When do Minimum Wages Increase Social Welfare?
A Sufficient Statistics Analysis with Taxes and Transfers*

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Preliminary and incomplete - Comments are very welcomed!

Abstract

This paper characterizes optimal redistribution for a social planner with three instruments: labor income taxes and transfers, corporate income taxes, and a minimum wage. The modeled economy features search-and-matching frictions, generates positive firm profits in equilibrium, and accommodates empirically relevant effects of the minimum wage such as wage spillovers and reallocation effects. I find that minimum wages are more likely to be desirable when corporate taxes are low because minimum wages generate corporate revenue losses and redistribute from capitalists to low-skill workers. Minimum wages can improve welfare even under optimal income taxes by shifting tax incidence when wages bunch at the minimum. I estimate the sufficient statistics that guide the welfare analysis using state-level variation in minimum wages. I find that minimum wages have increased low-skill workers’ welfare with null effects on high-skill workers and negative effects on capitalists. Results suggest that, under current corporate tax rates, weak social preferences for redistribution toward low-skill workers would justify small state-level minimum wages increases.

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“The simplest expedient which can be imagined for keeping the wages of labor up to the desirable point would be to fix them by law; the ground of decision being, not the state of the labor market, but natural equity; to provide that the workmen shall have reasonable wages, and the capitalist reasonable profits.”

John Stuart Mill, *Principles of Political Economy*, 1884.

1 Introduction

A large literature finds that minimum wage increases have important effects on the wage distribution (Lee, 1999; Autor et al., 2016; Dube, 2019; Haanwinckel, 2020; Engbom and Moser, 2021; Fortin et al., 2021) while yielding limited employment consequences (Manning, 2021). Do these findings imply that governments should use the minimum wage to redistribute toward low-wage workers? While this question was raised by Stigler (1946) more than seventy years ago, a consensus on the welfare desirability of the minimum wage, especially when other redistributive policies are available for the policymaker, remains elusive among economists.

It is hard to study the desirability of the minimum wage in the presence of taxes and transfers because its effects on the labor market generate fiscal externalities (Reich and West, 2015; Dube, 2019) and, in general terms, it is not clear whether it should be viewed as a substitute or a complement to tax-based redistribution (for example, through the EITC). Earlier work has provided mixed answers to this question using insightful but restrictive environments that shut down empirically relevant avenues by which minimum wages may affect welfare. Hungerbühler and Lehmann (2009), Lee and Saez (2012), Cahuc and Laroque (2014), and Lavecchia (2020) each abstract from some combination of firm profits, wage spillovers, and other general equilibrium effects of the minimum wage, such as reallocation effects, that can dampen employment impacts. Therefore, the role of the minimum wage in the optimal redistributive policy mix remains unsettled in the literature.

To contribute to this debate, this paper develops a welfare analysis of the minimum wage that makes progress in the elements discussed above. The paper is structured in three parts. The first part proposes a tractable model of the labor market that can rationalize limited employment effects, wage spillovers, and reallocation effects, with positive profits in equilibrium. The second part uses the model to analyze the welfare implications of the minimum wage following an optimal policy approach where a social planner chooses the minimum wage, the income tax schedule, and the corporate tax rate to maximize aggregate welfare. This analysis characterizes the welfare tradeoff of the minimum wage as a function of estimable sufficient statistics. The third part provides estimates of the sufficient statistics exploiting state-level variation in minimum wages and uses the results to develop a simple back-of-the-envelope welfare calculation.
The model of the labor market features directed search and two-sided heterogeneity. On one side, there is a population of workers with heterogeneous skills and costs of participating in the labor market that decide whether to enter the labor market. Conditional on participating in the labor market, workers decide on jobs to which they will apply. On the other side, there is a population of capitalists with heterogeneous productivities that decide whether to create firms. Conditional on creating a firm, capitalists decide the number of vacancies they post and their corresponding wages. In the model, minimum wage increases affect the workers’ job application strategies which, in turn, induce reactions in the posting behavior of firms. I show that these behavioral responses can lead to limited employment effects, wage spillovers, and reallocation effects. In addition, frictions in the labor market imply that firm-level heterogeneity leads to positive profits in equilibrium.

The model provides an attractive setting for analyzing the desirability of the minimum wage because it reproduces empirically relevant features of low-wage labor markets. Specifically, the model admits wage dispersion for similar workers (Card et al., 2018; Song et al., 2019), wage posting rather than bargaining which appears most relevant for low-wage jobs (Hall and Krueger, 2012; Caldwell and Harmon, 2019; Lachowska et al., 2021), finite firm-specific labor supply elasticities (Staiger et al., 2010; Azar et al., 2019; Dube et al., 2020; Bassier et al., 2021; Sokolova and Sorensen, 2021), and bunching in the wage distribution at the minimum wage (Cengiz et al., 2019). Moreover, the competitive nature of directed search models (Wright et al., 2021) imply that the model avoids standard arguments in favor of the minimum wage driven by search and matching inefficiencies (e.g., Burdett and Mortensen, 1998; Acemoglu, 2001), implying that this is possibly a conservative framework for analyzing the welfare desirability of the minimum wage.

With the model in hand, I proceed to analyze the welfare implications of the minimum wage following an optimal policy approach where a social planner chooses the minimum wage, the income tax schedule, and the corporate tax rate to maximize social welfare.

The first result characterizes the welfare tradeoff of the minimum wage in the absence of taxes. The minimum wage affects the welfare of active low- and high-skill workers through its effects on the labor market equilibrium, and the welfare of capitalists through effects on profits. This means that the minimum wage can be used to affect both the income distribution within workers and between workers and capitalists. The change in workers’ welfare is summarized by changes in the expected utility of participating in the labor market, which is shown to be equal to the change in the average post-tax wage of labor market participants including the unemployed. While the signs of the workers’ welfare sufficient statistics are theoretically ambiguous, welfare improvements for workers are not tied to positive employment effects. In fact, the sufficient statistic can be used
to compute, given wage effects, the disemployment effects that can be tolerated for the minimum wage to have positive effects on workers’ welfare.

The second result solves for the optimal minimum wage under fixed income and corporate taxes and shows that the welfare tradeoff is augmented with fiscal effects. On the workers’ side, changes in wages and employment induce a change in tax collection and transfer spending. On the firms’ side, the change in profits affects the corporate tax revenue. When the corporate tax rate is low—which could happen, for example, under international tax competition– the optimal minimum wage increases, because the corporate revenue loss is smaller and the gains from redistributing from capitalists to workers increase.

The final theoretical result shows that binding minimum wages may be desirable even if taxes are optimal. While an optimal tax system limits the ability of the minimum wage to directly increase workers’ welfare (since desired after-tax allocations can be generated with non-linear tax schedules), the minimum wage may increase aggregate welfare by shifting the incidence of the tax system. To understand why, suppose that the optimal tax schedule considers an EITC at the bottom of the wage distribution. Firms internalize that the EITC increases job applications for a given posted wage, so they react by lowering posted pre-tax wages (as in Rothstein, 2010). Then, the EITC becomes both a transfer to workers and firms. The minimum wage limits the ability of firms to decrease wages, thereby increasing the efficacy of the EITC to redistribute toward low-skill workers. The importance of this mechanism depends on the mass of workers earning the minimum wage. When bunching at the minimum wage is large, the joint optimality analysis suggests that tax-based redistribution should be viewed as a complement to the minimum wage.

The final part of the paper illustrates the empirical relevance of the theoretical results by estimating the sufficient statistics that guide the welfare analysis. I follow Cengiz et al. (2019) and estimate stacked event studies exploiting state-level variation in minimum wages for the period 1979-2019 using Vaghul and Zipperer (2016) data on local minimum wages. Similar results are found when using alternative event study estimators proposed in the recent literature. As in Cengiz et al. (2019), events are defined as state-level hourly minimum wage increases of at least $0.25 (in 2016 dollars) in states where at least 2% of the pre-event year working population earned less than the new minimum wage. Average pre-tax hourly wages are computed using the individual-level NBER Merged Outgoing Rotation Group of the CPS, and the corresponding estimated elasticities are then transformed to post-tax values using Dube (2019) estimates. Measures of state-level average profit per establishment are built using the gross operating surplus estimates from the BEA regional accounts normalized by the average number of private establishments reported in the QCEW data.
files. I also compute measures of profit margin using state-level tax revenue data from the Census Annual Survey of State Government Tax Collection Datasets combined with local tax rates data from Suárez Serrato and Zidar (2016).

Results show that state-level minimum wage increases have had a positive effect on low-skill workers’ welfare, with a corresponding null effect on high-skill workers’ welfare, and a negative effect on capitalists’ welfare. The average pre-tax wage of low-skill active workers (including the unemployed) increased between 1.6% and 2.3% after state-level minimum wage real increases of about 10%. This result implies an increase of between 1.1% and 1.5% in low-skill workers’ welfare. Conversely, the effect on high-skill workers’ wages is essentially zero. Both results are consistent with Cengiz et al. (2019, 2021)’s findings on wage, employment, and participation effects. On the other hand, profits per establishment fell, on average, 2.5% after the state-level minimum wage increases. The decrease in profits represented between 10% and 15% of the pre-event year profit margin. These results are in line with Draca et al. (2011), Harasztosi and Lindner (2019), and Drucker et al. (2021)’s findings based on firm-level microdata.

To better understand the welfare implications of these results, I end the paper by using the estimates of the sufficient statistics to develop a back-of-the-envelope calculation based on the theoretical results of the welfare analysis with fixed taxes. The exercise is similar in spirit to the “inverse-optimum” problem of the optimal taxation literature (Bourguignon and Spadaro, 2012; Hendren, 2020). Specifically, I compute, under different assumptions, what is the minimum marginal welfare weight that society should put on low-skill workers to argue that state-level minimum wage increases have increased aggregate welfare in the US.

Results show that, in most of the cases, weak preferences for redistribution toward low-skill workers are sufficient for justifying past state-level minimum wage increases. Most of the considered scenarios just require that the social planner values redistribution to low-skill workers, regardless of the strength of the social preference. The result is sensitive to the choice of the corporate tax rate. For example, considering a corporate tax rate of 35%, such as the one that applied in the US between 1993 and 2017, doubles the social preference requirement for justifying minimum wage increases relative to the current statutory tax rate of 21%. The intuition is that, if effective tax rates for corporate profits are large, then using corporate tax revenue for redistribution toward low-skill workers can be more efficient than binding minimum wages. Under the current statutory and effective corporate tax rates, the social preference requirement is minimal. That is, if one is willing to extrapolate the estimations for projecting behavioral responses to future minimum wage increases, small increases in the minimum wage under current policy parameters should be expected.
to be welfare improving so long as the social planner values redistribution toward low-skill workers.

Related literature This paper contributes to the normative analysis of the minimum wage in frameworks with taxes and transfers, and equity and efficiency concerns. Hungerbühler and Lehmann (2009) and Lavecchia (2020) consider random search models but abstract from firm profits, restricting the role of the minimum wage under optimal taxes to solving search and matching inefficiencies. Lee and Saez (2012) use a competitive supply-demand framework and show that the case for binding minimum wages under optimal taxes depends on labor rationing assumptions. Rationing assumptions do not play a role in my analysis given the focus on expected utilities. Cahuc and Laroque (2014) contest Lee and Saez (2012)'s result by arguing that the minimum wage cannot improve welfare on top of an optimal non-linear tax schedule even if the demand side is modeled as a standard monopsonist. However, the analysis abstracts from search frictions, firm-level heterogeneity, and do not give a role to firm profits. The papers mentioned above follow the optimal tax tradition. Alternative approaches to analyze the welfare impacts of the minimum wage include the structural work of Flinn (2006), Wu (2021), and Berger et al. (2022), which mostly focus on efficiency and misallocation and abstract from the tax system, and Dworczak et al. (2020), that analyze redistribution through markets using mechanism design techniques. Finally, Hurst et al. (2021) develop a general equilibrium model to compare the minimum wage policy to tax-based redistribution, concluding that the latter dominates the former. Their analysis does not formally model an optimal policy problem (thus abstracting from potential complementarities between the policy tools) and focuses on the effects on labor income earners, and gives a central role to capital-labor substitution and the distinction between short- and long-run effects.

This paper also contributes to other strands of the literature. First, it adds to the analysis of redistributive policies in labor markets with frictions (e.g., Hungerbühler et al., 2006; Stantcheva, 2014; Sleet and Yazici, 2017; Hummel, 2019; Doligalski et al., 2020; Kroft et al., 2020; Mousavi, 2021; Craig, 2022). Second, it contributes to the analysis of policies for redistributing between capital and labor income earners (e.g., Atesagaoglu and Yazici, 2021; Eeckhout et al., 2021; Hummel, 2021) by formalizing a role for the minimum wage in this problem. Third, this paper adds to a literature that studies the interaction of different policies in second-best contexts (e.g., Diamond and Mirrlees, 1971; Atkinson and Stiglitz, 1976; Gaubert et al., 2020; Ferey, 2020). Fourth, the model presented adds to the literature that studies the theoretical foundations of monopsony power and firm wage premiums (e.g., Card et al., 2018; Haanwinckel, 2020; Berger et al., 2021, 2022; Engbom and Moser, 2021; Huneeus et al., 2021; Jarosh et al., 2021; Kroft et al., 2021; Lamadon et al., 2022). Finally, the empirical results add to a large empirical literature, referenced throughout the
paper, that studies the effects of minimum wages on labor market and firms outcomes.

2 Model

This section develops a tractable model of the labor market with directed search and two-sided heterogeneity. The model can accommodate non-trivial equilibrium effects of the minimum wage—limited employment effects, wage spillovers, and reallocation effects—, features positive firm profits in equilibrium, and reproduces stylized facts of low-wage labor markets—wage dispersion for similar workers, wage posting, finite firm-specific labor supply elasticities, and bunching at the minimum wage. To simplify the exposition, the model presented in this section does not consider taxes. Income and corporate taxes are formally included in the next section.

2.1 Setup

Overview The model is static and features two-sided heterogeneity. On one side, there is a population of workers that is heterogeneous in two dimensions. First, workers have different skills. For simplicity, I assume workers are either low-skill or high-skill. Second, workers have heterogeneous costs of participating in the labor market. On the other side, there is a population of capitalists with heterogeneous productivities. I assume individuals are either workers or capitalists.

Labor market interactions are modeled following a directed search approach inspired by Moen (1997).¹ Capitalists decide whether to create firms based on expected profits. Conditional on creating a firm, they post wages and vacancies, with all vacancies posted at a given wage forming a sub-market.² Labor markets are segmented, meaning that wages and vacancies are skill-specific. Workers observe wages and vacancies and make their labor market participation and application decisions. In equilibrium, there is a continuum of sub-markets indexed by \( m \), characterized by skill-specific wages, \( w^s_m \), vacancies, \( V^s_m \), and applicants, \( L^s_m \), with \( s \in \{l, h\} \) indexing skill.

Matching technology Within each sub-market, there are matching frictions. The number of matches within a sub-market is given by the matching function \( \mu(L^s_m, V^s_m) \), with \( \mu \) continuously differentiable, increasing and concave in both arguments, and with constant returns to scale.

¹The interaction between minimum wages and directed search have received little attention in the literature. For some applications, see Shi (2009), Gautier and Moraga-González (2018), Hurst et al. (2021), and Wu (2021).

²The notion of sub-market should not be confounded with the notion of local labor market. Sub-markets only vary with wages and, in principle, all workers are equally able to apply to them. Both concepts would be closer in a more general model with multidimensional firm heterogeneity and heterogeneous application costs.
Under these assumptions, the sub-market skill-specific job-finding rate (that is, the workers’ probability of finding a job conditional on applying) can be written as

\[ p_{sm} = \mu(\frac{L_{sm}}{V_{sm}}, V_{sm}) = \mu(1, \theta_{sm}^s) = p(\theta_{sm}^s), \tag{1} \]

with \( \partial p(\theta_{sm}^s)/\partial \theta_{sm}^s \equiv p_\theta > 0 \), where \( \theta_{sm}^s = V_{sm}^s/L_{sm}^s \) is the sub-market skill-specific vacancies to applicants ratio, usually referred to as sub-market tightness. Intuitively, the higher the ratio of vacancies to applicants, the more likely that an applicant will be matched with one of those vacancies. Likewise, the sub-market skill-specific job-filling rate (that is, the firms’ probability of filling a vacancy conditional on posting it) can be written as

\[ q_{sm} = \mu(\frac{L_{sm}}{V_{sm}}) = \mu \left( \frac{1}{\theta_{sm}^s}, 1 \right) = q(\theta_{sm}^s), \tag{2} \]

with \( \partial q(\theta_{sm}^s)/\partial \theta_{sm}^s \equiv q_\theta < 0 \). Intuitively, the lower the ratio of vacancies to applicants, the more likely that the firm will be able to fill the vacancy with a worker.

I assume that neither workers nor firms internalize that their application and posting behavior affects equilibrium tightness, so they take \( p_{sm} \) and \( q_{sm} \) as given when making their decisions.

**Workers** The population of workers is normalized to 1. The shares of low-skill and high-skill workers are given by \( \alpha_l \) and \( \alpha_h \), respectively. Conditional on skill, each worker draws a parameter \( c \in C = [0, C] \subset \mathbb{R} \) that represents the cost of participating in the labor market. Let \( f_s \) and \( F_s \) be the skill-specific density and cumulative distributions of \( c \), respectively, assumed to be smooth.

Workers derive utility from the wage net of labor market participation costs. The utility of not entering the labor market is normalized to \( u_0 = 0 \).\(^3\) When entering the labor market, workers apply to jobs. Following Moen (1997), I assume that workers can apply to jobs in only one sub-market.\(^4\) Then, the expected utility of entering the labor market for a worker of type \( (s, c) \) is given by \( u_1(s, c) = \max_m \{ p_m^s w_m^s \} - c \), since workers decide to apply to the sub-market that gives them the highest expected earnings.

Recall that \( p_{sm}^s \) depends on the mass of workers of skill \( s \) that apply for jobs in sub-market \( m \). Then, although individuals take \( p_{sm}^s \) as given, it is endogenously determined by the aggregate application behavior. In equilibrium, all markets give the same expected earnings, i.e., \( p_i^s w_i^s = \)

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\(^3\)Outside options and home production are captured by \( c \). \( u_0 \) will be positive when considering taxes.

\(^4\)This is assumed for tractability. Kircher (2009) and Wolthoff (2018) develop models when workers can simultaneously apply to several sub-markets.
The population of capitalists is normalized to 1. Each capitalist draws a parameter \( \psi \in \Psi = [\underline{\psi}, \overline{\psi}] \subset \mathbb{R}^+ \) that represents firm productivity. Let \( \sigma \) and \( O \) be the density and cumulative distributions of \( \psi \), respectively, assumed to be smooth. Capitalists observe \( \psi \) and choose whether to create a firm. Firms are price-takers in the output market (with the price normalized to 1). Technology only uses workers for production, so a firm of productivity \( \psi \) that hires \( (n^l, n^h) \) workers generates a revenue equal to \( \psi \cdot \phi(n^l, n^h) \), with \( \phi \) twice differentiable, and with \( \phi_0 > 0 \) and \( \phi_{ss} < 0 \).

Firms choose skill-specific wages, \( w^s \), and vacancies, \( v^s \), knowing that \( n^s \) is the result of the matching process. While firms take the job-filling probabilities as given, they are aware of the equilibrium relationship between \( \theta_m^s \) and \( w_m^s \), and therefore, internalize that paying higher wages increases the job-filling probabilities. In other words, the wage choice is equivalent to the sub-market choice. Given this, to simplify notation in the firm’s problem, I rewrite the job-filling probabilities as \( \tilde{q}^s(w^s) = q(\theta^s(w^s, U^s)) \), with \( \tilde{q}^s_0 = q_0 \cdot (\partial \theta^s / \partial w^s) > 0 \), so \( n^s = \tilde{q}^s(w^s) \cdot v^s \). Posting \( v^s \) vacancies has a cost \( \eta^s(v^s) \), with \( \eta^s_0 > 0 \) and \( \eta^s_{vv} > 0 \). Then, profits are given by

\[
\pi \left( \psi, w^l, w^h, v^l, v^h \right) = \psi \cdot \phi \left( \tilde{q}^l(w^l) \cdot v^l, \tilde{q}^h(w^h) \cdot v^h \right) - \sum_{s \in \{l, h\}} (w^s \cdot \tilde{q}^s(w^s) \cdot v^s + \eta^s(v^s)). \tag{3}
\]

Conditional on \( \psi \), firms are homogeneous. Then, the solution of the problem can be character-

\( ^5 \)Since \( U^s = p(\theta_m^s) \cdot w_m^s \), then \( dU^s = p_0 \cdot d\theta_m^s \cdot w_m^s + p^s_m \cdot dw_m^s \).
ized by the functions $w^*(\psi)$ and $v^*(\psi)$. Appendix A derives the first-order conditions and shows that dispersion in productivities leads to dispersion in observed wages, with wages marked down relative to the marginal productivities, and possibly with more productive firms paying higher wages.\footnote{I say possibly since large second-order cross effects across skill types can induce non-linearities in the wage-productivity relationship. For more details, see Appendix A.} It also shows that, within firms and skill type, wages and vacancies are positively correlated, implying that more productive firms hire more workers. Finally, the within firm correlation between low- and high-skill workers depends on the sign of $\phi_{lh}$. That is, if low- and high-skill workers are complements ($\phi_{lh} > 0$), more productive firms hire both more low- and high-skill workers.

Without loss of generality, $m$ indexes sub-markets as well as the productivity levels of capitalists that create firms, so $w^*_m = w^*(\psi_m)$, $v^*_m = v^*(\psi_m)$, and $V^*_m = K \cdot v^*(\psi) \cdot o(\psi)$.\footnote{As it is discussed below, the relationship between wages, size, and productivity, is a consequence of assuming that firm-level heterogeneity is one-dimensional, which is likely to be a restrictive assumption. Then, these predictions should not be taken literally and, by contrast, only seen as instrumental for inducing wage dispersion.}

Let $\Pi(\psi) = \max_{w^l,w^h,v^l,v^h} \pi(\psi; w^l, w^h, v^l, v^h)$ be the value function of firms of type $\psi$. Capitalists have to pay a fixed cost, $\xi$, to create firms, so they do so when $\Pi(\psi) \geq \xi$. Since profits are strictly increasing in productivity, the entry rule defines a productivity threshold implicitly determined by $\Pi(\psi^*) = \xi$, such that capitalists create firms only if $\psi \geq \psi^*$. Then, the mass of active capitalists— the mass of capitalists that create firms— is given by $K_A = K \cdot (1 - O(\psi^*))$. The remaining mass of capitalists, $K_I$, denoted inactive capitalists, does not create firms and gets zero utility, with $K_I = K \cdot O(\psi^*)$.

2.2 Introducing a minimum wage

This subsection introduces a minimum wage to the model and shows it can accommodate some of the equilibrium effects found in the empirical literature. The minimum wage is denoted by $\bar{w}$. I separately explore the effects on workers and capitalists decisions to be specific on the different forces that play a role in the general equilibrium effects.

