Monopsony Power and Firm Organization

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Abstract

Monopsony power may be particularly strong in certain hierarchical occupations within firms, and production complementarities between occupations may amplify its adverse effects. To quantify this phenomenon, we extend a general equilibrium oligopsony model to include firm organization. Adding a management layer increases production workers' productivity and overhead costs, so only high-productivity firms hire managers to expand production. Using Portuguese administrative data, we quantify the model and validate it against quasi-experimental evidence on demand-wage pass-through and minimum wage effects. Relative to the efficient economy, welfare losses from monopsony are 3.4 and 2.4 percent for managers and production workers, respectively. Monopsony is stronger over managers because they sort into larger firms, view firms' non-wage attributes as less substitutable, and are less likely to be bound by the minimum wage. Through production complementarities, managers' monopsony alone explains one-fifth of the overall earnings losses from monopsony for production workers.

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JEL: D21, J21, J31, J42, O40.

1 Introduction

Imperfect labor market competition enables firms to reduce wages, leading to lower employment, labor misallocation, and welfare losses.[1] The size of firms, the ease of substituting between firms, and institutions, such as minimum wages, shape firms' wage-setting power. These factors may particularly strengthen monopsony power over certain occupations, yet its adverse effects spread across occupations when these are production complements. Consider managers and production workers: managers sort into larger firms, as employers only delegate decision-making to managers when they are sufficiently large.[2] In turn, when large firms restrict managerial employment, they also forgo potential production worker teams under managers' supervision. This paper shows that the heterogeneity in and interaction of monopsony power between these two occupations matter for efficiency and welfare.

To that end, we build a general equilibrium oligopsony model in which firms trade off adding a managerial layer to increase production workers' productivity against an extra overhead cost. We estimate and validate the model using matched employer-employee and balance sheet data from the universe of Portuguese private sector firms. Relative to the efficient economy, welfare losses from monopsony power are 3.4 and 2.4 percent for managers and production workers, respectively. Managers bear greater losses because they sort into larger firms, view firms' non-wage attributes as less substitutable, and are less likely to be bound by the minimum wage. Through production complementarities, monopsony over managers alone explains one-fifth of production workers' overall earnings losses from monopsony power.

The model features a representative household for each occupation and a continuum of local labor markets, each with a finite number of firms. Households choose consumption, capital, and labor supply to each firm for their respective occupations, viewing firms within the same and across distinct markets as imperfect substitutes in terms of non-wage characteristics with occupation-specific degrees of substitutability. Firms exogenously differ in terms of

[1]For evidence on monopsony power, see Staiger et al. (2010); Kline et al. (2019); Sokolova and Sorensen (2021); Azar et al. (2022); Yeh et al. (2022); Berger et al. (2022); Kline (2025).

[2]In Portugal, the average Herfindahl index (HHI) across local labor markets (LLM) is 0.25 for managers and 0.19 for production workers. We define a LLM as the combination of a municipality, a two-digit industry, and an occupation. We exclude CEOs, and most managers are supervisors, team leaders, or middle managers.

productivity and the local labor market they inhabit. Each firm's organizational decision involves adopting a single- or two-layer organizational structure. Single-layer firms hire only production workers, while two-layer firms add a management layer and decide how many managers and production workers to hire. Managerial employment increases the marginal productivity of production workers, reflecting production complementarities between both occupations. Thus, firms trade off the productivity gains from adding a managerial layer against the extra overhead cost of this layer. In equilibrium, only firms with sufficiently high productivity find it optimal to hire managers due to complementarities between firm productivity and managerial labor. Regarding monopsony power, the model allows for firm-occupation-specific markdowns due to differences in: (i) occupational sorting across firms of distinct size, (ii) firm substitutability, and (iii) exposure to the statutory minimum wage.

We quantify the model using matched employer-employee linked to balance sheet data from Portugal to fit moments of firm organization, wages, and market concentration. The firm substitutability parameters are key for the amount of monopsony power in each occupation. To calibrate the *within-market* firm substitutability parameters, we exploit the relationship between employment and wages at the establishment level, while controlling for market unobserved heterogeneity and using an instrument to address potential endogeneity. Next, we estimate the *across-market* firm substitutability parameters from plausibly exogenous changes in labor demand at the municipal level, which we generate with a Bartik-type instrument that interacts each municipality's pre–Great Recession sectoral exposure with national post–Great Recession value-added sector trends. We then employ an indirect inference approach to recover the across-market parameters from these estimates.

We validate the model by assessing its predictions against cross-sectional moments and quasi-experimental evidence regarding the presence of imperfect demand-wage pass-through and the effects of minimum wage changes. The model reproduces the empirical distributions of employment, wages, and managers' span of control across firms. It also matches average moments of market concentration across occupations. Moreover, the model quantitatively replicates two reduced-form experiments. First, it matches quasi-experimental evidence on the pass-through of idiosyncratic demand shocks to wages in Portugal (Garin and Silvério, 2024; henceforth GS). Following a labor demand shock, the model-generated pass-through from log output to log wages of 0.17 is not significantly different from GS's estimate at standard confidence levels, and the model reproduces a higher pass-through in more concentrated markets. Second, the model aligns with the employment effects of minimum wage changes from a comprehensive set of developed countries (Dube and Zipperer, 2024). Specifically, the model reproduces the empirical distribution of employment and mean wage responses to minimum wage changes, and correctly captures that, on average, raising the statutory minimum wage generates modest employment losses.

To quantify the effect of monopsony power on the aggregate economy, we compare the benchmark equilibrium with a counterfactual efficient economy where we exogenously set wages to the marginal product of labor for both occupations. In the benchmark economy, we find that the average manager and production worker bear a wage markdown of 31.9 and 16.0 percent, respectively. Firms generally exert wider wage markdowns on managers because they: (i) sort into firms with higher market payroll shares, (ii) have higher across and within-market firm substitutability, and (iii) are less likely to be bound by the minimum wage. Our finding of a higher firm substitutability for production workers aligns with evidence showing that low-wage workers exhibit higher labor supply elasticities (Diamond, 2016; Langella and Manning, 2021; Bachmann et al., 2022; Goolsbee and Syverson, 2023; Bils et al., 2025).

We derive four main results when comparing the efficient economy with the benchmark economy. First, employment and wages increase in the efficient economy, along with the concentration of employment at the most productive firms, especially for managers. Second, part of this increase in employment concentration arises from rising wages, which makes management delegation unprofitable for medium-productivity firms, leading to a decline of 10.9 percent in the share of two-layer firms in the efficient relative to the benchmark economy. This organizational change increases manager concentration at the most productive firms, which also expands their hiring of production workers and production. Third, removing managers' monopsony power alone affects production workers' outcomes due to production complementarities, an overlooked channel in models without firm organization. Particularly, it accounts for one-fifth of the overall increase in employment, wages, and employment concentration of production workers in the efficient relative to the benchmark economy. Fourth, the efficient economy provides a social welfare gain of 2.7 percent in consumption equivalent units relative to the benchmark due to higher earnings and despite higher labor disutility and profit losses. The welfare effects of monopsony power on each occupation depend on its respective profit share. Considering a range of profit shares between equal shares and population shares, we find that while managers always enjoy welfare gains, production workers' welfare only rises when they bear sufficiently low profit losses. Under equal profit shares, the welfare gain is 3.4 percent for managers and 2.4 percent for production workers.

To assess the implications for the design of policies that alleviate the efficiency losses from monopsony power, we examine whether an occupation-specific minimum wage, rather than a single statutory one, more effectively captures the gains from the efficient economy.[3] We find that the optimal single statutory minimum wage, which maximizes social welfare with population weights, provides less than one-tenth of the welfare gains from an efficient economy. Despite the presence of occupation-specific monopsony power, an optimal occupation-specific minimum wage only slightly improves upon the optimal single minimum wage, recovering about 15 percent of the welfare gains from efficiency. This is because minimum wages inevitably bind first for lower productivity firms, where monopsony power is relatively weaker. Notably, despite the stronger monopsony power over managers, the optimal manager-specific minimum wage is lower than that for production workers. This occurs because a low manager-specific minimum wage mitigates managerial job losses and the associated decline in labor demand and welfare for production workers, whose outcomes primarily determine social welfare.

Literature. This paper contributes to the literature on oligopsonistic labor markets and how this affects the aggregate economy (MacKenzie, 2021; Berger et al., 2022; Lamadon et al., 2022; Jarosch et al., 2023; Azkarate-Askasua and Zerecero, 2024; Deb et al., 2024). Using models where monopsony power arises from firm granularity and imperfect firm substitutability, these papers study the effect of monopsony on wages, efficiency, and welfare. Our main theoretical contribution to this literature is to study the effect of monopsony power on these outcomes through the organization of work within firms. The distinctive mechanisms in our model are that (i) firms make organizational decisions that endogenously contribute to markdown heterogeneity, and (ii) worker types are complementary in production. Quantitatively, we show that these contributions are key to understanding how monopsony power affects workers' outcomes, compresses the firm size distribution, and reduces welfare.

[3] Occupation-based minimum wages are implemented in Australia (Modern Awards) and are common in many European countries, whose collective bargaining agreements set occupation-specific wage floors.

We connect to the literature on the effects of minimum wage policies in models with imperfect labor market competition (Bamford, 2021; Ahlfeldt et al., 2022; Hurst et al., 2022; Karabarbounis et al., 2022; Drechsel-Grau, 2023). We build our framework on Berger et al. (2025), which studies optimal minimum wages in a general equilibrium model of oligopsony. Similarly, we find that the optimal minimum wage captures a small fraction of the welfare gains from an efficient economy. Our main contribution is to allow for production complementarities between occupations and occupation-specific firm substitutability. This allows us to draw two novel conclusions. First, we rationalize empirical evidence on how minimum wage changes propagate up the management hierarchy within firms (Forsythe, 2023). Second, we show that an optimal occupation-based minimum wage does not significantly improve upon an optimal single statutory minimum wage.

This paper also contributes to the literature on production organization models (Garicano and Rossi-Hansberg, 2006; Caliendo and Rossi-Hansberg, 2012). Several studies build on these models to analyze firm-size distortions (Garicano et al., 2016; Tamkoç, 2022), the adoption of information and technological capital (Mariscal, 2020), the misallocation of labor in developing countries (Grobovsek, 2020), and technological adoptions across urban areas (Santamaria, 2023). Conceptually, two papers are particularly related to our work. Bao et al. (2022) shows that firms compensate managers for increasing product market power, and Lawson et al. (2023) studies how minimum wages affect productivity through firm organization in a perfectly competitive framework. To the best of our knowledge, we are the first to incorporate monopsony power in a general equilibrium model with managerial delegation choices. This adds two contributions to this literature. First, delegation choices help to explain the degree of monopsony power over managers and production workers. Second, monopsony power depresses managers' wages, especially in large firms, thereby increasing the share of middle-productivity firms that find it profitable to delegate tasks to managers.

