Redistributive Income Taxation with Collective Wage Bargaining and Investment Hold-Up*

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Abstract

I derive a sufficient statistics formula for optimal nonlinear labor income taxes in a model where collective wage bargaining generates involuntary unemployment and investment hold-up. Key sufficient statistics are employment responses, wage responses, and a novel sufficient statistic—the capital-bargaining wedge—that captures the fiscal relevance of hold-up under entry-constrained profit taxation. I show that while collective wage bargaining raises the efficiency costs of redistribution by generating involuntary unemployment, the capital-bargaining wedge determines whether hold-up amplifies or offsets this distortion. Quantitatively, a calibration to France (2017) suggests that the hold-up amplifies the union-induced distortion, thereby warranting lower labor income taxes.

Keywords: Optimal taxation; hold-up problem; unionized labor markets; wage bargaining.

JEL Classification: H21, H23, J51, J58

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1 Introduction

Collective bargaining remains a central institution for wage-setting and rent sharing across advanced economies.[1] Nonetheless, by pushing negotiated wages above competitive levels, it introduces efficiency costs that can amplify the distortions of income redistribution—especially when bargaining interacts with irreversible investment. In this paper, I analyze optimal labor income taxation in a setting where ex-post wage bargaining generates investment holdup (i.e., under-investment),[2] and firm entry constrains the taxation of profits. I derive a sufficient-statistics formula for optimal nonlinear labor income taxes in such an environment. Labor supply responses are not sufficient to characterize the effects of taxation, since taxes affect equilibrium wage demands and unemployment through movements along the labor demand curve. The resulting formula utilizes employment responses, wage responses, and a novel sufficient statistic—the capital-bargaining wedge—which captures the fiscal relevance of investment hold-up under entry-constrained profit taxation.

I consider an economy that includes a representative firm, a government, and sectoral unions representing discrete worker types (as in Saez, 2002). A central feature of the model is an endogenous entry decision involving irreversible investment: to operate, the firm must incur a sunk cost to install capital, anticipating how this investment influences subsequent wage bargaining and employment. Consequently, entry occurs only if expected after-tax profits cover sunk costs. Workers are immobile across sectors—each type i of workers is tied to a specific sector— and differ in their participation costs, such that labor supply responses occur solely on the extensive (participation) margin if wage bargaining succeeds. Wages are determined through Nash bargaining between sectoral unions and the firm. Following the right-to-manage framework of Nickell and Andrews (1983), the firm unilaterally determines sectoral employment given the negotiated wages. Finally, a benevolent government sets labor income taxes, unemployment benefits, and profit taxes—subject to the firm's entry constraint— to maximize social welfare.

The main contribution of this paper is to derive a sufficient statistics optimal tax formula that is valid in the presence of involuntary unemployment and investment holdup induced

[1] Evidence from the US suggests that unions' influence on earnings remains economically meaningful: using five decades of data, Blanchflower and Bryson (2024) find that while the regression-adjusted hourly union wage premium has declined, the premium in weekly earnings has remained relatively stable. In France, where industry-wide agreements are extended to all employees irrespective of membership, Breda (2015) estimate an additional 2–3% wage premium associated with firm-level union recognition on top of extended sectoral agreements.

[2] Workers can appropriate part of the quasi-rents generated by sunk investment through ex-post wage bargaining, weakening firms' ex ante investment incentives (Grout, 1984; Van der Ploeg, 1987; MacLeod and Malcomson, 1993).

by collective wage bargaining. I show that the total tax wedge in sector j comprises an explicit employment tax t_j—defined as the tax the worker pays plus the amount of welfare benefit[3]—and a net implicit component, $\tau_j^{\text{implicit}} - \tau_{Kj}^{\text{implicit}}$. The first term, τ_j^{implicit}, characterizes the welfare loss from labor rationing: because collective bargaining pushes wages above market-clearing levels, the marginal participant (under efficient rationing) is no longer indifferent between participating and not participating, creating an implicit distortion on participation (Hummel and Jacobs, 2023). The second term, $\tau_{Kj}^{\text{implicit}}$, captures the fiscal relevance of investment holdup under entry-constrained profit taxation. It summarizes how tax-induced employment responses alter the residual surplus required to sustain firm entry through two channels: (i) a production-complementarity channel, where higher employment raises the marginal return to sunk capital, and (ii) a bargaining-incidence channel—direct and spillover—through which marginal capital returns are passed through into higher bargained wages (i.e., unions appropriate marginal capital returns through higher negotiated wages), and employment responses can amplify or dampen this wage–capital pass-through across sectors. The sign of τ_j^{implicit} governs how employment responses affect the tightness of the entry constraint on profit taxation. When the production-complementarity channel dominates ($\tau_j^{\text{implicit}} > 0$), employment responses relax the entry constraint, increasing the level of profit taxation that can be imposed while sustaining entry. Conversely, when bargaining-incidence dominates ($\tau_j^{\text{implicit}} < 0$), the holdup problem is exacerbated, and employment reductions tighten the entry constraint.

The core insight is that while union-induced rationing typically pushes the social optimum toward lower employment taxes—or subsidies—to induce lower wage demands and thus higher participation, the presence of investment holdup under entry-constrained profit taxation can tilt the optimum toward higher employment taxes when $\tau_{Kj}^{\text{implicit}} > 0$. In that case, tax-induced employment reductions relax the entry constraint and expand the level of profit taxation. Consequently, relative to the benchmark without investment holdup under entry-constrained profit taxation, higher employment taxes are welfare-enhancing if the marginal gain in profit tax revenue—generated by the relaxation of the entry constraint—outweighs the marginal efficiency cost of the induced labor market distortion.

I also consider a special case with independent labor markets, in which sector-specific employment taxes do not affect wages or employment in other sectors (no cross-effects). In this case, the optimality condition collapses to a within-sector formula that is directly comparable to the pure extensive-margin results in Diamond (1980), Saez (2002), and Choné and

[3]In perfectly competitive labor markets with no labor rationing, this corresponds to the standard participation tax

Laroque (2011). The effective employment wedge is negative for low-income workers with above-average social welfare weight. Hummel and Jacobs (2023) suggest that employment subsidies can arise even for workers with below-average welfare weights if the social cost of union-induced involuntary unemployment is sufficiently high. In my framework, however, such subsidies are less likely when the capital–bargaining wedge is positive and sufficiently large relative to the rationing wedge, since it offsets part of the net implicit distortion.

To assess the quantitative importance of union-induced hold-up risk for equilibrium capital and optimal tax-benefit system, I calibrate a structural version of the model to the French economy in 2017. Our simulations imply substantial underinvestment: equilibrium capital is 44.6% lower than in the perfect-competition benchmark. This falls well within the range of empirical estimates in the literature. For the US, Hirsch (1992) finds that unionized firms invested 20% less in physical capital compared to nonunion firms. Evidence from the Canadian manufacturing sector is even more pronounced: Odgers and Betts (1997) find that an industry with the mean level of unionization has a net investment rate that is 66-74% lower than it would be if the industry were not unionized, and gross investment that is 18-25% lower. Optimal employment tax rates are, on average, 12.7 percentage points lower in unionized labor markets subject to hold-up than under perfect competition. Moreover, within unionized economies, the hold-up mechanism further reduces optimal employment tax rates by 4.4 percentage points relative to the union case with a perfectly competitive capital market (i.e., no hold-up). The reduction in employment tax rates is implemented through both lower labor income taxes and less generous unemployment benefits. In the unionized economy without hold-up, the optimal nonemployment benefit falls to €8,855, relative to €10,949 in the perfect competitive benchmark (i.e., no union). Under hold-up, it declines further to €8,703. This is consistent with stronger wage–capital pass-through: unions capture a larger share of capital's marginal return through higher negotiated wages, exacerbating hold-up and increasing the marginal efficiency cost of labor taxation.

Related literature This paper contributes to the literature on optimal income taxation with extensive (participation) margin labor supply responses, including Diamond (1980), Saez (2002), Choné and Laroque (2011), Jacquet et al. (2013), and Christiansen (2015).[4] These papers solve for the optimal labor income tax under competitive wage-setting and no rationing. A central insight from these papers is that an earned income tax credit (EITC) policy is desirable whenever labor supply responses occur along the extensive margin. This corresponds to a negative participation tax at the bottom of the earnings distribution, tar-

[4] Christiansen (2015) extends that by allowing for imperfect substitutability between labor types.

geting low-income workers with an above-average social welfare weight. These models are special cases of my framework when labor types are perfect substitutes, unions are absent, and the investment margin is shut down; allowing instead for imperfect substitutability between labor types yields Christiansen (2015) under the same assumptions. Kroft et al. (2020) develop a sufficient-statistics approach to optimal income taxation in a setting with unemployment and wage responses. Other contributions study optimal income taxation in models with search-and-matching frictions and worker–firm wage bargaining (Nash or à la Kalai) (Hungerbühler and Lehmann, 2009; Jacquet et al., 2014). In contrast, I abstract from search frictions and consider unionized labor markets in which equilibrium unemployment arises from unions biding up wages above market-clearing levels. In addition, I incorporate the endogenous interaction between collective bargaining and firm's (irreversible) investment decisions.

Second, this paper contributes to the literature on union behavior and investment under incomplete contracts. A large body of work examines how labor unions affect wages, employment, wage inequality, productivity, and firm performance (see, e.g., McDonald and Solow, 1981; Nickell and Andrews, 1983; Freeman and Medoff, 1984; Addison, 1985; Manning, 1987; Hirsch, 2007). Within this line of research, an important strand focuses on the hold-up problem under contractual incompleteness and irreversible investment, where ex post bargaining over surplus can lead to underinvestment by exposing the investing party to rent extraction (Williamson, 1975; Hart and Moore, 1988). Grout (1984) shows that once firms make sunk investments under incomplete contracts, they become vulnerable to ex post wage negotiations and may therefore choose to underinvest ex ante. Subsequent theoretical research extends this insight to a variety of settings—such as search-and-matching frameworks—and highlights how decision timing, bargaining structures, the degree of capital specificity, and capital–labor interactions shape investment behavior (Acemoglu and Shimer, 1999; Cahuc et al., 2008; Cardullo et al., 2015). Empirically, evidence on the hold-up problem is mixed, reflecting cross-country differences in institutions, bargaining structures, and capital specificity (Bronars et al., 1994; Odgers and Betts, 1995; Fallick and Hassett, 1999; Dustmann and Schönberg, 2009; Card et al., 2014; Cardullo et al., 2015; Addison et al., 2007, 2017). Because these studies focus mainly on investment efficiency, this paper broadens the analysis by examining both efficiency and distributional issues between firm owners and workers, and by linking hold-up dynamics directly to the design of optimal redistributive policies.

