u/\partial\bar{l}_{ir}^u}{\lambda_i^e}}+(1-\bar{\rho}_{ir})\,\overline{\bar{w}_{ir}^u}\right]$.

## A.3. **Details about MVPF Formulas for Applications.**

A.3.1. *Payroll Tax Cut.* Saez, Schoefer, and Seim (2019) (SSS) study the impact of a payroll tax cut in Sweden on wages and on firm outcomes. The reform in 2007 cut the payroll tax rate paid by the employer on young workers (19-25 years old) by about 10 percentage points from 31.4 to 21.3. The cut was then extended to reach a tax rate of 15.5 percent (and 26 years old were added to the eligible group). SSS exploit the heterogeneous variation in labor costs between firms employing a high and middle share of young workers in a difference-in-differences framework. They find significant and positive effects of the tax cut on incuments' wages, profits, revenues. On the other hand, by comparing workers around the age eligibility threshold they find no passthrough of the tax to the net of payroll tax wage.

In my calibration, I distinguish two types of workers: young workers ($y$) and their coworkers ($c$). The budget constraint for employees of any of the two groups is

$$x_{ij} \leqslant \left(1-\tau^{\mathrm{PIT}}\right) w_{ij} l_{ij}^{w} + T_i + y_i \tag{A.9}$$

$l^w$ is paid labor in a firm, $w_{ij}$ is the net of payroll tax wage, and $\tau^{\mathrm{PIT}}$ is the personal income tax rate, which in Sweden is applied after payroll taxes on $w_{ij}$. The incidence of payroll taxes is fully on the employer. Hence, the labor cost faced by employer $j$ is $\sum_{i=y,o}\left[(1+\tau^{w})\overline{l_i w_i}\right]$

The MVPF of the reform is

$$MVPF^{\mathrm{payroll}} = \frac{\overbrace{\sum_{i=y,o}\left[\left(1-\tau_i^{\mathrm{PIT}}\right) \overline{l_i^w \frac{dw_i}{d\theta}}\right]}^{\text{Incumbent's marginal WTP}} + \overbrace{\sum_{i=y,c}\left(1-\tau_i^{\mathrm{PIT}}\right)\overline{\Delta w_i l_i}\overline{\frac{dn_i^e}{d\theta}}}^{\text{Utility benefit of employment increase}} + \overbrace{\frac{dP}{d\theta}}^{\text{Producers' WTP}}}{\underbrace{\sum_{i=y,c}\left[-\overline{w_i l_i^w \frac{d\tau_i^w}{d\theta}} - \left(\tau_i^w+\tau_i^{\mathrm{PIT}}\right)\overline{l_i^w \frac{dw_i}{d\theta}}\right] - \sum_{i=y,c}\left(\tau_i^w+\tau_i^{\mathrm{PIT}}\right)\overline{\Delta w_i l_i}\overline{\frac{dn_i^e}{d\theta}} - \tau^{\pi}\overline{\frac{d\pi}{d\theta}}}_{\text{Cost of the policy}}} \tag{A.10}$$

where $\tau^w$ is the payroll tax faced by the employer, whose tax base is $w_{ij}$. The first term in the numerator is proportional to the firm-level average effect of the policy on net wages. I set $\frac{d\tau_c^w}{d\theta}=0$ since the reform leaves payroll taxes unchanged for coworkers. I take estimates of $\overline{\frac{dw_i}{d\theta}}$ for the two groups of workers from the firm-level analysis in the second part of SSS. The latter also provides estimates of the effect of the policy on firm employment, which I use to quantify $\overline{\frac{dn_i^e}{d\theta}}$. Firms with a high share of young workers increase average net of payroll tax wages by 1.9 percent and increase employment by 4.6 percent relative to medium share firms. Divided by 2.4 (the change in labor costs between high and low share firms) it amounts to an increase of 0.79 and 1.92 percent respectively in response to a 1 percent decrease in labor costs. In order to implement the formula in (A.10), I multiply these numbers by the mechanical change in labor costs that is caused by a one percentage point shift in $\tau^w$ on young workers, which is computed using the share of the young workers' wage bill over total labor costs. In particular, I rely on the fact that the gross wage bill is $(1+\tau^w)(\overline{l_c w_c} + \overline{l_y w_y})$ and, because the tax rate before the reform is the same for both groups of workers, the share of young workers' wages over the gross wage bill is the same as their share over the total net of payroll wage bill. This allows me to quantify total net of payroll wages paid to each group of workers. Hence, the mechanical change in labor cost caused by a change in the payroll rate on young workers is:

$$\frac{d\text{Labor Costs}^{\text{mech}}}{d\theta} = \underbrace{\frac{(1+\tau^w)\overline{l_c w_c}}{(1+\tau^w)(\overline{l_c w_c} + \overline{l_y w_y})}}_{\text{Share of Young Workers' Wage Bill}} \times 0.01$$