We also contribute to the literature on the misallocation of labor across firms (Hsieh and Klenow, 2009; Bartelsman et al., 2013; Davis et al., 2014; Garcia-Santana and Pijoan-Mas, 2014; Heise and Porzio, 2023). We show that monopsony power compresses the firm size distribution mainly by making medium-productivity firms inefficiently large, as they have an inefficiently high share of managers.

2 Model

This section presents a general equilibrium model that incorporates firm organization, oligopsonistic labor markets, and minimum wages. The model considers two permanent occupations, managers and production workers, each with heterogeneous labor disutility costs and substitutability across firms. For each occupation, there is a household that chooses consumption, the capital stock, and the labor supply to each firm. Firms are heterogeneous in productivity and the local labor market they inhabit. Regarding their organization, firms have a layer of production workers and choose whether to add a management layer. Moreover, they choose how much capital to rent and the number of workers in each layer. When making hiring decisions, firms face upward-sloping labor supply curves and a minimum wage constraint, which jointly determine firm-occupation-specific wage markdowns.

Agents. The economy consists of two households, indexed by their permanent occupation type $o \in \{w, m\}$, and a continuum of firms. Households are ex-ante heterogeneous in their disutility of labor, which depends on the aggregate labor supply and the allocation of labor across firms. Firms are heterogeneous in two dimensions. First, they inhabit distinct locations $j \in [0, 1]$, each with a finite number of firms indexed by $i \in \{1, \ldots, M_j\}$. Second, they differ in productivity z_{ijt}, drawn from a standard log-normal distribution with standard deviation σ_z.

Goods and technology. Firms combine capital and labor to produce a tradable good in a perfectly competitive national market whose price we normalize to one. We assume there are two types of labor: production workers (n_w) and managers (n_m). Production workers are essential for production, while managers are optional. Specifically, each firm chooses between two organizational types, which vary in the number of layers, $\ell \in \{1, 2\}$. The production technology of single-layer firms ($\ell = 1$) is given by:

$$y(z, 1) \;=\; z^w_{ijt}\Big(k^{1-\gamma}_{ijt}\, n^{\gamma}_{ijwt}\Big)^{\alpha}, \quad \gamma \in (0, 1),\ \alpha > 0. \tag{1}$$

The total factor productivity (TFP) of single-layer firms is the product of the idiosyncratic component and a layer-specific shifter, $z^w_{ijt} = \bar{z}_w z_{ijt}$. This technology captures the essential features of the standard Lucas (1978) model, incorporating productivity heterogeneity and allowing for diminishing returns to scale. The degree of returns to scale α governs how much firms can expand production by increasing the number of production workers. Alternatively, firms may add a managerial layer ($\ell = 2$) and produce according to:

$$y(z, 2) = z^{m}_{ijt}\, n^{(1-\alpha)\alpha}_{ijmt} \Big(k^{1-\gamma}_{ijt}\, n^{\gamma}_{ijwt}\Big)^{\alpha}. \tag{2}$$

We follow the tradition of considering managerial labor as a shifter of the total productivity of capital and production workers (Lucas, 1978). Specifically, all else equal, hiring more managers raises the marginal productivity of *all* other inputs, which gives rise to production complementarities between occupations. Moreover, we allow for layer-specific TFP differences, $z^{m}_{ijt} = \bar{z}_m z_{ijt}$. Overall, this technological specification enables tractable model quantification while capturing the main trade-off from the firm organization literature: adding a managerial layer allows firms to manage larger workforces but imposes an implicit fixed cost (see, e.g., Garicano, 2000; Garicano and Rossi-Hansberg, 2006; Grobovsek, 2020).[4] Moreover, note that higher productivity firms benefit the most from adding a management layer as the production function features complementarity between firm productivity and managerial labor. Regarding the parameter α, it governs both returns to scale and the managers' span of control. Thus, this approach naturally embeds within a single parameter the technological constraints of expanding production through additional production workers.

Households. Each household type $o \in \{w, m\}$ chooses the measure of workers to supply to each firm n_{ijot}, the capital stock in the next period K_{ot+1} and consumption of each good c_{ijot} to maximize their utility:

$$\mathcal{U}_{ot} = \max_{\{n_{ijot}, c_{ijot}, K_{ot+1}\}^{\infty}_{t=0}} \sum_{t=0}^{\infty} \beta^t \left[\mathbf{C}_{ot} \,-\, \varphi_o \, \frac{\mathbf{N}_{ot}^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} \right], \tag{3}$$

subject to the household's budget constraint:

$$\mathbf{C}_{ot} + [K_{ot+1} - (1-\delta)K_{ot}] \;=\; \int_0^1 \sum_{i=1}^{M_j} w_{ijo} n_{ijo}\, dj \,+ R_t K_{ot} + \kappa_o \Pi_t, \tag{4}$$

[4]To see this, set $y(z, 2) = y(z, 1)$ with the same amount of capital and production workers, which implies $n_m = 1$. Thus, for a given number of production workers and capital, a two-layer firm must hire and pay an extra manager to produce the same as the single-layer firm.

where we define the aggregate consumption and labor supply indexes as:

$$\mathbf{C}_o := \int_0^1 \sum_{i=1}^{M_j} c_{ijo}\, dj$$

$$\mathbf{N_o} := \left[\int_0^1 \left(\frac{\mathbf{n_{jo}}}{B_{jo}} \right)^{\frac{\theta_o+1}{\theta_o}} dj \right]^{\frac{\theta_o}{\theta_o+1}} \quad \mathbf{n_{jo}} := \left[\sum_{i=1}^{M_j} n_{ijo}^{\frac{\eta_o+1}{\eta_o}} \right]^{\frac{\eta_o}{\eta_o+1}}.$$

The parameter ϕ stands for the aggregate Frisch elasticity of households, φ_o is an occupation-specific labor disutility shifter, B_{jo} is an occupation-specific location amenity shifter, and κ_o stands for the occupation-specific fraction of profits rebated to the household. We assume that consumption goods are perfect substitutes, but households view firms as imperfect substitutes with respect to non-wage characteristics (see, e.g., Card et al., 2018; Berger et al., 2022). Importantly, we extend the model to allow individual firms to face *occupation-specific* upward-sloping labor supply curves that depend on two elasticities of substitution θ_o and η_o. The parameter θ_o regulates the degree of substitutability of firms in distinct markets and, thus, captures the costs of moving across markets or idiosyncratic tastes for each market. If these costs decrease ($\theta_o \uparrow$), workers find it easier to substitute firms across markets and become more responsive to market wage differentials. The parameter η_o regulates the degree of substitutability of firms within the same market, thus capturing features such as commuting costs, search costs, or idiosyncratic tastes for the firm. As these costs decrease ($\eta_o \uparrow$), workers find within-market, across-firm substitutability easier and become more responsive to wage differentials across firms in the same market.

We refer to η_o and θ_o as the within- and across-market firm substitutability parameters. When $\eta_0 > \theta_0 > 0$, the household $o \in \{w, m\}$ perceives firms within the same market as closer substitutes than firms across different markets. Consequently, larger firms hinder labor reallocation to other firms by reducing the number of alternative employers within the same market, forcing workers to seek less substitutable firms in different markets. This limited substitutability dampens workers' responsiveness to firm-specific wage policies, granting larger firms greater monopsony power.

For each occupation $o \in \{w, m\}$, the first order necessary conditions of the utility maximization problem imply that the supply of capital is infinitely elastic:

$$R_t = \frac{1}{\beta} - (1-\delta), \tag{5}$$

the aggregate supply of labor is given by:

$$\mathbf{N}_{ot} \;=\; \left(\frac{\mathbf{W}_{ot}}{\varphi_o}\right)^{\phi}, \tag{6}$$

and the labor supply curve of occupation o to firm i in market j is:

$$n_{ijot} = B_{jo}^{1+\theta_o}\left(\frac{w_{ijot}}{\mathbf{w}_{jot}}\right)^{\eta_o}\left(\frac{\mathbf{w}_{jot}}{\mathbf{W}_{ot}}\right)^{\theta_o}\mathbf{N}_{ot} \;\longleftrightarrow\; \underbrace{w_{ijot} = \left(\frac{1}{B_{jo}}\right)^{\frac{1+\theta_o}{\theta_o}}\left(\frac{n_{ijot}}{\mathbf{n}_{jot}}\right)^{\frac{1}{\eta_o}}\left(\frac{\mathbf{n}_{jot}}{\mathbf{N}_{ot}}\right)^{\frac{1}{\theta_o}}\mathbf{W}_{ot}}_{\text{Inverse labor supply curve } \forall ijo}, \tag{7}$$

where we define the market wage index $\mathbf{w}_{jot}$ and the aggregate wage index $\mathbf{W}_{ot}$ as

$$\mathbf{w}_{jot} := \left[\sum_{i\in j} w_{ijot}^{1+\eta_o}\right]^{\frac{1}{1+\eta_o}} \qquad \mathbf{W}_{ot} := \left[\int_0^1 \left(B_{jo}\mathbf{w}_{jot}\right)^{1+\theta_o} dj\right]^{\frac{1}{1+\theta_o}}. \tag{8}$$