**Low-skill workers** Recall that, in equilibrium, $U^l = p(\theta^l) \cdot w^l_m$, for all $m$. Let $i$ be a sub-market that is constrained by the minimum wage, so $w^l_i = \bar{w}$, and $U^l = p(\theta^l) \cdot \bar{w}$. Differentiating yields

$$
\frac{dU^l}{d\bar{w}} = p_\theta \cdot \frac{d\theta^l}{d\bar{w}} \cdot \bar{w} + p(\theta^l). \quad (4)
$$

Since $p(\theta^l) > 0$, $dU^l/d\bar{w} = d\theta^l_i/d\bar{w} = 0$ is not a feasible solution of (4). This implies that changes in $\bar{w}$ have to affect the equilibrium values of $U^l$, $\theta^l$, or both. Intuitively, an increase in the minimum
wage makes low-skill affected jobs more attractive for workers. This mechanical effect on expected utility is captured by \( p(\theta_l^i) \). This effect attracts new applicants toward affected sub-markets, thus pushing \( \theta_l^i \) downwards to restore the across sub-markets equilibrium. This decreases the employment probability in sub-market \( i \). This effect on expected utility is captured by \( p \theta_l^i \cdot \left( \frac{d\theta_l^i}{dw^i} \right) \cdot w^i \).

Changes in \( w \) also affect the equilibrium of unconstrained sub-markets. To see this, let \( j \) be a sub-market that is not constrained by the minimum wage, so \( w_j^l > \overline{w} \) and \( U_l^j = p(\theta_j^l) \cdot w_j^l \). Differentiating yields

\[
\frac{dU_l^j}{dw} = p \theta_j^l \cdot \frac{d\theta_j^l}{dw} \cdot w_j^l + p(\theta_j^l) \cdot \frac{dw_j^l}{dw}.
\]

In this case, \( dU_l^j/d\overline{w} = d\theta_j^l/d\overline{w} = dw_j^l/d\overline{w} = 0 \) is a feasible solution. However, \( dU_l^j/d\overline{w} \) is unlikely to be 0 given (4), suggesting some equilibrium effect on non-affected low-skill workers.

Intuitively, applicant flows toward minimum wage sub-markets mechanically affect tightness in non-minimum wage sub-markets. This has two implications. First, the reduction in applicants increases the employment probabilities in other sub-markets, thus allowing them to absorb part of the application responses. Second, firms react to the changes in applicants by changing their posting behavior to further reduce the exodus of applicants. Below I discuss with more detail the firms’ reactions, but the mechanism is similar in spirit, albeit simplified, to the spillover forces derived in Engbom and Moser (2021), where responses in firm pay policies amplify minimum wage shocks to other parts of the distribution. Both general equilibrium responses attenuate the potential employment effects of the minimum wage policy.

Changes in \( U_l^i \) also induce changes in labor market participation, since \( L_A^l = \alpha_l \cdot F_l(U_l^i) \) and, therefore \( dL_A^l/d\overline{w} = \alpha_l \cdot f_l(U_l^i) \cdot (dU_l^i/d\overline{w}) \). Then, if \( dU_l^i/d\overline{w} > 0 \), minimum wage hikes increase labor market participation. Note, however, that the behavioral response depends on \( f_l(U_l^i) \), which may be small. This may result in an equilibrium effect with positive wage effects, limited employment effects, and quantitatively negligible effects on participation, which Cengiz et al. (2021) suggest constitutes a puzzle for the random-search literature.\(^8\)

**High-skill workers** Under the assumption that \( \min_m \{ w_m^h \} > \overline{w} \), equilibrium effects for high-skill workers take the form of (5). Then, the question is whether there are equilibrium forces that rule out solutions of the form \( dU_h^i/d\overline{w} = d\theta_h^i/d\overline{w} = dw_h^i/d\overline{w} = 0 \). In this model, effects in high-skill sub-

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\(^8\)Cengiz et al. (2021) argues that the random-search literature needs large participation effects to rationalize positive wage effects with no disemployment effects. Directed search alleviates this force by reallocating applications within the labor market.
markets are mediated by the production function, since demand for high-skill workers depends on
low-skill workers through $\phi$. Then, this model can rationalize within-firm spillovers explained by a
technological force: changes in low-skill markets may affect high-skill vacancy posting, thus affecting
high-skill workers application decisions. This mechanism is similar in spirit, albeit simplified, to
the spillover forces derived in Haanwinckel (2020), where technologies with distance-dependent
substitution patterns amplify minimum wage shocks to other parts of the distribution.

Firms The previous analysis shows that low-skill workers react to changes in the minimum wage
by potentially changing their application strategies and extensive margin decisions, thus affecting
low-skill sub-markets' tightness. These reactions can be attenuated or amplified if firms' reactions
to minimum wage shocks also affect equilibrium tightness. The effects of the minimum wage on
firms' decisions are less trivial, not only because the optimization problem is more complex, but also
because the non-linearities in the production function and the vacancy posting cost functions induce
additional effects that go beyond the mechanical equilibrium changes in sub-market tightness and
the job-filling probabilities. Appendix A formally addresses the problem and provides analytical
results. In what follows, I describe the main conclusions of the analysis.

It is illustrative to separate the analysis between constrained and unconstrained firms. Con-
strained firms are firms that operate in sub-markets where the minimum wage binds for low-skill
workers. Therefore, they optimize low-skill vacancies and high-skill wages and vacancies taken low-
skill wages as given. A first result is that constrained firms adjust their low-skill vacancy posting
after changes in the minimum wage. The effect is, in principle, ambiguous, since there are two
first-order effects that work in opposite directions. On one hand, an increase in the minimum
wage induces a mechanical increase in labor costs that negatively affects low-skill vacancy posting.
On the other hand, if sub-market tightness decreases given the increase in applicants, job-filling
probabilities increase. This is profitable and may incentivize firm expansion.

Importantly, it is possible to have productivity dispersion across constrained firms: all firms
whose unconstrained optimal low-skill wage is lower than $\bar{w}$ bunch at $\bar{w}$. Within the minimum wage
sub-markets, the net effect on vacancies is more likely to be negative the lower the firm productivity.
This implies that the least productive constrained firms reduce their size after increases in the
minimum wage. Moreover, using standard envelope arguments, Appendix A shows that profits
for all constrained firms decrease after increases in the minimum wage. This implies that marginal
firms—firms created by capitalists that are indifferent at the extensive margin—exit the market after
increases in the minimum wage. Hence, this model reproduces the standard intuition of the basic
supply and demand framework that predicts that increases in the minimum wage may negatively affect employment either by making firms smaller or pushing them out of the market.

What is novel is that the model generates additional market-level responses that may affect the general equilibrium effects in opposite directions. Not only the most productive constrained firms could expand at the cost of the least productive firms shrinkage, but also unconstrained firms react by adapting their wages and vacancies after changes in their relevant sub-market tightness. While the sign of the analytical expression for the wage spillover is ambiguous given the several effects that play a role in this reaction, it directly depends on the change in the sub-market tightness and, therefore, it is non-zero provided sub-market tightness change, something that is likely to happen given equations (4) and (5). Therefore, this model predicts wage spillovers toward low-skill workers that are earning more than the minimum wage. Moreover, since wages and vacancies are positively correlated at the firm and skill level, if wage spillovers are positive, then unconstrained firms also post more vacancies and, therefore, increase their size. This is one of the forces that can attenuate the direct employment effects discussed above: part of the jobs that are destroyed by the minimum wage effects on low productivity firms are absorbed by more productive firms. This mechanism is similar, albeit simplified, to the reallocation argument developed in Berger et al. (2022).9

Finally, since skill-specific vacancies are correlated within firms depending on the sign of $\phi_{th}$, changes in low-skill sub-markets may generate changes high-skill sub-markets. Then, this model can accommodate spillover effects to high-skill workers, although the sign and magnitudes depends on the nature and strength of the technological relationship.

Relation to empirical literature The main motivation for building a model of the labor market is to develop a welfare analysis of the minimum wage that incorporates more realistic predictions after changes in the minimum wage. One way to assess if the model achieves this objective is to evaluate its capacity for accommodating the empirical findings of the related literature.10

As discussed above, the model can accommodate positive wage effects with limited employment effects (Manning, 2021). This can be rationalized without strong participation effects, which Cengiz et al. (2021) suggest are negligible. Also, the model can generate wage spillovers between (e.g., Dustmann et al. (2021) also present a model with monopsonistic competition that generate reallocation effects after minimum wage hikes. In this exercise, it has to be kept in mind that, to develop a parsimonious welfare analysis, realistic predictions cannot sacrifice tractability. In this context, parsimony means deriving welfare results based on sufficient statistics (Chetty, 2009; Kleven, 2021). Then, the reduced form nature of the model is a necessary building block. In this regard, this model can be thought of as a complement to the related structural literature (e.g., Haanwinckel, 2020; Engbom and Moser, 2021; Berger et al., 2022) that, almost surely, outperforms the proposed model in its quantitative ability for matching empirical moments, at the cost of preventing reduced form welfare analyses.
Derononcourt et al., 2021) and within (e.g., Giupponi and Machin, 2018) firms. In the model, if these spillovers are positive, they induce additional vacancy openings, thus rationalizing the reallocation effects documented by Dustmann et al. (2021). The model also features positive profits in equilibrium, with profits decreasing in the minimum wage when firms are constrained. This is consistent with evidence provided by Draca et al. (2011), Harasztosi and Lindner (2019), and Drucker et al. (2021). In the model, the impact on profits may induce the least productive firms to leave the market. This is consistent with the evidence presented in Luca and Luca (2019) and reinforces the reallocation narrative for rationalizing limited employment effects.

Despite these attributes, the model misses relevant effects of the minimum wage. In what follows, I discuss how abstracting from these elements may affect the welfare analysis.

**Price effects** The model assumes that output prices are fixed, ruling out price increases driven by minimum wage shocks. However, the empirical literature finds substantial passthrough to prices (Allegretto and Reich, 2018; Harasztosi and Lindner, 2019; Renkin et al., 2020; Ashenfelter and Jurajda, 2021; Leung, 2021). Price effects matter for welfare since they can erode nominal minimum wage increases. Also, the unemployed and non-employed households can be made worse off given the absence of nominal improvements (MaCurdy, 2015). The distributional effect depends on which consumers buy the goods produced by firms that pay the minimum wage, and the relative importance of these goods in consumption bundles. In addition, it depends on the share of minimum wage workers since it affects the mapping from product-level prices to economy-level price indexes.

While more research is needed to assess the distributional impacts of the price effects, the available evidence suggests that they are unlikely to play a big role in the welfare analysis. Harasztosi and Lindner (2019) show that the goods produced by firms that pay the minimum wage are evenly consumed across the income distribution. Ashenfelter and Jurajda (2021) analyze McDonald’s restaurants responses to local minimum wage shocks and show that the elasticity of the number of Big Mac’s that can be purchased by minimum wage workers is around 80% of the own-wage elasticity, meaning that even if workers spend all their money in Big Mac’s, their real wage increases are still sizable. Renkin et al. (2020) also suggest that the price effects do not neutralize the redistributive potential of the minimum wage.12 Based on these pieces of evidence, I conjecture

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11 Modeling price increases after minimum wage shocks in the presence of limited employment effects is challenging: if employment does not fall and demand curves are downward sloping, prices should decrease rather than increase. Bhaskar and To (1999) and Sorkin (2015) try to formally reconcile limited employment effects with price increases.

12 “The rise in grocery store prices following a $1 minimum wage increase reduces real income by about $19 a year for households earning less than $10,000 a year. (...) The price increases in grocery stores offset only a relatively small part of the gains of minimum wage hikes. Minimum wage policies thus remain a redistributive tool even after
that ignoring price effects is unlikely to dramatically affect the conclusions of the welfare analysis.

**Productivity effects**  The model assumes that technology and labor productivity are independent from the minimum wage. This abstracts from recent literature that finds that minimum wages can increase both workers’ (Ku, 2020; Coviello et al., 2021; Ruffini, 2021) and firms’ (Riley and Bondibene, 2017; Mayneris et al., 2018) productivities. Potential mechanisms include efficiency wages (Shapiro and Stiglitz, 1984) and effects on investment in training (Acemoglu and Pischke, 1999). Abstracting from this worker- and firm-specific increases in productivity after minimum wage hikes is likely to make the case for a positive minimum wage conservative. Note, however, that the model can accommodate aggregate increases in productivity through reallocation effects, as in Dustmann et al. (2021).

### 2.3 Additional discussion

Beyond the presence of positive profits and the accommodation of empirically-relevant effects of the minimum wage, I argue that the model has additional desirable properties for studying the effects of the minimum wage. I also acknowledge that some of the assumptions invoked for tractability may have non-trivial implications. The rest of the section discusses some of the modeling choices and predictions, and considers how these assumptions may affect the welfare analysis.

**Directed search**  The choice of directed search offers some advantages. First, directed search models are *competitive* and usually lead to efficient (or constrained-efficient) outcomes in terms of search and posting (Wright et al., 2021). This implies that the welfare analysis avoids potential arguments in favor of the minimum wage driven by search and matching inefficiencies (e.g., Burdett and Mortensen, 1998; Acemoglu, 2001). If these inefficiencies are real, the welfare analysis is likely to be conservative. Second, directed search offers an empirically relevant sorting mechanism for rationalizing why similar workers work in firms that pay different wages, since the empirical evidence supports the assumption that higher wages attract more applicants (Dal Bó et al., 2013; Harasztosi and Lindner, 2019) argue that it is unlikely that productivity increases play a major role at the firm level as it would contradict the heterogeneous employment effects found between tradable and non-tradable sectors.

13 This approximation accommodates the results of Berger et al. (2022) which find that efficiency increases are unlikely to play a large role in the welfare implications of increasing the minimum wage.
Banfi and Villena-Roldan, 2019; He et al., 2021).\textsuperscript{15, 16}

Low-wage labor markets The model reproduces stylized facts of low-wage labor markets. First, there is wage dispersion for similar workers driven by “firm-effects” (Card et al., 2018; Song et al., 2019). Second, the model features wage posting rather than bargaining, which has been found to be more relevant for low-wage jobs (Hall and Krueger, 2012; Caldwell and Harmon, 2019; Lachowska et al., 2021). Third, the model can rationalize bunching in the wage distribution at the minimum wage (Cengiz et al., 2019).

Monopsony power The model reproduces finite firm-specific labor supply elasticities through endogenous wage-dependent job-filling probabilities, which is consistent with the empirical monopsony literature (Staiger et al., 2010; Azar et al., 2019; Dube et al., 2020; Bassier et al., 2021; Sokolova and Sorensen, 2021). In particular, when firms increase wages they attract more applicants per posted vacancy, which has a similar flavor to the standard monopsony intuition of upward-slopping firm-specific supply curves (Robinson, 1933; Card et al., 2018).

Firm-level heterogeneity and amenities One restriction of the model is that firm-level heterogeneity is one-dimensional. For example, I do not consider heterogeneity in production functions (as in Haanwinckel, 2020) or entry costs. Then, the relationship between productivity, wages, and size should not be taken literally and it should just be interpreted as a simplified way to induce wage dispersion in equilibrium. Importantly, the welfare analysis is based on reduced-form profit elasticities, so the particular driver of heterogeneous responses, as long as they reflect heterogeneity in posted wages, will not play an important role.

In this discussion, one important missing piece that has been recently shown to be relevant for workers’ decisions is non-wage job-amenities.\textsuperscript{17} Amenities may reduce the potential welfare benefits for workers after minimum wage increases if constrained firms worsen the non-wage attributes after minimum wage increases (Clemens et al., 2018; Clemens, 2021).

\textsuperscript{15}Marinescu and Wolthoff (2020) show that the relationship between wages and applications is more complex when more general patterns of heterogeneity are considered. In particular, the positive relationship only holds after controlling for job-titles, which can be accommodated by the segmented labor markets assumption of the model.

\textsuperscript{16}An alternative sorting mechanism is to assume idiosyncratic logit preferences for firms (Card et al., 2018). However, preference heterogeneity induces complications to welfare analyses (Eden, 2021) and, on a more specific note, logit shocks may be problematic since expected utilities become invariant to choices (Anas and Feng, 1988).

\textsuperscript{17}See Bonhomme and Jolivet (2009), Mas and Pallais (2017), Lavetti and Schmutte (2018), Maestas et al. (2018), Sorkin (2018), Taber and Vejlin (2020), Jäger et al. (2021), Le Barbanchon et al. (2021), Lindenlaub and Postel-Vinay (2021), Marinescu et al. (2021), Sockin (2021), Lamadon et al. (2022), and Roussille and Scuderi (2022).
Dynamics The model is static. The implications of this assumption for the welfare analysis are, in principle, ambiguous. Dube et al. (2016) and Gittings and Schmutte (2016) show that minimum wage shocks decrease employment flows—separation, hires, and turnover rates—while keeping the employment stock constant, thus increasing job stability. In the presence of labor market frictions, this induces an efficiency gain from minimum wage increases that is not captured by the model. On the other hand, Sorkin (2015), Aaronson et al. (2018), and Hurst et al. (2021) argue that the long-run employment distortions of minimum wage shocks are larger than the short-run responses, thus reducing the attractiveness of the minimum wage policy.

Segmented labor markets For simplicity, the model assumes that workers can only apply to vacancies that are directly tied to their idiosyncratic skill level. This assumption implies that the model abstracts from intensive margin responses (Saez, 2002). For example, increasing the minimum wage could induce high-skill workers to apply to low-skill vacancies. To the extent that these responses are empirically relevant, this is a caveat of the welfare analysis.18

Informality In some contexts, the interaction between the minimum wage and the degree of formality of the labor market may be a first order consideration. In the model, the costs of participating in the labor market, which are not taxed, may rationalize heterogeneity in outside options, including informal labor market opportunities. For detailed analyses, see Bosch and Manacorda (2010), Meghir et al. (2015), Pérez (2020), and Haanwinckel and Soares (2021).

Capital in the production function For simplicity, the production function is only a function of labor. However, firms may also use capital. This is a caveat of the welfare analysis since minimum-wages could induce capital-labor substitution. Harasztosi and Lindner (2019) finds that firms that pay the minimum wage are usually labor intensive. Therefore, even if capital-labor substitution is substantive, it is unlikely to have a meaningful impact on aggregate outcomes. This point is also related to the discussion on the labor market effects of automation (e.g., Autor, 2015; Acemoglu and Restrepo, 2019) since minimum wage shocks could accelerate labor-saving automation. While evidence is scarce, the Ashenfelter and Jurajda (2021) study of McDonald’s restaurants suggests that minimum wage shocks have not accelerated the automation process.19

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18 Note that this is different from changes in demand for skills, as suggested by Butschek (2021) and Clemens et al. (2021). The model can rationalize this by changes in the skill composition of posted vacancies mediated by $\phi$.

19 They show that the differential adoption of touch screen ordering technology across franchises is not correlated with local minimum wage increases.
3 Welfare Analysis

This section analyzes the welfare implications of the minimum wage using the model presented in the previous section. I start abstracting from taxes and characterizing the welfare tradeoff between active low-skill workers, active high-skill workers, and active capitalists, as a function of sufficient statistics. When including taxes, the welfare tradeoff is augmented by fiscal effects from both the workers’ and capitalists’ sides. Finally, I show that binding minimum wages may be desirable even if taxes are optimal. While optimal taxes limit the ability of the minimum wage to directly increase low-skill workers’ welfare, the minimum wage may increase aggregate welfare by shifting the incidence of the tax system when the mass of workers earning the minimum wage is large.

3.1 Starting point: no taxes

Setup Following related literature (Hummel, 2019; Kroft et al., 2020; Lavecchia, 2020), the social planner is assumed to be utilitarian and maximize expected utilities. I assume the social planner does not observe $c$ nor $\psi$ and, therefore, is constrained to second-best incentive-compatible policy schemes. Then, social welfare is given by

$$SW(\varpi) = \left( L^I_l + L^I_h + K_I \right) \cdot G(0) + \alpha_I \cdot \int_0^{U_l} G(U_l - c) dF_l(c) + \alpha_h \cdot \int_0^{U_h} G(U_h - c) dF_h(c) + K \cdot \int_{\psi} G(\Pi(\psi) - \xi) dO(\psi).$$

(6)

where $G$ is an increasing and concave function that accounts for social preferences for redistribution. The first term accounts for the utility of inactive workers and inactive capitalists. Both get zero utility. The second and third terms account for the expected utility of low- and high-skill workers that enter the labor market, also referred to as active workers. The average expected utility of active workers of skill $s$ is $\int_0^{U_s} G(U_s - c) d\tilde{F}_s(c)$, where $\tilde{F}_s(c) = F_s(c)/F_s(U_s)$. Then, total expected utility is given by $L^s_A \cdot \int_0^{U_s} G(U_s - c) d\tilde{F}_s(c)$ which yields the expressions above noting that $L^s_A = \alpha_s \cdot F(U_s)$. Finally, the last term accounts for the utility of active capitalists. Their average utility is $\int_{\psi} G(\Pi(\psi) - \xi) d\tilde{O}(\psi)$, with $\tilde{O}(\psi) = O(\psi)/(1 - O(\psi^*))$. Their total utility is therefore $K_A \cdot \int_{\psi} G(\Pi(\psi) - \xi) d\tilde{O}(\psi)$, which yields the expression above noting that $K_A = K \cdot (1 - O(\psi^*))$.

Following standard conventions in public economics, define

$$g_0 = \frac{G'(0)}{\gamma}, \quad g'_1 = \frac{\alpha_s \cdot \int_0^{U_s} G'(U_s - c) dF_s(c)}{(\gamma \cdot L^s_A)}, \quad g_\psi = \frac{G'(\Pi(\psi) - \xi)}{\gamma},$$

(7)
as the average social marginal welfare weights of inactive workers, active workers of skill type $s$, and active capitalists of type $\psi$, respectively, with $\gamma > 0$ constant. The role of $\gamma$ is to express average marginal utilities in terms of the social cost of raising funds, and coincides with the planner’s budget constraint multiplier when adding taxes to the analysis. Average social marginal welfare weights measure the social marginal value of redistributing one dollar uniformly across a group of individuals, so they are sufficient statistics for the redistributive preferences of the social planner.

Three things are worth noting about this setup. First, there is no need to impose additional incentive compatibility restrictions since they are implicit in the limits of integration. This follows from focusing on extensive margin responses. Second, since the social planner cares about expected utilities, the rationing assumption conditional on entering the labor market does not affect the welfare analysis. In supply-demand welfare analyses, rationing assumptions are of first-order (e.g., Lee and Saez, 2012), which may be considered restrictive.\footnote{For example, Gregory Mankiw’s reading of Lee and Saez (2012) results is: “Rather than providing a justification for minimum wages, the paper seems to do just the opposite. It shows that you need implausibly strong assumptions, such as efficient rationing, to make the case.” See http://gregmankiw.blogspot.com/2013/09/some-observations-on-minimum-wages.html.} Third, this social welfare function builds from the initial assumption that the only income firm owners receive are their unique firm’s profits. However, in the real world, capitalists may receive income from several firms and income sources. This implies that a literal reading of the social welfare function is likely to overestimate capitalists’ average welfare weights given the concavity of $G$. Nevertheless, results derived below depend on reduced-form profit elasticities, so average social marginal welfare weights can be adjusted when knowing who are the owners of the firms that are affected by minimum wage increases.