I further assume that there are no behavioral responses on the intensive margin of labor supply.

The policy has also an effect on the producer's surplus. I assume that the producer surplus is measured by profits so that producers' WTP is proportional to the mechanical change in the wage bill caused by the tax reform: $(1-\tau^{\pi})\,\overline{l_y w_y}\frac{d\tau^w}{d\theta}$. Finally, I account for the externalities of changes in profits on the government budget by calibrating a corporate tax rate $\tau^{\pi}$ and using the elasticity of profits to a change in labor costs.

I calibrate $\tau^{\text{PIT}}$ using the average personal income tax rate that applies to the average earnings in the sample of workers. To do so, I convert earnings net of payroll taxes into SEK (using an exchange rate of 8.9 SEK/USD as reported in Table 3) and then I apply the personal income tax schedule with zero-tax until 20,200 SEK and a 32% rate above it. This results in an average PIT rate of around 8%. Alternative calibrations using a tax rate of 20% lead to virtually the same results.

I calibrate $\overline{\Delta wl}$ as a 32 percent of the average gross wage earned by incumbents (Couch and Placzek, 2010).

Under the approach that disregards firm behavior and focuses on individual responses to the policy, the MVPF would be

(A.11)

$$\widetilde{MVPF}^{\text{payroll}} = \frac{\overbrace{\left(1-\tau_y^{\text{PIT}}\right) l_y^w \frac{dw_y}{d\theta}}^{\text{Young incumbents' marginal WTP}} + \overbrace{\left(1-\tau_y^{\text{PIT}}\right) \overline{\Delta w} \left(\frac{dh_y}{d\theta} - \frac{df_y}{d\theta}\right)}^{\text{Benefit of employment increase}}}{\underbrace{-w_y l_y^w \frac{d\tau_y^w}{d\theta} - \left(\tau_y^w + \tau_y^{\text{PIT}}\right) l_y^w \frac{dw_y}{d\theta} + \left(\tau_y^w + \tau_y^{\text{PIT}}\right) \overline{\Delta w} \left(-\frac{dh_y}{d\theta} + \frac{dfy}{d\theta}\right)}_{\text{Cost of the policy}}}$$

This approach would only consider the individuals targeted by the policy ($y$), and the welfare impact would depend on the effect of the reform on their net wages (first two terms in the numerator) and employment probability. The employment impact on the willingness to pay is composed of two terms: the benefit of an increase in the probability of being hired, and the benefit of a decrease in the probability of separating. $\frac{dh_y}{d\theta}$ and $\frac{df_y}{d\theta}$ represent the change in the probability of being hired and being laid off caused by the reform. The cost of the reform for the government would depend on the money spent on the payroll subsidy and on the extra taxes raised on the workers who find an employment.

Additional details about the calibrations are reported in Table B.1.

A.3.2. *Cut in top income tax rates.* Labanca and Pozzoli (2019) (LP hereafter) study the existence of hours coordination within firms. Using matched employer-employee data from Denmark they document a positive correlation between wages, productivity and the degree of hours coordination. In the second part of the paper, they investigate how hours coordination can affect the passthrough of changes in personal income taxes. Exploiting a PIT reform implemented in 2010 that changed top income tax rates, they find that hours coordination attenuated labor supply elasticities and generated spillovers on coworkers, which had in turn a significant effect on tax revenues.