Firms. Firms decide the organizational structure to maximize profits, which consists of choosing whether to add a management layer:

$$\pi(z) = \max_{\ell}\;\{\pi(z,\ell)\}_{\ell=1}^{2}, \tag{9}$$

When deciding on the optimal organizational structure, firms compare their maximum profits under single- and two-layer organizations. Single-layer organizations choose how much capital to rent, k_{ijt}, and the number of production workers to hire, n_{ijwt}. Two-layer organizations additionally choose the number of managers to hire, n_{ijmt}. When making these decisions, both organization take as given the labor supply curves, the labor demand of their competitors within the same market (n^*_{-ijot}), the statutory minimum wage ($\underline{w}$), and the aggregate variables ($\mathbf{W}_{ot}, \mathbf{N}_{ot}$). Formally, single-layer organizations maximize profits:

$$\pi(z,1) \;=\; \max_{n_{ijwt},k_{ijt}} \quad y(z,1) \;-\; R_t k_{ijt} \;-\; w_{ijwt}\Big(n_{ijwt}, n^*_{-ijwt}, \mathbf{N}_{wt}, \mathbf{W}_{wt}\Big)n_{ijwt}, \tag{10}$$

subject to:

$$w_{ijwt}\Big(n_{ijwt}, n^*_{-ijwt}, \mathbf{N}_{wt}, \mathbf{W}_{wt}\Big) = \left(\frac{1}{B_{jw}}\right)^{\frac{1+\theta_o}{\theta_o}}\left(\frac{n_{ijwt}}{\mathbf{n}_{jw}(n_{ijwt}, n^*_{-ijwt})}\right)^{\frac{1}{\eta_w}}\left(\frac{\mathbf{n}_{jwt}(n_{ijwt}, n^*_{-ijwt})}{\mathbf{N}_{wt}}\right)^{\frac{1}{\theta_w}}\mathbf{W}_{wt},$$

$$\mathbf{n}_{jw}(n_{ijwt}, n^*_{-ijwt}) = \left[n_{ijwt}^{\frac{1+\eta_w}{\eta_w}} + \sum_{k\neq i} n^*_{kjwt}{}^{\frac{1+\eta_w}{\eta_w}}\right]^{\frac{\eta_w}{1+\eta_w}},$$

$$w_{ijwt} \geq \underline{w}$$

In addition, the profit maximization problem of two-layer organizations is given by:

$$\pi(z,2) \;=\; \max_{n_{ijwt}, n_{ijmt}, k_{ijt}} \quad y(z,2) \;-\; R_t k_{ijt} \;-\; \sum_{o\in\{w,m\}} w_{ijot}\Big(n_{ijot}, n^*_{-ijot}, \mathbf{N}_{ot}, \mathbf{W}_{ot}\Big) n_{ijot}, \quad (11)$$

subject to:

$$w_{ijot}\Big(n_{ijot}, n^*_{-ijot}, \mathbf{N}_{ot}, \mathbf{W}_{ot}\Big) = \left(\frac{1}{B_{jot}}\right)^{\frac{1+\theta_o}{\theta_o}} \left(\frac{n_{ijot}}{\mathbf{n}_{jot}(n_{ijot}, n^*_{-ijot})}\right)^{\frac{1}{\eta_o}} \left(\frac{\mathbf{n}_{jot}(n_{ijot}, n^*_{-ijot})}{\mathbf{N}_{ot}}\right)^{\frac{1}{\theta_o}} \mathbf{W}_{ot},$$

$$\mathbf{n}_{jot}(n_{ijot}, n^*_{-ijot}) = \left[n_{ijot}^{\frac{1+\eta_o}{\eta_o}} + \sum_{k\neq i} n^{*\,\frac{1+\eta_o}{\eta_o}}_{kjot} \right]^{\frac{\eta_o}{1+\eta_o}},$$

$$w_{ijot} \geq \underline{w}, \quad \forall o \in \{w,m\}.$$

The first-order necessary condition for capital implies that the interest rate equals the marginal product of capital:

$$\frac{\partial y(z,\ell)}{\partial k} \;=\; R_t, \quad \forall \ell \in \{1,2\}.$$

For each occupation $o \in \{w,m\}$, the presence of the statutory minimum wage implies that the solution for the labor demand has three cases. First, we refer to those firms for which the minimum wage constraint is not binding as *unconstrained*. Second, for firms for which the minimum wage is binding, and labor demand equals the labor supply curve, we refer to them as *supply-constrained*. Third, we refer to firms for which the minimum wage is binding, and labor supply exceeds labor demand, as *demand-constrained*. We summarize the system of first-order conditions for each type of firm as follows.

Case I: The minimum wage is not binding. The marginal cost of labor equals its marginal product at the optimal employment level:

$$w^*_{ijot} \;=\; \mu_{ijot} \left.\frac{\partial y(z,\ell)}{\partial n_{ijot}}\right|_{n^*_{ijot}}, \qquad \mu_{ijot} \;=\; \frac{\varepsilon_{ijot}}{\varepsilon_{ijot}+1} \in (0,1), \qquad \varepsilon_{ijot} \;=\; \left[\frac{\partial \log w_{ijot}}{\partial \log n_{ijot}}\right]^{-1}. \quad (12)$$

When the structural elasticity is positive, $\varepsilon_{ijot} > 0$, Equation (12) implies that workers earn wages below their marginal productivity (see Appendix A for complete derivations). As in the classical monopsony environment (Manning, 2013), the marginal cost of labor is equal to both the wage and the additional cost of increasing wages because firms internalize upward-sloping labor supply curves. Hence, there is a wedge between wages and the marginal product of labor $\mu_{ijot} < 1$. In addition, the oligopsonistic market structure implies that the structural labor supply elasticity depends on the payroll share of the firm:

$$\varepsilon_{ijot}(s_{ijot}) \;=\; \left[\frac{1}{\eta_o} + \left(\frac{1}{\theta_o} - \frac{1}{\eta_o}\right)\frac{\partial \log \mathbf{n}_{jot}}{\partial \log n_{ijot}}\right]^{-1} \;=\; \left[\frac{1}{\eta_o} + \left(\frac{1}{\theta_o} - \frac{1}{\eta_o}\right)s_{ijot}\right]^{-1}, \tag{13}$$

where s_{ijot} stands for the payroll share of firm i in market j:

$$s_{ijot} := \frac{w_{ijo}n_{ijot}}{\sum_{i\in j} w_{ijot}n_{ijot}}. \tag{14}$$

The model explicitly distinguishes the potential forces shaping wage dispersion across occupations. The first source of dispersion arises from differences in marginal productivity, which partly depends on organizational choices. The second source of dispersion comes from firm-occupation-specific markdowns due to different (i) occupational sorting across firms of distinct size (s_{ijot}), (ii) firm substitutability (η_o, θ_o), and (iii) exposure to the statutory minimum wage, which we describe in the next cases.

Case II: The minimum wage is binding, and labor supply equals labor demand. The minimum wage is binding and is below the efficient wage level where the labor supply curve intersects the marginal product curve. In this case, firms pay the minimum wage, and the markdown is the ratio between the minimum wage and the marginal product, with the level of employment given by the labor supply curve evaluated at the minimum wage:

$$w^*_{ijot} \;=\; \underline{w}, \qquad \mu_{ijot} \;=\; \frac{\underline{w}}{\left.\frac{\partial y(z,\ell)}{\partial n_{ijot}}\right|_{n^*_{ijot}}}, \qquad n^*_{ijot} = \left(\frac{\underline{w}}{\mathbf{w}_{jot}}\right)^{\eta_o}\left(\frac{\mathbf{w}_{jot}}{\mathbf{W}_{ot}}\right)^{\theta_o}\mathbf{N}_{ot}. \tag{15}$$

In this case, firms pay higher wages and hire more workers than they would have without the minimum wage.

Case III: The minimum wage is binding, and labor supply exceeds labor demand. The minimum wage is binding and is above the efficient wage level where the labor supply curve intersects the marginal product curve. In this case, firms pay a wage that is equal to both the minimum wage and marginal product, with the employment level given by the marginal product, and firms potentially face an excess of labor supply:

$$w^*_{ijot} \;=\; \underline{w} \;=\; \left.\frac{\partial y(z,\ell)}{\partial n_{ijot}}\right|_{n^*_{ijot}}, \qquad \mu_{ijot} \;=\; 1, \qquad n^*_{ijot} < \left(\frac{\underline{w}}{\mathbf{w}_{jot}}\right)^{\eta_o}\left(\frac{\mathbf{w}_{jot}}{\mathbf{W}_{ot}}\right)^{\theta_o}\mathbf{N}_{ot}. \tag{16}$$

In this case, firms pay higher wages and hire fewer workers than they would have without the minimum wage.

Equilibrium. Given the statutory minimum wage $\underline{w}$, the steady state general equilibrium of the model is a set of organizational structures $\{\ell^*_{ij}\}_{\forall ijt}$, capital stock $(k^*_{ijt})_{\forall ijt}$, and employment levels $\{n^*_{ijwt}, n^*_{ijmt}\}_{\forall ijt}$ such that:

1. *Households*: households choose labor supply to each individual firm n^*_{ijot}, and supply of capital, K^*_{ot}, to maximize utility. That is, Equations (5)-(7) hold $\forall t$, $\forall o \in \{w,m\}$, $\forall j \in [0,1]$, and $\forall i = \{1,\ldots,M_j\}$.

2. *Firms*: firms optimally choose the organizational structure, ℓ^*_{ijt}, demand for capital, k^*_{ijt}, and the number of workers to hire in each occupation, n^*_{ijot}. That is, Equations (11)-(16) hold $\forall t$, $\forall o \in \{w,m\}$, $\forall j \in [0,1]$, and $\forall i = \{1,\ldots,M_j\}$.

3. *Market Clearing*: all markets clear $\forall t$, $\forall o \in \{w,m\}$, $\forall j \in [0,1]$, and $\forall i = \{1,\ldots,M_j\}$,

   - Output: $\int_o^1 \sum_i^{m_j} y^*_{ijt}\, dj \;=\; \sum_{o\in\{w,m\}}(C^*_{ot} + \delta K^*_{ot})$.
   - Capital: $\int_o^1 \sum_i^{m_j} k^*_{ijt}\, dj \;=\; \frac{1}{\beta} - (1-\delta)$.
   - Labor: labor supply and demand are given by Equations (12) and (15) for firms in Cases I and II. For firms in Case III, households supply the labor demand n^*_{ijot} given by Equation (16).

Two comments are worth noting about the equilibrium definition. First, note that the equilibrium considers market-clearing in the presence of minimum wages. To handle non-market-clearing wages, we solve the equilibrium using a shadow wages approach as in Berger et al. (2025), which we explain in detail in Appendix B. This approach considers that households perceive a lower wage than the minimum wage for firms in Case III, which implies that the excess labor supply at the minimum wage is reallocated towards other firms. Second, linear utility implies a perfectly elastic supply of capital by households. Thus, we assume that households split the aggregate equilibrium capital stock according to their respective empirical population weights: $K^*_{wt} = 0.76 \cdot K^*_t$ and $K^*_{mt} = 0.24 \cdot K^*_t$.[5]

3 Quantification of the Model

The quantification of the model parameters proceeds in three steps: (i) we exogenously calibrate the minimum wage and Frisch elasticity; (ii) we endogenously calibrate the discount factor, several technological parameters, and the within-market firm substitutability parameters; and (iii) we jointly estimate the remaining model parameters, including the across-market firm substitutability parameters, using the SMM approach. The firm's substitutability parameters are key for measuring the amount of monopsony power. We set the within-market substitutability parameters to match the slope between wages and employment, controlling for market-year fixed effects and instrumenting employment, while we use an indirect inference approach to estimate the across-market substitutability parameters from plausibly exogenous changes in local labor demand.