**Welfare tradeoff**  The first result characterizes the welfare tradeoff of the minimum wage as a function of sufficient statistics.

**PROPOSITION I:** In the absence of taxes, increasing the minimum wage is welfare improving if

$$\frac{dU_l}{dw} \cdot L_A \cdot g_1^l + \frac{dU_h}{dw} \cdot L_A \cdot g_1^h + K \cdot \int_{\psi^*} \gamma \cdot \frac{d\Pi(\psi)}{dw} dO(\psi) > 0. \quad (8)$$

*Proof: See Appendix B.*

Proposition I characterizes the welfare tradeoff of the minimum wage, which is between the welfare of active low-skill workers, active high-skill workers, and active capitalists. The first two terms represent the welfare gains or losses of active low- and high-skill workers after a small change in the minimum wage. The third term represents the welfare losses of active capitalists after a small
change in the minimum wage. While changes in $U^*$ and $\Pi(\psi^*)$ also affect entry and exit decisions, those margins do not induce first-order welfare effects because marginal workers and capitalists are initially indifferent between states. Depending on the values of the elasticities ($dU^*/d\bar{w}$ and $d\Pi(\psi)/d\bar{w}$) and the average marginal social welfare weights ($g_s^s$ and $g_\psi$), increasing the minimum wage may be desirable or not for the social planner. These objects are referred to as sufficient statistics in the sense that summarize all the relevant “structural” forces that play a role in the planner’s problem, both in terms of behavioral responses and preferences for redistribution, without the need to impose additional structural assumptions to the model presented in Section 2.

Relative to the related literature, one novel aspect of Proposition I is that it explicitly incorporates profits to the welfare discussion. While Berger et al. (2022) recognizes the potential of the minimum wage for affecting both the labor income distribution and the labor share, previous analyses based on optimal policy frameworks usually abstract from profits and only consider tradeoffs between workers (Hungerbühler and Lehmann, 2009; Lee and Saez, 2012; Cahuc and Laroque, 2014; Lavecchia, 2020). Giving a role to profits, which potentially decrease after minimum wage increases, makes the minimum wage potentially valuable for redistributing from capitalists to workers on top of its effects on the labor income distribution. Despite being an old and widely shared intuition, the role of the minimum wage for redistributing between workers and capitalists is usually not incorporated in the formal welfare analyses of the minimum wage.\footnote{See the quote from Mill (1884) at the beginning of the introduction.}

Proposing sufficient statistics for assessing the welfare changes for the different groups is an important feature of Proposition I. As discussed in Section 4, these sufficient statistics can be estimated without large data and design requirements. Of particular interest are the sufficient statistics for active workers, $dU^*/d\bar{w}$, since they capture all equilibrium effects on wage and employment that affect workers’ welfare conditional on participating in the labor market, including wage spillovers and reallocation effects. This object is valuable for two reasons. First, it proposes an avenue to aggregate the different labor market effects of the minimum wage that affect workers. Second, it does not tie welfare increases to positive employment effects, which is a more flexible way to assess the welfare consequences of the minimum wage policy. To illustrate this, Appendix A shows that this framework allows to calculate the disemployment effects that can be tolerated for the minimum wage to increase workers’ welfare given positive wage effects. The converse is not true: whenever employment effects for minimum wage workers are positive, $dU^1/d\bar{w}$ is likely to be positive as well.
3.2 Introducing taxes

The absence of taxes makes the analysis so far incomplete. This is mainly because of two reasons. First, the equilibrium effects of the minimum wage generate fiscal effects in revenue and spending. For example, Reich and West (2015) and Dube (2019) show that minimum wage increases cause reductions in income assistance transfers. Also, if minimum wage increases decrease profits, they may induce a fiscal loss in corporate tax revenue. These effects on the government’s budget constraint possibly affect the welfare analysis. Second, even if the minimum wage increases welfare, other policies may be preferred to achieve the same objective. For example, Clemens and Wither (2015), Neumark (2016), and Hurst et al. (2021) argue that the EITC is a better tool for redistributing toward low-skill workers. By contrast, OECD (2009) and Rothstein and Zipperer (2020) argue that the minimum wage and income taxes are likely to be complementary policies. To incorporate these concerns, I extend the welfare by considering the presence of taxes and transfers.

Setup

The tax system is characterized by \((T(\cdot), t)\), where \(T(\cdot)\) is a (possibly non-linear) income-tax schedule that only depends on the wage, and \(t\) is a flat corporate tax rate.

On the workers’ side, the expected utility when entering the labor market is now given by
\[
u_1(s, c) = \max_m \{p_m^s y_m^s + (1 - p_m^s)y_0\} - c,
\]
with \(y_m^s = w_m^s - T(w_m^s)\) the after-tax income if employed at sub-market \(m\), and \(y_0 = -T(0) \geq 0\) the transfer paid to non-employed workers. The utility of not entering the labor market is, therefore, \(u_0 = y_0\). It is still the case that all sub-markets yield the same expected utility, \(U^s = p_m^s y_m^s + (1 - p_m^s)y_0\), so the labor market participation decision follows a threshold rule, with the threshold now equal to \(U^s - y_0\). This implies that \(L_A^s = \alpha_s \cdot F_s(U^s - y_0)\).

On the capitalists’ side, after tax profits are now given by \((1 - t) \Pi(\psi)\). Capitalists also receive \(y_0\) if they do not create firms. This implies that, while the corporate tax is assumed to be non-distortionary with respect to marginal decisions, it is likely to affect the entry decision since \(\psi^*\) is implicitly defined by \((1 - t) \Pi(\psi^*) - \xi = y_0\) and, therefore, is affected by \(t\).

Finally, the social welfare function is now given by
\[
SW(\pi) = \left( L_I^h + L_h^h + K_I \right) \cdot G(y_0) + \alpha_l \cdot \int_0^{U_l - y_0} G(U_l - c) dF_l(c) \\
+ \alpha_h \cdot \int_0^{U_h - y_0} G(U_h - c) dF_h(c) + K \cdot \int_{\psi^*} G((1 - t) \Pi(\psi) - \xi) dO(\psi).
\]
Assuming no exogenous spending requirement, the planner’s budget constraint is given by

\[
(L_l^I + L_l^h + K_l + \rho^I \cdot L_A^I + \rho^h \cdot L_A^h) \cdot y_0 \leq \int (E_m^l \cdot T(w_m^l) + E_m^h \cdot T(w_m^h)) \, dm + t \cdot K \cdot \int \psi^* \Pi(\psi) \, dO(\psi),
\]

where \(\rho^s\) is the skill-specific unemployment rate given by \(L_s^I \rho_s / L_s A\), with \(L_s^I \rho_s = \int (1 - p_s m) L_s m \, dm = L_A^s - \int p_s^m L_s^m \, dm\) the mass of workers that enter the labor force and are not matched with vacancies, and \(E_m^s = p_m^s \cdot L_m^s\) is the mass of employed workers of skill \(s\) in sub-market \(m\). The budget constraint establishes that the transfer paid to inactive workers, unemployed workers, and inactive capitalists (left-hand-side), must be funded by the tax collection on employed workers and active capitalists (right-hand-side).

**Fixed taxes** To explore the interaction between the tax system and the minimum wage, I first consider a case with fixed taxes, that is, a case where the social planner takes \(T(\cdot)\) and \(t\) as given, sets \(y_0\) to mechanically balance the budget constraint, and optimizes \(\overline{w}\) to maximize social welfare.

**Proposition II:** If taxes are fixed, increasing the minimum wage is welfare improving if

\[
\frac{dU^I}{dw} \cdot L_A^I \cdot g_I^I + \frac{dU^h}{dw} \cdot L_A^h \cdot g_I^h + K \cdot (1 - t) \cdot \int \psi^* g_\psi \frac{d\Pi(\psi)}{dw} \, dO(\psi)
+ \int \left( \frac{dE_m^l}{dw} \left( T(w_m^l) + y_0 \right) + E_m^l T'(w_m^l) \frac{dw_m^l}{dw} \right) \, dm
+ \int \left( \frac{dE_m^h}{dw} \left( T(w_m^h) + y_0 \right) + E_m^h T'(w_m^h) \frac{dw_m^h}{dw} \right) \, dm
+ t \cdot K \cdot \int \psi^* \frac{d\Pi(\psi)}{dw} \, dO(\psi) - \frac{dK_I}{dw} \cdot (t \cdot \Pi(\psi^*) + y_0) > 0.
\]

**Proof:** See Appendix B.

Including taxes generates two effects. First, since utility is evaluated at post-tax wages and profits, the average marginal social welfare weights may change if the tax system induces some degree of redistribution. Second, the previous welfare tradeoff is augmented by fiscal effects.

To better understand the proposition, it is illustrative to describe it line by line. The first line mimics Proposition I: the welfare tradeoff is still between active low-skill workers, active high-skill workers, and active capitalists, with taxes potentially affecting the weights’ levels.

The second line accounts for the fiscal effects of low-skill labor markets. Equilibrium employment
changes (driven by direct employment effects, reallocation effects, or participation effects) and wage effects (including spillovers) affect tax collection and spending on low-skill workers. If wages of employed low-skill workers increase, net income tax collection increases, possibly because of a reduction in income assistance transfers that phase-out with income. By contrast, if disemployment effects are large, the social planner forfeits tax collection and spends additional funds on transfers to the non-employed. The third line represents the same effects, but for high-skill labor markets.

The fourth line summarizes fiscal effects driven by capitalists’ behavioral responses. Changes in profits affects the corporate tax revenue. Also, capitalists that exit the market switch from paying taxes to receiving a transfer. The optimal minimum wage increases when the corporate tax rate is low—which could happen, for example, under international tax competition—because the corporate revenue loss is smaller and the gains from redistributing from capitalists to workers increase.

**Optimal taxes** The previous analysis illustrates the mechanical interaction between the minimum wage and the tax schedule but does not answer if both policies are desirable at the joint optimum. In second-best contexts, using multiple policies for optimizing the planner’s problem could be virtuous (as in, for example, Ferey, 2020; and Gaubert et al., 2020) or redundant (as in, for example, Diamond and Mirrlees, 1971 and Atkinson and Stiglitz, 1976). In simple words, it is not ex-ante clear whether the welfare gains of the minimum wage can be reproduced by a well-designed income tax schedule with less efficiency costs or if both policies can complement each other in the joint optimum to make redistribution more efficient.

The following proposition explores the desirability of the minimum wage when the social planner jointly optimizes the tax system and the minimum wage.

**Proposition III:** If taxes are optimal, increasing the minimum wage is welfare improving if

\[
\frac{\partial U'}{\partial w} \cdot L_A \cdot g^l + \frac{\partial U^h}{\partial w} \cdot L_A^h \cdot g^h + K \cdot (1 - t) \cdot \int_{\psi^*}^\psi g_{\psi} \frac{\partial \Pi(\psi)}{\partial \omega} dO(\psi) \\
+ \int \left( \frac{\partial E^l_m}{\partial w} \left( T(w^l_m) + y_0 \right) + E^l_m \frac{\partial w^l_m}{\partial \omega} \right) dm \\
+ \int \left( \frac{\partial E^h_m}{\partial w} \left( T(w^h_m) + y_0 \right) + E^h_m \frac{\partial w^h_m}{\partial \omega} \right) dm \\
+ t \cdot K \cdot \int_{\psi^*}^\psi \frac{\partial \Pi(\psi)}{\partial \omega} dO(\psi) - \frac{\partial K}{\partial \omega} \cdot (t \cdot \Pi(\psi^*) + y_0) > 0 .
\]

(12)

*Proof: See Appendix B.*

Proposition III shows that binding minimum wages may be desirable even when taxes are
optimal depending on the relative importance of competing forces. To see this, note that the expression is almost identical to Proposition II, with two important differences.

First, all relevant elasticities are micro rather than macro elasticities, a distinction emphasized in Landais et al. (2018b,a) and recently applied in Kroft et al. (2020) and Lavecchia (2020). I use partial rather than total derivatives to represent this difference. Macro elasticities (present in Propositions I and II) internalize all general equilibrium effects, while micro elasticities keep after-tax allocations constant. Because of envelope arguments, this distinction does not affect capitalists’ welfare (see Appendix A), however, it affects the ability of the minimum wage to affect workers’ welfare. In particular, the direct welfare effects of the minimum wage on workers are likely to be negative, but also smaller in absolute terms, when taxes are optimal. This formalizes the intuition of the proponents of the EITC as a preferred policy for redistribution.

Second, note that in the second and third lines there are novel terms, $E_{m}^{s} \cdot (\partial w_{m}^{s} / \partial \bar{w})$. For minimum wage sub-markets $\partial w_{m}^{l} / \partial \bar{w} = 1$, which means that there is a fiscal gain equivalent to the mass of low-skill workers earning the minimum wage. Intuitively, the minimum wage generates savings to the government by forcing firms to fund low-skill workers earnings. To see why, consider the case of the EITC. Firms internalize that the EITC increases job applications for a given posted wage, so they optimally react by lowering posted pre-tax wages. In this setting, the EITC becomes both a transfer to workers and firms. The minimum wage limits the ability of firms for decreasing wages and, therefore, increases the efficacy of the EITC to redistribute toward low-skill workers. The relevance of this mechanism depends on the mass of workers earning exactly the minimum wage, which has been shown to be substantial (Cengiz et al., 2019). This formalizes the intuition of the potential complementarity between tax-based redistribution and the minimum wage.

In summary, several competing forces determine if binding minimum wages are desirable on top of optimal taxes. On one hand, the partial effect of binding minimum wages on workers’ welfare is probably negative. The relevance of this force depends on the mechanical employment losses given by the size reduction of the least-productive firms. On the other hand, the minimum wage keeps being a valid alternative for redistributing from capitalists to workers and, also, may increase the efficiency of the income tax to redistribute toward low-wage workers by preventing capitalists to capture rents from income taxes. The relevance of this force depends on the mass of workers that

\[ U^{*} = p_{m}^{*} y_{m}^{*} + (1 - p_{m}^{*}) y_{0} = p_{m}^{*} \cdot \Delta y_{m}^{*} + y_{0} \]

Recall that $U^{*}$ is fixed when choosing the optimal minimum wage, so the minimum wage directly affects workers’ welfare only through $p_{m}^{*}$. Since after-tax allocations are fixed, changes in the minimum wage do not mechanically affect disposable income for minimum wage workers, so the application strategies do not react. Then, changes in employment probabilities come from the reduction in vacancies of lower-productivity firms and the corresponding (attenuated) equilibrium effects.

Firm-level heterogeneity and entry distortions impede $t$ to fully redistribute from capitalists to workers. The
exactly earn the minimum wage. How these forces balance is a quantitative question.

**Summary** The welfare analysis illustrates that the minimum wage affects the relative welfare of active low-skill workers, active high-skill workers, and capitalists. Therefore it can be useful for redistribution within labor-income earners, and between labor and capital, depending on the sign and value of the elasticities and the relative welfare valuations of the different groups. Fiscal effects also play an important role in the analysis, since equilibrium effects affect tax collection and spending, and consequently the redistributive scope of the tax system. While Proposition III shows that there may be a role for the minimum wage in a joint optimal scenario, it has to be kept in mind that additional unmodeled constraints (such as tax evasion and avoidance behavioral responses, or matching inefficiencies) may affect the comparative advantage of the tax system in terms of the policy-specific efficiency costs. In that regard, Proposition II, which treats taxes as fixed, may be thought of as the policy relevant expression to assess actual minimum wage policy.

4 **Sufficient Statistics Estimation**

This section uses publicly available US data to estimate stacked event studies exploiting state-level variation in minimum wages to analyze the effects of minimum wages on the welfare of low-skill workers, high-skill workers, and capitalists. Results suggest that minimum wages have increased low-skill workers’ welfare with no effect on high-skill workers’ welfare. On the other hand, capitalists’ welfare decreased after minimum wage increases.

Recall that the sufficient statistic that measures changes in welfare for low- and high-skill workers is \( dU^s/d\bar{w} \). Below is shown that \( U^s \) equals the average post-tax wage among active workers of skill \( s \) (including the unemployed) implying that \( dU^s/d\bar{w} \) can be estimated with data on wages, employment, and participation. Estimating changes in average post-tax wages among active workers, while related, differs from Cengiz et al. (2019) estimations in two regards. First, the focus is on skill-specific labor markets rather than minimum wage earners or total low-wage jobs. Second, the estimation aggregates all wage, employment, and participation responses in a single statistic rather than analyzing each margin separately. Regarding capitalists, changes in welfare are given by changes in post-tax profits. The estimates provided in this section use state-level measures of average welfare weight for capitalists is below 1 at the optimal corporate tax rate (see Appendix A). Part of this result relies on the corporate tax rate being flat. Extending to non-linear frameworks may induce additional welfare gains from using the tax system relative the minimum wage. For example, Saez and Zucman (2021) propose non-linear payroll taxes to mimic minimum wages. Non-linear corporate taxes, however, are not common and may induce additional behavioral responses that affect the efficiency of the tax system (e.g., Bachas and Soto, 2020).
profits and, therefore, can be seen as complementary to the literature that estimates profit effects using firm-level data (Draca et al., 2011; Harasztosi and Lindner, 2019; Drucker et al., 2021).

In light of the discussion developed in the previous section, I estimate the macro-version of the sufficient statistics, that is, the version that considers all general equilibrium effects of minimum wage changes. This implies that the results can be used to quantitatively assess Proposition II, but not Proposition III. To illustrate this, the final part of this section provides a back-of-the-envelope calculation of the welfare implications of past state-level minimum wage increases in the US through the lens of Proposition II. The analysis suggests that weak social preferences for redistribution toward low-skill workers are sufficient for arguing that past state-level minimum wage increases have increased aggregate welfare in the US.

4.1 Empirical strategy

This subsection describes the empirical strategy, the outcome variables, and the data used.

Events The empirical exercise closely follows Cengiz et al. (2019) and estimates stacked event studies exploiting state-level variation in minimum wages. Annual data on state minimum wages is taken from Vaghul and Zipperer (2016). The state-by-year minimum wage is defined as the maximum between the statutory values of the federal and state minimum wages throughout the calendar year. Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. As in Cengiz et al. (2019), an event is defined as a state-level hourly minimum wage increase above the federal minimum wage of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected, where the affected population is computed using the NBER Merged Outgoing Rotation Group of the CPS. These restrictions are imposed to focus on minimum wage increases that are likely to have labor market equilibrium effects. Federal minimum wage increases are also excluded since across-state variation cannot be used to identify their effects. While they do not constitute an event, regressions control for small state-level and federal minimum wage increases. I consider the 1979-2019 period.

Figure 1 shows the distribution of events across time. Panel (a) shows that, in total, there are 169 state-level minimum wage increases that qualify as events. The frequency of state-level minimum wage changes has increased over time. As I specify below, for ensuring balance and avoid

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24 Estimating micro elasticities requires a cleanly identified natural experiment where minimum wages vary and after-tax allocations are fixed constant.

25 Following Cengiz et al. (2019), I compute employment counts by wage bins and check whether, on average, the previous year share of workers with wages below the new minimum wage is above 2%.
Figure 1: State-level events by time

Notes: This figure plots the annual frequency of state-level minimum wage increases classified as events. Data on minimum wages is taken from Vaghul and Zipperer (2016). A state-level hourly minimum wage increase above the federal level is classified as an event if the increase is of at least $0.25 (in 2016 dollars) in a state with at least 2% of the working population affected, where the affected population is computed using the NBER Merged Outgoing Rotation Group of the CPS. Panel (a) consider all events. Panel (b) shows the distribution for the events used in the main specification. These are events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event.

confounding pre-trends with multiple treatments, the main specification focus on a subset of 71 events. The distribution of these events is plotted in Panel (b). To ensure that the selection of events is not biasing the main estimations, results using the complete sample of events are presented in Appendix C. As it is shown in Figure C.1 and Table C.1, the events used in the main specifications represent, on average, between a 9% and 10% increase in the real hourly state-level minimum wage.

**Estimating equation** Estimating standard event studies in this setting is challenging because of two reasons. First, events do not induce an absorbing status. That is, states may increase their minimum wages several times throughout the period considered. This may induce complications on how to label specific state-year combinations and may confound pre-trends when multiple events take place in a short period of time. Second, treatment effect heterogeneity may induce bias when treatment adoption is staggered (de Chaisemartin and D’Haultfoeuille, 2022; Roth et al., 2022). To deal with these issues, I implement a stacked-event study (Cengiz et al., 2019; Gardner, 2021; Baker et al., 2022). I also present results using alternative event-study estimators proposed by the recent literature (Borusyak et al., 2021; Callaway and Sant’Anna, 2020; De Chaisemartin and d’Haultfoeuille, 2020; Sun and Abraham, 2020).

I implement the stacked event-study as follows. For each event, it is defined a time window
that goes from 4 years previous to the event to 4 years after. To focus on balanced samples, only event dates between 1983 and 2015 are considered. Also, for avoiding confounding pre-trends with multiple treatment, events for which the treated state does experience other events in the pre-event 4-year window are excluded. These two restrictions reduce the number of events considered from 169 to 71. Then, event-specific control groups are defined, containing all states that do not experience events in the event-specific time-window. This defines an event-specific dataset. Finally, all event-specific datasets are appended and used to estimate a standard event study with event-specific fixed effects. To flexibly accommodate time varying shocks that may be correlated with minimum wage changes, I consider time trends that are census division-event- and census region-event specific.

This leads to the following estimating equation:

$$\log Y_{ite} = \sum_{\tau=-4}^{4} \beta_\tau D_{\tau ite} + \alpha_{ie} + \gamma_{r(i)te} + \rho_{ite} + \epsilon_{ite},$$

where $i$, $t$, and $e$ index state, year, and event, respectively, $r(i)$ maps states to census-regions or census-divisions (depending on the specification considered), $Y_{ite}$ is an outcome of interest, $D_{\tau ite}$ are event indicators with $\tau$ the distance from the event (in years), $\alpha_{ie}$ are state-by-event fixed effects, $\gamma_{r(i)te}$ are census-region (or division)-by-year-by-event fixed effects, and $\rho_{ite}$ are state-by-year-by-event varying controls that include small state-level minimum wage increases and federal minimum wage increases. $\beta_{-1}$ is normalized to 0. To allow for correlation within states across events, standard errors are clustered at the state level. Regressions are weighted by state-by-year average total population, taken from the BEA regional accounts. Appendix C presents results that are weighted by state-by-year average working-age population computed using the CPS monthly files.

I also consider non-saturated differences-in-differences regressions:

$$\log Y_{ite}^s = \beta_{ie}T_{ie}\text{Post}_{te} + \alpha_{ie} + \gamma_{r(i)te} + \rho_{ite} + \epsilon_{ite},$$

where $T_{ie}$ is an indicator variable that takes value 1 if state $i$ is treated in event $e$, Post$_{te}$ is an indicator variable that takes value 1 if year $t$ is larger or equal than the treatment year in event $e$, and all other variables are defined as in equation (13). The coefficient of interest is $\beta$, which captures the average treatment effect in the post-event years.