I classify workers into two categories: top earners ($t$) and low earners ($l$). They are employed in firms that adopt hours coordination policies. Workers take the number of hours as given. The budget constraint for a worker of type $i$ is

(A.12) $$x_{ij} \leqslant (1-\tau_i)\, w_{ij} \bar{l}_{ij}^w + T_i + y_i$$

Since LP show nonsignificant effects of the policy on wages, I assume that wages stay constant. $\tau_i$ is the personal income tax rate. The marginal willingness to pay for the tax change of individual $i$ in firm $j$ is

$$\sum_j \frac{\frac{dV_{ij}}{d\theta}}{\lambda_{ij}} = \sum_j n_{ij}^e \left[ -\bar{l}_{ij}^w w_{ij} \frac{d\tau_i}{d\theta} + \left( \frac{\frac{\partial u_i}{\partial \bar{l}_{ij}^w}}{\lambda_{ij}} + (1-\tau_i)\, w_{ij} \right) \frac{d\bar{l}_{ij}^w}{d\theta} \right]$$

The first term represents the mechanical effect of the tax change. The second term captures the first-order utility effect of the change in number of hours worked caused by hours coordination, and it is proportional to the marginal disutility of hours worked and to the value $w_{ij}$ of every hour worked. The MVPF is

$$MVPF^{\text{top rate}} = \frac{\overbrace{\sum_{i=t,l} \left( -\overline{\bar{l}_i^w w_i} \frac{d\tau_i}{d\theta} + \left( \frac{\frac{\partial u_i}{\partial \bar{l}_i^w}}{\lambda_i} + (1-\tau_i)\, \overline{w_i} \right) \overline{\frac{d\bar{l}_i^w}{d\theta}} \right)}^{\text{Incumbents' marginal WTP}}}{\underbrace{\sum_{i=t,l} \left( -\overline{\bar{l}_i^w w_i} \frac{d\tau_i}{d\theta} - \tau_i \overline{w_i} \overline{\frac{d\bar{l}_i^w}{d\theta}} \right)}_{\text{Cost of the policy}}} \tag{A.13}$$

where $\overline{\bar{l}_i^w w_i}$ is firm-level average total earnings of individuals $i$; while $\overline{\frac{d\bar{l}_i^w}{d\theta}}$ are firm-level responses of working hours. The decrease in tax rates generates a positive willingness to pay for incumbent employees. I derive estimates of the elasticity of hours worked from Tables 5 and 7 in LP. I follow the procedure described in LP Appendix A.6.1 to determine the total behavioral responses. In particular, $\overline{\frac{d\bar{l}_t^w}{d\theta}} = \overline{\frac{d\log\left(\bar{l}_t^w\right)}{d\log(1-\tau)}} \cdot \overline{\frac{\bar{l}_t}{1-\tau}} \cdot \frac{d\tau}{d\theta}$ and hours coordination implies $\overline{\frac{d\bar{l}_l^w}{d\theta}} = \overline{\frac{d\log\left(\bar{l}_l^w\right)}{d\log\left(\bar{t}_t^w\right)}} \cdot \overline{\frac{d\bar{l}_t^w}{d\theta}}$.

The externality on the government budget caused by $\overline{\frac{d\bar{l}_l^w}{d\theta}}$ changes the fiscal cost of the policy significantly. I estimate the MVPF of the policy under the baseline assumption that $\frac{\frac{\partial u_i}{\partial \bar{l}_i^w}}{\lambda_i} = (1-\tau)\, \overline{w_i}$. If I assumed no disutility, the MVPF would be even lower relative to the one ignoring firm-level spillovers.

The MVPF that disregards firm responses only focuses on high earners (those who are targeted by the policy) and does not incorporate the spillovers from hours coordination.

Additional details about the calibrations are reported in Table B.2.

A.3.3. *Parental leave.* Brenøe et al. (2020) study the effect of a worker parental leave on their firm and coworkers. Using matched employer-employee data on Denmark they estimate the effect of a worker giving birth using a difference-in-differences design that compares firms where a female employee is about to give birth to similar firms where a female employee is not close to giving birth. They find an increase in labor input, which compensates the hours lost by the worker on leave. Coworkers experience an increase in hours worked, earnings, and in the probability of being employed.

Consider two groups of workers: women in fertile age ($f$) and coworkers ($c$). A paid leave policy is in place such that if a woman leaves her job around a child birth the government covers her stipend up to a given number of months. Hence, the budget constraints for women $f$ is:

$$x_{ij} \leqslant (1-\tau^w)\, w_{ij} l_{ij}^w + \gamma^l\,(1-\tau^w)\, w_{ij} l_{ij}^l + y_i$$

where $l^l$ is the time spent on paid leave by the worker and $\gamma^l$ is the replacement rate set by the government for the period covered by paternal leave. I assume - as it is the case in Denmark - that there is full replacement so that $\gamma^l = 1$ in the counterfactual with a parental leave policy in place.