3.1 Data

Our primary data source is *Quadros de Pessoal* (QP), an annual census of private sector employees conducted by the Portuguese Ministry of Employment each October. This census provides matched employer-employee information on employment, hourly wages, occupation, industry, and geography for all private firms based in Portugal with at least one worker. We use anonymised firm identifiers to link these data to balance sheet data from the *Sistema de Contas Integradas das Empresas* (SCIE). Our sample period covers from 2010 to 2016. We explain the main aspects of the sample here and defer the details to Appendix D.

We assign workers to each occupation following a hierarchical classification similar to Caliendo et al. (2020). By Portuguese law, firms must assign workers to hierarchic categories that allow us to distinguish between two layers within each firm (see Appendix Tables D.1 and D.2). We exclude CEOs and assign middle managers, supervisors, team leaders, and top

[5] Appendix C shows an illustration of how firm organization and monopsony power interact in equilibrium.

managers to the management layer. The distinctive feature of managers is that they guide groups of employees in their tasks. We group the remaining categories as production workers, which range from non-skilled to higher-skilled professionals.[6] Below, the estimation of across-market elasticities in Section 3.3 shows that grouping production workers of different skill levels into a single occupation does not significantly change the quantification of monopsony power.

Next, we define a labor market for each occupation, jo, based on their geography (municipality) and industry (2-digit NACE), capturing that workers are more attached to their current labor market due to imperfect skill substitutability and costly geographical mobility (Neal, 1995; Kambourov and Manovskii, 2009; Sullivan, 2010; Kennan and Walker, 2011).

Lastly, we use the balance sheet data to compute the capital and labor share. Capital consists of investment properties, tangible fixed assets, and intangible fixed assets. We use an average return on capital of 15 percent (Barkai, 2020) and calculate the capital share as the ratio between the return of the capital stock and value added. Labor income corresponds to all personnel expenses, including employee remuneration and social charges (e.g., pensions or severance payments). The labor share is the ratio between labor income and value added.[7]

3.2 Calibrated Parameters

Minimum wage, technology, and preferences. Table 1 summarizes the model parameters. The model period is one month. We calibrate outside the model the statutory minimum wage and the aggregate Frisch elasticity. We adjust all nominal variables using the 2012 CPI and use the 2016 statutory minimum wage $\underline{w} = 525$€. We follow Berger et al. (2022) by setting $\gamma = 0.5$, which is within the range that the Congressional Budget Office considers for policy evaluation. On an annual basis, we endogenously calibrate the discount factor ($\beta = 0.96^{1/12}$) and the depreciation rate ($\delta = 0$) to match an annual discount and interest rate of 4 percent. We calibrate the parameter governing decreasing returns to scale (α) and the exponent on labor (γ) using the labor and capital share, respectively.

[6] These broad categories represent a persistent occupational state. Figure D.1 in the appendix shows that most workers remain within the same category even after changing employer.

[7] Appendix E shows the regression outputs of this section and the model fit of targeted moments.

Table 1: Quantification of model parameters

Parameter Value	Description	Value	Moment
Panel I: Exogenous calibration			
ϕ	Aggregate Frisch elasticity	0.50	Berger et al. (2022)
$\underline{w}$	Minimum wage	525	Real minimum wage in 2016 (in 2012 €)
Panel II: Endogenous calibration			
β	Discount factor	$0.96^{1/12}$	Annual discount rate of 4%
δ	Depreciation of capital	0	Annual interest rate of 4%
α	Decreasing returns to scale	0.55	Labor share of 62%
γ	Exponent on labor	0.82	Capital share of 31%
(η_w, η_m)	Within-market substitutability	(7.82 , 2.32)	Within-market labor supply elasticity
Panel III: SMM Estimation			
A: Preferences			
φ_w	Labor disutility: workers	122	Average firm size
φ_m	Labor disutility: managers	1.4	Share managers
B: Firm Organization			
$\bar{z}_w$	Worker efficiency	1,062	Mean wage of prod. workers
$\bar{z}_m/\bar{z}_w$	Managerial efficiency	2.1	Wage gap managers vs prod. workers
σ_z	Std. Dev. firm TFP	0.7	Weighted mean HHI prod. workers
C: Market Characteristics			
B_{ijw}	Amenities in small markets	0.7	Share workers in markets $M_j \leq 10$
$G(\cdot)$	Firm distribution		Mean, variance, and mass single-firm
D: Firm Substitutability			
(θ_w, θ_m)	Across-market substitutability	(2.4 , 1.0)	Across-municipality labor supply elasticity

Note: The Table reports the quantification of model parameters. Panels I and II report the parameters that we calibrate outside and inside the model, respectively. Panel III reports the estimated parameters using the SMM approach.

Within-market substitutability (η_w, η_m). We calibrate the within-market elasticity parameters, which are informative of the relationship between firms' wages and employment for the sub-sample of unconstrained firms in each local labor market. In particular, the inverse labor supply curve in Equation (7) delivers the following equilibrium relationship between (log) wages and (log) employment:

$$\log(w^*_{ijo}) \;=\; \frac{1}{\eta_o}\log(n^*_{ijo}) \;+\; \underbrace{\underbrace{\left(\frac{1}{\theta_o}-\frac{1}{\eta_o}\right)\log\Big(\mathbf{n}_{jo}(n^*_{ijo}, n^*_{-ijo})\Big)}_{\text{Effect of payroll share on wages due to } \mathbf{n}_{jo}} + \frac{1}{\theta_o}\log(\mathbf{N}_o) \;+\; \log(\mathbf{W}_o)}_{\text{Common across firms in local labor market } jo}.$$

Note that, conditional on common market features, all firms face the same labor supply elasticity η_o for each occupation. This occurs because the effect of strategic interactions on the labor supply elasticity shuts down when we control for market fixed effects. We use this insight to obtain a theory-consistent estimate of the within-market elasticity for each occupation. In particular, the previous equation implies the following empirical reduced-form relationship for the inverse labor supply curve:

$$\log(w_{ijo,t}) \;=\; \beta_o \log(n_{ijo,t}) \;+ \mu_{jo,t} \;+\; \nu_{ijo,t}, \tag{17}$$

where $\mu_{jo,t}$ stands for the market-year fixed effects that control for common labor demand and supply shifts within the same market year. Our coefficient of interest is β_o. In the model, conditional on the sub-sample of unconstrained firms, the OLS regression of Equation (17) identifies the within-market elasticity as $\hat{\eta}_o = 1/\hat{\beta}_o$. This regression exploits the cross-sectional variation in employment and wages that uniquely stems from differences in labor demand across firms in the same market, while keeping their labor supply curves fixed. The intuition is as follows. Firms pay different wages and hire different numbers of workers because they are heterogeneous in productivity. Increasing the productivity of a firm has two equilibrium effects. First, the labor demand curve shifts up because the marginal productivity rises. Second, the labor supply curve shifts down because the strategic complementarities from Cournot's competition imply that competitors restrict employment. The coefficient β_o absorbs the first effect while market-fixed effects absorb the second effect.

To address potentially endogenous firm-level supply shocks in the data, we estimate Equation (17) with an instrumental variable (IV) approach in our baseline specification. We use a value-added shift-share instrument that predicts firms' employment from national sector employment trends and initial exposure firm shares (Severen, 2021; Ahlfeldt et al., 2022):

$$\hat{n}_{ijo,t} = \underbrace{\frac{y_{is(j),2004}}{\sum_i y_{is(j),2004}}}_{\substack{\text{Industry-firm}\\ \text{share}}} \times \underbrace{\sum_i y_{is(j),t}}_{\substack{\text{National value added}\\ \text{in industry } s}} .$$

The identification of β_0 relies on the fact that the interaction between firms' exposure shares and national industry shifts predicts demand-driven changes in employment that are not correlated with labor supply shocks. We provide a discussion on the sources of exogenous variation in this shift-share instrument when estimating the across-market elasticity below.

To capture unconstrained firms, which effectively respond on their supply curve through employment and wages, we restrict the sample to firms paying wages at least five percent higher than the minimum wage of the reference year. This regression implies a within-market labor supply elasticity of 7.8 for production workers and 2.3 for managers (see Table E.2).

3.3 Estimated Parameters

We estimate the remaining parameters by the SMM approach. In particular, we set the parameter values to minimize the percentage difference with equal weighting between the vector of model moments and its data counterpart. We describe each parameter and its most informative moment in detail.

Labor disutility shifter (ϕ_w, ϕ_m). The most associated moment with the labor disutility shifter of production workers ϕ_w is the average firm size. In the data, the average firm hires 5.3 production workers. For the labor disutility shifter of managers ϕ_m, we include as the most informative moment that about 18.6 percent of all employees are managers.

Efficiency of labor ($\bar{z}_w, \bar{z}_m$). The efficiency of each organization type is informative of wages. Thus, we include as targets the mean monthly wage of 867€ for production workers and the wage gap in mean wages between managers and production workers, which is equal to 0.62 log points.[8]

Dispersion in firm productivity (σ_z). Labor markets are more concentrated in the presence of higher productivity differentials across firms. Thus, we choose the employment-weighted average Herfindahl-Hirschman Index (HHI) in production workers' local labor markets, which is equal to 0.20, as the moment most associated with the standard deviation of firm productivity.

Market amenities (B_{ijw}). We note that only 12 percent of production workers belong to markets with fewer than ten firms, despite these markets representing nearly 65 percent of the total. Thus, we set a common market amenity for production workers in these markets and include this moment as the most informative of market amenities in the estimation. The rationale for using amenities rather than productivity differences is that we would require excessively low productivity in small markets, which would overestimate the share of minimum wage earners in such markets.

Firm distribution (G). The distribution of the number of firms across markets, $M_j \sim G(\cdot)$, combines a discrete mass at $m_j = 1$ with a Pareto distribution. To estimate these parameters, the most associated moments include that 29 percent of markets have just one firm, the average market has 17.4 firms, and the standard deviation in the number of firms equals 59.9.