26 These controls are included as binary indicators that switch from 0 to 1 when there is a small state minimum wage increase or a federal minimum wage increase, and remain switched on until the end of the event time window.
4.2 Dependent variables and data

This subsection describes the outcome variables considered in the analysis and the data used to proxy them. The outcomes considered measure workers’ and capitalists’ welfare.

**Workers’ welfare** The sufficient statistic that summarizes changes in active workers’ welfare driven by minimum wage changes is \(dU^s/d\bar{w}\), for \(s \in \{l, h\}\).

To get an empirical measure of \(U^s\), recall that, in equilibrium, \(U^s = p^s_my^s_m + (1 - p^s_m)y_0\). Multiplying both sides by the sub-market mass of applicants, \(L^s_m\), and integrating across \(m\) gives

\[
U^s = \int E^s_m(w^s_m - T(w^s_m) - y_0)dm / L^s_A + y_0 = \frac{\int E^s_m w^s_m dm}{L^s_A} - \frac{\int E^s_m (T(w^s_m) + y_0)dm}{L^s_A} + y_0, \tag{15}
\]

where \(E^s_m = p^s_m \cdot L^s_m\). If the tax schedule is constant, then

\[
\frac{dU^s}{d\bar{w}} = \frac{d}{d\bar{w}} \left( \frac{\int E^s_m w^s_m dm}{L^s_A} \right) - \frac{d}{d\bar{w}} \left( \frac{\int E^s_m (T(w^s_m) + y_0)dm}{L^s_A} \right). \tag{16}
\]

This implies that the change in welfare of workers of skill \(s\) driven by changes in the minimum wage can be approximated by the change in the average wage of active workers including the unemployed (first term) net of the change in their average tax liabilities (second term).

Computing these statistics requires microdata with information on skills, wages, employment, participation, and tax liabilities (including transfers). In the absence of such data, I use the NBER Merged Outgoing Rotation Group of the CPS that have all the needed information to approximate \(dU^s/d\bar{w}\) except the tax liabilities. Given this, the change in workers’ welfare is estimated by changes in average hourly pre-tax wages and then corrected to represent post-tax values using Dube (2019)’s finding that post-tax family income elasticities are 66% as large as pre-tax ones.

The exercise requires defining low- and high-skill individuals. Low-skill individuals are defined as individuals with high-school or less, with age less than 30, and whose hourly wage (when employed) is lower or equal than 2.5 times the federal minimum wage. These additional restrictions are imposed to avoid confounding skill differences not reflected in schooling (e.g., driven by experience). Also, including workers with wages above the minimum allows to capture spillovers in the welfare measure. On the other hand, high-skill workers are defined as individuals with a college degree. Appendix C presents results using alternative skill definitions.

I follow Cengiz et al. (2019) for computing pre-tax hourly wages using the NBER Merged Outgoing Rotation Group of the CPS. Hourly wages are either directly reported or can be indirectly
computed by dividing weekly earnings by weekly hours worked. I drop self-employed individuals and compute average wages (including zeros for the unemployed) across individuals that are in the labor force by state and year. Nominal wages are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Observations whose hourly wage is computed using imputed data (on wages, earnings, and/or hours) are excluded to minimize the scope for measurement error. Since imputation flags are unreliable for years 1994 and 1995, those years are excluded from the main specification. Appendix C presents results without the imputation restrictions.

**Capitalists’ welfare**  The sufficient statistic that summarizes changes in active capitalists’ welfare driven by minimum wage changes is the change in firm profits, \( d\Pi(\psi)/d\bar{w} \), for \( \psi \in [\psi^*, \overline{\psi}] \).

Absent firm-level microdata, capitalists’ welfare is proxied by measures of average profits by state and year. The main measure uses Gross Operating Surplus (GOS) estimates from the BEA regional accounts as a proxy of state-level aggregate profits and divides them by the average number of private establishments reported in the QCEW data files.\(^\text{27}\) Nominal profits are transformed to 2016 dollars using the R-CPI-U-RS index including all items.\(^\text{28}\) As an alternative measure, state-level tax revenue data taken from the Census Annual Survey of State Government Tax Collections Datasets is combined with tax rates data from Suárez Serrato and Zidar (2016) to compute measures of profit margins at the state by year level. I divide total state-level corporate tax revenue and sales tax revenue by state corporate and sales taxes to estimate aggregate profits and sales. Then, the average profit margin can be computed by dividing total profits over total sales.\(^\text{29}\)

4.3 Results

**Event studies**  Figure 2 plots the estimated coefficients \( \{\beta_\tau\}_{\tau=-4}^4 \) of equation (13) with their corresponding 95% confidence intervals using the average pre-tax wage of active workers as a dependent variable and census-region-by-year-by-event fixed effects. Results using census-division-by-year-by-event fixed effects are presented in Figure C.III. Panel (a) shows that state-level minimum wage

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\(^{27}\)The BEA definition of gross operating surplus is as follows: “Value derived as a residual for most industries after subtracting total intermediate inputs, compensation of employees, and taxes on production and imports less subsidies from total industry output. Gross operating surplus includes consumption of fixed capital (CFC), proprietors’ income, corporate profits, and business current transfer payments (net).”

\(^{28}\)The number of establishments can also change in response to the minimum wage. This does not directly affect capitalists’ welfare but may induce fiscal externalities. I come back to this discussion at the end of the section, where I show that minimum wages did not affect the number of private establishments in my estimation sample.

\(^{29}\)One caveat of this analysis is that not all states have corporate taxes on top of the federal corporate tax or sales taxes, so regressions using this outcome exclude these states from the analysis. Also, state-level tax rates estimates of Suárez Serrato and Zidar (2016) are only available until 2010.
Figure 2: Estimating changes in workers’ welfare after minimum wage increases

Notes: These figures plot the estimated $\beta_\tau$ coefficients with their corresponding 95% confidence intervals from equation (13) using census-region-by-year-by-event fixed effects and the log of the average wage of active workers (including the unemployed) as a dependent variable. Then, these regressions estimate $d\log U^l/dw$ and $d\log U^h/dw$ as discussed in the main text. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 and excludes microdata with imputed information. Panel (a) estimates the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panel (b) estimates the regression for high-skill workers, where high-skill individuals are defined as having a college degree. An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.

Increases have increased active low-skill workers’ welfare. Panel (b) shows that minimum wage increases have had null effects on active high-skill workers’ welfare. These results suggest that state-level minimum wages have reduced welfare gaps between low- and high-skill active workers.

Figure 3 plots the estimated coefficients $\{\beta_\tau\}_{\tau=4}^{4}$ of equation (13) with their corresponding 95% confidence intervals using measures of average profits as a dependent variable and census-region-by-year-by-event fixed effects. Results using census-division-by-year-by-event fixed effects are presented in Figure C.III. Panel (a) shows results using gross operating surplus per establishment, while Panel (b) shows results using average profit margins as a dependent variable. Both panels suggest that minimum wage increases have decreased capitalists’ welfare.30 As a validation of the estimation, Table C.II shows the difference-in-differences estimations of gross operating surplus per establishment separated by industry. While noisy, results suggest that the fall in average profits is mainly driven by the primary sector (agriculture, forestry, fishing, and mining) and, to

30One limitation of this analysis is that relying on aggregate data prevents me from exploring heterogeneities by firm size and firm owners’ income that can be relevant for the welfare analysis (Drucker et al., 2021).
Notes: These figures plot the estimated $\beta_\tau$ coefficients with their corresponding 95% confidence intervals from equation (13) using census-region-by-year-by-event fixed effects and the log of firm-level profits as a dependent variable. Then, these regressions estimate $d \log \Pi(\psi) / dw$ as discussed in the main text. Panel (a) proxies average profits using the total gross operating surplus taken from the BEA regional accounts normalized by the number of private establishments reported in the QCEW data files. Panel (b) proxies average profits by the ratio of total corporate profits to total sales estimated using the Census Annual Survey of State Government Tax Collection Datasets combined with tax rates data from Suárez Serrato and Zidar (2016). An event is defined as a state-level hourly minimum wage increase of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.

Summary: differences-in-differences estimates Table 1 shows the estimated $\beta$ coefficients of equation (14). Models with both census-region- and census-division-specific time-by-event fixed effects are considered. The table shows that state-level minimum wage increases have increased active low-skill workers pre-tax wages by between 1.6% and 2.3%. The effect decreases when

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These estimates are noisy because of two reasons. First, QCEW data on private establishments by sector is only available since 1990, which restricts the number of events considered. Second, there is potential measurement error in the industry definition since the industry classification of the BEA regional accounts changed in 1997. This is why I focus on a subset of broad industry categories. For more details, see the notes of Table C.II.

Both articles find stronger minimum wage effects for tradable sectors. The primary sector is arguably tradable. Employment and revenue elasticities are also larger for the manufacturing sector. Cengiz et al. (2019) find null employment effects on retail and restaurants, and Harasztosi and Lindner (2019) find null employment and revenue elasticities on services. Finally, while Cengiz et al. (2019) find null employment elasticities on the construction sector, they show that the sector has the larger share of affected wages and employment across the considered sectors.

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| Panel (a): Census-region-specific time-by-event fixed effects | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|-------------------------------------------------------------|------------------|-------------------|-----------------|--------------|
| Post x Treated                                              | 0.023            | 0.003             | -0.023          | -0.113       |
|                                                              | (0.005)          | (0.005)           | (0.011)         | (0.060)      |
| Observations                                                | 17,586           | 17,586            | 18,386          | 8,700        |
| Adj. R-squared                                              | 0.978            | 0.979             | 0.909           | 0.912        |

| Panel (b): Census-division-specific time-by-event fixed effects | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|---------------------------------------------------------------|------------------|-------------------|-----------------|--------------|
| Post x Treated                                                | 0.016            | -0.001            | -0.025          | -0.153       |
|                                                              | (0.005)          | (0.006)           | (0.013)         | (0.055)      |
| Observations                                                 | 16,736           | 16,736            | 17,521          | 8,449        |
| Adj. R-squared                                                | 0.943            | 0.961             | 0.918           | 0.928        |

Notes: This table shows the estimated β coefficient from equation (14). All columns represent different regressions using different dependent variables, all in logarithms. Low-skill workers and High-skill workers use the average wage of active low- and high-skill workers, respectively. Profits per est. uses gross operating surplus by private establishment. Profit margin uses the average profit margin. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figures 2 and 3. Standard errors (in parenthesis) are clustered at the state level and regressions are weighted by state-by-year population.

considering the stricter time fixed effects, suggesting that census division-specific shocks may play a role in explaining part of the average wage dynamics. Since the relevant measure for welfare is changes in average post-tax wages, I use Dube (2019) results for adjusting estimates by the fiscal effects of the minimum wage. The semi-elasticities decrease to between 1.1% and 1.5%. The table also confirms that state-level minimum wage increases have had zero effects on high-skill workers and have induced a 2.5% decrease in profits per establishment, which represents between 10% and 15% of the pre-event average firm profitability.

The results on workers’ welfare are consistent with Cengiz et al. (2019, 2021) who find positive wage effects and limited employment and participation effects in the part of the distribution close to the minimum wage which, arguably, most closely represents low-skill workers. They report null effects on higher parts of the wage distribution. The effects on capitalists are also consistent with the related literature. Draca et al. (2011) study the introduction of the national minimum wage in the United Kingdom and find that profit margins fell by almost 30%. Harasztosi and Lindner (2019) find that profits fell around 1% after a large minimum wage increase in Hungary. This decrease
represented around 30% of the average profitability in the pre-reform year. Drucker et al. (2021) study the Israeli case and finds a reduction of 7.5% in profits of highly exposed firms. One difference between these studies and this paper’s results is that they use firm-level rather than market-level data on profits. Therefore, results displayed above are likely to better reflect the aggregate effects of the minimum wage on firm profits to assess its overall welfare implications with the limitation of being silent of potential heterogeneous effects. My results are also consistent with the quantitative exercise in Berger et al. (2022) that suggests that welfare gains are concentrated in workers and are decreasing in skill, while welfare losses are concentrated in capital owners.

**Alternative event study specifications** While stacked event-studies successfully deal with the potential bias induced by treatment effect heterogeneity by carefully selecting the control group (Gardner, 2021; Baker et al., 2022), not being derived from first principles may cast doubt on the policy relevance of its implicit weighting scheme. Then, I check whether the results hold when considering alternative event study specifications proposed by the recent literature.

I estimate the model using the estimators proposed by Borusyak et al. (2021) (BJS), Callaway and Sant’Anna (2020) (CS), De Chaisemartin and d’Haultfoeuille (2020) (dCdH), and Sun and Abraham (2020) (SA). One caveat is that these estimators assume that units can be treated at most once.\(^\text{33}\) Then, I focus on the period 1996-2019, when most of the significant minimum wage increases are concentrated, and redefine the event as the first increase by state in this period. In this period, 35 states have at least one minimum wage increase that qualifies as event. I focus on a balanced sample, thus restricting the attention to events between 2000 and 2015.\(^\text{34}\) I present results for the average pre-tax wage of active low- and high-skill workers, and for the average profit per establishment. Since profit margins are only observed until 2010, the period considered prevents me for estimating reliable regressions using this outcome variable.

Results are presented in Figure C.II and Table C.III. All specifications include state fixed effects and census division-specific fixed-effects (with the exception of CS estimator that cannot accommodate more flexible fixed-effects).\(^\text{35}\) The event study coefficients have a similar behavior to the stacked event-studies presented in Figures 2 and 3: trends are stable before events for all outcomes and suggest positive effects for low-skill workers, null effects for high-skill workers, and

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\(^{33}\)Except dCdH, they also assume that the treatment is absorbent.

\(^{34}\)An additional benefit of the period considered is that it excludes the years where imputation information on wages is not reliable (years 1994-1995).

\(^{35}\)For simplicity, I conduct these estimations without time-varying unit controls, which should not be problematic given that the main results are robust to their exclusion (see Figure C.VI and Table C.VI). Additional details of the implementation can be found in the notes of Figure C.II and Table C.III.
negative effects for capitalists. To compare the magnitude of the estimates to the results presented in Panel (b) of Table 1, Table C.III presents the average effect in the four years following the minimum wage increase. The estimated average effect on active low-skill workers average pre-tax wages is 0.017, 0.020, 0.025 and 0.011 when using BJS, CS, dCdH, and SA estimators, respectively. For high-skill workers, all methods estimate precise zeros, with the exception of SA method that suggests a small negative effect. Finally, the estimated average effect on profits per establishment is -0.058, -0.028, -0.040 and -0.064 when using BJS, CS, dCdH, and SA estimators, respectively. Given the similarity with the results provided in Table 1, I take this as strong evidence supporting the validity of the main estimations.

Additional robustness checks  The results displayed in Figures 2, 3, and Table 1 are robust to a series of robustness checks. Figure C.V and Table C.V present results of regressions weighted by working-age population rather than total population. Results are practically unaffected. Figure C.VII and Table C.VII present results using the balanced sample but including events experienced by treated states in the pre-event window. This increases the number of considered events from 71 to 120. Figure C.VIII and Table C.VIII present results including all 169 events regardless of the event-window balance. Both exercises show that the inclusion of these events confound pre-trends with multiple treatment, thus validating the event-selection strategy for the main specifications. However, the quantitative results are similar to the results displayed in Figures 2 and 3 and Table 1, suggesting that the restrictions put on the events are not inducing any selection bias.

Figure C.IX and Table C.IX present results for the workers’ welfare estimations where the average wage of workers is computed including the imputed data. The magnitude of the estimated effect on low-skill workers is slightly smaller, suggesting that imputation induces measurement error. Despite that, it is still the case that minimum wages have positive and significant effects on low-skill workers’ welfare and null effects on high-skill workers’ welfare. Figure C.X and Table C.X present results using different definitions of low skill. Recall that low-skill workers are individuals with high-school or less, younger than 30 years old, and earning an hourly wage (when employed) lower than 2.5 times the federal minimum wage. I consider restricting the hourly wage to be smaller than 2 or 3 times the federal minimum wage, and the individuals to be younger than 25 and 35 years old. Results hold under all these alternative definitions. Finally, Figure C.XI and Table C.XI present results using different definitions of high skill. Recall that high-skill workers are individuals with a college degree. I consider restricting the individuals to be older than 30 years old, and excluding wage outliers by restricting the hourly wage to be smaller or equal than 25 times the federal minimum wage. All specifications confirm the null effect on high-skill workers’ welfare.
4.4 Discussion: back to the welfare analysis

Results so far inform about the average changes in welfare by group, but are not enough to make an assessment of the aggregate welfare changes. The welfare desirability of the minimum wage depends on (i) the social value of the welfare effects on active low-skill workers, (ii) the social value of the welfare effects on active high-skill workers, (iii) the social value of the welfare effects on active capitalists, and (iv) the fiscal effects on both workers’ and capitalists’ sides. The results presented so far suggest that (i) are positive, (ii) are negligible, (iii) are negative, and (iv) are unknown on the workers’ side and likely to be negative on the capitalists’ side. Then, it is not obvious whether state-level minimum wage increases have increased or not aggregate welfare in the US.

To make progress in this regard, the remainder of the section develops a back-of-the-envelope welfare calculation using Proposition II, the results displayed in Table 1, and additional inputs from the related literature. The exercise is similar in spirit to the “inverse-optimum” problem of the optimal taxation literature (Bourguignon and Spadaro, 2012; Hendren, 2020). I compute, under different assumptions, the minimum welfare weight that society should put on low-skill workers to assert that minimum wage increases have been welfare improving given the elasticities’ estimates.

Consider the following modified version of equation (11). When taxes are fixed, increasing the minimum wage increases aggregate welfare if

\[
\frac{d \log U_l}{d w} \cdot U_l \cdot L_l \cdot A \cdot g_1 + K_A \cdot (1 - t) \cdot \int_{\psi^*}^{\psi} g_\psi \frac{d \log \Pi(\psi)}{d \tilde{\omega}} \Pi(\psi) d\tilde{\omega} + \text{Fiscal effects} > 0, (17)
\]

where \( K_A = K \cdot (1 - O(\psi^*)) \), \( \tilde{O}(\psi) = O(\psi)/(1 - O(\psi^*)) \), and the high-skill workers component is omitted since \( dU_h/d\tilde{\omega} = 0 \). Note that \( U_l \cdot L_l \cdot A \) is approximately \( \int E_{m}^l y_{m}^l dm \), that is, total post-tax wages of low-skill workers.\(^{36}\)

Fiscal effects can be decomposed into workers’ (mainly changes in transfers received) and capitalists’ (changes in corporate tax revenue) fiscal effects. Figure C.IV and Table C.IV show that the number of establishments did not change after minimum wage increases.\(^{37}\) Then, the fiscal loss in corporate tax revenue can be approximated by the decrease in profit per establishment times the average profit per establishment times the number of establishments times the corporate tax rate

\(^{36}\)The aggregate sum of post-tax earnings should be augmented by the transfer to non-employed workers times the probability of entering the labor market and ending unemployed. I omit this additional term for simplicity. Ignoring this additional term is likely to underestimate the welfare gains driven by minimum wage increases.

\(^{37}\)Regressions suggest, if anything, an increase in establishments following minimum wage increases. However, the increase is partially confounded with a positive pre-trend and the difference-in-difference coefficient is a precisely estimated zero when including census-division-specific time-by-event fixed effects.
or, similarly, the decrease in aggregate profits times the corporate tax rate.

On the workers’ side, I build on Dube (2019) finding that post-tax family income elasticities with respect to the minimum wage are 66% as large as pre-tax family income elasticities. Wages are transformed to earnings by computing the average usual weekly hours worked (including zeros) taken from the NBER Merged Outgoing Rotation Group of the CPS files. Importantly, as shown in Figure C.XII and Table C.XII, average usual hours worked per week were not affected by state-level minimum wage increases, implying that this assumption does not affect the validity of the estimated welfare effect. After transforming wages to earnings, total-pre tax earnings of low-skill workers are added to total income maintenance transfers by state-by-year reported by the BEA regional accounts and compute how much transfers should have to decrease to match the pre- and post-tax elasticities relationship.\footnote{The BEA regional accounts define income maintenance transfers as “Supplemental Security Income (SSI) benefits, Earned Income Tax Credit (EITC), Additional Child Tax Credit, Supplemental Nutrition Assistance Program (SNAP) benefits, family assistance, and other income maintenance benefits, including general assistance”.

38} Low-skill workers’ side fiscal effects are then computed as total income maintenance transfers times the reduction factor. A similar procedure is used to transform pre-tax earnings to post-tax earnings. Specifically, I compute the ratio of total income maintenance transfers over total pre-tax earnings of low-skill workers and amplify pre-tax incomes by one plus the ratio. Additional details on these calculations can be found in Appendix D.

Under the assumption that \( d\log \Pi(\psi)/d\psi \) is constant, and letting \( \overline{\Pi} \) denote the unweighted average profit per establishment, equation (17) can be written as

\[
0.66 \cdot 0.023 \cdot \text{Total post-tax earnings}^l \cdot \gamma^l \\
-0.023 \cdot \text{Total pre-tax profits} \cdot (1 - t) \cdot \int_{\psi^*}^{\overline{\psi}} g_\psi \frac{\Pi(\psi)}{\overline{\Pi}} d\tilde{O}(\psi) \\
-0.023 \cdot t \cdot \text{Total pre-tax profits + Workers’ fiscal effects} > 0,
\]

where Total pre-tax profits = \( K_A \cdot \overline{\Pi} \), and the imputed numbers are the semi-elasticities reported in Table 1 in the estimations including census-region-specific time-by-event fixed effects. I also provide results using the semi-elasticities computed using the model with census-division-specific time-by-event fixed effects. Workers’ side fiscal effects are specific to each calibration so they vary with the more specific assumptions of the back-of-the-envelope calculations developed below.

To calibrate the average welfare weights, let \( g^K = \int_{\overline{\psi}}^{\psi^*} g_\psi \frac{\Pi(\psi)}{\overline{\Pi}} d\tilde{O}(\psi) \) be the average welfare weight of active capitalists. The overall welfare value the social planner puts on capitalists depends on the distribution of profits across firms. Since results rely on aggregate data, I assume all firms earn the average profit, so \( \Pi(\psi)/\overline{\Pi} = 1 \) and \( g^K = \int_{\overline{\psi}}^{\psi^*} g_\psi d\tilde{O}(\psi) \) reduces to the unweighted average
welfare weight across firms. Given this, I follow the optimal taxation literature (e.g., Saez, 2001; Kleven et al., 2009; Mankiw et al., 2009) and assume that the $G$ function of the social welfare criterion is CRRA, that is, $G(V) = V^{1-\zeta}/(1 - \zeta)$, with $\zeta > 0$ and preferences for redistribution increasing in $\zeta$. This functional form allows to approximate $g^l/g^K$ using (powers of) the ratio of average post-tax incomes. Denote by $\omega(\zeta) = g^l(\zeta)/g^K(\zeta)$ the ratio of average marginal welfare weights given $\zeta$. Details on its calculation can be found in Appendix D.