The willingness to pay of incumbents for an increase in the replacement rate $\gamma$ is

$$WTP_i^{\text{parental leave},e} = \sum_j \left[ (1-\tau^w) \left( l_{i,j} \frac{dw_{i,j}}{d\theta} + \frac{d\gamma}{d\theta} w_{i,j} l_{i,j}^l \right) \right]$$

The willingness to pay of $f$ workers depends on the effect of the policy on their wages, and on the mechanical effect of receiving a replacement rate $\gamma$ on time spent on leave before the policy is implemented. Hence, $f$ workers's WTP for the parental leave policy depends on the change in income they receive. This follows from the assumption that the workers are free to choose how much time to spend on leave, and leave is not mandated. The coworkers' willingness to pay depends only on the change in their wages within the firm.[10] A positive willingness to pay also arises from an increase in hiring. The MVPF for an increase in paid leave coverage is therefore:

[10]I assume that workers choose the working hours.

$$MVPF^{\text{parental leave}} = \frac{\overbrace{\sum_{i=f,c} (1-\tau^w)\, \overline{l_i^w \frac{dw_i}{d\theta}} + (1-\tau^w)\, \frac{d\gamma}{d\theta}\overline{w_i^l l_i^l}}^{\text{Incumbent's WTP}} + \overbrace{(1-\tau^w)\, \overline{\frac{dn_c^f}{d\theta}}\,\overline{\Delta w_c} + (1-\tau^w)\, \overline{\frac{dn_c^h}{d\theta}}\,\overline{\Delta w^h}}^{\text{Utility benefit from employment increase}}}{\underbrace{-\sum_{i=f,c} \tau^w \overline{\frac{dz_i}{d\theta}} + (1-\tau^w)\left(\frac{d\gamma}{d\theta}\overline{w_i^l l_i^l} + \gamma \overline{w_i^l \frac{dl_i^l}{d\theta}}\right) - \tau^w \overline{\frac{dn_c^f}{d\theta}}\,\overline{\Delta w_c} - \tau^w \overline{\frac{dn_c^h}{d\theta}}\,\overline{\Delta w^h}}_{\text{Cost of the policy}}}$$

where I call $\overline{z_i} = \overline{w_{ij} l_{ij}^w}$. The denominator measures the cost of the policy. It is proportional to the change in revenues from labor earnings, the total transfer paid to workers on parental leave, and the increase in revenues caused by a change in employment.

I evaluate the MVPF looking at the effect of a worker taking paid leave on firm-level outcomes. The government spends money on the policy only when an employee leaves the firm, but in order to calibrate the willingness to pay one needs to calibrate what the worker taking paid leave would do in the counterfactual with no policy. I assume for my baseline estimates that without paid leave the worker would take six months of leave, going back to her normal salary afterwards.[11] I calibrate the change in coworkers' earnings using the total percentage change of 1.765 estimated for the two years after the birth event (Table 6). I rescale the latter with the level of average earnings presented in Table 4.

The utility benefit from the employment increase depends on the response of turnover and hiring to an extra worker on leave. The latter are calibrated equal to -0.102 and 0.204, respectively (Table 5). I calibrate the percentage benefit of finding/not losing a job following Couch and Placzek (2010) and I interact it with the average earnings at the firm. Finally, I calibrate the change in time spent at work $\overline{\frac{dl_f^l}{d\theta}}$ using the median duration of the parental leave (50 weeks, p. 24 and Figure 2).

A more conservative calibration considers future losses of income caused by a long paid leave. I calibrate these losses as an average 5 percent of the income for the following 5 years and I use a 3 percent discount rate to compute their net present value. In this case the MVPF would decrease to 0.47, but would drop to 0.11 when only $f$ workers are included in the formula. Again, firm-level spillovers make a significant difference.

[11] The longer time is taken on leave in the counterfactual, the larger will be the WTP of incumbent $f$ workers.