Across-market substitutability (θ_w, θ_m). The across-market firm substitutability parameters govern how greater market productivity translates into more employment. When firm substitutability is high, employment in a particular market is highly responsive to increased market productivity. We use an indirect-inference approach for each occupation to match the reduced-form inverse labor supply elasticity from a municipality-level regression. We estimate the following equation:

$$\text{Log}\, w_{mo,t} = \gamma\, \text{Log}\, n_{mo,t} + \alpha_{mo} + e_{mo,t}, \tag{18}$$

[8]We are particularly interested in matching wage differential at the bottom of the distribution. Thus, we restrict the sample to managerial wages below the 90th percentile for this moment.

where $w_{m,o,t}$ is the mean wage in municipality m for occupation o in period t, $n_{m,o,t}$ is total employment in that municipality, and $\alpha_{m,o}$ are municipality fixed effects. The main threat to identification is that employment and wages in a municipality may vary over time due to changes in labor supply. To overcome this problem, we leverage a value-added shift-share instrument for municipal employment following Lamadon et al. (2022):

$$\hat{n}_{mo,t} = \sum_s \left(\underbrace{\frac{y_{imso,2004}}{\sum_i y_{imso,2004}}}_{\substack{\text{Industry-municipality} \\ \text{initial share}}} \times \underbrace{\sum_i y_{iso,t}}_{\substack{\text{National value-added} \\ \text{in sector } s}} \right). \tag{19}$$

This instrument predicts employment in each municipality as the sector-wide value-added growth interacted with the past concentration of that sector's value added across municipalities.[9] With this approach, we estimate the coefficient γ from within-municipality, across-time variation in wages and employment that arises from the interaction between national sector value-added shocks and the municipality's initial exposure to them, which plausibly represent exogenous changes in the municipality's labor demand.

We interpret the Great Recession and subsequent financial crisis in Portugal as an *aggregate shock* with a sector-specific component driven primarily by the global economic downturn. As a result, we view two potential sources of exogeneity in our shift-share instruments. First, pre-recession exposure shares (Goldsmith-Pinkham et al., 2020) reflect differential exposure to the common aggregate shock based on historical economic activity distribution, which predicts future firm- or municipality-specific labor demand shocks but arguably not labor supply shocks. Second, national two-digit industry trends triggered by the recession (Borusyak et al., 2022) stem from the global downturn and, in a small open economy like Portugal, are also plausibly not correlated with firm- or municipal-level labor supply shocks.

We restrict the sample to municipalities with a mean wage higher than 5 percent of the minimum wage in the reference year to capture unconstrained firms. We impose this restriction to exclude municipalities where a high share of firms pay wages close to the minimum wage, as the labor supply elasticity of these firms is not informative of the across-market elasticity

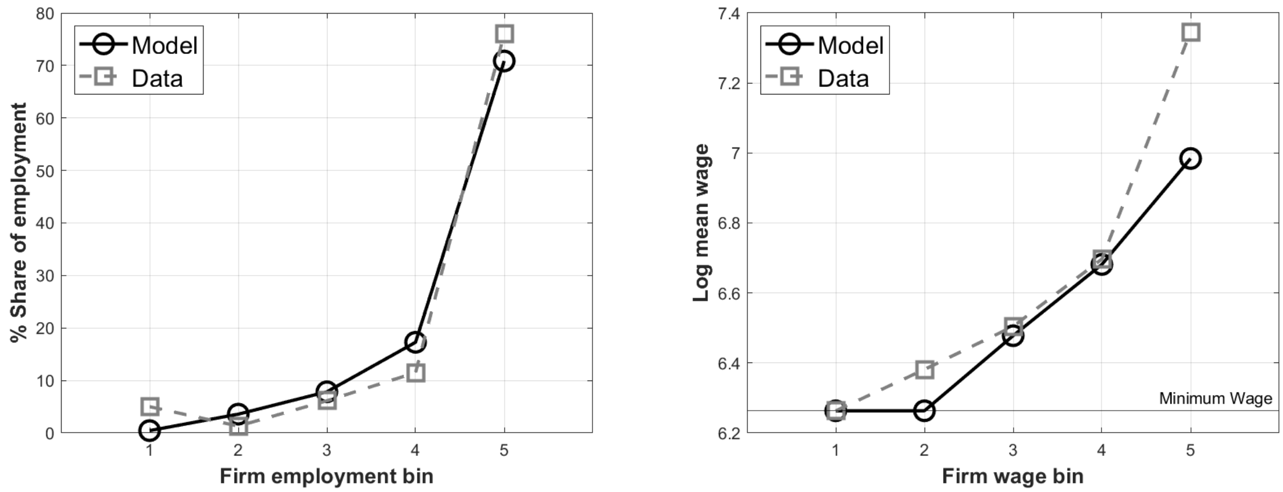
[9] In the model, the municipality is a collection of local labor markets. We use a municipality-level regression rather than a market-level regression to employ the more standard formulation of the shift-share instrument.

because they may pay the minimum wage either before or after the labor demand shock. The implied coefficients are 2.5 for production workers and 1.0 for managers, indicating that managerial employment is less responsive to a given municipality's labor demand shock. For a detailed regression output of the estimation, see Appendix E.

To replicate this regression in the model, we randomly assign markets to each municipality to approximate the number of markets that the average municipality has in the data while keeping a reasonable sample size of municipalities. Then, we simulate two periods, where the second period involves random productivity shocks at the municipality level from a standard log-normal distribution with $\sigma = 0.05$. Moreover, we restrict the sample of municipalities to those with a mean wage higher than 5 percent of the model's minimum wage in both periods. Finally, we choose (θ_w, θ_m) to target the inverse labor supply elasticity γ that results from estimating the regression in Equation (18) with the simulated sample. We infer a similar across-market elasticity of 2.5 for production workers and 1.0 for managers.

A potential concern is that municipality-level wage changes following demand shocks may reflect compositional shifts in workers' skills within occupations rather than underlying labor supply elasticities, e.g., due to non-random hiring or firing of workers with specific skills. Table E.4 addresses this by estimating Equation (18) separately for high- and low-skilled production workers. Moreover, we add another regression that focuses on the wages of "stayer" workers who have been employed at the same firm for at least three years. The elasticity when using stayers' wages is not significantly different from the benchmark. Moreover, low-skilled production workers exhibit somewhat higher across-market elasticities than high-skilled production workers. Yet, our key findings remain robust: (i) managerial elasticities are at most half those of production workers, and (ii) even when disaggregating production workers by skill level, the across-market elasticities imply a fairly tight upper bound for production workers' markdowns ($\frac{\theta}{1+\theta}$) of about 30 percent. Lastly, given the importance of both the within- and across-market firm-substitutability parameters in the distribution of wage markdowns, Appendix E.3 shows that our findings are consistent with and fall within the range of labor supply elasticity estimates in the literature.

Figure 1: Distribution of employment and wages across firms



(a) Employment (b) Wages

Note: The Figures show the distribution of employment and wages across firms in the model and data. In particular, the graphs plot the mean outcome for each quintile of the variable of interest.

4 Validation of the Model

We compare the model predictions to empirical moments that are informative of the presence of imperfect demand-wage pass-through, firm organization, and the effects of minimum wages. The model closely matches moments of wages, employment, market concentration, and firm organization. Notably, the model quantitatively matches quasi-experimental evidence on the pass-through of idiosyncratic demand shocks to wages in Portugal (Garin and Silvério, 2024), as well as the employment and wage effects of minimum wage reforms in a comprehensive set of studies in developed economies (Dube and Zipperer, 2024).

4.1 Cross-sectional Evidence

Moments of employment and wages. We begin by analyzing the wage and employment distributions, which are relevant to understanding the degree of market concentration and the effects of minimum wage policies. Figure 1 displays the average level of employment and wages across quintiles of the firm distribution in the model and data. The model closely

Table 2: Model fit of untargeted moments

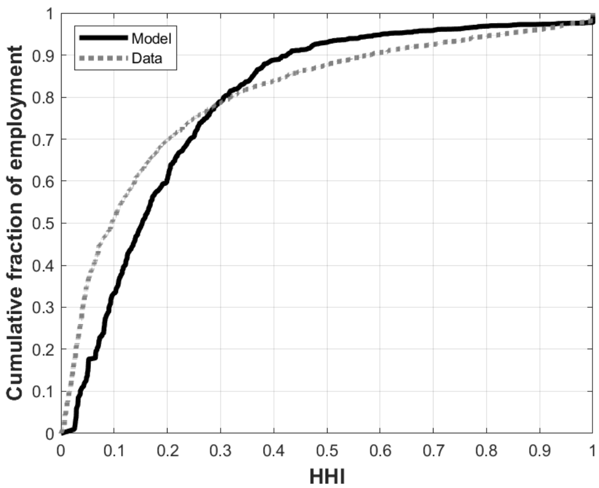
	Production Workers		Managers	
	Model	**Data**	**Model**	**Data**
Panel A: Minimum Wage				
Share | Minimum wage earner	0.85	0.94	0.15	0.06
Panel B: Firm Organization				
Median span of control	3.57	3.14		
P25 firm size	1	1	0	0
P50 firm size	2	2	1	1
P90 firm size	13	9	4	5
P99 firm size	55	59	9	34
Panel C: Market Concentration				
Weighted mean HHI	*	*	0.24	0.27
Weighted mean Max s_{ij}	0.31	0.30	0.34	0.38

Note: The Table reports untargeted moments of the distributions of wages, firm organization, and market payroll concentration. For each occupation, we report the statistics from the data and the baseline model. Asterisks (*) refer to targeted moments in the model quantification described in Table 1.

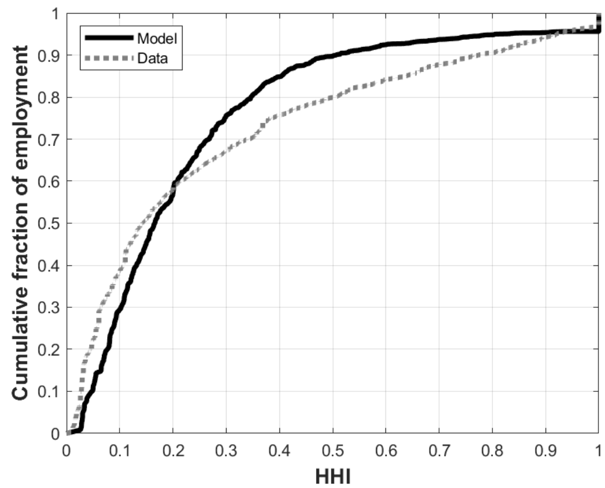
matches that the vast majority of employees are concentrated in the top employment quintile of firms. It also captures that approximately half of the firms pay wages near the minimum wage. Moreover, Panel A in Table 2 shows that the model fits well that about 90 percent of minimum wage earners are production workers. Hence, the calibrated model delivers realistic patterns regarding *how* likely and *who* is most likely to be affected by minimum wage reforms.