With these assumptions, equation (18) can be written as

$$g^l > \left( 0.023 \cdot \text{Total post-tax earnings}^l - \frac{0.023 \cdot \text{Total pre-tax profits} \cdot (1 - t)}{\omega(\zeta)} \right)^{-1} \times (t \cdot 0.023 \cdot \text{Total pre-tax profits} - \text{Workers’ fiscal effects}), \quad (19)$$

to the extent the first parenthesis in the right hand side is positive.

When putting numbers to equation (19), it can be computed the minimum welfare weight the social planner has to put on low-skill workers such that increasing the minimum wage is welfare improving, which is the value of $g^l$ that meets the condition with equality. Since the semi-elasticities are estimated using past state-level minimum wage increases, equation (19) can also be interpreted as deriving the minimum welfare weight needed to justify past state-level minimum wage increases through the lens of welfare analysis developed in Section 3.

In what follows, I make a general description of the additional details needed to complete the calibration of equation (19). A detailed description is provided in Appendix D.

First, the corporate tax rate, $t$, has to be calibrated. I consider four scenarios. The first scenario sets $t = 35\%$, which corresponds to the statutory corporate tax rate that applied between 1993 and 2017. The second considers $t = 21\%$, which is the current statutory corporate tax rate. The third scenario sets $t = 23\%$, which corresponds to the average effective corporate tax rate between 1979 and 2017 using Zucman (2014) series extended to 2017, and the fourth considers the last value of the series, which corresponds to 13\%. Second, three cases are considered to compute total and average pre-tax earnings of low-skill workers, total and average pre-tax profits, and total income maintenance transfers. First, I consider the population-weighted average across all state-by-year observations of the estimation sample. Second, I consider the population-weighted average across all treated states in the pre-event year. Third, I consider the population-weighted average across

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39 Estimating profit effects with firm-level microdata would allow a better welfare assessment on the firms’ side allowing for heterogeneous elasticities and welfare weights (Drucker et al., 2021).

40 Effective corporate tax rates are computed by dividing all the corporate taxes paid by US firms (to US and foreign governments) by US corporate profits, with national accounts information taken from the BEA NIPA tables.
Table 2: Minimum $g^l$ such that increasing the minimum wage is welfare improving

Panel (a): Semi-elasticities from models with census-region-specific time-by-event fixed effects

| All obs. | Pre-event obs. | 2019 |
|----------|---------------|------|
| $\zeta$  | $\zeta$ | $\zeta$ | $\zeta$ | $\zeta$ | $\zeta$ | $\zeta$ | $\zeta$ |
| 1 | 1.5 | 2 | 1 | 1.5 | 2 | 1 | 1.5 | 2 |
| 0.35 | 1.40 | 1.28 | 1.26 | 1.75 | 1.59 | 1.57 | 1.35 | 1.23 | 1.21 |
| $t$ | 0.21 | 0.69 | 0.63 | 0.62 | 0.91 | 0.83 | 0.81 | 0.64 | 0.59 | 0.58 |
| 0.23 | 0.79 | 0.72 | 0.71 | 1.03 | 0.94 | 0.92 | 0.74 | 0.68 | 0.67 |
| 0.13 | 0.28 | 0.26 | 0.25 | 0.43 | 0.39 | 0.39 | 0.24 | 0.22 | 0.22 |

Panel (b): Semi-elasticities from models with census-division-specific time-by-event fixed effects

| All obs. | Pre-event obs. | 2019 |
|----------|---------------|------|
| $\zeta$  | $\zeta$ | $\zeta$ | $\zeta$ | $\zeta$ | $\zeta$ | $\zeta$ | $\zeta$ |
| 1 | 1.5 | 2 | 1 | 1.5 | 2 | 1 | 1.5 | 2 |
| 0.35 | 2.57 | 2.23 | 2.17 | 2.86 | 2.48 | 2.42 | 2.51 | 2.16 | 2.10 |
| $t$ | 0.21 | 1.39 | 1.19 | 1.16 | 1.56 | 1.35 | 1.32 | 1.33 | 1.14 | 1.11 |
| 0.23 | 1.56 | 1.34 | 1.31 | 1.75 | 1.51 | 1.48 | 1.50 | 1.28 | 1.25 |
| 0.13 | 0.71 | 0.60 | 0.59 | 0.82 | 0.71 | 0.69 | 0.65 | 0.56 | 0.55 |

Notes: this table presents the value of $g^l$ that meets equation (19) with equality under different calibration assumptions. Panel (a) uses the semi-elasticities from Panel (a) of Table 1. Panel (b) uses the semi-elasticities from Panel (b) of Table 1. All obs. means that total and average annual low-skill workers’ earnings, firms’ profits, and income maintenance transfers are computed using the population-weighted average of all state-by-year observations in the estimation panel. Pre-event obs. restricts the observations to the pre-event year of treated states. 2019 only uses observations of year 2019. Different rows consider different values for the corporate tax rate, $t$. The first row of each panel considers the statutory corporate tax rate that applied between 1993 and 2017. The second row considers the current statutory corporate tax rate. The third row considers the average effective corporate tax rate between 1979 and 2017 using Zucman (2014) series extended to 2017. The fourth row uses the latter value for 2017. Different columns consider different values for the social welfare function parameter, $\zeta$. Low-skill workers’ pre-tax earnings are converted to post-tax values using Dube (2019) results. Additional details can be found in Appendix D.

all states in 2019. Finally, the social welfare function parameter, $\zeta$, has to be calibrated. I consider $\zeta \in \{1, 1.5, 2\}$. This implies that $\omega(\zeta)$ corresponds to (i) the inverse of the ratio of average post-tax incomes, (ii) the square root of the inverse of the ratio of average post-tax incomes to the power of three, and (iii) the square of the inverse of the ratio of average post-tax incomes.\footnote{For simplicity, this exercise does not include the participation and entry costs that ultimately matter for the computation of the welfare weights. Given Jensen’s inequality, to the extent that entry costs for firms do not represent a much more larger share of profits than search costs represent for low-skill workers average earnings (including the unemployed), abstracting for them implies that the calibration of $\omega(\zeta)$ is possibly a lower bound.}
Results  Table 2 summarizes the results. To interpret the results, recall that average marginal social welfare weights are equal to the social value of the marginal utility of consumption normalized by the social cost of raising public funds. In simple words, $g^l$ is defined such that the government is indifferent between $g^l$ more dollars of public funds and 1 dollar of additional consumption to low-skill workers (Saez, 2001). Alternatively, $g^l$ measures the dollar value for the social planner of giving 1 extra dollar to low-skill workers. Whenever $g^l$ is greater than one, the social planner values redistribution toward low-skill workers. The greater the value of $g^l$, the greater the social value of redistribution. Then, the correct interpretation of Table 2 is that lower values of the minimum $g^l$ such that increasing the minimum wage is welfare improving make a better case for the minimum wage since they demand weaker distributional preferences to justify the policy change.

Five points are worth discussing about Table 2 results. First, it suggests that weak restrictions have to be put on the social planner’s redistributive preferences to conclude that state-level minimum wage increases have been welfare improving. In many cases, the minimum average welfare weight on low-skill workers that justifies the minimum wage increases is below 1, implying that as long as the social planner values redistribution toward low-skill workers, minimum wages have increased aggregate welfare.

Second, using the semi-elasticities from the difference-in-differences models with census-division-specific time-by-event fixed effects make the case for the minimum wage slightly more restrictive, but still favorable in light of the analysis of the previous paragraph. This is expected since low-skill workers’ welfare elasticities decrease when controlling for the stricter fixed effects, suggesting lower distributional benefits from its application.

Third, results are robust to changing the sample used to calculate the aggregate and average annual values. This implies that the analysis can be thought of being valid both for assessing past and current minimum wage increases, under the assumption that the estimated elasticities are time-invariant.

Fourth, the conditions for justifying the minimum wage are weaker as $\zeta$ increases, that is, as the social planner has stronger preferences for redistribution. This reflects the fact that the relative social value of low-skill workers’ and capitalists’ welfare is an important ingredient for assessing the desirability of the minimum wage.

Fifth, results illustrate the importance of the corporate tax rate to assess the welfare desirability of the minimum wage. As the corporate tax rate increases, the social planner requires larger valuations on low-skill workers’ welfare to justify the minimum wage. This is mainly driven by the fiscal loss produced by lower profits that is increasing in the corporate tax rate. Important for the
ongoing policy debate, current values of the statutory and effective corporate tax rates (second and fourth rows) are low enough to make minimum wage increases welfare improving regardless of the parametrization considered as long as distribution towards low-skill workers is socially valuable.

Summarizing, through the lens of Proposition II and the empirical results presented throughout the section, small state-level minimum wage increases have increased aggregate welfare and, assuming the structural elasticities remain valid for current times, further increases are also expected to be welfare improving. This analysis should be read with caution since it relies on several assumptions and assumes that the macro semi-elasticities are fixed. In addition, the lack of microdata on firm profits limits the possibility of exploiting further heterogeneities in capitalists’ behavioral responses and welfare valuations.

While this analysis suggests that small minimum wage increases are likely to be welfare improving given the tax schedule, it does not inform whether increasing the minimum wage is preferred to reforming the tax schedule. Proposition III of Section 3 shows that binding minimum wages can be desirable even if taxes are optimal, but its quantitative assessment requires knowledge of micro-elasticities that cannot be estimated with the setting of this paper.

5 Conclusion

A large literature studies the labor market effects of the minimum wage. A smaller but growing literature builds from the empirical facts to develop welfare analyses and policy recommendations to inform actual minimum wage policy. This paper aims to contribute to this latter discussion.

With that purpose, the paper proposes a tractable model of the labor market that explicitly accommodates non-trivial equilibrium effects of the minimum wage to develop a welfare analysis. The model features two-sided heterogeneity, has positive firm profits in equilibrium, reproduces several facts of low-wage labor markets, and is based on modelling choices that probably induce a conservative analysis of the welfare implications of the minimum wage.

With the model, a standard optimal policy analysis is developed. The analysis shows that the welfare tradeoff of the minimum wage policy is between active low-skill workers, active high-skill workers, and firm owners. The welfare tradeoff is expressed as a function of flexible estimable sufficient statistics. This welfare tradeoff is shown to be augmented by fiscal externalities when taxes and transfers enter the analysis. I show that the ability of the minimum wage to shift the tax system incidence implies that there may be a role for binding minimum wages even when the
tax system is optimal.

The sufficient statistics that guide the welfare analysis are estimated using state-level variation in minimum wages. I find that minimum wages have increased low-skill workers’ welfare with no effects on high-skill workers and a decrease in firm profits. The estimated coefficients are used to calibrate a back-of-the-envelope welfare calculation, finding that past state-level minimum wage increases have probably increased aggregate US welfare and, under certain assumptions, small future increase will do that as well.
Bibliography

Aaronson, D., E. French, I. Sorkin, and T. To (2018). Industry dynamics and the minimum wage: a putty-clay approach. *International Economic Review* 59(1), 51–84.

Acemoglu, D. (2001). Good jobs versus bad jobs. *Journal of Labor Economics* 19(1), 1–21.

Acemoglu, D. and J. S. Pischke (1999). The structure of wages and investment in general training. *Journal of Political Economy* 107(3), 539–572.

Acemoglu, D. and P. Restrepo (2019). Automation and new tasks: How technology displaces and reinstates labor. *Journal of Economic Perspectives* 33(2), 3–30.

Allegretto, S. and M. Reich (2018). Are local minimum wages absorbed by price increases? Estimates from internet-based restaurant menus. *ILR Review* 71(1), 35–63.

Anas, A. and C. M. Feng (1988). Invariance of expected utilities in logit models. *Economics Letters* 27(1), 41–45.

Ashenfelter, O. and Š. Jurajda (2021). Wages, minimum wages, and price pass-through: The case of McDonald’s restaurants. *Working Paper*.

Atesagaoglu, O. E. and H. Yazici (2021). Optimal taxation of capital in the presence of declining labor share. *Working Paper*.

Atkinson, A. B. and J. E. Stiglitz (1976). The design of tax structure: Direct versus indirect taxation. *Journal of Public Economics* 6(1-2), 55–75.

Autor, D. (2015). Why are there still so many jobs? The history and future of workplace automation. *Journal of Economic Perspectives* 29(3), 3–30.

Autor, D., A. Manning, and C. L. Smith (2016). The contribution of the minimum wage to US wage inequality over three decades: A reassessment. *American Economic Journal: Applied Economics* 8(1), 58–99.

Azar, J., S. Berry, and I. E. Marinescu (2019). Estimating labor market power. *Working Paper*.

Bachas, P. and M. Soto (2020). Corporate taxation under weak enforcement. *American Economic Journal: Economic Policy*.

Baker, A., D. F. Larcker, and C. C. Wang (2022). How much should we trust staggered difference-in-differences estimates? *Journal of Financial Economics*.
Banfi, S. and B. Villena-Roldan (2019). Do high-wage jobs attract more applicants? Directed search evidence from the online labor market. *Journal of Labor Economics* 37(3), 715–746.

Bassier, I., A. Dube, and S. Naidu (2021). Monopsony in movers: The elasticity of labor supply to firm wage policies. *Journal of Human Resources*.

Berger, D. W., K. F. Herkenhoff, and S. Mongey (2021). Labor market power. *American Economic Review*.

Berger, D. W., K. F. Herkenhoff, and S. Mongey (2022). Minimum wages and welfare. *Working Paper*.

Bhaskar, V. and T. To (1999). Minimum wages for Ronald McDonald monopsonies: A theory of monopsonistic competition. *The Economic Journal* 109(455), 190–203.

Bonhomme, S. and G. Jolivet (2009). The pervasive absence of compensating differentials. *Journal of Applied Econometrics* 24(5), 763–795.

Borusyak, K., X. Jaravel, and J. Spiess (2021). Revisiting event study designs: Robust and efficient estimation. *Working Paper*.

Bosch, M. and M. Manacorda (2010). Minimum wages and earnings inequality in urban mexico. *American Economic Journal: Applied Economics* 2(4), 128–49.

Bourguignon, F. and A. Spadaro (2012). Tax–benefit revealed social preferences. *The Journal of Economic Inequality* 10(1), 75–108.

Burdett, K. and D. T. Mortensen (1998). Wage differentials, employer size, and unemployment. *International Economic Review*, 257–273.

Butschek, S. (2021). Raising the bar: Minimum wages and employers’ hiring standards. *American Economic Journal: Economic Policy*.

Cahuc, P. and G. Laroque (2014). Optimal taxation and monopsonistic labor market: Does monopsony justify the minimum wage? *Journal of Public Economic Theory* 16(2), 259–273.

Caldwell, S. and N. Harmon (2019). Outside options, bargaining, and wages: Evidence from coworker networks. *Working Paper*.

Callaway, B. and P. H. Sant’Anna (2020). Difference-in-differences with multiple time periods. *Journal of Econometrics*. 

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Card, D., A. R. Cardoso, J. Heining, and P. Kline (2018). Firms and labor market inequality: Evidence and some theory. Journal of Labor Economics 36(S1), S13–S70.

Cengiz, D., A. Dube, A. Lindner, and D. Zentler-Munro (2021). Seeing beyond the trees: Using machine learning to estimate the impact of minimum wages on labor market outcomes. Journal of Labor Economics.

Cengiz, D., A. Dube, A. Lindner, and B. Zipperer (2019). The effect of minimum wages on low-wage jobs. The Quarterly Journal of Economics 134(3), 1405–1454.

Chetty, R. (2009). Sufficient statistics for welfare analysis: A bridge between structural and reduced-form methods. Annual Review of Economics 1(1), 451–488.

Clemens, J. (2021). How do firms respond to minimum wage increases? Understanding the relevance of non-employment margins. Journal of Economic Perspectives 35(1), 51–72.

Clemens, J., L. B. Kahn, and J. Meer (2018). The minimum wage, fringe benefits, and worker welfare. Working Paper.

Clemens, J., L. B. Kahn, and J. Meer (2021). Dropouts need not apply? The minimum wage and skill upgrading. Journal of Labor Economics 39(S1), S107–S149.

Clemens, J. and M. Wither (2015). The minimum-wage and the US employment slump. VOX EU - CEPR.

Coviello, D., E. Deserranno, and N. Persico (2021). Minimum wage and individual worker productivity: Evidence from a large US retailer. Journal of Political Economy.

Craig, A. C. (2022). Optimal income taxation with spillovers from employer learning. American Economic Journal: Economic Policy.

Dal Bó, E., F. Finan, and M. A. Rossi (2013). Strengthening state capabilities: The role of financial incentives in the call to public service. The Quarterly Journal of Economics 128(3), 1169–1218.

De Chaisemartin, C. and X. d’Haultfoeuille (2020). Two-way fixed effects estimators with heterogeneous treatment effects. American Economic Review 110(9), 2964–96.

de Chaisemartin, C. and X. D’Haultfoeuille (2022). Two-way fixed effects and differences-in-differences with heterogeneous treatment effects: A survey. Working Paper.

Derenoncourt, E., C. Noelke, and D. Weil (2021). Spillovers from voluntary employer minimum wages. Working Paper.
Diamond, P. A. and J. A. Mirrlees (1971). Optimal taxation and public production I: Production efficiency. *The American Economic Review* 61(1), 8–27.

Doligalski, P., A. Ndiaye, and N. Werquin (2020). Redistribution with performance pay. *Working Paper*.

Draca, M., S. Machin, and J. Van Reenen (2011). Minimum wages and firm profitability. *American Economic Journal: Applied Economics* 3(1), 129–51.

Drucker, L., K. Mazirov, and D. Neumark (2021). Who pays for and who benefits from minimum wage increases? Evidence from Israeli tax data on business owners and workers. *Journal of Public Economics* 198.

Dube, A. (2019). Minimum wages and the distribution of family incomes. *American Economic Journal: Applied Economics* 11(4), 268–304.

Dube, A., J. Jacobs, S. Naidu, and S. Suri (2020). Monopsony in online labor markets. *American Economic Review: Insights* 2(1), 33–46.

Dube, A., T. W. Lester, and M. Reich (2016). Minimum wage shocks, employment flows, and labor market frictions. *Journal of Labor Economics* 34(3), 663–704.

Dustmann, C., A. Lindner, U. Schönberg, M. Umkehrer, and P. Vom Berge (2021). Reallocation effects of the minimum wage: Evidence from Germany. *Quarterly Journal of Economics*.

Dworczak, P., S. D. Kominers, and M. Akbarpour (2020). Redistribution through markets. *Econometrica*.

Eden, M. (2021). Price-independent anonymity. *Working Paper*.

Eeckhout, J., C. Fu, W. Li, and X. Weng (2021). Optimal taxation and market power. *Working Paper*.

Engbom, N. and C. Moser (2021). Earnings inequality and the minimum wage: Evidence from Brazil. *Working Paper*.

Ferey, A. (2020). Make work pay or make search pay? Redistributive taxation and unemployment insurance. *Working paper*.

Flinn, C. J. (2006). Minimum wage effects on labor market outcomes under search, matching, and endogenous contact rates. *Econometrica* 74(4), 1013–1062.
Fortin, N. M., T. Lemieux, and N. Lloyd (2021). Labor market institutions and the distribution of wages: The role of spillover effects. *Journal of Labor Economics* 39(S2), S369–S412.

Gardner, J. (2021). Two-stage differences in differences. *Working Paper*.

Gaubert, C., P. Kline, and D. Yagan (2020). Place-based redistribution. *Working Paper*.

Gautier, P. A. and J. L. Moraga-González (2018). Search intensity, wage dispersion and the minimum wage. *Labour Economics* 50, 80–86.

Gittings, R. K. and I. M. Schmutte (2016). Getting handcuffs on an octopus: Minimum wages, employment, and turnover. *ILR Review* 69(5), 1133–1170.

Giupponi, G. and S. J. Machin (2018). Changing the structure of minimum wages: Firm adjustment and wage spillovers. *Working Paper*.

Haanwinckel, D. (2020). Supply, demand, institutions, and firms: A theory of labor market sorting and the wage distribution. *Working Paper*.

Haanwinckel, D. and R. R. Soares (2021). Workforce composition, productivity, and labor regulations in a compensating differentials theory of informality. *Review of Economic Studies*.

Hall, R. E. and A. B. Krueger (2012). Evidence on the incidence of wage posting, wage bargaining, and on-the-job search. *American Economic Journal: Macroeconomics* 4(4), 56–67.

Harasztosi, P. and A. Lindner (2019). Who pays for the minimum wage? *The American Economic Review* 109(8), 2693–2727.

He, H., D. Neumark, and Q. Weng (2021). “I still haven’t found what I’m looking for”: Evidence of directed search from a field experiment. *Working Paper*.

Hendren, N. (2020). Measuring economic efficiency using inverse-optimum weights. *Journal of Public Economics* 187, 104198.

Hummel, A. J. (2019). Unemployment and tax design. *Working Paper*.

Hummel, A. J. (2021). Monopsony power, income taxation and welfare. *Working Paper*.

Huneeus, F., K. Kroft, and K. Lim (2021). Earnings inequality in production networks. *Working Paper*.

Hungerbühler, M. and E. Lehmann (2009). On the optimality of a minimum wage: New insights from optimal tax theory. *Journal of Public Economics* 93(3-4), 464–481.
Hungerbühler, M., E. Lehmann, A. Parmentier, and B. Van der Linden (2006). Optimal redistributive taxation in a search equilibrium model. *The Review of Economic Studies* 73(3), 743–767.

Hurst, E., P. Kehoe, E. Pastorino, and T. Winberry (2021). The Distributional Impact of the Minimum Wage. *Working Paper*.

Jäger, S., C. Roth, N. Roussille, and B. Schoefer (2021). Worker beliefs about outside options. *Working Paper*.

Jarosch, G., J. S. Nimczik, and I. Sorkin (2021). Granular search, market structure, and wages. *Working Paper*.

Kircher, P. (2009). Efficiency of simultaneous search. *Journal of Political Economy* 117(5), 861–913.

Kleven, H. (2021). Sufficient statistics revisited. *Annual Review of Economics* 13.

Kleven, H., C. Kreiner, and E. Saez (2009). The optimal income taxation of couples. *Econometrica* 77(2), 537–560.

Kroft, K., K. Kucko, E. Lehmann, and J. Schmieder (2020). Optimal income taxation with unemployment and wage responses: A sufficient statistics approach. *American Economic Journal: Economic Policy* 12(1), 254–92.

Kroft, K., Y. Luo, M. Mogstad, and B. Setzler (2021). Imperfect competition and rents in labor and product markets: The case of the construction industry. *Working Paper*.

Ku, H. (2020). Does minimum wage increase labor productivity? Evidence from piece rate workers. *Journal of Labor Economics*.

Lachowska, M., A. Mas, R. Saggio, and S. A. Woodbury (2021). Wage Posting or Wage Bargaining? A Test Using Dual Jobholders. *Journal of Labor Economics*.

Lamadon, T., M. Mogstad, and B. Setzler (2022). Imperfect competition, compensating differentials and rent sharing in the US labor market. *American Economic Review* 112(1), 169–212.