Formally, the MVPF that only considers the workers directly targeted by the policy is:

$$\widetilde{MVPF}^{\text{parental leave}} = \frac{\overbrace{\left(1-\tau^{w}\right)\frac{d\gamma}{d\theta}\overline{w_i^l l_i^l}}^{\text{Marginal Utility from transfer received}} + \overbrace{\overline{\frac{dl_f^l}{d\theta}}\,\overline{\frac{\frac{\partial u_f}{\partial l^l}}{\lambda_f^e}}}^{\text{Marginal Utility from leave time}}}{\underbrace{-\tau^{w}\overline{\frac{dz_f}{d\theta}} + \left(1-\tau^{w}\right)\left(\frac{d\gamma}{d\theta}\overline{w_f^l l_f^l} + \gamma w_f^l \overline{\frac{dl_f^l}{d\theta}}\right)}_{\text{Cost of the policy}}}$$

The MVPF depends on how much a female worker evaluates the paid leave policy relative to the cost for the government of providing the transfer and losing the revenues from labor income.

Additional details about the calibrations are reported in Table B.3.

A.3.4. *Changes in corporate taxes.* Fuest, Peichl, and Siegloch (2018) (FPS hereafter) estimate the incidence of corporate taxes on wages using a 20-year panel of German municipalities. They exploit municipality-level tax changes for identification implementing difference-in-differences and event study approaches. FPS find significant and negative effects of corporate tax increases on wages and local GDP. Moreover, testing alternative models of wage formation, they show the importance of labor market institutions and profit-shifting opportunities for the incidence of corporate taxes on wages.

Suppose there is only one type of workers whose budget constraint is

$$x_{ij} \leqslant \left(1-\tilde{\tau}_i\right) w_{ij} l_{ij}^{w} + T_i + y_i$$

where $w_{ij}$ represents the gross wage including payroll and personal income taxes. $\tilde{\tau}_i$ is the combination of payroll and personal income taxes such that $1-\tilde{\tau}_i = \left(1-\tau_i^{w,\text{emp}}\right)\left(1-\tau_i^{\text{PIT}}\right)$, where $\tau^{w,\text{emp}}$ is the payroll tax rate levied on the employee and $\tau_i^{\text{PIT}}$ is the personal income tax rate for the group of workers $i$. Call $\tau^{w,\text{firm}}$ the payroll tax rate on the employer. The MVPF is

$$MVPF^{i}_{P^{\tau^{\pi}}} = \frac{\overbrace{\left(1-\tilde{\tau}_i\right) l_i^{w}\overline{\frac{dw_i}{d\theta}}}^{\text{Incumbents' marginal WTP}} + \overbrace{\left(1-\tilde{\tau}_i\right)\Delta\bar{w}_i\overline{\frac{dn_i^e}{d\theta}}}^{\text{Utility cost of unemployment}} - \overbrace{\overline{\left(\bar{\pi}\frac{d\tau^{\pi}}{d\theta}\right)}}^{\text{Producer's WTP}}}{\underbrace{-\left(\tilde{\tau}_i+\tau^{w,\text{firm}}\right) l_i^{w}\overline{\frac{dw_i}{d\theta}} - \left(\tilde{\tau}_i+\tau^{w,\text{firm}}\right)\Delta\bar{w}_i\overline{\frac{dn_i^e}{d\theta}} - \bar{\pi}\frac{d\tau^{\pi}}{d\theta} - \tau^{\pi}\overline{\frac{d\pi}{d\theta}}}_{\text{Cost of the policy}}} \tag{A.14}$$

The first term in the numerator represents the marginal willingness to pay of incumbent workers, which is proportional to the effect of corporate taxes on wages. I calibrate it using the baseline estimate in FPS, *i.e.* an elasticity of the gross wage to the local business net of tax rate of 0.39. I omit the cost of unemployment in my calibrations since FPS estimate it to be null. Finally, the producers' willingness to pay is determined by the mechanical effect of the tax on profits. Assuming that the municipal's GDP is approximated by the sum of value added across firms, I apply the estimated effect of a large tax increase on GDP (-0.4%) to profits. FPS present results for GDP using a dummy treatment with value 1 in case of large tax increases above the 75th percentile of the distribution (1.1%). Hence, I calibrate the elasticity of profits using a 1.5% tax increase and the estimated 0.4% decrease.

I calibrate the level of average profits subtracting average labor costs from average value added. I take values for mean value added and firm employment from the working paper version (ZEW Discussion Paper No. 16-003) since they are not reported in the published manuscript.