Moments of firm organization and market concentration. The distribution of workers and managers across firms is key to understanding the misallocation of labor that results from high-productivity firms exerting greater monopsony power. Panel B in Table 2 shows that the model predictions of the distribution of production workers across firms align with the data. Most firms are small and hire fewer than two employees, whereas only firms in

Figure 2: Labor market concentration



(a) Production workers



(b) Managers

Note: The Figures show the cumulative fraction of employment across local labor markets ranked by their level of concentration in the model and data for production workers (left) and managers (right).

the top one percent of the distribution hire more than 50 production workers. The model somewhat underestimates the number of managers in the top one percent of two-layer firms. However, it closely matches the data up to the 90th percentile and replicates a median span of control of 3 production workers per manager among two-layer firms.

Moments of market concentration. The moments of labor market concentration, which endogenously arise from agents' labor demand and supply decisions, directly speak to the level of wage markdowns. Figure 2 shows that the model delivers a realistic pattern of the distribution of employment across markets ranked by their HHI. The model rationalizes two key features: (i) most production workers sort into relatively low-concentrated labor markets, and (ii) managers tend to work in more concentrated markets than production workers. The first pattern arises because low-concentration markets have more firms, which pay higher wages. The second reflects that managerial markets are more likely to exhibit high concentration levels and that managers face higher across-market mobility costs, discouraging them from leaving markets that pay relatively low wages. For the reasons mentioned above, the model successfully predicts average differences in market concentration across occupations. Panel C in Table 2 shows that the model closely matches the average manager works in a market with an HHI of around one-fourth, which is greater than that of production workers. In addition, the last row in Panel C of Table 2 shows that the model captures that the average firm size in terms of payroll shares is higher for managers than production workers.

4.2 Quasi-experimental Evidence

Pass-through of demand shocks to wages. How firms adjust wages following a demand shock provides information about joint changes in firms' employment and monopsony power. To see this, note that Equation (12) implies that the equilibrium relationship between workers' wages of occupation o and firms' output is given by:

$$w_{ijo} = \mu_{ijo} \cdot \gamma\alpha \cdot \frac{y_{ij}}{n_{ijo}} \;\Rightarrow\; \Delta \log w_{ijo} \;=\; \Delta \log \mu_{ijo} + \Delta \log y_{ij} - \Delta \log n_{ijo}.$$

Therefore, markdowns must widen or employment must increase for wages to change less than one-for-one with output ($\Delta \log w_{ijo} < \Delta \log y_{ij}$). To validate our model in this dimension, we replicate the quasi-experiment developed in Garin and Silvério (2024), who find an elasticity of wages with respect to output close to zero in the Portuguese economy.

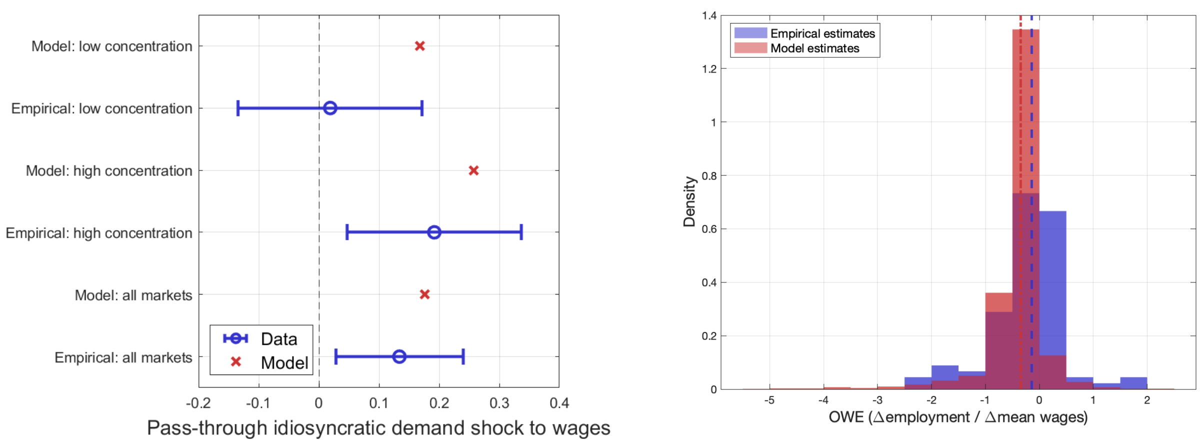
GS exploits idiosyncratic export shocks during the onset of the Great Recession (2009-2010) in Portugal to estimate demand-wage pass-through by comparing wage growth across exporting firms with different baseline exposure to product-country pairs and unexpected shifts in foreign import demand. We replicate their quasi-experiment through the following procedure. We solve the model in general equilibrium, then draw a random sample of firms and increase their idiosyncratic productivity by $\omega^{GS} \sim \text{Lognormal}(\mu_\omega, \sigma_\omega)$. Moreover, we limit our sample to firms with more than $\underline{n}^{GS}$ employees. We take $\sigma_\omega = 0.05$ and calibrate the parameters $\{\underline{n}^{GS}, \mu_\omega\}$ to match an average firm size of 27 employees and an average decline of 19.4 percentage points in log value-added among affected firms, respectively.[10]

Next, we solve the model in the new general equilibrium and treat the observations before and after the shock as a panel with two time periods. We then regress log wage growth

[10]We take the average employment size of firms from the first row of Table 2 and the average drop in value-added from the second column in Table 5 of GS. Results are robust to choosing $\sigma_\omega \in \{0.03, 0.08\}$.

on log output growth and measure the wage pass-through as the regression coefficient. The left panel of Figure 3 presents our model's results compared with GS's empirical findings on export shocks. GS documents a pass-through of idiosyncratic shocks to wages of 0.13.[11] In our simulated data, we estimate a wage pass-through of 0.17, which is remarkably close and not statistically different from the GS point-estimate. Furthermore, GS also provides wage pass-through estimates for the sub-sample of firms located in markets above and below the national median of the HHI. Consistent with an oligopsonistic framework, they find that wage pass-through is slightly higher in highly concentrated markets (p-value=0.10). Using the simulated sample, we show that our model quantitatively replicates these results. Our pass-through estimates are not statistically different from GS and reproduce the higher pass-through observed in more concentrated markets. Reassuringly, our model successfully replicates measures derived from firm-level quasi-experimental variation that are informative of firms' employment responses.

Figure 3: Quasi-experimental evidence and model simulations



(a) Wage pass-through

(b) Effects of minimum wage policies

Note: The Figure plots the pass-through of idiosyncratic demand shocks to wages (left) and the own wage elasticities (right) from the model simulations and quasi-experimental evidence from Garin and Silvério (2024) and Dube and Zipperer (2024). We exclude the 1st and 99th percentiles in the graphs for visual illustration, but all the highlighted results still hold.

[11] This is the result from the first column of Table 7. We use monthly wages as a baseline for the model's quantification, as it does not significantly differ from results based on hourly wages.

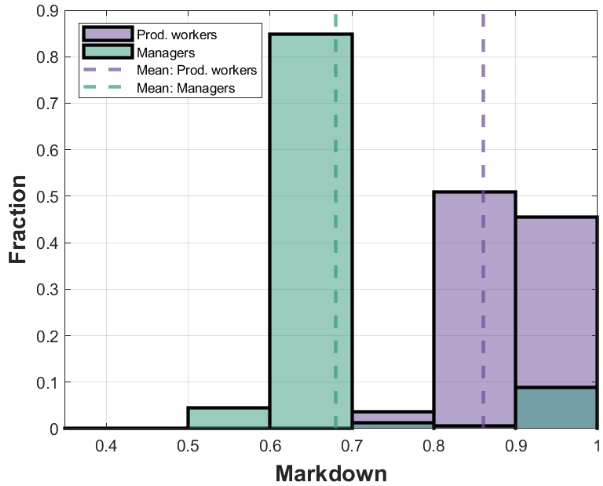
Labor market effects of minimum wages. Dube and Zipperer (2024; henceforth DZ) collects a comprehensive set of estimates of the own-wage elasticity (OWE) from about 90 studies that cover a set of developed countries since 1992. The OWE measures the percent change in employment for a given percent change in the average wage induced by a minimum wage change.[12] The OWE is a meaningful measure to analyze the labor market effects of minimum wage changes because, as long as the effect of minimum wages on the mean wage is positive, an OWE > -1 implies that minimum wage reforms increase economy-wide pre-tax earnings.

The key restrictions for inclusion in the DZ sample require that studies evaluate the employment effects of the statutory minimum wage and include experimental or quasi-experimental variation. To replicate this quasi-experimental evidence, we simulate a general equilibrium for statutory minimum wages such that $\underline{w} \in \{0 \cdot \bar{w}^*_w, 0.02 \cdot \bar{w}^*_w, 0.04 \cdot \bar{w}^*_w, \ldots, 1.08 \cdot \bar{w}^*_w\}$, where w^*_w is the mean wage of production workers in the benchmark economy. Namely, we simulate economies ranging from one without a minimum wage to one where the statutory minimum wage is 8 percent higher than the benchmark mean wage of production workers (980€). This yields a 48×48 matrix of OWEs derived from pairwise comparisons across these economies, which differ only in the statutory minimum wage.

The right panel of Figure 3 shows the histogram of empirical and model-simulated estimates of the OWE. The dashed lines display the mean value of each distribution. The model quantitatively replicates the labor market effects of minimum wage reforms, generating most of the OWEs within the range of empirical estimates. Moreover, the mean OWE is -0.2 in DZ, which is close to the model-simulated mean of -0.4. It is reassuring that our model estimates are consistently within the range of findings that suggest raising the statutory minimum wage leads to modest employment losses and higher earnings.

[12] Most of the studies use data from the U.S., and the remaining studies are based on the United Kingdom, Canada, or countries in the European Union. Formally, OWE $= \frac{(\%\Delta\text{Employment})}{(\%\Delta\text{Minimum wage})} \Big/ \frac{(\%\Delta\text{Mean wage})}{(\%\Delta\text{Minimum wage})}$.

Figure 4: Distribution of wage markdowns



Note: The Figure plots the distribution of wage markdowns (μ_{ij}) across firms for production workers and managers. The wage markdown is the wedge between the wage and the marginal productivity of labor. Dashed lines display the weighted mean of each variable, where the weight of each firm is its employment size.