The remainder of the paper is organized as follows. Section 2 presents our theoretical framework. Section 3 analyzes the implications of our model for optimal income taxation and welfare outcomes. Section 4 presents our numerical simulations. Section 5 concludes. Finally, the Appendix contains the proofs and provides additional details.

2 The Theoretical Model

I develop a multi-stage framework featuring a representative firm, a government, and sectoral unions representing distinct worker types. In this framework, workers supply labor along the extensive (participation) margin: workers participate if wage bargaining succeeds. Labor types are imperfect substitutes in production. A central feature of the model is that firm-owners determine irreversible capital endogenously, anticipating how irreversible investments influence subsequent wage negotiations and employment levels. The timing of decisions follows a four-stage sequential structure. First, the government acts as a Stackelberg leader, fully committing to a tax policy. Second, anticipating future labor costs, the firm makes entry decision and commits to sunk capital investment. Third, sectoral wages are determined via Nash bargaining between unions and firm-owners representatives. Fourth, firm-owners unilaterally determine employment levels given the negotiated wage—consistent with the 'right-to-manage' framework (Nickell and Andrews, 1983).

2.1 Workers

There are $i \in \mathcal{I} = \{1, \ldots, I\}$ distinct types of risk-averse individuals. Each type i corresponds to a specific labor sector with a mass of individuals who can work N_i. Workers are assumed to be immobile across sectors; thus, an individual of type i faces a binary choice between participating in sector i or remaining outside the labor force. Individuals within each sector are heterogeneous with respect to their monetary participation costs, φ. These costs are drawn from a sector-specific cumulative distribution function $G_i(\varphi)$ with support $[\underline{\varphi}, \overline{\varphi}]$, where $\underline{\varphi} < \overline{\varphi} \leq \infty$. While the distribution $G_i(\varphi)$ is common knowledge, φ is private information.

An employed worker in sector i receives gross earnings w_i and pays a labor income taxes T_i, whereas those who remain unemployed receive unemployment benefits $-T_u$. Let $c_{i,\varphi} = w_i - T_i - \varphi$ be the disposable income of a worker in sector i, and $c_u = -T_u$ her income when unemployed (non-participant). Utility is described by:

$$\begin{cases} u(c_{i,\varphi}) = u(w_i - T_i - \varphi) & \text{if she works} \\ u(c_u) = u(-T_u) & \text{if she does not.} \end{cases} \tag{1}$$

The utility function is assumed to be twice-continuously differentiable, increasing and concave in disposable income. Since I study optimal income taxation when labor supply reacts only along the extensive margin, the participation decision depends solely on the utility derived from the relative after-tax rewards of being active or inactive. Therefore, a worker

type i will then opt to participate in the labour market according to whether:

$$u(c_{i,\varphi}) = u(w_i - T_i - \varphi) \lesseqgtr u(-T_u) = u(c_u). \tag{2}$$

In the case of indifference, equation (2) defines a cut-off point φ_i^* at which individuals are indifferent between working and not. For each sector i, the cut-off is determined by:

$$\varphi_i^* = w_i - T_i + T_u \tag{3}$$

Labor participation in sector i is determined by the participation threshold φ_i^*, which is increasing in the wage net of employment taxes $(T_i - T_u)$.

2.2 The Firm

Entry requires an upfront irreversible capital investment K to establish the workstation at a per-unit cost of ϕ. The total cost ϕK is non-recoverable once incurred, so the firm will enter the market only if their expected profits are non-negative, ensuring that the potential returns justify the sunk cost of entry. Observing the government policy on T_f, the firm enters if its expected after-tax profit is at least the sunk cost. Mathematically, the firm entry condition is given by:

$$\mathbb{E}[\Pi] - T_f - \phi K \geq 0, \tag{4}$$

where pre-tax profits Π can be written as:

$$\Pi = F(K, L_1, \ldots, L_I) - \sum_i w_i L_i. \tag{5}$$

The representative firm produces the final good using a constant-returns-to-scale technology given by $Y = F(K, L_1, ..., L_I)$. This technology adheres to customary assumptions: it is twice-continuously differentiable in K and L_i, and exhibits both positive and diminishing marginal products. This is described by:

$$F_K(.),\ F_i(.) > 0,\ F_{KK}(.),\ F_{ii}(.),\ -F_{Ki}(.) \leq 0, \tag{6}$$

where the subscripts denote derivatives with respect to capital and labor in sector i and the cross derivative. I assume that capital and labor in sector i are co-operant production factors $(F_{Ki} \geq 0)$. In the baseline, I abstract from cross-sectoral spillovers, a restriction that yields analytically tractable comparative statics. I then relax this assumption.

Assumption 1 (Independent Labor Markets)**.** *The marginal product of labor in sector i is unaffected by labor employed in any other sector $j \neq i$; that is, $F_{ij} = 0$ for all $j \neq i$* [5].

Upon entry, the firm chooses K to maximize net profits net of capital costs, which yields the investment condition:

$$F_K(.) - \phi = 0. \tag{7}$$

Condition (7) pins down the efficient level of capital under a perfectly competitive capital market with no hold-up wedge.

2.3 Sectoral Unions

It is widely acknowledged that labor market policies and institutions that establish wage rates above the market-clearing level result in an inefficient allocation of production resources. The imbalance, driven by elevated wage levels, fosters an oversupply of individuals seeking employment at prevailing wages compared to available job opportunities, leading to involuntary unemployment and, consequently, a welfare loss. Such labor rationing may arise from various sources, including union-set wages. Given the heterogeneity in participation costs among union members, it becomes then crucial to incorporate considerations of labor rationing in our settings i.e., which workers lose their jobs due to the elevated wage rate set by unions? Lee and Saez (2012), in a perfectly competitive labor market, assume that rationing is efficient to analyze optimal minimum wage policy for redistribution purposes, so that rationing primarily affects those workers with the least surplus of work (cf. Gerritsen, 2017; Gerritsen and Jacobs, 2020). In our scenario where there are heterogeneous participation costs among workers, I also assume that labor rationing is efficient, as in Hummel and Jacobs (2023).

Assumption 2 (Efficient Rationing)**.** *Involuntary unemployment induced by the union wage is concentrated on those with the least surplus from working—that is, those facing the highest participation costs.*

Under Assumption 2, the involuntary unemployment, triggered the elevated wage rate set by unions, is concentrated on individuals with the highest dis-utility of work, in other words, on those who are indifferent between employment and their outside option. This ensures that the efficiency loss due to the involuntary unemployment caused by unions bidding up wages above the clearing level is a second order welfare loss [6].

[5] With no spillover effects, labor demand in sector i depends only on w_i, and labor-demand elasticity in sector i is given by $\varepsilon_i = -F_i/L_i F_{ii} > 0$.

[6] However, if I relax the efficient rationing labor market and assume a uniform rationing i.e., unemployment

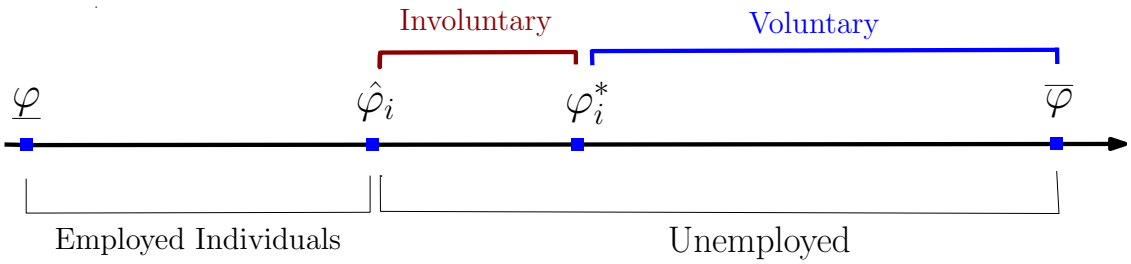


Figure 1: Efficient rationed labor market

Let $E_i \equiv L_i/N_i$ denotes the employment rate for workers in the sector i, where N_i denote the mass of individuals in sector i. In accordance with Assumption 2, I adopt the schedule shown in Figure 1. Individuals with participation costs $\varphi \in [\underline{\varphi}, \hat{\varphi}_i]$ are employed, where $\hat{\varphi}_i = G_i^{-1}(E_i)$. Conversely, individuals with $\varphi \in (\hat{\varphi}_i, \overline{\varphi}]$ are not employed. Among the non-employed, those with $\varphi \in (\hat{\varphi}_i, \varphi_i^*]$ are involuntarily unemployed, while those with $\varphi \in (\varphi_i^*, \overline{\varphi}]$ are voluntarily unemployed. Given the voluntary nature of participation, the proportion of workers willing to participate exceeds the actual employment rate, i.e., $E_i = G_i(\hat{\varphi}_i) \leq G_i(\varphi_i^*)$.

Under Assumption 2, the union in sector i seeks to maximize the expected utility of its members, with its objective function given by:

$$\Lambda = \left(\int_{\underline{\varphi}}^{\hat{\varphi}_i} u(c_{i,\varphi}) dG_i(\varphi) + \int_{\hat{\varphi}_i}^{\overline{\varphi}} u(c_u) dG_i(\varphi) \right) = E_i \overline{u(c_i)} + (1 - E_i) u(c_u), \tag{8}$$

where $\overline{u(c_i)} = \int_{\underline{\varphi}}^{\hat{\varphi}_i} u(c_{i,\varphi}) dG_i(\varphi)/E_i$ denotes the average utility of employed workers type i.