I calibrate the personal income tax rate using the average effective tax rate that applied to the average earnings in the sample. Personal income taxes are levied on income net of payroll taxes. The PIT rate is 14% for income between 9,169 and 14,255, and 24% for income above 14,255.

Additional details about the calibrations are reported in Table B.4.

A.3.5. *Tax allowance on ICT investments.* Gaggl and Wright (2017) (GW hereafter) evaluate the impact on workers and firms of a tax allowance on ICT investments. They exploit the discontinuity generated by a reform implemented in UK in 2000 that introduced a 100 percent tax allowance on ICT investments for small ($<50$ employees) firms. They identify the effect of the policy through an RD research design, finding a positive effect of ICT allowance on average wages, revenues, ICT and non-ICT investments.

The MVPF for this policy is similar to the one in (A.14) and reads

(A.15)

$$MVPF^{i}_{P^{\tau^{\pi}}} = \frac{\overbrace{(1-\tilde{\tau}_i)\, \overline{l^w_i \frac{dw_i}{d\theta}}}^{\text{Incumbents' marginal WTP}} + \overbrace{(1-\tau^{\pi})\left(\frac{d\tau^{I,\text{ICT}}}{d\theta}\overline{I^{\text{ICT}}}\right)}^{\text{Producer's WTPs}}}{\underbrace{-\tilde{\tau}_i \overline{\frac{dz_i}{d\theta}} - \tau^{\pi}\overline{\frac{R}{d\theta}} + \tau^{\pi}\left(\frac{d\tau^{I,\text{ICT}}}{d\theta}\overline{I^{\text{ICT}}} + \frac{\overline{dI^{\text{ICT}}}}{d\theta}\tau^{I,\text{ICT}} + \frac{\overline{dI^{\text{other}}}}{d\theta}\tau^{I,\text{other}}\right) + \left(\tau^{\pi} - \tau^{w,\text{firm}}\right)\overline{\frac{dz_i}{d\theta}}}_{\text{Cost of the policy}}}$$

I assume that producers adjust on the margins of investment and labor. I define $\overline{\frac{dz_i}{d\theta}} = \overline{l^w_i \frac{dw_i}{d\theta}} + \overline{w_i \frac{dl^w_i}{d\theta}}$ as the total change in the gross wage bill, and I calibrate $\overline{\frac{dw_i}{d\theta}}$, and $\overline{\frac{dl^w_i}{d\theta}}$ using estimates from GW on the effects of the policy on total earnings and working hours. The average wage change is 23 pounds per week, the hours change is 0.887. I assume that workers choose the number of hours so that the incumbents' WTP only depends on the wage change, keeping labor supply constant. The effect on producer's surplus depends on the mechanical effect of the policy on ICT investment cost.

The tax allowance increases investments in ICT by 84,000 pounds, creating an externality on the government budget that I include in the denominator together with the externality of changes in other types of investments. The denominator also includes the externality of the change in the total wage bill caused by adjustments in wages and in labor supply, which affects payroll, PIT and corporate taxes (having an effect on profits). I calibrate the increase in revenues $\overline{dR/d\theta}$ by using the estimated effect of the policy on labor productivity (revenues/employment) and the number of employees per firm.

I calibrate the change in the tax allowance exploiting information provided in Section I of GW. In particular, footnote 10 claims that a 50 percent tax allowance was available to small and medium enterprises (<250 employees) for plant and machinery expenditures. Since the natural experiment used for identification provides 100 percent tax allowance on ICT investments for firms <50 employees, I calibrate $d\tau^{I,ICT}/d\theta = 0.5$.

I calibrate payroll and personal income taxes by using the effective tax rates that apply to the average income in the sample. Payroll taxes for the employee are levied at a 12% rate for weekly income that exceeds £184.01, while for the employer a 13.8% rate applies above £170.01 per week. Personal income taxes are levied on income net of payroll taxes at a 20% rate for yearly income exceeding £12,571.