5 Implications of Occupation-Specific Monopsony Power

Monopsony power over managers plays a central role in explaining the overall efficiency and welfare losses from monopsony power. The average markdown is twice as high for managers (31.9 percent) as for production workers (16.0 percent). Relative to the efficient economy, we find that welfare losses arising from monopsony power are 3.4 and 2.4 percent for managers and production workers under equal profit shares. Moreover, managers' wage markdowns alone account for one-fifth of the overall earnings losses of production workers from monopsony power due to production complementarities.

5.1 Measuring Monopsony Power

Figure 4 displays the distribution of wage markdowns for both occupations in the benchmark economy. Markdowns are below one due to imperfect firm substitutability and firm granularity, implying that wages are below the marginal revenue product of labor. We estimate an employment-weighted markdown of 16.0 percent for production workers and 31.9 percent for managers. Three reasons explain why monopsony power is stronger over managers than production workers. First, both the upper (η_o) and lower bounds (θ_o) of the structural elasticities are lower for managers. Namely, compared to production workers, managers perceive distinct firms as more imperfect substitutes in terms of non-wage characteristics. Second, firms tend to have higher managers' payroll shares than production workers'. Thus, the labor supply elasticity of managers is closer to the across-market elasticity than that of production workers. In other words, managers find it harder to reallocate towards other firms because more of their alternatives are outside of their current local market. Third, minimum wages mainly constrain low-productivity firms, which primarily employ production workers.

5.2 Welfare and Efficiency Losses from Monopsony Power

The presence of wage markdowns translates into pure dead-weight and misallocation losses. Thus, we now turn to quantify the effect of monopsony power on efficiency and welfare. We compute the efficient allocation by setting wage markdowns to one, i.e., equalizing wages to the marginal product of labor for all firms. Note that this counterfactual does not change households' preferences. Table 3 summarizes the results by comparing the aggregate outcomes in the efficient relative to the benchmark economy.

Panel A in Table 3 shows the change in mean wages across occupations. Since managers bear wider markdowns, the mean wage increase is greater for managers than for production workers. As a result, the wage gap across occupations increases. Panel B shows the employment effects of monopsony power. When firms face upward-sloping labor supply curves, they restrict employment relative to the efficient allocation to reduce labor costs and maximize profits. We find that employment rises by 7.9 percent and 14.6 percent for production workers and managers in an efficient economy, respectively.

In an efficient economy, apart from the rise in wages and employment, the concentration of employment at the most productive firms increases. The top panels in Figure 5 show that the share of employees, especially managers, working in the most productive firms rises by more than 15 percent. Moreover, the bottom-left panel shows that part of this increase in concentration stems from rising wages, which make management delegation no longer profitable for medium-productivity firms, leading to a 10.9 percent decrease in the share of two-layer firms. Taken together, employment gains and reallocation towards more productive

Table 3: Effects of efficient economy relative to benchmark with monopsony power

	Efficient economy (% change)	Manager effects (pp.)		Efficient economy (% change)	Manager effects (pp.)
Panel A: Mean wages					
Production workers	20.5	4.6	Managers	46.8	43.2
Panel B: Employment					
Production workers	7.9	1.7	Managers	14.6	14.5
Total	9.1	4.1	Output	10.1	5.9
Panel C: Firm organization					
Share two-layer firms	-10.9	-4.5	Span of control	-4.4	-0.4
Panel D: Mean HHI					
Production workers	20.0	4.6	Managers	20.4	14.6

Note: The Table reports the percent change in outcomes in the efficient (wage markdowns equal to one) relative to the benchmark economy with monopsony power. In addition, the Table also shows the contribution of managers' monopsony power to the overall effects. We compute the latter as the difference between (i) the efficient economy and (ii) a counterfactual with markdowns equal to one exclusively for production workers.

firms increase output by 10.1 percent.

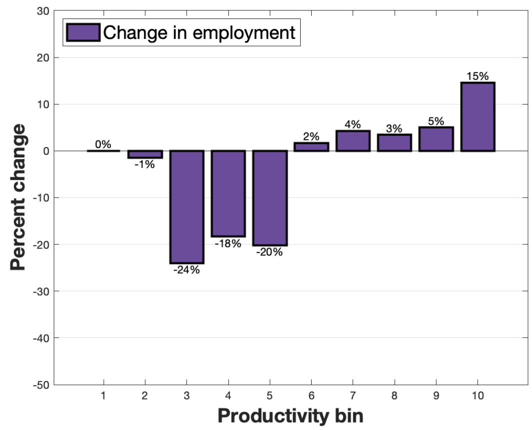
The large and heterogeneous wedges between marginal productivity and wages become a major detriment to households' welfare. We use a utilitarian welfare function that defines social welfare as the sum of utilities of both occupations: $\mathcal{U}_S = \sum_{o\in\{w,m\}} \mathcal{U}_o$. Note that the size of the household enters the utility function through aggregate consumption and labor supply. We find a consumption-equivalent social welfare gain of 2.7 percent, which arises from earnings gains that more than offset the increase in labor disutility and the profit losses.

Linear utility in consumption implies that the distribution of firm profits across occupations, κ_o, does not affect social welfare. In contrast, Figure 5(d) shows that the share of profits rebated to a specific household significantly affects the impact of monopsony power on each household's welfare. We consider a reasonable range for the share of profits rebated to production workers to be between equal shares and population shares, $\kappa_w \in [0.4, 0.8]$. Within this interval, the welfare change of production workers between the efficient and benchmark economies lies in the range $\xi_w \in [-0.02, 0.04]$. When the share is slightly below equal shares ($\kappa_w = 0.4$), production workers enjoy a welfare gain of up to 4.3 percent. In contrast, when they suffer the bulk of the profit losses ($\kappa_w = 0.8$), these losses largely offset the relatively small gains from higher earnings, and they experience a welfare loss of 2.5 percent. Unlike production workers, managers always enjoy welfare gains over the same range of profit-sharing allocations, $\xi_m \in [0, 0.18]$, reflecting the greater monopsony power firms hold over them, with welfare gains of up to 18.1 percent.

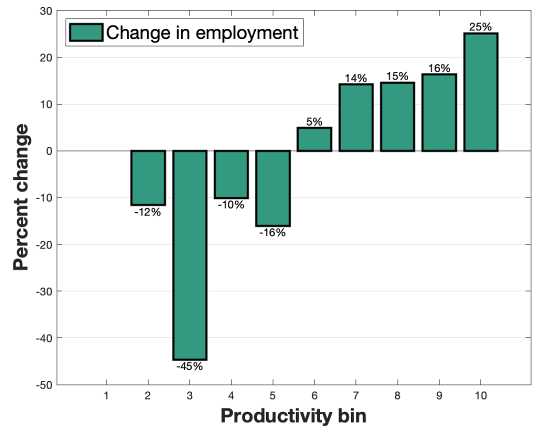
5.3 The Role of Managers' Monopsony Power

In our framework, where production complementarities exist between occupations, the joint distribution of allocations and prices across occupations is mutually dependent. Hence, monopsony power over one occupation spills over to others and has far-reaching consequences for the entire workforce. To quantify this channel, we simulate a counterfactual economy in which we exogenously set wage markdowns to one exclusively for production workers. We then attribute the differences between this counterfactual and the efficient economy solely to removing managers' monopsony power. Throughout the rest of the paper, we refer to *effects from managers' monopsony power* as both the *direct* effects and the *spillover* effects arising

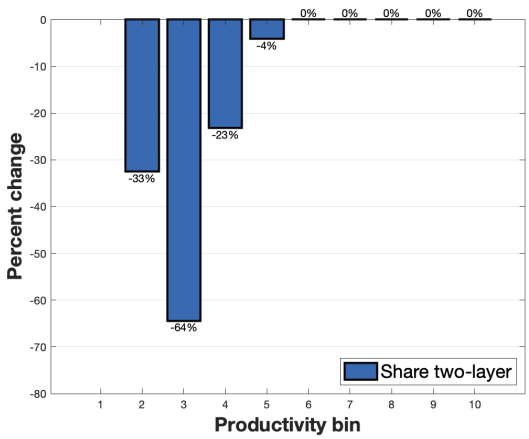
Figure 5: Effect of monopsony power on misallocation and welfare



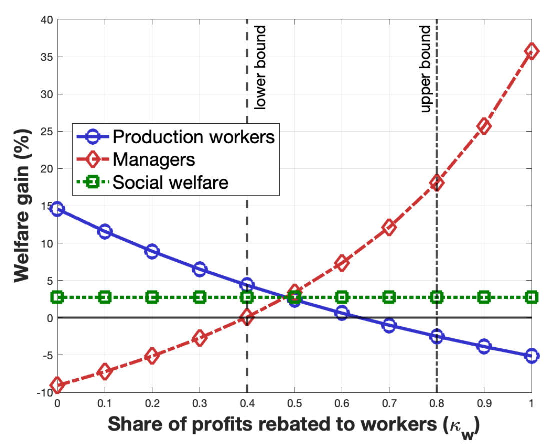
(a) Production workers



(b) Managers



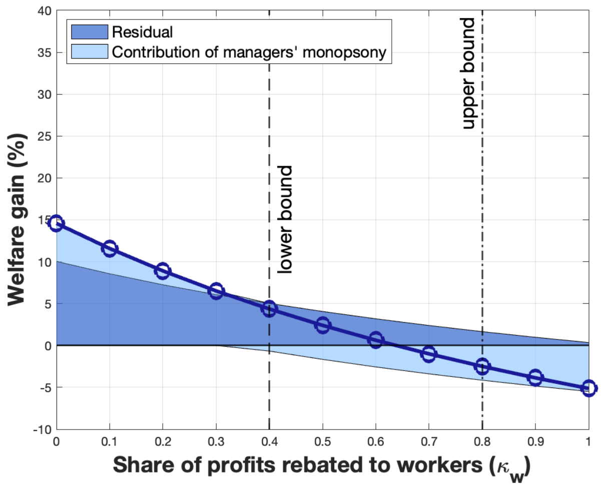
(c) Share two-layer firms



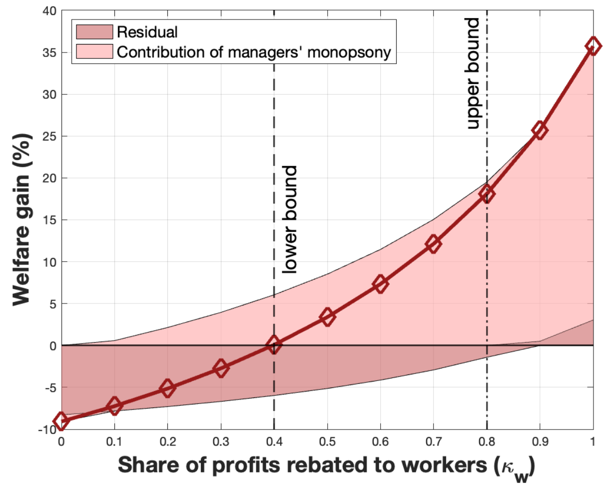
(d) Welfare

Note: The top panels in the Figure plot the percent change in employment of production workers (left) and managers (right) across firms in the efficient relative to the benchmark economy. The bottom left panel shows the percent change in the share of two-layer firms, where we express the change as a fraction over the total number of firms in the same productivity bin. The bottom right panel shows the social and occupation-specific welfare gains in (percent) consumption equivalent terms. The efficient economy consists of an economy where wages are equal to the marginal product of labor. We classify firms into ten bins according to their productivity, where a higher bin implies higher productivity.