2.4 Wage Bargaining

I model wage bargaining using the right-to-manage (RtM) bargaining framework of Nickell and Andrews (1983), a generalization of the union monopoly model (Dunlop, 1944) that allows the firm to earn positive profits. In each sector i, the union bargains solely over the sector wage w_i; once this wage is set, firm owners unilaterally select employment E_i to maximize profits [7]. As it is standard in the literature, the negotiated wage in sector i solves the maximization of the generalized Nash product, defined as the product of the surplus for both the sectoral union and the firm-owners— over its respective fallback (no-agreement) position—weighted by their respective bargaining powers taking into account the voluntary

strikes independently of surplus, then unionization may create a first order welfare loss. In that case, the desirability of unions will be under question.

[7] Bargaining over wages and employment would be more efficient, but there is little evidence that unions negotiate over employment.

participation and labor demand constraints:

$$\max_{w_i, E_i} \left(E_i \overline{u(c_i)} - (1 - E_i) u(c_u) \right)^{\delta_i} \cdot \left(u(c_f) - u(c_f^{-i}) \right)^{1-\delta_i}$$
$$\text{s.t.} \quad w_i = F_i,$$
$$G_i(w_i - T_i + T_u) - E_i \geq 0, \tag{9}$$

where the term u_f^{-i} captures the utility level of firm-owners in the absence of an agreement with the union in sector i; explicit expressions are provided in Appendix A. If an agreement is reached in sector i, the firm employs labor type i at the negotiated wage w_i, and produces output using capital with all types of labor. In the absence of an agreement, the firm refrains from hiring labor in sector i, who instead receive unemployment benefits $-T_u$, while maintaining labor in all other sectors ($j \neq i$). Since capital investments are sunk at the time of bargaining, the absence of labor type i leads to underutilization of capital and a decline in its marginal productivity due to capital–labor complementarity. As a result, the firm incurs a loss proportional to the fall in capital productivity when labor in sector i is not employed. This can be expressed as:

$$\text{Strike cost per unit of capital } = \left(F_K \big|_{E_i > 0} - F_K \big|_{E_i = 0} \right). \tag{10}$$

2.5 Government Policy

A benevolent government acts as a Stackelberg leader and maximizes a weighted utilitarian social welfare function of the form:

$$\mathcal{W} = \sum_i \psi_i N_i \Big(E_i \overline{u(c_i)} + (1 - E_i) u(c_u) \Big) + \psi_f u(c_f), \tag{11}$$

where ψ_f and ψ_i represent the Pareto weights that the government attaches to firm-owners and individuals type i, respectively.

Information. The government observes workers' employment status, sectoral wages, and firm profits. Individual participation costs φ are private information. Hence, among individuals with the same observed income the government cannot distinguish high-φ from low-φ workers, and among the non-employed it cannot distinguish voluntary from involuntary unemployment. As a result, taxes cannot be conditioned on φ, so redistribution must rely on distortionary taxes. The government sets sectoral income taxes T_i, non-distortionary yet restricted tax on firm profits T_f— to ensure firm entry, to finance unemployment benefits

$-T_u$ and exogenous public spending R. It faces the following budget constraint:

$$\sum_i N_i \Big(E_i T_i + (1 - E_i) T_u \Big) + T_f = R, \tag{12}$$

2.6 Labor Market Equilibrium

In the baseline model, collective wage bargaining does not internalize the hold-up effect on capital or the subsequent feedback on labor demand. I therefore characterize labor market equilibrium following Hummel and Jacobs (2023). Wage negotiations are governed by a union bargaining-power parameter $\rho \in [0, 1]$, which pins down the equilibrium wage outcome.

Monopoly Union Power: When the union holds full bargaining power ($\rho_i = 1$), it unilaterally sets the sectoral wage w_i to maximize its own objective (8). Under this monopoly union framework, the equilibrium wage satisfies the following condition:

$$\varepsilon_i \frac{u(\hat{c}_i) - u(c_u)}{\overline{u'(c_i)} w_i} = 1. \tag{13}$$

Condition (13) reflects the union's wage-setting rule, whereby the union pushes wages above the competitive level, balancing the marginal utility gain from higher wages for employed workers against the utility loss for marginally employed individuals who face higher participation costs.

Intermediate Bargaining Power: When union power falls between the monopoly and competitive extremes ($0 < \rho_i < 1$), the equilibrium condition is given by:

$$\varepsilon_i \frac{u(\hat{c}_i) - u(c_u)}{\overline{u'(c_i)} w_i} = \rho_i, \tag{14}$$

where $u(\hat{c}_i)$ represents the utility of a marginally employed worker in sector i facing participation costs $\hat{\varphi}_i$. Condition (14) implies that, as long as $\rho_i > 0$, a marginally employed worker attains a higher utility level than a non-employed individual; union wage markup , which increases with union bargaining power ρ_i and decreases with the sectoral labor-demand elasticity ε_i. The markup reflects how unions, when exercising partial bargaining power, push for above-market clearing wages, thereby creating a utility premium for employed workers.

Competitive Scenario: Sectoral wages are set at the market-clearing level (i.e., $\rho_i = 0$), ensuring that a marginally employed worker is indifferent between employment and non-employment (i.e., $u(\hat{c}_i) = u(c_u)$), satisfying:

$$E_i = G(\varphi_i^*). \tag{15}$$

This equilibrium reflects a perfectly competitive labor market, where wages adjust to equate labor supply and demand, ensuring that no involuntary unemployment arises.

2.7 Equilibrium and Comparative Statics

Definition 1. *Given union power ρ_i and taxes T_i, T_u, and T_f, a subgame perfect equilibrium is obtained by backward induction as follows:*

- ***Stage 4: Employment Decision***
  Given the wage w_i negotiated in Stage 3, the firm unilaterally chooses the employment rate E_i for each labor type i. Equilibrium employment for all sector i is determined:

$$F_i(N_1E_1, \ldots, N_iE_i, K) = w_i \tag{16}$$

  This condition shows how employment in each sector is influenced by the level of capital investment through its effect on the marginal product of labor.

- ***Stage 3: Wage Bargaining***
  Under the generalized Nash bargaining framework, the implicit wage-demand equation for each sector i satisfies:

$$\begin{aligned}\rho_i \int_{\underline{\varphi}}^{G_i^{-1}(E_i)} u'\left(w_i - T_i - \varphi\right)\, dG_i(\varphi)\, F_{ii}(N_1E_1, \ldots, N_iE_i, K)N_i \\ + \left[u\left(w_i - T_i - G_i^{-1}(E_i)\right) - u(-T_u)\right] = 0.\end{aligned} \tag{17}$$

  Since K is determined in a preceding stage, equations (17) and (16) determine sectoral wages and employment as a function of capital. Hence, for notational simplicity, I write $w_i = w_i(K)$ and $E_i = E_i(w_i(K)) = E_i(K)$.

- ***Stage 2: Capital Investment Decision***
  Since the wage rate in sector i depends on capital, the firm-owners choose K to maximize its expected profits, accounting for the fact that investment levels influence the sectoral Nash bargaining outcomes. If the entry condition is binding in equilibrium, the optimal capital choice satisfies:

$$F_K(K, N_1E_1, \ldots, N_IE_I) = \phi \; + \underbrace{\sum_i \frac{\partial w_i(.)}{\partial K} N_iE_i}_{\textit{Capital effect on wages}} . \tag{18}$$

Capital demand equation (18) shows that the marginal product of capital in equilibrium has to be equal to the marginal costs plus capital effect on wages—a strategic wedge that is absent under the competitive benchmark, where $F_K = \phi$. This reflects that since K is predetermined, higher capital can shift unions wage demands through its effect on labor productivity. More generally, capital effect on wages can be either positive or negative and depends on technology. Under the assumption of co-operant factors ($F_{Ki} \geq 0$), more capital raises labor productivity and strengthens unions' bargaining position to extract rents, leading to underinvestment; with substitutable inputs, firms may instead overinvest to depress negotiated rents. In section 2.8, I characterize the resulting distortion in capital investment arising from this strategic interaction.

- ***Stage 1: Government Policy***
  The government maximizes the weighted utilitarian social welfare function (11) subject to:

  1. *A balanced budget constraint (12), and*
  2. *A fiscal constraint on firm profits taxation, requiring that:*

$$\Pi - T_f \geq \phi K. \tag{19}$$

  Our analytical results show that this constraint is binding. Intuitively, given the restricted, non-distortionary tax on firm profits, the government's best policy is to set T_f such that the firm is indifferent between entering the market or not.

By Assumption 1 (Independent Labour Markets), equilibrium wages and employment in sector i only depend on union power and income taxes in sector i. Since K is predetermined; already sunk by the bargaining stage, I can write $E_i = E_i(T_i, T_u, K, \rho_i)$ and $w_i = w_i(T_i, T_u, K, \rho_i)$ for all sectors i. For analytical convenience, we further assume no income effects.

Assumption 3 (No income effects)**.** *The equilibrium wage and employment in sector i respond symmetrically to an increase in the income tax T_i or an increase in the unemployment benefit $-T_u$.*

Under assumption 3, one-euro increase in disposable income for both employed workers and the unemployed does not affect equilibrium wages or employment rates. This makes the equilibrium wage and employment in sector i depend solely on union power ρ_i and the employment taxes, $(T_i - T_u)$, in that sector.