Additional details are reported in Table B.5

## Appendix B. Confidence Intervals to MVPF Estimates

I provide a simple procedure to incorporate uncertainty into MVPF estimates that relies on information collected in the original sources. Suppose the values of $WTP$ and $C$ are a function of a vector of firm responses $p$ with standard errors $\sigma_p$. I first run bootstrap iterations where I sample the values of the parameters from *i.i.d.* normal distributions centered around $p$ with standard deviation $\sigma_p$. For each iteration I construct the couple $(WTP, C)$ and I then select the 95 percent confidence interval from the observed distribution. As Hendren and Sprung-Keyser (2020) point out, some issues may arise with a subset of the bootstrap iterations. Suppose $WTP > 0$ and $C > 0$, but for some draws they both turn negative. The latter suggest that the researcher is uncertain about the fundamental incidence of the policy: positive $WTP$ and $C$ correspond to a policy expansion, negative values would instead correspond to a policy contraction. To deal with these cases, I compute the share $\alpha^N$ of these cases out of total draws and I adjust confidence intervals accordingly so that they become $[2.5\% - \alpha^N\%/2; 97.5\% + \alpha^N\%/2]$. If $\alpha^N$ is greater than 5 percent, I set confidence intervals as $[-\infty, +\infty]$, although this never occurs in the data.

# Additional Tables

Table B.1. Payroll tax subsidy (Saez, Schoefer, and Seim, 2019) - Calibrations

| Quantity | Calibration | Source |
|---|---|---|
| **Firm-level Calibration** | | |
| $\frac{d\tau_i^w}{d\theta}$ | 0.16 | Page 1718 |
| $\frac{1}{\bar{n}^e}\frac{dn_i^e}{d\theta}$ | 0.046 | Table 4 |
| $\frac{1}{\bar{w}_y}\frac{dw_y}{d\theta}, \frac{1}{\bar{w}_o}\frac{d\bar{w}_o}{d\theta}$ | 0.019 | Table 4 |
| $\frac{1}{\bar{\pi}}\frac{d\pi}{d\theta}$ | 0.081 | Table 4 |
| $\tau_y^w, \tau_o^w$ | 0.3242 | Page 6 |
| $\tau^\pi$ | 0.262 | |
| $\bar{n}^e$ | 9.46 | Table 3 |
| $\bar{w}$ | 35,230 | Table 3 |
| $\bar{\pi}$ | 68,730 | Table 3 |
| $\Delta\bar{w}$ | $0.32\bar{w}$ | Couch and Placzek (2010) |
| $\frac{\overline{n_y^e w_y}}{\sum_{i=y,o} n_i^e w_i}$ | 0.125 | (Figure 5, mean share in middle group) |
| $w_y^{net}$ | $\bar{w}\bar{n}^e\left(1-\tau^w\right)$ | |
| **Targeted Workers Calibration** | | |
| $\frac{dw_y^{net}}{d\theta}$ | -31.625 (monthly) | Table 1 (medium-run) |
| $\frac{dw_y^{gross}}{d\theta}$ | -404.698 (monthly) | Table 1 (medium-run) |
| $\frac{1}{f_y}\frac{df_y}{d\theta}$ | -0.012 | Table 2 |
| $\frac{1}{h_y}\frac{dh_y}{d\theta}$ | 0.01 | Table 2 |
| $\Delta\bar{w}$ | $0.3\bar{w}$ | Couch and Placzek (2010) |

*Notes:* the calibrations in the bottom half of the Table are taken from the first part of SSZ. SSZ identify these responses by comparing the cohorts exposed to the tax cut to neighbouring cohorts that were not. I use these estimates to compute the MVPF that focuses on targeted workers. The calibrations in the top half of the Table refer to the estimates from the second part of SSZ where the authors take the firm as the unit of analysis and exploit variation in the tax burden across firms. These are the estimates that I use to compute the MVPF that includes firm responses.

Table B.2. Decrease in top income tax rate (Labanca and Pozzoli, 2019) - Calibrations

| Quantity | Calibration | Source |
|---|---|---|
| $\overline{\frac{d\Delta \log \bar{l}_t}{d\Delta \log(1-\tau_t)}}$ | -0.047 | Table 4 (Column 3) |
| $\overline{\frac{d\Delta \log \bar{l}_t}{d\Delta \log l_t}}$ | 0.878 | Table 5 (Column 3) |
| $w_t$ | 183.65 | Table 1 |
| $w_l$ (yearly) | 250,000 | Not provided, set arbitrarily below $\underline{w}^{top}$ |
| $\overline{n_j}$ | 44.52 | Table 1 |
| $\overline{\frac{n_t}{n_j}}$ | 0.54 | p. 26 |
| $\overline{\frac{n_l}{n_j}}$ | 0.34 | p. 26 |
| $\bar{l}_t, \bar{l}_l$ | 1896.19+27.62 | Table 1 |
| $\tau_t$ | 0.6228 | Appendix B.5 (WP 2018 version) |
| $\tau_l$ | 0.3954 | Appendix B.5 (WP 2018 version) |
| $\underline{w}^{top}$ | 279,800 | Appendix B.5 (lower bound top bracket, yearly) |