Figure 6: The role of managers' monopsony in welfare



(a) Production workers



(b) Managers

Note: The Figures display how much the firm organization channel, i.e., the endogenous firms' choice of layers, accounts for the percent change between the efficient and benchmark economies in several outcomes of production workers (left) and managers (right). For instance, the endogenous organizational choice of firms explains about 30 percent of the change in the average level of payroll concentration in managerial markets between the efficient and benchmark economies.

from production complementarities between occupations.

Table 3 shows the percentage-point contribution of removing managers' monopsony power alone, relative to overall gains from the efficient economy. Removing managers' monopsony power captures nearly all of the gains of managers' outcomes in an efficient economy and a significant portion of production workers' gains. The rise in managerial wages, especially at the most productive firms, results in an increase in both managerial employment and concentration of managers at the most productive firms. Combined with production complementarities, rising managers' employment incentivizes these firms to expand their hiring of production workers and their production. Specifically, nearly one-fifth of the increase in market concentration (4.6 pp.), employment (1.7 pp.), and wages (4.6 pp.) of production workers in the efficient economy solely stems from removing managers' monopsony power. Despite being only one-fifth of the labor force, managers' monopsony power explains about 60 percent of the output gains in the efficient economy.

Regarding welfare, we find that removing managers' monopsony power increases social welfare by 0.9 pp., representing about one-third of the gains from the efficient economy. Figure 6 shows the contribution of managers' monopsony power to each occupation's welfare changes from the efficient economy, with the remaining share (residual) attributed exclusively to production workers' monopsony. For each occupation, moving to an economy with efficient wages in its own occupation generates welfare gains for all profit shares, κ_o, due to the large earnings gains. However, workers in one occupation do not necessarily benefit from removing monopsony power over the other occupation. While their earnings rise as firms expand employment and wages due to production complementarities, this effect is counteracted by a decline in firm profits and the reallocation of workers. The positive effect only outweighs the negative one when the profit share of the occupation is relatively low.

These results highlight that policies targeting firms' wage-setting power in low-wage occupations would prove ineffective at addressing the substantial welfare losses that also stem from monopsony power over high-wage occupations. This motivates our evaluation of minimum wage policies as a tool to capture some of the welfare gains of the efficient economy.

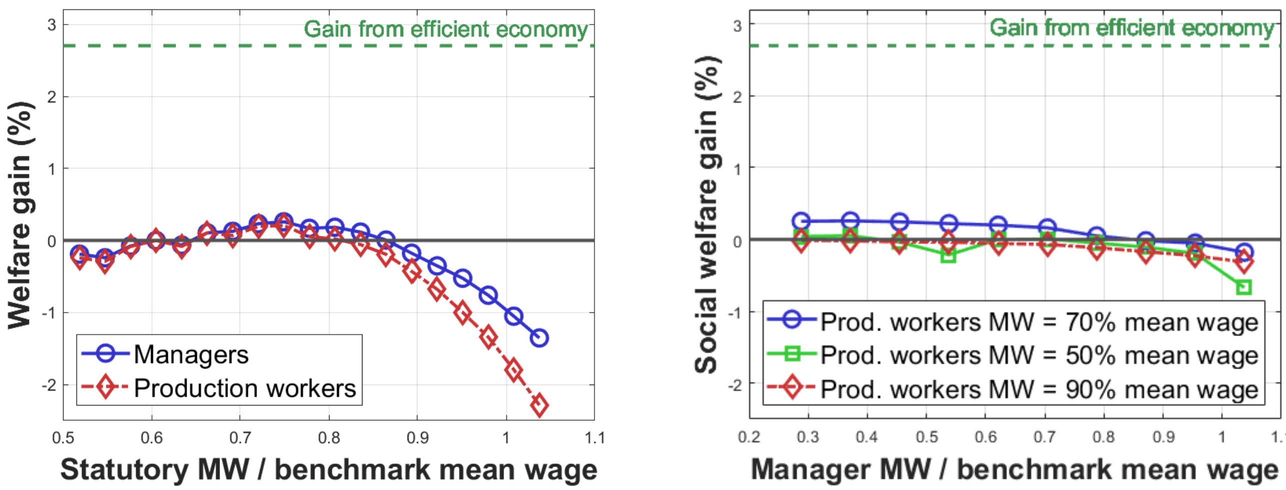
6 Minimum Wage Policies

Among other reasons, minimum wage policies aim to improve the well-being of low-income workers by reducing the wage-setting power of firms. We find that the single statutory minimum wage that maximizes social welfare captures less than 10 percent of the social welfare gains from an efficient economy. Despite the presence of occupation-specific monopsony power, an optimal occupation-based minimum wage only slightly improves upon the optimal single minimum wage. The reason is that, conditional on an occupation, minimum wages inevitably bind first for low-productivity firms where monopsony power is relatively weaker.

6.1 The Optimal Statutory Minimum Wage

The Portuguese government has significantly increased the (real) statutory minimum wage during the last two decades, with the share of employees earning the minimum wage reaching one-fourth by 2017 (see Appendix Figure D.2). In the model, raising the minimum wage

Figure 7: Welfare effects of minimum wage policies



(a) Statutory minimum wage

(b) Occupation-based minimum wage

Note: The Figure plots the occupation-specific (left) and social (right) consumption equivalent gains in a counterfactual relative to the benchmark economy. On the left panel, the only difference between the counterfactual and benchmark economy is a different statutory minimum wage. On the right panel, the counterfactual simulations differ in terms of occupation-specific minimum wages.

mitigates monopsony power in supply-constrained firms by inducing these firms to increase employment and wages.

Figure 7(a) plots the welfare effects of different statutory minimum wages relative to the benchmark economy. Welfare is hump-shaped and attains the same welfare-maximizing minimum wage for both occupations, with the minimum-to-mean wage at about 75%. At best, an optimal statutory minimum wage captures less than one-tenth (0.2 pp.) of the social welfare gains from an efficient economy (2.7 percent). Despite generally larger wage markdowns, the statutory minimum wage fails to effectively address monopsony power because of heterogeneity in firm- and occupational-level wage markdowns. Conditional on occupation, the statutory minimum wage binds first for low-productivity firms, which exert relatively narrow markdowns. Similarly, conditional on firm productivity, the statutory minimum wage is more likely to bind for low-wage occupations, which also display relatively smaller markdowns. As a result, a statutory minimum wage is not able to address the stronger monopsony over high-wage workers without considerable losses in output, employment, and ultimately, welfare.

6.2 The Optimal Occupation-Based Minimum Wage

The occupational heterogeneity in wage markdowns suggests that designing a minimum wage for each occupation, rather than a single statutory minimum wage, could be more effective at tackling the welfare losses from monopsony power, as managers tend to earn wages above the minimum wage and bear wider markdowns than production workers. Indeed, many developed countries already implement occupation-based wage floors.[13]

For these reasons, we simulate different scenarios where we set a specific minimum wage for each occupation. Figure 7(b) depicts the change in the utilitarian social welfare for different values of occupation-specific minimum wages. Each line represents the social welfare gains for varying manager-specific minimum wages, conditional on a fixed production worker minimum wage. For clarity, we display only the blue line representing the welfare-maximizing combination of minimum wages, along with two additional lines from setting alternative production workers' minimum wages.

We find that the combination of occupation-based minimum wages that maximizes social welfare provides a gain of 0.3 percent relative to the benchmark. This occurs when the minimum wage of production workers is about 75 percent of their mean wage and the minimum wage of managers is about 50 percent of their mean wage. Two things stand out from this result. First, despite strong monopsony power over managers, a social planner would set the minimum wage relatively low. This is because social welfare largely depends on the outcomes of production workers, and managerial job losses resulting from a higher manager-specific minimum wage reduce labor demand and welfare for these workers. Second, optimal

[13]Under the Modern Awards system, Australia implements statutory minimum wages that are occupation-based. Moreover, collective bargaining agreements that set distinct wage floors across occupations in an industry are common in European countries such as Italy (Adamopoulou et al., 2023), France (Fougère et al., 2018), Norway (Bhuller et al., 2022), Sweden (International Labour Organization, 2023), and Portugal. Still, Portuguese workers typically earn wages above their respective wage floors (Card and Cardoso, 2022), indicating that wage bargaining may be less effective at preventing firm-level wage-setting power.

occupation-specific minimum wages provide only marginal improvement over the optimal single statutory minimum wage. Like the single minimum wage, they capture relatively modest welfare gains compared to an efficient economy, as they primarily affect low-productivity firms where monopsony power is weaker. Nevertheless, these remain practical instruments available to governments to help counteract firms' wage-setting power.

7 Conclusion

Extending a general equilibrium model of oligopsony to include minimum wages and firm organization, we show that the heterogeneity in monopsony power and production complementarities between managers and production workers helps to understand the welfare effects of monopsony power. We estimate the model using employer-employee matched data linked to balance sheet information in Portugal and validate it against reduced-form evidence. We quantify an average wage markdown of 31.9 percent and 16.0 percent for managers and production workers, respectively. Thus, moving from the benchmark to an efficient economy increases employment, mean wages, and employment concentration at the most productive firms, especially for managers. Removing managers' monopsony alone explains nearly one-fifth of these gains for production workers due to the presence of production complementarities. Under equal profit shares, managers and production workers enjoy a welfare gain of 3.4 and 2.4 percent, respectively, as the higher earnings offset the profit losses and utility costs from worker reallocation. In terms of policy, we find that occupation-specific minimum wages are slightly more effective than a single statutory rate in recovering the welfare gains from efficiency.

We consider two valuable extensions for future research. We believe market concentration and mobility costs may also show a systematic relationship with other market characteristics. For instance, factors such as the skill level required in the job, workers' age, or the market's formality in developing countries. Regarding the model specification, future model extensions may consider worker heterogeneity in productivity and across-occupation mobility.

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