Lemma 1. *If Assumptions 1 (independent labor markets), 2 (efficient rationing), and 3 (no income effects) are satisfied, then the comparative statics of an increase in employment taxes $(T_i - T_u)$, ρ_i, and K (since K is predetermined) on equilibrium wages and employment rates in each sector i are given by:*

$$\frac{dE_i}{dK} = -\frac{\rho_i E_i \overline{u_i''} F_{ik} F_{ii} N_i + \rho_i E_i \overline{u_i'} F_{iik} N_i + \hat{u}_i F_{ik}}{\rho_i E_i \,\overline{u_i''}\,(F_{ii}\,N_i)^2 + \rho_i E_i \,\overline{u_i'}\,F_{iii}\,N_i^2 + \hat{u}_i' \left((1+\rho_i)F_{ii}N_i - \frac{1}{G_i'}\right)} \overset{?}{\gtrless} 0, \tag{20}$$

$$\frac{\partial E_i}{\partial \rho_i} = -\frac{E_i \overline{u_i'} F_{ii} N_i}{\rho_i E_i \,\overline{u_i''}\,(F_{ii}\,N_i)^2 + \rho_i E_i \,\overline{u_i'}\,F_{iii}\,N_i^2 + \hat{u}_i' \left((1+\rho_i)F_{ii}N_i - \frac{1}{G_i'}\right)} < 0, \tag{21}$$

$$\frac{\partial E_i}{\partial (T_i - T_u)} = \frac{\rho_i E_i \,\overline{u_i''}\,F_{ii}\,N_i \;+\; \hat{u}_i'}{\rho_i E_i \,\overline{u_i''}\,(F_{ii}\,N_i)^2 + \rho_i E_i \,\overline{u_i'}\,F_{iii}\,N_i^2 + \hat{u}_i'((1+\rho_i)F_{ii}N_i - 1/G_i')} < 0, \tag{22}$$

$$\frac{\partial w_i}{\partial (T_i - T_u)} = \frac{(\rho_i E_i \,\overline{u_i''}\,F_{ii}\,N_i \;+\; \hat{u}_i')F_{ii}N_i}{\rho_i E_i \,\overline{u_i''}\,(F_{ii}\,N_i)^2 + \rho_i E_i \,\overline{u_i'}\,F_{iii}\,N_i^2 + \hat{u}_i'((1+\rho_i)F_{ii}N_i - 1/G_i')} > 0. \tag{23}$$

Proof. See Appendix B.

According to Lemma 1, a higher employment taxes raise union wage demands, reducing labor demand and thus lowering employment. For the impact of capital on union wage demands is analytically ambiguous. Thus, I assess that by using the generalized Nash criterion in the following subsection.

2.8 Investment Distortions

The wage-setting condition (17) demonstrates that the equilibrium wage in sector i is endogenously determined by the level of capital investment committed ex ante. To assessing whether increases in capital investment are associated with higher wage levels, I use the first-order condition of the generalized Nash criterion (9) with respect to the sectoral wage w_i. In Appendix A.1, I show that under the assumption of capital-labor complementarities and specific firm risk preferences, sectoral wages increase with capital investment (i.e., $w_i'(K) > 0$).

Lemma 2 (Capital increases the bargained wage)**.** *Let $w_i(K)$ be implicitly defined by the Nash bargaining first-order condition $\Phi_i(w_i, K, \cdot) = 0$ in (9). With the second-order condition $\Phi_{w_i w_i} < 0$, then, the sufficient conditions for $w_i'(K) > 0$ are: (i) capital–labor complementarity and (ii) firm owners' preferences satisfy* [8]

$$A(c_f) \;\geq\; A(c_f^{-i}), \tag{24}$$

[8] Condition (24) holds under risk neutrality and under CARA preferences

where $A(c) \equiv -u''(c)/u'(c)$ denotes the absolute risk aversion. Under these sufficient conditions, the negotiated wage rate in sector i increases in sunk capital (i.e., $w_i'(K) > 0$).

3 Optimal Taxation

The government optimally sets employment taxes $(T_i - T_u)$, the level of unemployment benefits $(-T_u)$, and profit taxes (T_f) to maximize the social welfare objective (11) subject to the budget constraint (12) and a fiscal constraint on firm profits taxation (19) while taking into account the behavioral responses to tax policy.

I derive the optimal conditions in terms of social welfare weights and behavioral elasticities. Following Saez (2002), I define the marginal social welfare weights:

$$\mathbf{g}_i \equiv \frac{\psi_i \overline{u'(c_i)}}{\lambda}, \quad \mathbf{g}_f \equiv \frac{\psi_f \, u'(c_f)}{\lambda}, \tag{25}$$

where $\mathbf{g}_i$ and $\mathbf{g}_f$ represent, respectively, the social value (in terms of public funds) in monetary terms of transferring an additional dollar to a worker in sector i, and to firm-owners.

Proposition 1. *Suppose Assumption 2 (Efficient Rationing) and Assumption 3 (No Income Effect) hold, but Assumption 1 (independent labor markets) is violated, then the optimal policy satisfies:*

$$\mathbf{g}_f < 1, \tag{26}$$

$$\underbrace{\sum_j h_j \left(\frac{t_j + \tau_j^{implicit} - \tau_{Kj}^{implicit}}{1 - t_j} \right) \eta_{ji}}_{\textit{Marginal efficiency costs}} = \underbrace{h_i \big(1 - \mathbf{g}_i\big) + \sum_j h_j \big(\mathbf{g}_j - 1\big) \, \kappa_{ji}}_{\textit{Marginal distributional benefits}}, \tag{27}$$

where

$$h_j \equiv \frac{N_i E_i}{\sum_j N_j}, \quad t_j \equiv \frac{T_j - T_u}{w_j}, \quad \tau_j^{implicit} \equiv \frac{\psi_j \left(\hat{u}_j - u_u\right)}{w_j \lambda} = \frac{\rho_j \mathbf{g}_j}{\varepsilon_j}, \tag{28}$$

$$\tau_{Kj}^{implicit} \equiv \frac{(1 - \mathbf{g}_f)}{w_j} \left(F_{Kj} - w_j'(K) - \sum_i E_i \frac{\partial w_i'(K)}{\partial E_j} \right) K, \tag{29}$$

$$\eta_{ji} \equiv - \left(\frac{\partial E_j}{\partial \left(T_i - T_u\right)} \frac{w_i - (T_i - T_u)}{E_j} \right) \frac{w_j \left(1 - t_j\right)}{w_i \left(1 - t_i\right)}, \tag{30}$$

$$\kappa_{ji} \equiv \left(\frac{\partial w_j}{\partial \left(T_i - T_u\right)} \frac{w_i - (T_i - T_u)}{w_j} \right) \frac{w_j}{w_i \left(1 - t_i\right)}. \tag{31}$$

h_j is the share of employed workers in sector j, η_{ji} and κ_{ji} represent the elasticity of employment and wages in sector j, respectively, with respect to the employment taxes $(T_i - T_u)$ weighted with relative net wages. t_j denotes the employment tax rate in sector j. $\tau_j^{implicit}$ is the implicit wedge on participation, and $\tau_{Kj}^{implicit}$ denotes the implicit capital–bargaining wedge under constrained profit taxes.

Proof. See Appendix C.

Expression (26) follows from the first-order condition for T_f together with the fiscal constraint on firm profits taxation (19). It implies that the government places a relatively low marginal social value on firm owners' consumption compared to the marginal value of public funds. Using the Kuhn–Tucker multiplier μ on the fiscal constraint (19), the optimality condition (26) can be written as

$$\mathbf{g}_f = 1 - \mu/\lambda < 1, \tag{32}$$

When the constraint binds (i.e., $\mu > 0$), the government sets T_f such that the firm is indifferent between entering the market or not, $T_f = \Pi - \phi K$, so additional revenue must be raised through distortionary labor-market instruments.

Expression (27) characterizes the optimal employment taxes in sector i, which follows from the first-order condition for $(T_i - T_u)$. At the optimum, the government sets $(T_i - T_u)$ such that the marginal efficiency costs of taxation equal its marginal distributional benefits, capturing the core equity–efficiency trade-off.

The left-hand side of (27) is the marginal efficiency costs of of increasing the sector-i employment taxes. It is the sum of labor tax wedges across all sectors j, weighted by the cross-sector employment elasticity η_{ji}, consistent with Diamond (1980) and Saez (2002). The total wedge in sector j consists of the explicit employment tax t_j and a net implicit component, $\tau_j^{\text{implicit}} - \tau_{Kj}^{\text{implicit}}$, where τ_j^{implicit} is a union-induced implicit wedge on participation. We refer to $\tau_{Kj}^{\text{implicit}}$ as the (entry-constrained) capital–bargaining wedge: it measures the fiscal relevance of investment hold-up when profit taxation is constrained by firm entry (so that $\tau_{Kj}^{\text{implicit}} = 0$ whenever the entry constraint is slack).

A reduction in employment induced by higher employment taxes generates three welfare-relevant effects. First, it reduces social welfare because fewer workers contribute employment taxes $(T_j - T_u)$ to the government revenue. Second, because unions demand wages above the market-clearing level, employment is rationed on the extensive margin. A tax-induced reduction in employment entails an additional welfare loss through τ_j^{implicit}. Under efficient rationing with heterogeneous participation costs, τ_j^{implicit} measures the monetized welfare loss

if the marginal worker in sector i loses employment: the participation cutoff shifts so that the marginal worker is no longer indifferent between participating and not. Thus, τ_j^{implicit} acts as an implicit tax on labor participation, see Hummel and Jacobs (2023). Third, because capital is sunk prior to wage bargaining and profit taxation is constrained by entry, employment responses to labor taxes affect also welfare through the tightness of the firm-side feasibility constraint: they affect the residual surplus generated by sunk capital that must be left to the firm to satisfy entry. This channel is captured by:

$$\tau_{Kj}^{\text{implicit}} \equiv \frac{(1-\mathbf{g}_f)}{w_j}\Big[F_{Kj} - w_j'(K) - \sum_i E_i \frac{\partial w_i'(K)}{\partial E_j}\Big]K, \qquad (1-\mathbf{g}_f) = \mu/\lambda > 0, \tag{33}$$

where $(1-\mathbf{g}_f) = \mu/\lambda > 0$ is the shadow price of relaxing the binding profit-tax constraint. The bracketed term is the effect of sector-j employment on the residual marginal return to sunk capital after bargaining, $\phi = F_K - \sum_i w_i'(K)E_iN_i$. The production-complementarity component, F_{Kj}, measures the effect of employment type j on the marginal product of capital, while $w_j'(K)$ captures the direct wage–capital pass-through (hold-up) in sector j, i.e., the extent to which marginal capital returns are translated into higher bargained wages. The final term, $\sum_i E_i \partial w_i'(K)/\partial E_j$, captures bargaining spillovers: employment shifts in sector j can amplify or dampen wage–capital pass-through across sectors by changing how bargained wages respond to capital.