Landais, C., P. Michaillat, and E. Saez (2018a). A macroeconomic approach to optimal unemployment insurance: Applications. *American Economic Journal: Economic Policy* 10(2), 182–216.

Landais, C., P. Michaillat, and E. Saez (2018b). A macroeconomic approach to optimal unemployment insurance: Theory. *American Economic Journal: Economic Policy* 10(2), 152–81.
Lavecchia, A. M. (2020). Minimum wage policy with optimal taxes and unemployment. *Journal of Public Economics* 190, 104228.

Lavetti, K. and I. M. Schmutte (2018). Estimating compensating wage differentials with endogenous job mobility. *Working Paper*.

Le Barbanchon, T., R. Rathelot, and A. Roulet (2021). Gender differences in job search: Trading off commute against wage. *The Quarterly Journal of Economics* 136(1), 381–426.

Lee, D. (1999). Wage inequality in the United States during the 1980s: Rising dispersion or falling minimum wage? *The Quarterly Journal of Economics* 114(3), 977–1023.

Lee, D. and E. Saez (2012). Optimal minimum wage policy in competitive labor markets. *Journal of Public Economics* 96(9-10), 739–749.

Leung, J. H. (2021). Minimum wage and real wage inequality: Evidence from pass-through to retail prices. *Review of Economics and Statistics* 103(4), 754–769.

Lindenlaub, I. and F. Postel-Vinay (2021). The worker-job surplus. *Working Paper*.

Luca, D. L. and M. Luca (2019). Survival of the fittest: The impact of the minimum wage on firm exit. *Working Paper*.

MaCurdy, T. (2015). How effective is the minimum wage at supporting the poor? *Journal of Political Economy* 123(2), 497–545.

Maestas, N., K. J. Mullen, D. Powell, T. Von Wachter, and J. B. Wenger (2018). The value of working conditions in the united states and implications for the structure of wages. *Working Paper*.

Mankiw, N. G., M. Weinzierl, and D. Yagan (2009). Optimal taxation in theory and practice. *Journal of Economic Perspectives* 23(4), 147–74.

Manning, A. (2021). The elusive employment effect of the minimum wage. *Journal of Economic Perspectives* 35(1), 3–26.

Marinescu, I., Y. Qiu, and A. Sojourner (2021). Wage inequality and labor rights violations. *Working Paper*.

Marinescu, I. and R. Wolthoff (2020). Opening the black box of the matching function: The power of words. *Journal of Labor Economics* 38(2), 535–568.
Mas, A. and A. Pallais (2017). Valuing alternative work arrangements. *American Economic Review* 107(12), 3722–59.

Mayneris, F., S. Poncet, and T. Zhang (2018). Improving or disappearing: Firm-level adjustments to minimum wages in China. *Journal of Development Economics* 135, 20–42.

Meghir, C., R. Narita, and J.-M. Robin (2015). Wages and informality in developing countries. *American Economic Review* 105(4), 1509–46.

Mill, J. S. (1884). *Principles of political economy*. D. Appleton.

Moen, E. R. (1997). Competitive search equilibrium. *Journal of Political Economy* 105(2), 385–411.

Mousavi, N. (2021). Optimal labor income tax, incomplete markets, and labor market power. *Working Paper*.

Neumark, D. (2016). Policy levers to increase jobs and increase income from work after the great recession. *IZA Journal of Labor Policy* 5(1), 1–38.

OECD (2009). *OECD Employment Outlook 2009: Tackling the Jobs Crisis*. Organisation for Economic Co-operation and Development.

Pérez, J. (2020). The minimum wage in formal and informal sectors: Evidence from an inflation shock. *World Development* 133, 104999.

Reich, M. and R. West (2015). The effects of minimum wages on food stamp enrollment and expenditures. *Industrial Relations* 54(4), 668–694.

Renkin, T., C. Montialoux, and M. Siegenthaler (2020). The pass-through of minimum wages into US retail prices: Evidence from supermarket scanner data. *Review of Economics and Statistics*.

Riley, R. and C. R. Bondibene (2017). Raising the standard: Minimum wages and firm productivity. *Labour Economics* 44, 27–50.

Robinson, J. (1933). *The economics of imperfect competition*. Springer.

Roth, J., P. H. Sant’Anna, A. Bilinski, and J. Poe (2022). What’s trending in difference-in-differences? a synthesis of the recent econometrics literature. *Working Paper*.

Rothstein, J. (2010). Is the eitc as good as an nit? conditional cash transfers and tax incidence. *American Economic Journal: Economic Policy* 2(1), 177–208.
Rothstein, J. and B. Zipperer (2020). The EITC and minimum wage work together to reduce poverty and raise incomes. *Economic Policy Institute Report*.

Roussille, N. and B. Scuderi (2022). Bidding for talent: Equilibrium wage dispersion on a high-wage online job board. *Working Paper*.

Ruffini, K. (2021). Higher wages, service quality, and firm profitability: Evidence from nursing homes and minimum wage reforms. *Working Paper*.

Saez, E. (2001). Using elasticities to derive optimal income tax rates. *The Review of Economic Studies* 68(1), 205–229.

Saez, E. (2002). Optimal income transfer programs: Intensive versus extensive labor supply responses. *The Quarterly Journal of Economics* 117(3), 1039–1073.

Saez, E. and G. Zucman (2021). Increasing the minimum wage through tax policy. *Working Paper*.

Shapiro, C. and J. E. Stiglitz (1984). Equilibrium unemployment as a worker discipline device. *The American Economic Review* 74(3), 433–444.

Shi, S. (2009). Directed search for equilibrium wage–tenure contracts. *Econometrica* 77(2), 561–584.

Sleet, C. and H. Yazici (2017). Taxation, redistribution and frictional labor supply. *Working Paper*.

Sockin, J. (2021). Show me the amenity: Are higher-paying firms better all around? *Working Paper*.

Sokolova, A. and T. Sorensen (2021). Monopsony in labor markets: A meta-analysis. *ILR Review* 74(1), 27–55.

Song, J., D. J. Price, F. Guvenen, N. Bloom, and T. Von Wachter (2019). Firming up inequality. *The Quarterly Journal of Economics* 134(1), 1–50.

Sorkin, I. (2015). Are there long-run effects of the minimum wage? *Review of Economic Dynamics* 18(2), 306–333.

Sorkin, I. (2018). Ranking firms using revealed preference. *The Quarterly Journal of Economics* 133(3), 1331–1393.

Staiger, D. O., J. Spetz, and C. S. Phibbs (2010). Is there monopsony in the labor market? Evidence from a natural experiment. *Journal of Labor Economics* 28(2), 211–236.
Stantcheva, S. (2014). Optimal income taxation with adverse selection in the labour market. *The Review of Economic Studies* 81(3), 1296–1329.

Stigler, G. J. (1946). The economics of minimum wage legislation. *The American Economic Review* 36(3), 358–365.

Suárez Serrato, J. C. and O. Zidar (2016). Who benefits from state corporate tax cuts? A local labor markets approach with heterogeneous firms. *American Economic Review* 106(9), 2582–2624.

Sun, L. and S. Abraham (2020). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*.

Taber, C. and R. Vejlin (2020). Estimation of a roy/search/compensating differential model of the labor market. *Econometrica* 88(3), 1031–1069.

Vaghul, K. and B. Zipperer (2016). Historical state and sub-state minimum wage data. *Washington Center for Equitable Growth*.

Wolthoff, R. (2018). Applications and interviews: Firms’ recruiting decisions in a frictional labour market. *The Review of Economic Studies* 85(2), 1314–1351.

Wright, R., P. Kircher, B. Julien, and V. Guerrieri (2021). Directed search and competitive search: A guided tour. *Journal of Economic Literature* 59(1), 90–148.

Wu, L. (2021). Partially directed search in the labor market. *Working Paper*.

Zucman, G. (2014). Taxing across borders: Tracking personal wealth and corporate profits. *Journal of Economic Perspectives* 28(4), 121–48.
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Online Appendix
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A  Additional theoretical results

Firm’s problem  The first-order conditions of a firm of type \( \psi \) are given by

\[
\begin{align*}
  w^s : & \quad (\psi \cdot \phi_s - w^s) \cdot \tilde{q}^s_w = \tilde{\eta}^s, \quad (A.I) \\
  v^s : & \quad (\psi \cdot \phi_s - w^s) \cdot \tilde{q}^s = \eta^s_v, \quad (A.II)
\end{align*}
\]

for \( s \in \{l, h\} \), where \( \phi_s = \partial \psi / \partial n^s \) and arguments are omitted to simplify notation. Is direct from the FOCs that wages are below the marginal productivities, that is, that \( \psi \cdot \phi_s > w^s \). Also, combining both FOCs yields \( \tilde{q}^{s2} = \eta^s_v \cdot \tilde{q}^s_w \). Differentiating and rearranging terms yields

\[
\frac{dw^s}{dv^s} = \eta^s_v \cdot \tilde{q}^s_w \cdot \tilde{q}^s > 0, \quad (A.III)
\]

given \( \tilde{q}^{s2}_w < 0 \).\(^2\) Moreover, differentiating (A.II) yields

\[
(d\psi \cdot \phi_s + \psi \cdot d\phi_s - dw^s) \cdot \tilde{q}^s + (\psi \cdot \phi_s - w^s) \cdot \tilde{q}^{s2}_w \cdot dw^s = \eta^s_v \cdot dv^s. \quad (A.IV)
\]

Note that

\[
d\phi_s = \phi_{ss} \cdot (\tilde{q}^{s2}_w \cdot dw^s \cdot v^s + \tilde{q}^s \cdot dv^s) + \phi_{sj} \cdot (\tilde{q}^{s2}_w \cdot dw^s \cdot v^s + \tilde{q}^s \cdot dv^s), \quad (A.V)
\]

where \( j \) is the other skill-type. Replacing (A.I) and (A.V) in (A.IV), yields

\[
(d\psi \cdot \phi_s + \psi \cdot \phi_{ss} \cdot (\tilde{q}^{s2}_w \cdot dw^s \cdot v^s + \tilde{q}^s \cdot dv^s) + \phi_{sj} \cdot (\tilde{q}^{s2}_w \cdot dw^s \cdot v^s + \tilde{q}^s \cdot dv^s) + \phi_{ss} \cdot (\tilde{q}^{s2}_w \cdot dw^s \cdot v^s + \tilde{q}^s \cdot dv^s)) \cdot \tilde{q}^s = \eta^s_v \cdot dv^s. \quad (A.VI)
\]

\(^2\)Ignoring the superscripts, note that \( \tilde{q}_w = q_\theta \cdot (\partial \theta / \partial w) \), which is positive in equilibrium since \( U \) is fixed. Then

\[
\tilde{q}^{s2}_w = q_\theta \cdot \left( \frac{\partial \theta}{\partial w} \right)^2 + q_\theta \cdot \frac{\partial^2 \theta}{\partial w^2}.
\]

In principle the sign of \( \tilde{q}^{s2}_w \) is ambiguous, since \( q_\theta > 0 \) and \( \partial^2 \theta / \partial w^2 > 0 \). I assume that the second term dominates so \( \tilde{q}^{s2}_w < 0 \). In any case, for the result above, \( \tilde{q}^{s2}_w < 0 \) is a sufficient but not necessary condition, that is, \( \tilde{q}^{s2}_w \) is allowed to be moderately positive, which is plausible since the opposite forces in \( \tilde{q}^{s2}_w \) are interrelated. \( q_\theta > 0 \) follows the concavity and constant returns to scale of the matching function. To see why \( \partial^2 \theta / \partial w^2 > 0 \), recall that

\[
dU = p_\theta \cdot d\theta_m \cdot w_m + p_m \cdot dw_m. \quad \text{Setting } dU = 0 \text{ and differentiating again yields}
\]

\[
0 = \left( w_m \cdot p_\theta \cdot \frac{\partial \theta_m}{\partial w_m} + 2 \cdot p_\theta \right) \frac{\partial \theta_m}{\partial w_m} + p_m \cdot w_m \cdot \frac{\partial^2 \theta_m}{\partial w_m^2},
\]

which implies that \( \partial^2 \theta / \partial w^2 > 0 \).
Setting \( d\psi = 0 \) and rearranging terms gives

\[
\frac{dv^s}{dv^j} = \left[ \phi_{sj} \cdot \left( \tilde{q}^j \cdot \frac{dw^j}{dv^j} \cdot v^j + \tilde{q}^s \right) \right]^{-1} \cdot \left[ \frac{\eta_{sv}^w}{\psi} \cdot \tilde{q}^s - \phi_{ss} \cdot \left( \tilde{q}^s \cdot v^s + \tilde{q}^s \right) \right],
\]

(A.VII)

which, given (A.III), implies that \( \text{sgn} \left( \frac{dv^s}{dv^j} \right) = \text{sgn} \phi_{sj} \). Also, departing from (A.VI), I can write

\[
\frac{dw^s}{d\psi} = \phi_s \cdot \left[ \frac{\eta_{sv}^w}{\tilde{q}^s} \cdot \frac{dv^s}{dw^s} - \psi \cdot \left( \phi_{ss} \cdot \left( \tilde{q}^s \cdot v^s + \tilde{q}^s \cdot \frac{dv^s}{dw^s} \right) + \phi_{sj} \cdot \frac{dv^j}{dw^s} \cdot \left( \tilde{q}^j \cdot \frac{dw^j}{dv^j} \cdot v^j + \tilde{q}^j \right) \right) \right]^{-1}.
\]

(A.VIII)

Note that \( \frac{dw^s}{d\psi} \) is positive provided the cross effects do not dominate.

**Firms’ responses to changes in the minimum wage**  To see the effect of the minimum wage on firms’ decisions, note that the four first order conditions (equations (A.I) and (A.II) for \( s = \{l, h\} \)) hold for firms that are not constrained by the minimum wage, while (A.I) no longer holds for firms that are constrained by the minimum wage. Then, for firms that operate in sub-markets with \( w^l_m > \bar{w} \), it is sufficient to verify the reaction of one of the four endogenous variables to changes in the minimum wage and use the within-firm correlations to predict reactions in the other variables. For firms that operate in sub-markets that \( w^l_m = \bar{w} \), it is necessary to first compute the change in low-skill vacancies and then infer the changes in high-skill vacancies and wages using the within-firm between-skill correlations that still hold for the firm.

In both cases, it is easier to work with equation (A.II) for \( s = l \). For an unconstrained firm, totally differentiating the first order condition and setting \( d\psi = 0 \) yields

\[
\left( \psi \cdot \left[ \phi_{ll} \cdot \left( q_{\theta}^l \cdot d\theta^l \cdot v^l + q^l \cdot dv^l \right) \right] + \phi_{lh} \cdot \left( q_{\theta}^h \cdot d\theta^h \cdot v^h + q^h \cdot dv^h \right) \right) - dw^l \cdot q^l + (\psi \cdot \phi_{l} - w^l) \cdot q_{\theta}^l \cdot d\theta^l = \eta_{lw}^v \cdot dv^l,
\]

where I omitted sub-market sub-indices to simplify notation. Rearranging terms gives

\[
\frac{dw^l}{d\theta^l} = \left[ \frac{dv^l}{dw^l} \cdot \left( \eta_{lw}^v - \psi \cdot \phi_{ll} \cdot q^l - \psi \cdot \phi_{lh} \cdot q^h \cdot \frac{dv^h}{dw^l} \right) + q^l \right] - q_{\theta}^l \cdot (\psi \cdot \phi_{l} - w^l) + \phi_{ll} \cdot q_{\theta}^l \cdot d\theta^l.
\]

(A.IX)

Note that the sign and magnitude of \( \frac{dw^l}{d\bar{w}} \) is ambiguous but is likely to be non-zero since it depends on \( \frac{d\theta^l}{d\bar{w}} \). With the variation in wages it is possible to predict variation in vacancies (and, therefore, firm-size) and spillovers to high-skill workers.
On the other hand, for a constrained firm, totally differentiating the first order condition and setting $d\psi = 0$ yields

$$
\left( \psi \cdot \left[ \phi_h \cdot \left( q^h \cdot d\theta^l \cdot v^l + q^l \cdot dv^l \right) \right] + \phi_h \cdot \left( q^h \cdot d\theta^h \cdot v^h + q^h \cdot dv^h \right) \right) - \frac{d\psi}{d\psi} \cdot q^l \\
+ (\psi \cdot \phi_h - \psi) \cdot q^h \cdot d\theta^l = \eta^l_{vw} \cdot dv^l,
$$

where I omitted sub-market sub-indices to simplify notation. Rearranging terms gives

$$
\frac{dv^l}{dw} \cdot \left( \eta^l_{vw} - \psi \cdot \phi_h \cdot q^2 - \psi \cdot \phi_h \cdot q^h \cdot q^l \cdot \frac{dv^h}{dv^l} \right) = \frac{d\theta^l}{dw} \cdot q^l \cdot \left[ \psi \cdot \phi_l - \psi \cdot \phi_h \cdot q^l \right] \\
+ \frac{d\theta^h}{dw} \cdot q^h \cdot \phi_h \cdot q^l - q^l. \tag{A.X}
$$

Again, the sign is ambiguous but depends on the reaction on equilibrium sub-market tightness. However, note that the first-order effect is decreasing in productivity, since $(\psi \cdot \phi_l - \psi) \rightarrow 0$ as $\psi$ increases. That is, among firms that pay the minimum wage, the least productive ones are more likely to decrease their vacancies, and therefore shrink and eventually close.

Finally, to see the effect of the minimum wage on profits, we can use the envelope theorem and conclude that the total effect is equal to the partial effect ignoring general equilibrium changes. For an unconstrained firm, the first-order effects on profits of changes in the minimum wage are negligible. For constrained firms there is an increase in labor costs and a mechanic increase in job-filling probabilities. Formally

$$
\frac{d\Pi(\psi)}{dw} = \frac{\partial\Pi(\psi)}{\partial\psi} = q^l \cdot \frac{\partial\theta^l}{\partial w^l} \cdot v^l \cdot (\psi \cdot \phi_l - \psi) - v^l \cdot q^l. \tag{A.XI}
$$

This effect is negative given that the first-order condition with respect to low-skill wages holds with inequality and is stronger for less productive firms.

**Employment effects and workers’ welfare** Recall that, in equilibrium, $U^s = p^s_m \cdot w^s_m$. Multiplying by $L^s_m$ at both sides and integrating over $m$ yields $L^s_A \cdot U^s = \int E^s_m w^s_m dm$, where $E^s_m = L^s_m \cdot p^s_m$ is the mass of employed workers of skill $s$ in sub-market $m$. Differentiating gives

$$
\frac{dU^s}{dw} \cdot \left( L^s_A + U^s \cdot \alpha_s \cdot f_s(U^s) \right) = \int \left( \frac{dE^s_m}{dw} \cdot w^s_m + E^s_m \cdot \frac{dw^s_m}{dw} \right) dm, \tag{A.XII}
$$

where I used $L^s_A = \alpha_s \cdot F_s(U^s)$. This implies that I can calculate the wage-weighted disemployment effects, $\int \left( \frac{dE^s_m}{d\psi} \right) w^s_m dm < 0$, that can be tolerated for the minimum wage to still increase
aggregate welfare for workers given information on wage effects.

The converse is probably not true: whenever employment effects for minimum wage workers are positive, \( \frac{dU^l}{d\bar{w}} \) is likely to be positive as well. To see this, recall that \( U^l = p^l_m \cdot \bar{w} \), with \( m \) a sub-market constrained by the minimum wage. Multiplying both sides by \( L^l_m \), differentiating, and doing some algebra, gives the following expression

\[
\frac{dU^l}{d\bar{w}} \cdot \frac{1}{p^l_m} + \varepsilon^L_m - 1 = \varepsilon^E_m, \tag{A.XIII}
\]

where \( \varepsilon^X_m = (dX^l_m/d\bar{w}) \cdot (\bar{w}/X^l_m) \). Then, positive employment elasticities imply that \( \frac{dU^l}{d\bar{w}} > p^l_m \cdot (1 - \varepsilon^L_m) \). This means that a necessary (but not sufficient) condition for positive employment elasticities to be consistent with a decrease in low-skill workers’ welfare is that application elasticities have to be larger than one. That is implausible since when workers change their applications toward the minimum wage sub-market, (i) the employment probability falls, making it less attractive, and (ii) firms in other sub-markets react by changing vacancies and wages. Both factors reduce the incentives to change the application strategy toward minimum wage sub-markets. Therefore, application elasticities are likely to be lower than one given the general equilibrium feedbacks.