Table B.3. Parental leave (Brenøe et al., 2020) - Calibrations

| Quantity | Calibration | Source |
|---|---|---|
| $\overline{dn_c^f/d\theta}$ | $0.260 - 0.362 = -0.102$ | Table 5 |
| $\overline{dn_c^h/d\theta}$ | $0.350 - 0.146 = 0.204$ | Table 5 |
| $\frac{1}{\bar{z}_c}\overline{\frac{dz_c}{d\theta}}$ | $1.124 + 0.641 = 1.765$ | Table 6 |
| $\overline{n_c^e}$ | $12.94 - 6 = 6.94$ | Table 4 |
| $\overline{n_c^f}$ | 3.671 | Table 4 |
| $\overline{n_c^h}$ | 3.711 | Table 4 |
| $\overline{dl_f^l/d\theta}$ | $(46 + 4)/52 = 0.96$ years | p. 24 |
| $\bar{z}_c$ | 304 | Table 4 |
| $\bar{z}_f$ | $3369/12.94 = 260.35$ | Table 4 (wage bill/number employees) |
| $\overline{\Delta w_c}$ | $0.32\bar{z}_c$ | Couch and Placzek, 2010 |
| $\tau^w$ | 0.35 | |

Table B.4. Change in Corporate Tax Rate (Fuest, Peichl, and Siegloch, 2018) - Calibrations

| Quantity | Calibration | Source |
|---|---|---|
| $\overline{\frac{d\log w}{d\log(1-\tau^{\pi})}}$ | -0.39 | Table 1 (Column 1) |
| $\overline{\frac{d\log \pi}{dD_{\tau^{\pi}}}}$ | -0.4 | Figure 4, Panel A |
| $\bar{n}$ | 265 | Table C4 (ZEW Discussion Paper No. 16-003) |
| $\bar{\pi}$ | 2,164,000 | Table C4 (ZEW Discussion Paper No. 16-003) |
| $\bar{w}$ (monthly) | 2,733 | Table C5 |
| $\tau^{w,\text{emp}}$ | 0.2 | |
| $\tau^{w,\text{firm}}$ | 0.4 | |
| $\tau^{\pi}$ | 0.1865 | Table C5 |

TABLE B.5. Tax allowance on ICT investments (Gaggl and Wright, 2017) - Calibrations

| Quantity | Calibration | Source |
|---|---|---|
| $\overline{\frac{dwl^w}{d\tau^{I,\text{ICT}}}}$ (weekly) | 23.0448 | Table 3 |
| $\overline{\frac{dl^w}{d\tau^{I,\text{ICT}}}}$ (weekly) | 0.8879 | Table 3 |
| $\overline{\frac{d\text{Labor Productivity}}{d\tau^{I,\text{ICT}}}}$ | 11.3953 | Table 3 |
| $\overline{\frac{dI^{\text{ICT}}}{d\tau^{I,\text{ICT}}}}$ | 70,915.8+13,271.2 | Table 2 |
| $\overline{\frac{dI^{\text{other}}}{d\tau^{I,\text{other}}}}$ | -14,540.3 | Table 2 |
| $\bar{n}$ | 50 | Section I |
| $\bar{wl}$ (weekly) | 356.49 | Table 1 |
| $\bar{l}$ (weekly) | 33.75 | Table 1 |
| $\overline{I^{\text{ICT}}}$ | 750,730+54,350 | Table 1 |
| $\tau^{I,\text{ICT}}$ | 0.5 | p. 5 |
| $\tau^{I,\text{other}}$ | 0.5 | p. 5 |
| $\frac{d\tau^{I,\text{ICT}}}{d\theta}$ | 0.5 | p. 5 |
| $\tau^{\pi}$ | 0.19 | |