The sign of $\tau_{Kj}^{\text{implicit}}$ governs how tax-induced employment responses affect the tightness of the constraint on profit taxation. If $\tau_{Kj}^{\text{implicit}} > 0$, higher employment raises the entry rent, ϕK, that must be left to the firm. Hence, a reduction in employment induced by higher employment taxes lowers ϕK, relaxes the binding profit-tax constraint, and allows the government to raise additional revenue through T_f. Conversely, if $\tau_{Kj}^{\text{implicit}} < 0$, the opposite holds: lower employment increases ϕK, tightens feasibility, and thus shrinking T_f, which is the case where union wage bargaining appropriates a larger share of the marginal return to sunk capital.

The right-hand side of (27) gives the sum of the marginal distributional benefits over all sectors of higher employment taxes in sector i. Absent any behavioral response, a one-unit increase in $T_i - T_u$ raises government revenue by the mass h_i of employed individuals in sector i. The corresponding social welfare effect is captured by $1 - \mathbf{g_i}$, which reflects the monetized utility loss of workers type i because they need to redistribute to the government. Furthermore, an increase in $T_i - T_u$ induces general equilibrium effects, leading to both direct and indirect redistributive effects.

The Independent Labor Markets Case We specialize our analysis to the no-cross-effect case, in which employment and wages in sector i respond solely to the taxes in that same sector. That is, there are no cross-effects from taxes in other sectors, so I set $\eta_{ji} = \kappa_{ji} = 0$ for all $j \neq i$ and $\mathbf{g}_f < 1$.

Proposition 2. *The optimal tax in sector j in the independent labor markets case is:*

$$\left(\frac{t_j + \tau_j^{implicit} - \tau_{Kj}^{implicit}}{1 - t_j} \right) \eta_j = (1 - \mathbf{g}_i)(1 - \kappa_i). \tag{34}$$

Corollary 1. *In the case of independent labor markets, if wages in sector j respond less than one-for-one to the employment tax—i.e., $\kappa_j < 1$— then the optimal employment tax for the working poor should be negative (i.e., a subsidy) whenever $\mathbf{g}_i > 1$.*

According to the optimality condition (34), a negative employment tax (i.e., a subsidy) is typically optimal whenever workers' social welfare weight exceeds one (i.e., $\mathbf{g}_i > 1$). When the capita-bargaining wedge is negative, $\tau_{Kj}^{\text{implicit}} < 0$, the holdup problem generates a negative fiscal externality on the profit tax base. This effect compounds the labor-market distortion, raising the marginal social cost of labor taxation. In this regime, it is optimal to subsidize workers even with relatively low social welfare weights, as the subsidy serves the dual purpose of alleviating the welfare costs of involuntary unemployment and mitigating the fiscal tightening caused by severe holdup. Conversely, when it is positive, $\tau_{Kj}^{\text{implicit}} > 0$, and dominates the welfare costs of involuntary unemployment, the case for employment subsidies is weakened. In this scenario, the relaxation of the firm's entry constraint renders employment reductions less socially costly, shifting the tax policy toward positive employment tax rates.

4 Quantitative Analysis

This section provides a numerical analysis of how union-induced hold-up affects capital investment decisions and the design of the optimal tax-benefit system. Using a structural version of the model calibrated to the French economy in 2017, I compare outcomes under perfect competition, union bargaining without hold-up, and union bargaining with hold-up.

4.1 Calibration

In line with Assumptions 2 and 3, I calibrate the model under efficient rationing and no income effects. Furthermore, I consider interdependent labor markets. In the subsequent

sections, I present the data sources and describe the functional forms employed in our framework. These include the social welfare function, the utility function, the production function, and the distribution of participation costs.

4.1.1 Data

Our primary data are sourced from the French National Institute of Statistics and Economic Studies (INSEE), which provides detailed information on salaried domestic employment—measured in full-time equivalents (excluding the self-employed)—and average gross wages (INSEE, 2024a,c). The analysis focuses on $I = 84$ sectors at the two-digit level, following the Nomenclature d'activités française (NAF rév.2); sectors with incomplete or unavailable data were excluded. Regarding capital stock, I target 3.3 of aggregate output. This target reflects the net fixed capital stock as a share of total production, consistent with French national accounts (INSEE, 2017, 2024b). For income taxes and unemployment benefits, I utilize the OECD online tax-benefit calculator (OECD, 2024) to compute average net labor income taxes—defined as taxes paid minus transfers received when employed—for the year 2017. These figures are calculated for a single individual without children earning the sectoral average gross wage. Finally, the average yearly social assistance benefit, denoted as $-T_u$, is set at €10,980. This value represents the net average yearly benefit paid to non-employed individuals in 2017, as reported by DARES (2020).

4.1.2 Social welfare function

I assume a utilitarian social welfare function by setting the Pareto weights of workers and firm-owners equal to one: $\psi_i = \psi_f = 1$. To ensure firm entry, the non-distortionary profit tax T_f is calibrated such that all profits that exceed the initial capital cost flow back to the government.

4.1.3 Utility function

To ensure that income effects are absent, I assume a constant absolute risk aversion (CARA) utility function for union members given by:

$$u(c - \varphi) = -\exp(-\theta(c - \varphi))/\theta, \qquad \theta > 0. \tag{35}$$

The risk aversion parameter, θ, governs the curvature of the utility function and reflects the union's willingness to tolerate unemployment when negotiating for higher wages. In this analysis, I set $\theta = 0.0575$ to match a relative risk aversion target 1.5 at a reference income

level $\bar{c}$-the employment-weighted average net income without participation costs.

4.1.4 Production function

To allow for interdependent labor markets, I assume the following CES production function, which is defined over aggregate capital K and labor L_i in each sector i:

$$Y = AK^{1-\alpha}\left(\sum_i a_i L_i^{\frac{1}{\delta}}\right)^{\alpha\delta}, \quad \delta \equiv \frac{\sigma}{1-\sigma}. \tag{36}$$

where a_i reflect the productivity shifters, $\sigma > 0$ is the constant elasticity of substitution between different labor types, $\alpha \in (0,1)$ is the aggregate labor share, which is set to the empirically observed value of $\alpha = 0.623$ for the French economy in 2017 (Fred, 2021). In the baseline, A is normalized to one $A = 1$. I calibrate σ to match the following employment-weighted average labor-demand elasticity in each sector i:

$$\varepsilon_i = \frac{\sigma}{1 + \iota_i\big[\sigma(1-\alpha) - 1\big]}. \tag{37}$$

where $\iota_i \equiv \frac{w_i L_i}{\sum_j w_j L_j}$ denotes the share of aggregate labor income that goes to workers in sector i (refer to Appendix D.1 for the derivation of the labor-demand elasticity). For the productivity shifters a_i, it is calculated from the labor- demand equation:

$$w_i = \alpha a_i \; Y^{1-\frac{1}{\alpha\delta}} \; L_i^{\frac{1}{\delta}-1}, \tag{38}$$

where aggregate output follows from $Y = \sum_i w_i L_i/\alpha$.

4.1.5 Government budget and firm entry

The government must finance an exogenous revenue requirement R and unemployment benefits. The government budget constraint is

$$\sum_i N_i\Big(E_i\, T_i \;+\; (1-E_i)\, T_u\Big) \;+\; T_f \;=\; R, \tag{39}$$

To ensure firm entry, I calibrate the profit tax such that all profits exceeding the initial capital costs flow to the government budget. Formally, the profit tax is given by

$$T_f = \underbrace{(1-\alpha)\sum_i w_i L_i/\alpha \;-\; \phi K}_{\Pi - \phi K}. \tag{40}$$

In equation (40), the first term represents all capital income under CRS and competitive factor pricing, $\Pi = F_K K$. Since the per-unit cost of capital ϕ is calibrated to match the marginal product of capital implied by targeting a net fixed capital-to-output ratio $K/Y = 3.3$—consistent with French national accounts (INSEE, 2017, 2024b)— it follows that the profit tax is zero in the baseline: $T_f = \Pi - \phi K = 0$. As a result, the government's revenue requirement R amounts to 8.7% of GDP. This figure is low because the profit tax is restricted by the zero-profit condition for firm entry.

4.1.6 Distribution of participation costs

I adopt the following functional form for the distribution of participation costs, which is assumed to be identical across all sectors:

$$G(\varphi) = \frac{\gamma \varphi^{\zeta}}{1 + \gamma \varphi^{\zeta}}, \tag{41}$$

where γ determines the proportion of individuals who decide to participate in the labor market, and ζ governs the curvature of the distribution. This functional form generates participation elasticities that decline with income, expressed as:

$$\pi_i = \frac{G'(\varphi_i^*)\varphi_i^*}{G(\varphi_i^*)} = \frac{\zeta}{1 + \gamma(\varphi_i^*)^{\zeta}}. \tag{42}$$

As a benchmark, the parameter ζ is calibrated to match an empirically estimates of an average participation elasticity $\overline{\pi} = 0.25$ (Chetty et al., 2013):

$$\overline{\pi_i} = \sum_i \left(\frac{N_i}{\sum_j N_j} \right) \pi_i = \zeta \Bigg(1 - \underbrace{\frac{\sum_i N_i G(\varphi_i^*)}{\sum_j N_j}}_{\text{aggregate participation rate}} \Bigg). \tag{43}$$

For an aggregate participation rate 72.4% (OECD, 2017), the parameter ζ is calibrated as: $\zeta = \frac{0.25}{1-0.724} = 0.906$. For the calibration of the parameter γ, it must be performed jointly with the degree of union power, as I only have data on employment $L_i = N_i E_i$, not on labor force sizes N_i or sectoral employment rates E_i.

4.1.7 Union power

Union power is assumed to be consistent (uniform) across all sectors $\rho_i = \rho$. I calibrate the value of ρ, jointly with γ to ensure that the unemployment and participation rates in the

model align with the observed data. To proceed, I first need to solve the union wage-demand equation (14) for sectoral employment rate E_i:

$$\rho \left(\frac{\int_0^{\mathrm{G}^{-1}(E_i)} u'\left(w_i - T_i - \varphi\right) \mathrm{d}G(\varphi)}{E_i} \right) \frac{w_i}{\varepsilon_i} = u\left(w_i - T_i - G^{-1}\left(E_i\right)\right) - u\left(-T_u\right). \tag{44}$$

Based on that, I set $\rho = 0.121$ and $\gamma = 0.261$ to match involuntary unemployment rate (9.4%) and aggregate participation rate (72.4%) (OECD, 2017; INSEE, 2018).