**Average welfare weight of capitalists under optimal taxes**  Consider (B.VIII). The FOC w.r.t. \( t \) is given by

\[
\frac{\partial L}{\partial t} = \frac{\partial K_I}{\partial t} \cdot G(y_0) - K \cdot \frac{\partial \psi^*}{\partial t} \cdot G(y_0) \cdot o(\psi^*) - K \cdot \int_{\psi} G(1-t)\Pi(\psi) - \xi)\Pi(\psi)dO(\psi)
\]

\[
+ \gamma \cdot K \cdot \int_{\psi} \Pi(\psi) dO(\psi) - t \cdot K \cdot \frac{\partial \psi^*}{\partial t} \cdot \Pi(\psi^*) \cdot o(\psi^*) - y_0 \cdot \frac{\partial K_I}{\partial t} = 0. \tag{A.XIV}
\]

The first two terms cancel out. Then, the expression can be rewritten as

\[
\gamma \cdot K \cdot \int_{\psi} (1 - g_{\psi}) \Pi(\psi) dO(\psi) = \frac{\partial K_I}{\partial t} (t\Pi(\psi^*) + y_0). \tag{A.XV}
\]

The right-hand-side is negative, which implies that

\[
\int_{\psi} g_{\psi} \omega_{\psi} dO(\psi) < 1, \tag{A.XVI}
\]

where \( \omega_{\psi} = \Pi(\psi)/\int_{\psi} \Pi(\psi) dO(\psi) \) is a profit-based weight.
B Proofs

Proof of Proposition I Replacing \( L_I^l + L_I^h = 1 - L_A^l - L_A^h \), the total derivative with respect to the minimum wage is given by

\[
\frac{dSW}{dw} = \left( \frac{dK_I}{dw} - \frac{dL_A^l}{dw} - \frac{dL_A^h}{dw} \right) \cdot G(0)
\]

\[
+ \alpha_I \cdot G(0) \cdot f_I(U^l) \cdot \frac{dU^l}{dw} + \alpha_I \cdot \frac{dU^l}{dw} \cdot \int_0^{U^l} G'(U^l - c) dF_I(c)
\]

\[
+ \alpha_h \cdot G(0) \cdot f_h(U^h) \cdot \frac{dU^h}{dw} + \alpha_h \cdot \frac{dU^h}{dw} \cdot \int_0^{U^h} G'(U^h - c) dF_h(c)
\]

\[
+ K \cdot \left( \int_{\psi^*} G'(\Pi(\psi) - \xi) \frac{d\Pi(\psi)}{dw} dO(\psi) - \frac{d\psi^*}{dw} \cdot G(0) \cdot o(\psi^*) \right). \tag{B.I}
\]

Note that \( dL_A^s/dw = d(\alpha_s \cdot f_s(U^s))/dw = \alpha_s \cdot f_s(U^s) \cdot (dU^s/dw) \), for \( s \in \{l, h\} \), and that \( dK_I/dw = d(K \cdot O(\psi^*))/dw = K \cdot o(\psi^*) \cdot (d\psi^*/dw) \). Then, (B.I) is reduced to

\[
\frac{dSW}{dw} = \alpha_s \cdot \frac{dU^l}{dw} \cdot \int_0^{U^l} G'(U^l - c) dF_I(c) + \alpha_h \cdot \frac{dU^h}{dw} \cdot \int_0^{U^h} G'(U^h - c) dF_h(c)
\]

\[
+ K \cdot \int_{\psi^*} G'(\Pi(\psi) - \xi) \frac{d\Pi(\psi)}{dw} dO(\psi). \tag{B.II}
\]

Using the marginal welfare weights definitions, (B.II) is reduced to

\[
\frac{dSW}{dw} = \gamma \cdot \left( \frac{dU^l}{dw} \cdot L^l \cdot g_1 + \frac{dU^h}{dw} \cdot L^h \cdot g^h + K \cdot \int_{\psi^*} g_\psi \frac{d\Pi(\psi)}{dw} dO(\psi) \right). \tag{B.III}
\]

Proof of Proposition II The Lagrangian is given by

\[
\mathcal{L}(w, y_0) = \left( L_I^l + L_I^h + K_I \right) \cdot G(y_0)
\]

\[
+ \alpha_I \cdot \int_0^{U^l - y_0} G(U^l - c) dF_I(c) + \alpha_h \cdot \int_0^{U^h - y_0} G(U^h - c) dF_h(c)
\]

\[
+ K \cdot \int_{\psi^*} G((1 - t)\Pi(\psi) - \xi) dO(\psi) + \gamma \cdot \left[ \int \left( E_{m}^l T(w^l_m) + E_{m}^h T(w^h_m) \right) dm 
\]

\[
+ t \cdot K \cdot \int_{\psi^*} \Pi(\psi) dO(\psi) - y_0 \left( L_I^l + L_I^h + K_I + \rho^l \cdot L_A^l + \rho^h \cdot L_A^h \right) \right], \tag{B.IV}
\]
Using the social marginal weights definitions, and grouping common terms, (B.VI) can be written

\[ L(\bar{w}, y_0) = \left( L^l_I + L^h_I + K_I \right) \cdot G(y_0) \]

\[ + \alpha_l \int_{U^l - y_0}^U G(U^l - c) dF_l(c) \]

\[ + \alpha_h \int_{U^h - y_0}^U G(U^h - c) dF_h(c) \]

\[ + K \cdot \left[ \int_{\bar{\psi}^{*}} \psi^{*} \cdot G\left(1 - t\right)\Pi(\psi) - \xi \left(1 - t\right) d\Pi(\psi) \right] \cdot \left[ \int_{0}^{\psi^{*}} \alpha^{*} \cdot \Pi(\psi)\cdot dO(\psi) - G(y_0) \cdot \alpha(\psi^{*}) \cdot \frac{d\psi^{*}}{\bar{w}} \right] \]

\[ + E_m^h(T(u^h_m) + y_0) \cdot dm + t \cdot K \cdot \left[ \int_{\psi^{*}}^{\bar{\psi}^{*}} \psi^{*} \cdot G\left(1 - t\right)\Pi(\psi) - \xi \left(1 - t\right) d\Pi(\psi) \right] \cdot \left[ \int_{0}^{\psi^{*}} \alpha^{*} \cdot \Pi(\psi)\cdot dO(\psi) - G(y_0) \cdot \alpha(\psi^{*}) \cdot \frac{d\psi^{*}}{\bar{w}} \right] \cdot \left( \int_{\psi^{*}}^{\bar{\psi}^{*}} \Pi(\psi)\cdot dO(\psi) - G(y_0) \cdot \alpha(\psi^{*}) \cdot \frac{d\psi^{*}}{\bar{w}} \right) - y_0 \cdot \frac{dK_I}{\bar{w}} \].

The derivative with respect to \( \bar{w} \), taking \( y_0, t, \) and \( T(\cdot) \) as given, is given by

\[ \frac{dL}{d\bar{w}} = \left( \frac{dK_I}{\bar{w}} - \frac{dL_A^s}{\bar{w}} - \frac{dL_A^h}{\bar{w}} \right) \cdot G(y_0) \]

\[ + G(y_0) \cdot \alpha_l \cdot f_l(U^l - y_0) \cdot \frac{dU^l}{d\bar{w}} + \alpha_l \cdot \frac{dU^l}{d\bar{w}} \cdot \int_{0}^{U^l - y_0} G'\left(U^l - c\right) dF_l(c) \]

\[ + G(y_0) \cdot \alpha_h \cdot f_h(U^h - y_0) \cdot \frac{dU^h}{d\bar{w}} + \alpha_h \cdot \frac{dU^h}{d\bar{w}} \cdot \int_{0}^{U^h - y_0} G'\left(U^h - c\right) dF_h(c) \]

\[ + K \cdot \left[ \int_{\psi^{*}}^{\bar{\psi}^{*}} G'\left(1 - t\right)\Pi(\psi) - \xi \left(1 - t\right) d\Pi(\psi) \right] \cdot \left[ \int_{0}^{\psi^{*}} \alpha^{*} \cdot \Pi(\psi)\cdot dO(\psi) - G(y_0) \cdot \alpha(\psi^{*}) \cdot \frac{d\psi^{*}}{\bar{w}} \right] \]

\[ + E_m^h(T(u^h_m) + y_0) \cdot \frac{dE_m^h}{d\bar{w}} \left( T(u^h_m) + y_0 \right) + E_m^h T'(u^h_m) \left( \frac{du^h_m}{d\bar{w}} \right) \]

\[ + t \cdot K \cdot \left( \int_{\psi^{*}}^{\bar{\psi}^{*}} \Pi(\psi)\cdot dO(\psi) - \Pi(\psi^{*}) \cdot \alpha(\psi^{*}) \cdot \frac{d\psi^{*}}{d\bar{w}} \right) - y_0 \cdot \frac{dK_I}{d\bar{w}} \].

Recall that \( \frac{dK_I}{d\bar{w}} = K \cdot \alpha(\psi^{*}) \cdot \frac{d\psi^{*}}{d\bar{w}} \) and \( \frac{dL_A^s}{d\bar{w}} = \alpha_s \cdot f_s(U^s - y_0) \cdot \left( \frac{dU^s}{d\bar{w}} \right) \) for \( s \in \{l, h\} \).

Using the social marginal weights definitions, and grouping common terms, (B.VI) can be written
as
\[
\frac{dL}{d\psi} \cdot \frac{1}{\gamma} = \frac{dU^l}{d\psi} \cdot L^l \cdot g_1^l + \frac{dU^h}{d\psi} \cdot L^h \cdot g_1^h + K \cdot (1-t) \cdot \int_{\psi^*} \psi g_{\psi^*} dO(\psi)
\]
\[
+ \int \left( \frac{dE^l_m}{d\psi} \left( T(w^l_m) + y_0 \right) + E^l_m T'(w^l_m) \frac{dw^l_m}{d\psi} \right) dm
\]
\[
+ \int \left( \frac{dE^h_m}{d\psi} \left( T(w^h_m) + y_0 \right) + E^h_m T'(w^h_m) \frac{dw^h_m}{d\psi} \right) dm
\]
\[
+ t \cdot K \cdot \int_{\psi^*} \psi g_{\psi^*} dO(\psi) - \frac{dK_I}{d\psi} \cdot (t \cdot \Pi(\psi^*) + y_0).
\] (B.VII)

**Proof of Proposition III** As standard in optimal taxation problems, I assume that the planner optimizes allocations instead of taxes. That is, the planner chooses
\[
\Delta y^s_m = y^s_m - y_0,
\]
for all \(m\) and \(s \in \{l, h\}\), and then recover taxes by noting that
\[
T(w^s_m) + y_0 = w^s_m - \Delta y^s_m.
\]
This implies that the Lagrangian is given by
\[
L(w, \{\Delta y^s_m\}, y_0) = (L^l_I + L^h_I + K_I) \cdot G(y_0)
\]
\[
+ \alpha_l \cdot \int_0^{U^l - y_0} G(U^l - c)dF_l(c) + \alpha_h \cdot \int_0^{U^h - y_0} G(U^h - c)dF_h(c)
\]
\[
+ K \cdot \int_{\psi^*} \frac{d\Pi(\psi)}{d\psi} dO(\psi)
\]
\[
+ t \cdot K \cdot \int_{\psi^*} \psi g_{\psi^*} dO(\psi) - y_0 \cdot (1 + K_I).
\] (B.VIII)

There are two main differences w.r.t. to the first-order condition derived for Proposition II. First, now the planner takes partial derivatives rather than total derivatives, leaving \(\Delta y^s_m\) constant, for all \(m\) and \(s \in \{l, h\}\) when choosing the minimum wage. This implies that the relevant elasticities are micro rather than macro elasticities. Second, this transformation affects the term in the budget constraint that previously contained \(T(\cdot)\). This implies that the optimality condition of
the minimum wage can be written as

\[
\frac{\partial L}{\partial w} \cdot \frac{1}{\gamma} = \frac{\partial U}{\partial w} \cdot L_A \cdot g^l + \frac{\partial U}{\partial w} \cdot L_A \cdot g^h + K \cdot (1 - t) \cdot \int_{\psi^{*}} \left( g_{\psi} \frac{\partial \Pi(\psi)}{\partial w} dO(\psi) \right) \\
+ \int \left( \frac{\partial E}{\partial w} \left( T(w_m^l) + y_0 \right) + E_{m} \frac{\partial w_{m}^l}{\partial w} \right) dm \\
+ \int \left( \frac{\partial E}{\partial w} \left( T(w_m^h) + y_0 \right) + E_{m} \frac{\partial w_{m}^h}{\partial w} \right) dm \\
+ t \cdot K \cdot \int_{\psi^{*}} \left( \frac{\partial \Pi(\psi)}{\partial w} dO(\psi) - \frac{\partial K}{\partial w} \cdot (t \cdot \Pi(\psi^*) + y_0) \right). 
\]

See the main text for a discussion on micro versus macro elasticities. □
C Additional figures and tables and robustness checks

Figure C.I: State-level real minimum wage increase by event

Notes: These figures plot the estimated $\beta_\tau$ coefficients with their corresponding 95% confidence intervals from equation (13) using both census-region- and census-division-by-year-by-event fixed effects and the log of the real hourly state-level minimum wage as a dependent variable. An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population.

Table C.I: Differences in differences estimates of Figure C.I

| Post x Treated | 0.106 | 0.092 |
|---------------|-------|-------|
|               | (0.008) | (0.009) |
| Census-region time-by-event FE | Yes | No |
| Census-division time-by-event FE | No | Yes |
| Observations  | 18,386 | 17,521 |
| Adj. R-squared | 0.971 | 0.978 |

Notes: This table shows the estimated $\beta$ coefficient from equation (14). The dependent variable is the log of the real hourly state-level minimum wage. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.I. Standard errors (in parenthesis) are clustered at the state level and regressions are weighted by state-by-year population.
### Table C.II: Differences in differences estimates by industry

#### Panel (a): Census-region-specific time-by-event fixed effects

|                     | All   | Primary | Services | Manuf. | Constr. | Retail | Finance |
|---------------------|-------|---------|----------|--------|---------|--------|---------|
| Post x Treated      | -0.023| -0.026  | -0.011   | 0.001  | -0.070  | 0.002  | -0.012  |
|                     | (0.012)| (0.041) | (0.011)  | (0.043) | (0.047) | (0.015) | (0.013) |
| Observations        | 13,436| 13,273  | 13,387   | 13,392 | 13,408  | 13,436 | 13,436  |
| Adj. R-squared      | 0.936 | 0.942   | 0.977    | 0.947  | 0.910   | 0.950  | 0.974   |

#### Panel (b): Census-division-specific time-by-event fixed effects

|                     | All   | Primary | Services | Manuf. | Constr. | Retail | Finance |
|---------------------|-------|---------|----------|--------|---------|--------|---------|
| Post x Treated      | -0.030| -0.098  | -0.004   | -0.051 | -0.074  | -0.008 | -0.007  |
|                     | (0.014)| (0.053) | (0.012)  | (0.049) | (0.052) | (0.014) | (0.016) |
| Observations        | 12,724| 12,549  | 12,676   | 12,680 | 12,694  | 12,724 | 12,724  |
| Adj. R-squared      | 0.959 | 0.958   | 0.977    | 0.959  | 0.932   | 0.963  | 0.971   |

Notes: This table reproduces Table 1 results of profits per establishment considering industry heterogeneity. That is, this table shows the estimated $\beta$ coefficient from equation (14) using gross operating surplus by private establishment as a dependent variable. Since QCEW data on private establishments by industry, regressions consider data starting 1990. For ensuring balance, only events between 1994 and 2015 are considered. The first column reproduces the main result of Table 1 with the additional time restriction. The rest of the columns use the log of the gross operating surplus per establishment of different industries as dependent variable. Before 1997, BEA regional accounts classified industries using SIC. In 1997, the classification switched to NAIC. QCEW files use NAIC codes the whole period. Given that, I focus on broad industry categories. Primary includes agriculture, forestry, fishing, hunting, and mining. Services include professional and business services, educational services, health care, arts, entertainment, recreation, accommodation, and food services. Manuf. includes durable and nondurable goods manufacturing. Constr. includes construction. Retail includes retail trade. Finance includes finance, insurance, real estate, rental, and leasing. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure 3. Standard errors (in parenthesis) are clustered at the state level.
Figure C.II: Alternative event study estimators

(a) Low-skill workers

(b) High-skill workers

(c) Gross operating surplus per establishment

Notes: These figures estimate the main specifications using alternative event study estimators. Borusyak et al. (2021) model is estimated using the did_imputation package and drops observations for which fixed-effects cannot be imputed. Callaway and Sant’Anna (2020) model is estimated using the csdid package and consider the not yet treated as part of the control group. I thank Fernando Rios-Avila for help with the code. De Chaisemartin and d’Haultfoeuille (2020) model is estimated using the did_multiplegt package, and consider 100 bootstrap repetitions for the standard errors. Finally, Sun and Abraham (2020) model is estimated using the eventstudyinteract package with the interaction-weighted version. The figures are computed using the eventplot package. All models include state and census-division-by-year fixed effects, except the Callaway and Sant’Anna (2020) estimator that only includes state and year fixed effects. The dependent variables are the log of the average wage of active workers (including the unemployed) and the log of firm-level profits as a dependent variable. Then, these regressions estimate \( \frac{\log U_l}{\log w} \), \( \frac{\log U_h}{\log w} \), and \( \frac{\log \Pi(\psi)}{\log w} \) as discussed in the main text. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS and excludes microdata with imputed information. Panel (a) estimates the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panel (b) estimates the regression for high-skill workers, where high-skill individuals are defined as having a college degree. Panel (c) proxies average profits using the total gross operating surplus taken from the BEA regional accounts normalized by the number of private establishments reported in the QCEW data files. An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that took place between 2000 and 2015 and only consider the first event for states with multiple events. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.
Table C.III: Differences in differences estimates

| Panel (a): Low-skill workers | BJS    | CS     | dCdH   | SA     |
|-----------------------------|--------|--------|--------|--------|
| Post x Treated              | 0.017  | 0.020  | 0.025  | 0.011  |
|                             | (0.006)| (0.006)| (0.008)| (0.005)|
| Observations                | 858    | 1224   | 1555   | 1224   |

| Panel (b): High-skill workers | BJS    | CS     | dCdH   | SA     |
|-------------------------------|--------|--------|--------|--------|
| Post x Treated                | -0.006 | -0.009 | -0.008 | -0.015 |
|                              | (0.007)| (0.008)| (0.008)| (0.007)|
| Observations                  | 880    | 1224   | 1555   | 1224   |

| Panel (c): Profits per establishment | BJS    | CS     | dCdH   | SA     |
|--------------------------------------|--------|--------|--------|--------|
| Post x Treated                       | -0.058 | -0.028 | -0.040 | -0.064 |
|                                     | (0.016)| (0.016)| (0.018)| (0.016)|
| Observations                         | 858    | 1224   | 1555   | 1224   |

Notes: This table shows the average treatment effect in the four years after the event computed by different methods. That is, point estimates are the average $\beta_\tau$ from $\tau = 0$ to $\tau = 4$ as reported in Figure C.II. All columns represent different estimators. BJS accounts for Borusyak et al. (2021), CS accounts for Callaway and Sant’Anna (2020), dCdH accounts for De Chaisemartin and d’Haultfoeuille (2020), and SA accounts for Sun and Abraham (2020). All panels represent different dependent variables, all in logarithms. Low-skill workers and High-skill workers use the average wage of active low- and high-skill workers, respectively. Profits per est. uses gross operating surplus by private establishment. Additional details on data sources, variable definitions, and technical details for the different implementations, see notes of Figure C.II. Standard errors (in parenthesis) are clustered at the state level and build from the event study estimates and regressions are weighted by state-by-year population.
Figure C.III: Event studies with census-division-specific time-by-event fixed effects

Notes: These figures reproduce Figure 2 and 3 using census-division-by-year-by-event fixed effects. That is, these figures plot the estimated $\beta$ coefficients with their corresponding 95% confidence intervals from equation (13) using the log of the average wage of active workers (including the unemployed) and the log of firm-level profits as a dependent variable. Then, these regressions estimate $d\log U^l/dw$, $d\log U^h/dw$, and $d\log \Pi(\psi)/dw$ as discussed in the main text. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 and excludes microdata with imputed information. Panel (a) estimates the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panel (b) estimates the regression for high-skill workers, where high-skill individuals are defined as having a college degree. Panel (c) proxies average profits using the total gross operating surplus taken from the BEA regional accounts normalized by the number of private establishments reported in the QCEW data files. Panel (d) proxies average profits by the ratio of total corporate profits to total sales estimated using the Census Annual Survey of State Government Tax Collection Datasets combined with tax rates data from Suárez Serrato and Zidar (2016). An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.
Figure C.IV: Effects of minimum wage increases on number of establishments

(a) Census-region-specific time-by-event fixed effects

(b) Census-division-specific time-by-event fixed effects

Notes: These figures plot the estimated $\beta_\tau$ coefficients with their corresponding 95% confidence intervals from equation (13) using both census-region- and census-division-by-year-by-event fixed effects and the log of the number of private establishments reported in the QCEW data files. An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.

Table C.IV: Differences in differences estimates of Figure C.IV

|                       | Post x Treated | Census-region time-by-event FE | Census-division time-by-event FE | Observations | Adj. R-squared |
|-----------------------|---------------|--------------------------------|---------------------------------|--------------|----------------|
|                       | 0.020         | Yes                            | No                              | 18,386       | 0.999          |
|                       | (0.008)       | (0.008)                         |                                 | 17,521       |                |

Notes: This table shows the estimated $\beta$ coefficient from equation (14). The dependent variable is the log of the average number of private establishments by state-by-year reported in the QCEW data files. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.IV. Standard errors (in parenthesis) are clustered at the state level and regressions are weighted by state-by-year population.
Figure C.V: Main results with working-age population weights

Notes: These figures reproduce Figure 2 and 3 using both census-region- and census-division-by-year-by-event fixed effects changing the regression weights for the average working-age population computed using the monthly CPS files. That is, these figures plot the estimated $\beta_\tau$ coefficients with their corresponding 95% confidence intervals from equation (13) using the log of the average wage of active workers (including the unemployed) and the log of firm-level profits as a dependent variable. Then, these regressions estimate $d \log U_l / dw$, $d \log U_h / dw$, and $d \log \Pi(\psi) / dw$ as discussed in the main text. CR and CD identify whether the figure is estimated using census-region or census-division-specific time-by-event fixed effects. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 and excludes microdata with imputed information. Panels (a) and (b) estimate the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panels (c) and (d) estimate the regression for high-skill workers, where high-skill individuals are defined as having a college degree. Panels (e) and (f) proxy average profits using the total gross operating surplus taken from the BEA regional accounts normalized by the number of private establishments reported in the QCEW data files. Panels (g) and (h) proxy average profits by the ratio of total corporate profits to total sales estimated using the Census Annual Survey of State Government Tax Collection Datasets combined with tax rates data from Suárez Serrato and Zidar (2016). An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level.
Table C.V: Differences in differences estimates of Figure C.V

Panel (a): Census-region-specific time-by-event fixed effects

|                  | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|------------------|-------------------|--------------------|------------------|---------------|
| Post x Treated   | 0.023             | 0.003              | -0.023           | -0.112        |
|                  | (0.005)           | (0.005)            | (0.011)          | (0.061)       |
| Observations     | 17,586            | 17,586             | 18,386           | 8,700         |
| Adj. R-squared   | 0.978             | 0.909              | 0.942            | 0.918         |

Panel (b): Census-division-specific time-by-event fixed effects

|                  | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|------------------|-------------------|--------------------|------------------|---------------|
| Post x Treated   | 0.016             | -0.001             | -0.024           | -0.152        |
|                  | (0.005)           | (0.006)            | (0.013)          | (0.056)       |
| Observations     | 16,736            | 16,736             | 17,521           | 8,449         |
| Adj. R-squared   | 0.979             | 0.912              | 0.961            | 0.929         |

Notes: This table reproduces Table 1 changing the regression weights for the average working-age population computed using the monthly CPS files. That is, this table shows the estimated β coefficient from equation (14). All columns represent different regressions using different dependent variables, all in logarithms. Low-skill workers and High-skill workers use the average wage of active low- and high-skill workers, respectively. Profits per est. uses gross operating surplus by private establishment. Profit margin uses the average profit margin. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.V. Standard errors (in parenthesis) are clustered at the state level.
Figure C.VI: Main results with no time-varying controls

Notes: These figures reproduce Figure 2 and 3 using both census-region- and census-division-by-year-by-event fixed effects excluding controls. That is, these figures plot the estimated $\beta_\tau$ coefficients with their corresponding 95% confidence intervals from equation (13) using the log of the average wage of active workers (including the unemployed) and the log of firm-level profits as a dependent variable excluding $\rho_{ite}$. Then, these regressions estimate $d \log U^i/d\bar{w}$, $d \log U^h/d\bar{w}$, and $d \log \Pi(\psi)/d\bar{w}$ as discussed in the main text. CR and CD identify whether the figure is estimated using census-region or census-division-specific time-by-event fixed effects. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 and excludes microdata with imputed information. Panels (a) and (b) estimate the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panels (c) and (d) estimate the regression for high-skill workers, where high-skill individuals are defined as having a college degree. Panels (e) and (f) proxy average profits using the total gross operating surplus taken from the BEA regional accounts normalized by the number of private establishments reported in the QCEW data files. Panels (g) and (h) proxy average profits by the ratio of total corporate profits to total sales estimated using the Census Annual Survey of State Government Tax Collection Datasets combined with tax rates data from Suárez Serrato and Zidar (2016). An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level.
Table C.VI: Differences in differences estimates of Figure C.VI