4.1.8 Capital Stock

The model is solved via backward induction to characterize the subgame-perfect equilibrium. Since investment is fully sunk before wages are negotiated, the firm chooses capital in Stage 2 anticipating the bargaining outcomes of the subsequent subgame. I compute this equilibrium using a nested fixed-point algorithm: for a candidate capital stock K, the inner loop solves for the Stage 3–4 bargaining and employment outcomes, $\{w(K), E(K)\}$. An outer loop then updates K until the firm's Stage 2 optimality condition is satisfied. The equilibrium capital stock K^* is the fixed point of this procedure and solves:

$$\underbrace{(1-\alpha)K^{-\alpha}\left(\sum_i a_i L_i^{\frac{1}{\delta}}\right)^{\alpha\delta}}_{F_K(.)} = \sum_i w_i'(K) N_i E_i + \phi, \tag{45}$$

where we solve first for $w_i'(K)$ using comparative statics on equilibrium wages that follows from the labor demand condition $w_i = F(N_1 E_1, ..., N_I E_I, K)$. That is,

$$\frac{\mathrm{d}w_i}{\mathrm{d}K} = \sum_j F_{ij} \frac{\partial E_j}{\partial K} + F_{iK}, \tag{46}$$

and

$$\frac{dE_i}{dK} = -\frac{\rho_i E_i \overline{u_i''} F_{ik} F_{ii} N_i + \rho_i E_i \overline{u_i'} F_{iik} N_i + \hat{u}_i F_{ik}}{\rho_i E_i \,\overline{u_i''}\,(F_{ii}\,N_i)^2 + \rho_i E_i \,\overline{u_i'}\,F_{iii}\,N_i^2 + \hat{u}_i'\left((1+\rho_i)F_{ii}N_i - \frac{1}{G_i'}\right)}. \tag{47}$$

Equations (45)–(47) deliver the equilibrium mapping $K \mapsto (E(K), w(K))$, which I use in the numerical calibration to solve for the endogenous capital stock.

All simulation inputs are summarized in Table 1.

Table 1: Baseline calibration.

Parameter	Value	Calibration Target	Target Source	Notes
Per-unit cost of capital	$\phi = F_K = 0.114$	$K/Y = 3.3$	INSEE, 2017, 2024b	
Labor income share	$\alpha = 0.623$	62.3%	Fred (2021)	
CARA	$\theta = 0.057$	CRRA $(\bar{c}) = 1.5$		$\bar{c} = \frac{\sum_i L_i(w_i - T_i)}{\sum_i L_i}$
Elasticity of substitution	$\sigma = 0.664$	Labor-demand elasticity $\bar{\epsilon} = 0.697$	Lichter et al. (2015)	Eq.(37)
Union power	$\rho = 0.121$	Unemployment rate 9.4%	INSEE (2018)	Eq.(44)
Participation shifter	$\gamma = 0.261$	Participation rate 72.4%	OECD (2017)	Eq.(44)
Participation curvature	$\zeta = 0.906$	Average Participation elasticity $\bar{\pi} = 0.25$	Chetty et al. (2013)	Eq.(43)

4.2 Quantifying capital distortion in a unionized economy

I begin by quantifying the investment wedge generated by ex post union bargaining. My simulations imply substantial underinvestment: equilibrium capital is 44.6% lower than in the perfect-competition benchmark. Normalizing capital in the competitive benchmark to one, the hold-up equilibrium yields a capital index of 0.554 as illustrated in Figure 2. This pattern is consistent with the investment wedge implied by the firm's capital first-order condition under bargaining with hold-up. Such inefficiencies align with my theoretical results once I allow for interactions between collective wage bargaining and firms' investment decisions.

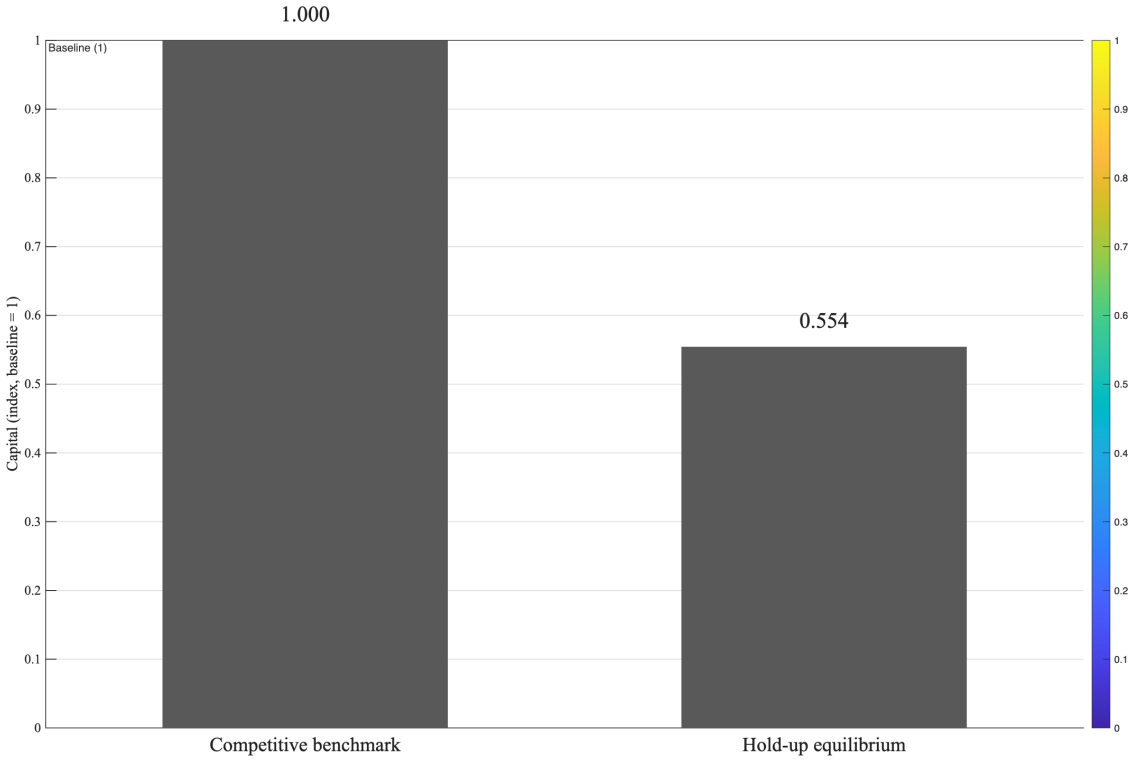


Figure 2: Equilibrium Capital (index, baseline = 1)

The substantial underinvestment identified above serves as the primary constraint for the social planner's problem. Because capital is sunk before the bargaining process, the planner in the unionized economy subject to the holdup must solve for the optimal tax-benefit schedule subject to this lower capital base. Following that, my simulations consider: (i) Perfect Competition Benchmark and Unionized Economy (with no hold-up): the planner operates with the efficient level of capital. (ii) Unionized Economy (Hold-up): the planner must solve for the optimal policy that maximizes social welfare while taking the 44.6% capital loss as a given structural constraint.

4.3 Optimal taxes

Following the calibration and capital distortion in the holdup economy, Figure 3 displays the optimal employment tax rate, defined as $t_i = (T_i - T_u)/w_i$, plotted against current income. I compares optimal employment tax schedules across four distinct economic environments: (i) baseline tax system; (ii) optimal tax system under perfect competition (i.e., union power $\rho = 0$); (iii) optimal tax system with union bargaining but with no holdup (i.e, capital market is competitive); and (iv) optimal tax system with union bargaining and holdup problem. See Appendix D.2 for additional details.

Figure 3 shows that the optimal employment tax rate is lower in a unionized economy facing the hold-up problem than in both a unionized economy without the hold-up and a competitive economy. Optimal employment tax rates are, on average, 12.7 percentage points lower in unionized labor markets subject to hold-up than under perfect competition. Moreover, within unionized economies, the hold-up mechanism further reduces optimal employment tax rates by 4.4 percentage points relative to the union case with an efficient capital (i.e., no hold-up). This reduction in employment tax rates is implemented through lower labor income taxes and lower unemployment benefits.

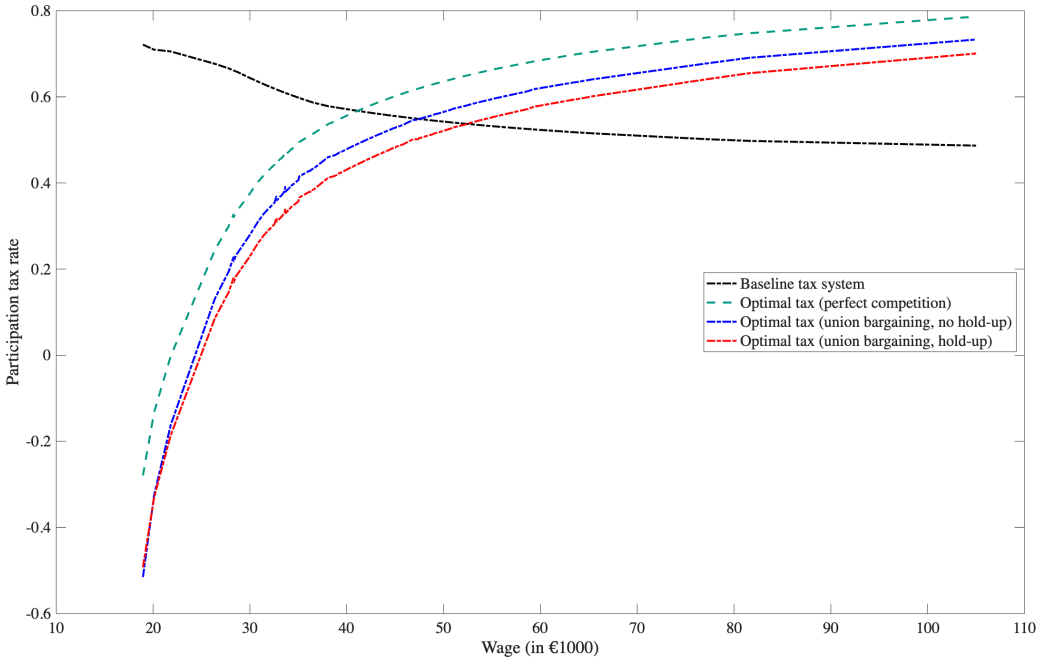


Figure 3: Optimal participation tax rates

Crucially, the result that participation is optimally subsidized for low-skilled workers (i.e., at the bottom of the income distribution) has an important implication: the social welfare weight of those low-skilled workers exceeds the average of one, as illustrated in Figure 4. This holds true for workers with earnings below €26,390, for whom participation is subsidized at the optimal tax system. Furthermore, relative to the perfect competition benchmark, the zero-participation tax threshold occurs at a higher income level in the unionized economy with hold-up. This suggests that the efficiency costs are substantially larger in the presence of hold-up frictions.

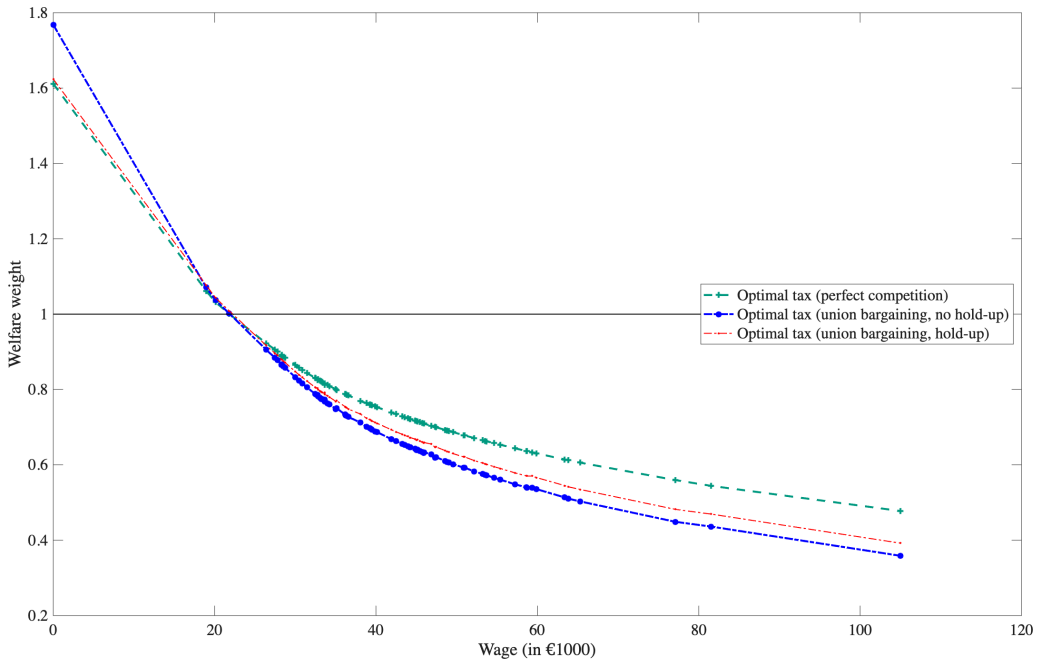


Figure 4: Social welfare weights

Figure 4 plots social welfare weights against current labor income under the optimal tax–benefit system in the competitive benchmark and in unionized labor markets (with and without hold-up). Across regimes, welfare weights are one average equal to one at the optimum and are monotonically decreasing in wages under concave preferences. As shown in the figure, the welfare weight attached to the non-employed (wage equal to zero) exceeds one and varies across labor-market environments. Relative to perfect competition, the welfare weight assigned to the non-employed is higher in the unionized economy—particularly in the no-hold-up case. These patterns are consistent with the optimal unemployment benefit levels. For example, the optimal non-employment benefit is lower in unionized economy without the holdup (€8,855) than in the competitive benchmark (€10,949). However, that the benefit is lowest under hold-up (€8,703) indicates that collective bargaining and the investment distortion tighten the equity–efficiency trade-off, making generosity toward non-employment more costly in terms of efficiency. This is consistent with our theoretical results that optimal employment tax rates are lower under unionization subject to the holdup.

For employment rates, Figure 5 illustrates the employment rates across the simulated regimes. Despite the corrective design of the optimal tax-benefit system, a persistent employment wedge remains between the competitive benchmark and the unionized economy

with hold-up. On average, the employment rate in the hold-up regime is 2 percentage points lower than in the competitive benchmark. This gap reveals the structural limit of redistributive policy: while the social planner optimizes the labor supply margin, the economy remains fundamentally constrained by the 44.6% reduction in capital stock identified in Section 4.1. Consequently, the 2-percentage-point difference serves as a quantitative measure of the permanent efficiency cost imposed by the hold-up friction—a distortion that the tax system can mitigate but not fully offset.

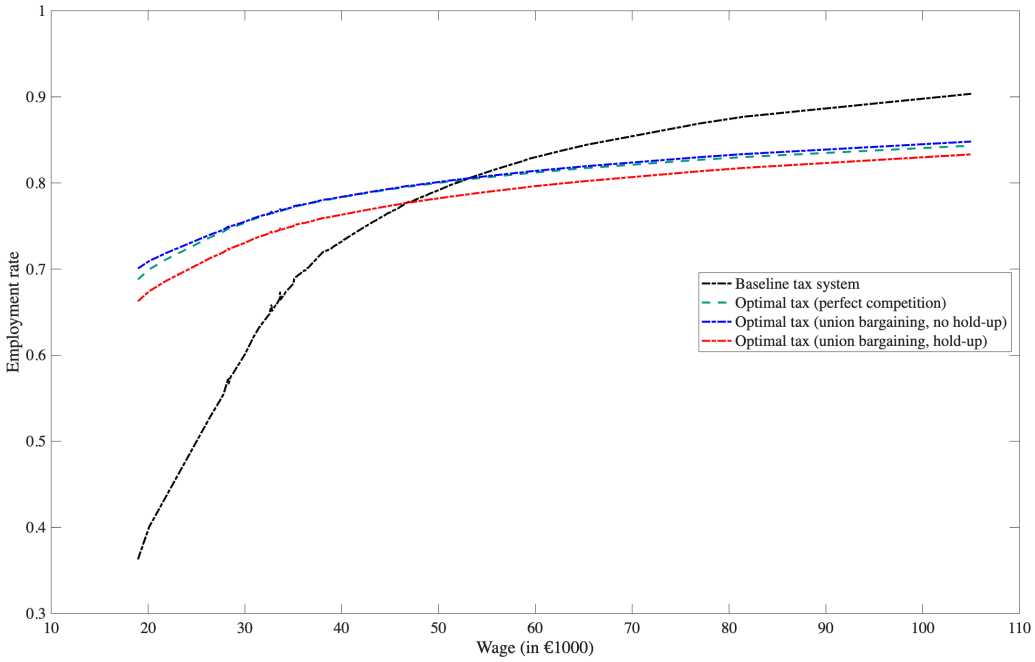


Figure 5: Employment rates

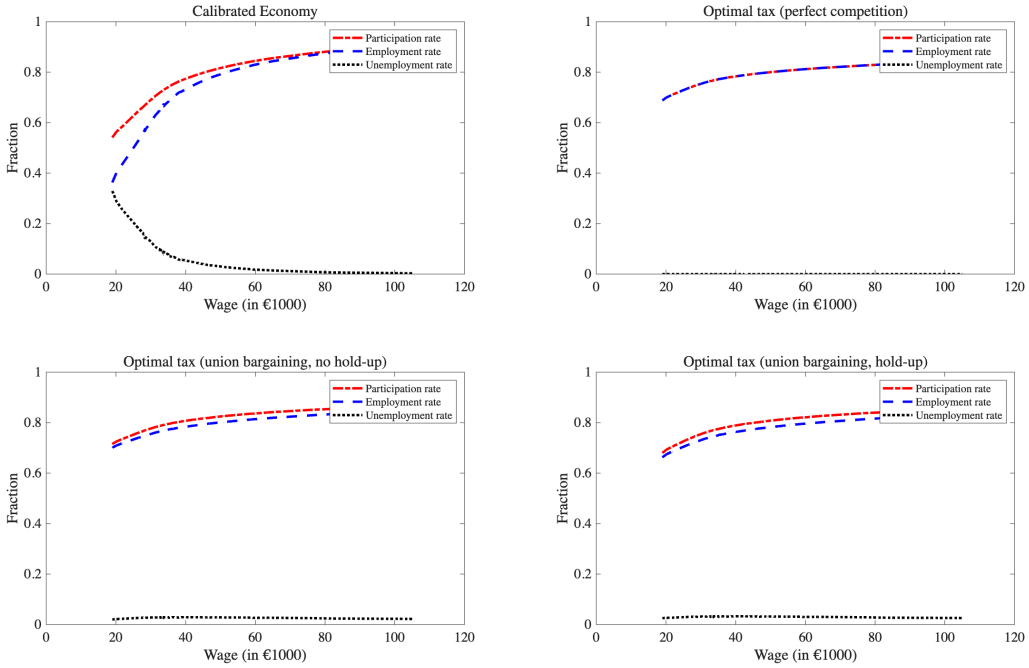


Figure 6: Participation, employment and unemployment rates by income

5 Conclusion

This paper studies optimal nonlinear labor income taxation in an economy where collective wage bargaining induces involuntary unemployment and investment holdup problem. Because collective bargaining raises wages above–market-clearing levels, labor income taxes affect employment not only through labor supply but also also through equilibrium wage demands and labor demand, so the standard extensive-margin formulas are insufficient in my settings.