### Panel (a): Census-region-specific time-by-event fixed effects

|                     | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|---------------------|-------------------|--------------------|------------------|--------------|
| Post x Treated      | 0.022             | -0.002             | -0.034           | -0.175       |
|                     | (0.004)           | (0.004)            | (0.012)          | (0.075)      |
| Observations        | 17,588            | 17,588             | 18,387           | 8,703        |
| Adj. R-squared      | 0.978             | 0.909              | 0.942            | 0.917        |

### Panel (b): Census-division-specific time-by-event fixed effects

|                     | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|---------------------|-------------------|--------------------|------------------|--------------|
| Post x Treated      | 0.015             | -0.006             | -0.023           | -0.160       |
|                     | (0.004)           | (0.005)            | (0.012)          | (0.063)      |
| Observations        | 16,739            | 16,739             | 17,523           | 8,451        |
| Adj. R-squared      | 0.979             | 0.911              | 0.960            | 0.928        |

Notes: This table reproduces Table 1 excluding time-varying controls. That is, this table shows the estimated $\beta$ coefficient from equation (14) excluding $\rho_{ite}$. All columns represent different regressions using different dependent variables, all in logarithms. Low-skill workers and High-skill workers use the average wage of active low- and high-skill workers, respectively. Profits per est. uses gross operating surplus by private establishment. Profit margin uses the average profit margin. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.V. Standard errors (in parenthesis) are clustered at the state level.
Figure C.VII: Main results including events in pre-period

Notes: These figures reproduce Figure 2 and 3 using both census-region- and census-division-by-year-by-event fixed effects including events in which treated states had additional treatments in the pre-event window. That is, these figures plot the estimated $\beta_\tau$ coefficients with their corresponding 95% confidence intervals from equation (13) using the log of the average wage of active workers (including the unemployed) and the log of firm-level profits as a dependent variable. Then, these regressions estimate $d \log U_l/dw$, $d \log U_h/dw$, and $d \log \Pi(\psi)/dw$ as discussed in the main text. CR and CD identify whether the figure is estimated using census-region or census-division time-by-event fixed effects. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 and excludes microdata with imputed information. Panels (a) and (b) estimate the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panels (c) and (d) estimate the regression for high-skill workers, where high-skill individuals are defined as having a college degree. Panels (e) and (f) proxy average profits using the total gross operating surplus taken from the BEA regional accounts normalized by the number of private establishments reported in the QCEW data files. Panels (g) and (h) proxy average profits by the ratio of total corporate profits to total sales estimated using the Census Annual Survey of State Government Tax Collection Datasets combined with tax rates data from Suárez Serrato and Zidar (2016). An event is defined as a state-level hourly minimum wage increase between 1983 and 2015 above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.
Table C.VII: Differences in differences estimates of Figure C.VII

Panel (a): Census-region-specific time-by-event fixed effects

|                      | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|----------------------|-------------------|--------------------|------------------|--------------|
| Post x Treated       | 0.024             | 0.004              | -0.024           | -0.054       |
|                      | (0.004)           | (0.004)            | (0.010)          | (0.052)      |
| Observations         | 30,402            | 30,402             | 32,204           | 17,097       |
| Adj. R-squared       | 0.975             | 0.911              | 0.942            | 0.916        |

Panel (b): Census-division-specific time-by-event fixed effects

|                      | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|----------------------|-------------------|--------------------|------------------|--------------|
| Post x Treated       | 0.018             | 0.002              | -0.023           | -0.153       |
|                      | (0.004)           | (0.005)            | (0.015)          | (0.056)      |
| Observations         | 29,004            | 29,004             | 30,771           | 16,575       |
| Adj. R-squared       | 0.976             | 0.914              | 0.958            | 0.924        |

Notes: This table reproduces Table 1 including events in which treated states had additional treatments in the pre-event window. That is, this table shows the estimated $\beta$ coefficient from equation (14). All columns represent different regressions using different dependent variables, all in logarithms. Low-skill workers and High-skill workers use the average wage of active low- and high-skill workers, respectively. Profits per est. uses gross operating surplus by private establishment. Profit margin uses the average profit margin. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.VII. Standard errors (in parenthesis) are clustered at the state level and regressions are weighted by state-by-year population.
Figure C.VIII: Main results including all events

(a) Low-skill workers (CR)

(b) Low-skill workers (CD)

(c) High-skill workers (CR)

(d) High-skill workers (CD)

(e) Gross operating surplus per establishment (CR)

(f) Gross operating surplus per establishment (CD)

(g) Profit margin (CR)

(h) Profit margin (CD)

Notes: Notes: These figures reproduce Figure 2 and 3 using both census-region- and census-division-by-year-by-event fixed effects including all events. That is, these figures plot the estimated \( \beta \) coefficients with their corresponding 95% confidence intervals from equation (13) using the log of the average wage of active workers (including the unemployed) and the log of firm-level profits as a dependent variable. Then, these regressions estimate \( \frac{d \log U^l}{d w}, \frac{d \log U^h}{d w}, \) and \( \frac{d \log \Pi(\psi)}{d w} \) as discussed in the main text. CR and CD identify whether the figure is estimated using census-region or census-division-specific time-by-event fixed effects. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 and excludes microdata with imputed information. Panels (a) and (b) estimate the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panels (c) and (d) estimate the regression for high-skill workers, where high-skill individuals are defined as having a college degree. Panels (e) and (f) proxy average profits using the total gross operating surplus taken from the BEA regional accounts normalized by the number of private establishments reported in the QCEW data files. Panels (g) and (h) proxy average profits by the ratio of total corporate profits to total sales estimated using the Census Annual Survey of State Government Tax Collection Datasets combined with tax rates data from Suárez Serrato and Zidar (2016). An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.
Table C.VIII: Differences in differences estimates of Figure C.VIII

Panel (a): Census-region-specific time-by-event fixed effects

|                  | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|------------------|-------------------|--------------------|------------------|--------------|
| Post x Treated   | 0.030 (0.004)     | 0.003 (0.004)      | -0.013 (0.009)   | -0.114 (0.059) |
| Observations     | 39,677            | 39,677             | 41,479           | 21,166       |
| Adj. R-squared   | 0.974             | 0.912              | 0.947            | 0.906        |

Panel (b): Census-division-specific time-by-event fixed effects

|                  | Low-skill workers | High-skill workers | Profits per est. | Profit margin |
|------------------|-------------------|--------------------|------------------|--------------|
| Post x Treated   | 0.024 (0.005)     | -0.001 (0.004)     | -0.016 (0.012)   | -0.208 (0.061) |
| Observations     | 37,668            | 37,668             | 39,435           | 20,423       |
| Adj. R-squared   | 0.974             | 0.913              | 0.964            | 0.915        |

Notes: This table reproduces Table 1 including all events. That is, this table shows the estimated $\beta$ coefficient from equation (14). All columns represent different regressions using different dependent variables, all in logarithms. Low-skill workers and High-skill workers use the average wage of active low- and high-skill workers, respectively. Profits per est. uses gross operating surplus by private establishment. Profit margin uses the average profit margin. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.VIII. Standard errors (in parenthesis) are clustered at the state level and regressions are weighted by state-by-year population.
Figure C.IX: Estimating \( d \log U^l/dw \) and \( d \log U^h/dw \) including imputed data

Notes: These figures reproduce Figure 2 using both census-region- and census-division-by-year-by-event fixed effects using imputed microdata for computing average wages. That is, these figures plot the estimated \( \beta_t \) coefficients with their corresponding 95% confidence intervals from equation (13) using census-region-by-year-by-event fixed effects and the log of the average wage of active workers (including the unemployed) as a dependent variable. Then, these regressions estimate \( d \log U^l/dw \) and \( d \log U^h/dw \) as discussed in the main text. CR and CD identify whether the figure is estimated using census-region or census-division-specific time-by-event fixed effects. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 including microdata with imputed information. Panels (a) and (b) estimate the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panels (c) and (d) estimate the regression for high-skill workers, where high-skill individuals are defined as having a college degree. An event is defined as a state-level hourly minimum wage increase above the federal level of at least \$0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.
Table C.IX: Differences in differences estimates of Figure C.IX

|                     | Low-skill workers | Low-skill workers | High-skill workers | High-skill workers |
|---------------------|-------------------|-------------------|--------------------|--------------------|
| Post x Treated      | 0.018             | 0.013             | -0.001             | -0.005             |
|                     | (0.003)           | (0.003)           | (0.003)            | (0.004)            |
| Census-region time-by-event FE | Yes | No | Yes | No |
| Census-division time-by-event FE | No | Yes | No | Yes |
| Observations        | 18,386            | 17,521            | 18,386             | 17,521             |
| Adj. R-squared      | 0.986             | 0.987             | 0.895              | 0.903              |

Notes: This table reproduces Table 1 results on workers’ welfare considering the microdata with imputed information for computing the average wages. That is, this table shows the estimated $\beta$ coefficient from equation (14). Low-skill workers and High-skill workers use the log of the average wage of active low- and high-skill workers, respectively, as a dependent variable. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.IX. Standard errors (in parenthesis) are clustered at the state level.
Figure C.X: Alternative low-skill definitions

(a) Hourly wage ≤ 2 times federal minimum wage (CR)
(b) Hourly wage ≤ 2 times federal minimum wage (CD)
(c) Hourly wage ≤ 3 times federal minimum wage (CR)
(d) Hourly wage ≤ 3 times federal minimum wage (CD)
(e) Age ≤ 25 (CR)
(f) Age ≤ 25 (CD)
(g) Age ≤ 35 (CR)
(h) Age ≤ 35 (CD)

Notes: These figures reproduce Figure 2 using both census-region- and census-division-by-year-by-event fixed effects using alternative definitions of low-skill workers. That is, these figures plot the estimated $\beta_\tau$ coefficients with their corresponding 95% confidence intervals from equation (13) using census-region-by-year-by-event fixed effects and the log of the average wage of low-skill active workers (including the unemployed) as a dependent variable. Then, these regressions estimate $d \log U_l / dw$ as discussed in the main text. $CR$ and $CD$ identify whether the figure is estimated using census-region or census-division-specific time-by-event fixed effects. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 and excludes microdata with imputed information. Panels (a) and (b) define low-skill individuals as high school or less, less than 30 years old, and with wages lower or equal than 2 times the federal minimum wage. Panels (c) and (d) define low-skill individuals as high school or less, less than 30 years old, and with wages lower or equal than 3 times the federal minimum wage. Panels (e) and (f) define low-skill individuals as high school or less, less than 25 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panels (g) and (h) define low-skill individuals as high school or less, less than 35 years old, and with wages lower or equal than 2.5 times the federal minimum wage. An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.
Table C.X: Differences in differences estimates of Figure C.X

Panel (a): Census-region-specific time-by-event fixed effects

|                     | $w \leq 2 \times \text{FMW}$ | $w \leq 3 \times \text{FMW}$ | $\text{Age} \leq 25$ | $\text{Age} \leq 35$ |
|---------------------|-----------------------------|-----------------------------|----------------------|----------------------|
| Post x Treated      | 0.010                       | 0.022                       | 0.024                | 0.018                |
|                     | (0.006)                     | (0.005)                     | (0.005)              | (0.004)              |
| Observations        | 17,586                      | 17,586                      | 17,586               | 17,586               |
| Adj. R-squared      | 0.982                       | 0.965                       | 0.966                | 0.984                |

Panel (b): Census-division-specific time-by-event fixed effects

|                     | $w \leq 2 \times \text{FMW}$ | $w \leq 3 \times \text{FMW}$ | $\text{Age} \leq 25$ | $\text{Age} \leq 35$ |
|---------------------|-----------------------------|-----------------------------|----------------------|----------------------|
| Post x Treated      | 0.016                       | 0.015                       | 0.016                | 0.011                |
|                     | (0.007)                     | (0.005)                     | (0.004)              | (0.004)              |
| Observations        | 16,736                      | 16,736                      | 16,736               | 16,736               |
| Adj. R-squared      | 0.984                       | 0.967                       | 0.967                | 0.986                |

Notes: This table reproduces Table 1 results on low-skill workers welfare changing the definition of low-skill workers. That is, this table shows the estimated $\beta$ coefficient from equation (14). $w \leq 2 \times \text{FMW}$ defines low-skill individuals as high school or less, less than 30 years old, and with wages lower or equal than 2 times the federal minimum wage. $w \leq 3 \times \text{FMW}$ defines low-skill individuals as high school or less, less than 30 years old, and with wages lower or equal than 3 times the federal minimum wage. $\text{Age} \leq 25$ defines low-skill individuals as high school or less, less than 25 years old, and with wages lower or equal than 2.5 times the federal minimum wage. $\text{Age} \leq 35$ defines low-skill individuals as high school or less, less than 25 years old, and with wages lower or equal than 2.5 times the federal minimum wage. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.X. Standard errors (in parenthesis) are clustered at the state level.
Notes: These figures reproduce Figure 2 using both census-region- and census-division-by-year-by-event fixed effects using alternative definitions of high-skill workers. That is, these figures plot the estimated $\beta$ coefficients with their corresponding 95% confidence intervals from equation (13) using census-region-by-year-by-event fixed effects and the log of the average wage of high-skill active workers (including the unemployed) as a dependent variable. Then, these regressions estimate $d\log U^h/dw$ as discussed in the main text. CR and CD identify whether the figure is estimated using census-region or census-division-specific time-by-event fixed effects. The average wage of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 and excludes microdata with imputed information. Panels (a) and (b) define high-skill individuals as having a college degree and less than 30 years old. Panels (c) and (d) define high-skill individuals as having a college degree and wages lower or equal than 25 times the federal minimum wage. An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.
Table C.XI: Differences in differences estimates of Figure C.XI

|                                      | Age ≥ 30 | Age ≥ 30 | w ≤ 25×FMW | w ≤ 25×FMW |
|--------------------------------------|----------|----------|-------------|-------------|
| Post x Treated                       | -0.009   | -0.025   | 0.003       | -0.004      |
|                                      | (0.012)  | (0.016)  | (0.004)     | (0.005)     |
| Census-region time-by-event FE       | Yes      | No       | Yes         | No          |
| Census-division time-by-event FE     | No       | Yes      | No          | Yes         |
| Observations                         | 17,586   | 16,736   | 17,586      | 16,736      |
| Adj. R-squared                       | 0.663    | 0.696    | 0.946       | 0.944       |

Notes: This table reproduces Table 1 results on high-skill workers welfare changing the definition of high-skill workers. That is, this table shows the estimated β coefficient from equation (14). Age ≥ 30 defines high-skill individuals as having a college degree and less than 30 years old. w ≤ 25×FMW defines high-skill individuals as having a college degree and wages lower or equal than 25 times the federal minimum wage. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.XI. Standard errors (in parenthesis) are clustered at the state level.
Figure C.XII: Estimating changes in usual hours worked per week

Notes: These figures plot the estimated $\beta_1$ coefficients with their corresponding 95% confidence intervals from equation (13) using census-region-by-year-by-event fixed effects and the log of the average usual hours worked per week (including the unemployed) as a dependent variable. CR and CD identify whether the figure is estimated using census-region or census-division-specific time-by-event fixed effects. The average hours of active workers including the unemployed is computed using the NBER Merged Outgoing Rotation Group of the CPS for the period 1979-2019 excluding microdata with imputed information. Panels (a) and (b) estimate the regression for low-skill workers, where low-skill individuals are defined as high school or less, less than 30 years old, and with wages lower or equal than 2.5 times the federal minimum wage. Panels (c) and (d) estimate the regression for high-skill workers, where high-skill individuals are defined as having a college degree. An event is defined as a state-level hourly minimum wage increase above the federal level of at least $0.25 (in 2016 dollars) in a state with at least 2% of the employed population affected. Regressions restrict to events that (i) take place between 1983 and 2015, and (ii) treated states do not experience events in the four years previous to the event. Minimum wage data is taken from Vaghul and Zipperer (2016). Nominal values are transformed to 2016 dollars using the R-CPI-U-RS index including all items. Standard errors are clustered at the state level, and regressions are weighted by state-by-year population taken from BEA regional accounts.
Table C.XII: Differences in differences estimates of Figure C.XII

|                        | Low-skill workers | Low-skill workers | High-skill workers | High-skill workers |
|------------------------|-------------------|-------------------|--------------------|--------------------|
| Post x Treated         | 0.001             | 0.008             | 0.004              | 0.006              |
|                        | (0.006)           | (0.007)           | (0.003)            | (0.004)            |
| Census-region time-by-event FE | Yes              | No                | Yes                | No                 |
| Census-division time-by-event FE | No               | Yes               | No                 | Yes                |
| Observations           | 17,586            | 16,736            | 17,586             | 16,736             |
| Adj. R-squared         | 0.808             | 0.814             | 0.777              | 0.785              |

Notes: This table shows the estimated $\beta$ coefficient from equation (14). *Low-skill workers* and *High-skill workers* use the log of the average usual hours worked per week of active low- and high-skill workers, respectively, as a dependent variable. All regressions include fixed effects and controls as described in equation (14). For more details on the data sources and variable definitions, see notes of Figure C.XII. Standard errors (in parenthesis) are clustered at the state level.
D Details of back-of-the-envelope welfare calculation

This appendix describes the details of the calibration that gives form to the results in Table 2.

**Monetary values** Total pre-tax earnings, total pre-tax profits, and total income maintenance transfers are computed using the estimation sample. Total pre-tax earnings are computed using the NBER Merged Outgoing Rotation Group of the CPS as described in Section 4. Since data on average pre-tax individual earnings is measured in hourly wages, I multiply the annual sum of hourly wages by the average usual weekly hours worked (including the zeros), 4 weeks, and 12 months, to estimate aggregate annual pre-tax earnings. To avoid underreporting aggregates, I include observations with imputed information. Total pre-tax profits are approximated by total gross operating surplus. Finally, total income maintenance transfers are taken from the BEA regional accounts. To compute average pre-tax low-skill workers’ earnings I compute the average estimation excluding imputed values to minimize measurement error. To compute average pre-tax profits I divide the total gross operating surplus by the average number of private establishments.

Table D.I shows the computed values for the three scenarios considered. Values are in 2016 thousand dollars. The first column is the population-weighted average of all state-by-year observations. The second column is the population-weighted average of all pre-event year observations. The third column is the population-weighted average across states using data on year 2019.

| Table D.I: Monetary values (in 2016 thousand dollars) |
|-------------------------------------------------------|
| All | Pre-event | 2019 |
|-----------------------------------------------|
| Total low-skill workers’ pre-tax annual earnings | 67,184,317 | 85,543,175 | 112,471,000 |
| Total pre-tax annual profits | 229,000,000 | 349,000,000 | 369,000,000 |
| Total annual income maintenance transfers | 8,823,798 | 13,300,000 | 12,000,000 |
| Average low-skill workers’ pre-tax annual earnings | 13.74 | 12.26 | 16.58 |
| Average pre-tax annual profits | 693.75 | 705.14 | 770.27 |

**Computing post-tax values** Computing post-tax profits is direct using the corporate tax rates discussed in Section 4. For computing post-tax low-skill workers’ earnings, I divide total income maintenance transfers by total pre-tax annual earnings and amplify pre-tax earnings by the computed factor. In the three cases, the share of transfers to earnings is 9.6%, 11.0%, and 8.2%, which implies that post-tax earnings are 1.096, 1.110, and 1.082 times pre-tax earnings, depending on the

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3 Average usual weekly hours worked are 29.16, 28.33, and 30.59, in the cases considered.
assumption used to compute aggregates. I denote these amplifying factors $\alpha$, such that post-tax incomes are $1 + \alpha$ times pre-tax incomes.

**Computing workers’ side fiscal effects** I approximate fiscal effects by a reduction in transfers. To do this, I take Dube (2019) result on post-tax family incomes elasticities with respect to the minimum wage being 66% as large as the pre-tax ones. Then, I calculate how much transfers should have decreased to meet the relationship between pre- and post-tax elasticities given pre-tax earnings estimates and factors $\alpha$. Formally, let $w$ be pre-tax earnings, so post-tax earnings can be written as $y = (1 + \alpha)w = w + t$, where $t$ are transfers. Let $\varepsilon$ be the semi-elasticities for low-skill workers reported in Table 1. Then

\[
0.66 \cdot \varepsilon y = \varepsilon w - \phi t, \tag{D.I}
\]

where $\phi$ is the reduction in transfers needed to meet the pre- and post-tax elasticities relationship. Using $\alpha$, we can work the expression to conclude that

\[
\phi = \frac{\varepsilon \cdot (1 - 0.66 \cdot (1 + \alpha))}{\alpha}. \tag{D.I}
\]

Table D.II shows the calibrated values of $\phi$ for the three cases described above and for the two values of $\varepsilon$ displayed in Table 1. The calibration suggests that the reduction in income maintenance transfers spending ranged between 4% and 8%.

**Table D.II: Calibration of $\phi$**

|       | All | Pre-event | 2019 |
|-------|-----|-----------|------|
| $\varepsilon = 0.023$ | 0.066 | 0.056 | 0.081 |
| $\varepsilon = 0.016$ | 0.046 | 0.039 | 0.056 |

**Computation of $\omega(\zeta)$** Recall that average social welfare weights are the social value of the marginal utility of consumption normalized by the marginal cost of raising public funds. Since the normalizing constant is equal for all agents, the ratio of average social welfare weights equates the ratio of the social value of the marginal utility of consumption. I assume that the social welfare function is CRRA, that is, $G(V) = V^{1-\zeta}/(1-\zeta)$. This implies that $G'(V) = V^{-\zeta}$. I approximate $V$ with average post-tax low-skill annual earnings, $y^l$, and average post-tax annual profits, $y^k$. Then $\omega(\zeta) = (y^l/y^k)^{-\zeta}$. Then, when $\zeta = 1$, $\omega(1)$ is the inverse of the ratio of average incomes. As $\zeta
increases, the ratio is amplified, implicitly capturing stronger preferences for redistribution, since
the relative social value is larger than the relative average incomes.

Table D.III shows the estimated value of $\omega(\zeta)$ for all cases considered in Table 2. Values for
both panels are the same since $\omega(\zeta)$ does not depend on $\varepsilon$.

Table D.III: Calibration of $\omega(\zeta)$

| $\zeta$ | All obs. | Pre-event obs. | 2019 |
|---------|----------|----------------|------|
| 1       | 1.5      | 2              | 1    | 1.5     | 2    | 1    | 1.5     | 2    |
| 0.35    | 21.83    | 101.97         | 476.42 | 23.86   | 116.54 | 569.24 | 21.35   | 98.62  | 455.63 |
| 0.21    | 26.53    | 136.64         | 703.75 | 29.00   | 156.15 | 840.85 | 25.94   | 132.14 | 673.04 |
| 0.23    | 25.86    | 131.48         | 668.57 | 28.26   | 150.26 | 798.82 | 25.29   | 127.15 | 639.39 |
| 0.13    | 29.21    | 157.91         | 853.49 | 31.93   | 180.46 | 1019.78| 28.57   | 152.71 | 816.25 |

**Calibration**  With all these values, I use equation (19) to derive the numbers of Table 2.