In this paper, I derive a sufficient-statistics formula for optimal nonlinear labor income taxes featuring an employment wedge that combines explicit employment tax with two implicit components. The first is the union-induced wedge on labor participation (Hummel and Jacobs, 2023). The second—and novel to this paper— is a capital bargaining wedge that captures the fiscal relevance of investment hold-up when profit taxation is constrained by firm entry: employment responses alter the residual surplus required to sustain entry, tightening or relaxing the constraint on profit taxation.

The sign of the capital–bargaining wedge is therefore central for the design of optimal tax policy. When it is positive, tax-induced employment reductions relax the entry constraint and expand the scope for profit taxation. In this case, optimal policy can shift toward higher employment taxes despite union-induced involuntary unemployment. When the wedge is negative, wage–capital pass-through is stronger and employment reductions tighten the entry constraint. The entry constraint then amplifies the participation distortion, strengthening the case for lower employment taxes (or subsidies). Bargaining power therefore shapes both the extent of involuntary unemployment and the sign of the firm-side fiscal externality.

There are several limitations to our analysis that should be addressed in future work. First, the framework features a single firm hiring multiple labor types; endogenizing the number of firms entering the market and incorporating product-market competition would shed light on how union wage bargaining, investment incentives, and fiscal policy interact in a more competitive environment. Second, it would be interesting to allow for endogenous technological change—for instance, the adoption of automation or other labor-saving innovations—and to study how bargaining frictions and redistributive policy affect the direction of technical change.

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A The Wage Bargain using the Right-to-Manage

The right-to-manage model is a generalization of the union monopoly model, with the assumption that the firm always decides its own labor demand but that wages are bargained over. If no agreement is reached in sector i, union members in that sector get the level of utility of a person not employed and the firm refrains from employing labor in sector i while maintaining employment in all other sectors ($j \neq i$). Let $\delta_i \in [0,1]$ designates the power of the union, then, as it is standard in the literature, the negotiated wage solves the maximization of the generalized Nash product in logarithmic form taking into account both constraints on voluntary participation and labor demand:

$$\begin{aligned}\max_{w_i,\, E_i} \ \Phi_i = \delta_i \log \Bigg(& \int_{\varphi}^{G_i^{-1}(E_i)} \Big[u(w_i - T_i - \varphi) - u(-T_u)\Big]\, dG_i(\varphi) \Bigg) \\ & + (1-\delta_i) \log \Bigg(u_f\Big(F(\cdot) - \sum_i w_i N_i E_i - T_f\Big) - u_f^{-i}\Big(F(\cdot)\big|_{E_i=0} - \sum_{j\neq i} w_j N_j E_j \\ & - \big(F_K\big|_{E_i>0} - F_K\big|_{E_i=0}\big)K - T_f\Big)\Bigg)\end{aligned}$$

$$\begin{aligned}\text{s.t.} \quad & w_i = F_i, \\ & G_i(w_i - T_i + T_u) - E_i \geq 0. \end{aligned} \tag{48}$$

where the term

$$u_f^{-i}\Big(F(\cdot)\big|_{E_i=0} - \sum_{j\neq i} w_j N_j E_j - \big(F_K\big|_{E_i>0} - F_K\big|_{E_i=0}\big)K - T_f\Big)$$

captures the utility level of firm-owners in the absence of an agreement with the union in sector i. $F(\cdot)\big|_{E_i=0}$ denotes the firm's output when labor from sector i is absent. Since capital investments are sunk at the bargaining stage, excluding labor type i leads to diminished capital productivity via capital–labor complementarity. Consequently, if no agreement is eventually reached, the firm incurs losses proportional to the decline in capital productivity—a measure we define as the strike cost per unit of capital:

$$\big(F_K\big|_{E_i>0} - F_K\big|_{E_i=0}\big).$$

The Lagrangian writes as:

$$\mathcal{L} = \delta_i \log\left(\int_{\varphi}^{G_i^{-1}(E_i)} \Big[u(w_i - T_i - \varphi) - u(-T_u)\Big]\, dG_i(\varphi)\right)$$
$$+ (1-\delta_i)\log\Bigg(u_f\Big(F(\cdot) - \sum_i w_i N_i E_i - T_f\Big) - u_f^{-i}\Big(F(\cdot)\big|_{E_i=0} - \sum_{j\neq i} w_j N_j E_j$$
$$- \big(F_K\big|_{E_i>0} - F_K\big|_{E_i=0}\big)K - T_f\Big)\Bigg)$$
$$+ \vartheta_i\,(w_i - F_i) + \nu_i\Big(G_i(w_i - T_i + T_u) - E_i\Big). \tag{49}$$

The first-order conditions are given by:

$$w_i: \qquad \frac{\delta_i \overline{u}_i'}{(\overline{u}_i - u_u)} - \frac{(1-\delta_i)}{(u_f - u_f^{-i})} u_f' N_i E_i + \vartheta_i + \mu_i G' = 0, \tag{50}$$

$$E_i: \qquad \frac{\delta_i(\hat{u}_i - u_u)}{E_i(\overline{u}_i - u_u)} + \frac{(1-\delta_i)\ {u_f'}^{-i}}{(u_f - u_f^{-i})} N_i F_{Ki} K - \vartheta_i F_{ii} N_i - \nu_i = 0, \tag{51}$$

$$\vartheta_i: \qquad w_i - F_i = 0, \tag{52}$$

$$\nu_i: \qquad \nu_i(G_i - E_i) = 0, \tag{53}$$

where $\overline{u}_i$ and $\hat{u}_i$ respectively denote the average utility over all employed workers, and the utility of the marginal worker in sector i. Condition (51) makes the holdup channel explicit. Its second term,

$$\frac{(1-\delta_i)\ {u_f'}^{-i}}{(u_f - u_f^{-i})} N_i F_{Ki} K,$$

measures the extra utility gain the firm secures when an additional worker is hired in sector i. By co-operant production factors, hiring an additional worker raises the marginal product of capital by F_{Ki}; this prevents capital from lying idle and restores the profits otherwise lost in the strike (no-agreement) state. Hence, $F_{Ki}K$ is the profit the firm forfeits if sector-i labor is not employed. A larger idle-capital term, $F_{Ki}K$, amplifies this utility cost—valued at ${u_f'}^{-i} > u_f'$—and therefore strengthens the firm's incentive to reach an agreement that maintains employment and avoids under-utilization of its capital stock. To characterize the wage–employment outcome, note that for sufficiently small values of δ_i, the constraint $G_i \geq E_i$ becomes binding, leading to a competitive outcome. In the extreme case $\delta_i = 0$, the

multiplier, μ_i, becomes strictly positive [9], enforcing a competitive outcome (i.e., $G_i = E_i$) from the complementary-slackness condition (53). This extends for all $\delta_i \in [0, \delta_i^*]$. The threshold δ_i^* is obtained by setting $G_i = E_i$ and $\nu_i = 0$ in conditions (50) and (51):

$$\frac{\delta_i^*}{1-\delta_i^*} = \frac{(\overline{u}_i - u_u)}{\overline{u}_i'} \left(\frac{F_{ii} E_i N_i \; u_f' - F_{Ki} K \; {u_f'}^{-i}}{F_{ii} \; (u_f - u_f^{-i})} \right), \tag{54}$$

indicating the exact value beyond which the constraint becomes slack $\nu_i = 0$. For all $\delta_i \geq \delta_i^*$, we have $\nu_i = 0$. Solving condition (50) for ϑ_i, and substituting it into condition (51) leads to:

$$\frac{\delta_i(\hat{u}_i - u_u)}{E_i(\overline{u}_i - u_u)} + \frac{(1-\delta_i)}{u_f - u_f^{-i}} N_i \left(\underbrace{F_{Ki}}_{\geq 0} K \; {u_f'}^{-i} - \underbrace{F_{ii}}_{<0} N_i E_i \; u_f' \right) + \frac{\delta_i \overline{u_i'}}{(\overline{u}_i - u_u)} F_{ii} N_i = 0, \tag{55}$$

Expression (55) characterizes an implicit relation between the bargained wage and the firm-chosen employment. Assuming risk-neutral firm owners (i.e., constant marginal utility)[10]:

$$\frac{\delta_i(\hat{u}_i - u_u)}{E_i(\overline{u}_i - u_u)} + \frac{(1-\delta_i)}{\Pi_f - \Pi_f^{-i}} N_i \left(\underbrace{F_{Ki}}_{\geq 0} K - \underbrace{F_{ii}}_{<0} N_i E_i \right) + \frac{\delta_i \overline{u_i'}}{(\overline{u}_i - u_u)} F_{ii} N_i = 0, \tag{56}$$

Or:

$$\overbrace{\varepsilon_i \frac{(\hat{u}_i - u_u)}{\overline{u}_i' w_i}}^{\text{Marginal costs (unemployment)}} = \overbrace{1 - \frac{(1-\delta_i)}{\delta_i} \frac{(\overline{u}_i - u_u)}{\overline{u}_i'} \underbrace{\left[\frac{F_{ii} E_i N_i - F_{Ki} K}{F_{ii} \; (\Pi_f - \Pi_f^{-i})} \right]}_{>0}}^{\text{Marginal rents from a 1 € wage rise}}. \tag{57}$$

The equilibrium condition (57) equates the union's the marginal costs (on the left-hand side)—in terms of higher unemployment—with its marginal benefit (on the right-hand side) from one euro wage rise in sector i.

[9]

$$\nu_i = \frac{\dfrac{u_f'}{u_f - u_f^{-i}} \, N_i^2 \, E_i \, F_{ii} \; - \; \dfrac{{u_f'}^{-i}}{u_f - u_f^{-i}} \, N_i \, F_{Ki} \, K}{F_{ii} \, N_i \, G_i' \; - \; 1} \; > 0.$$

[10] When firm owners are risk-averse, it is given by

$$\varepsilon_i \frac{(\hat{u}_i - u_u)}{\overline{u}_i' w_i} = 1 - \frac{(1-\delta_i)}{\delta_i} \frac{(\overline{u}_i - u_u)}{\overline{u}_i'} \left[\frac{F_{ii} E_i N_i \; u_f' - F_{Ki} K \; {u_f'}^{-i}}{F_{ii} \; (u_f - u_f^{-i})} \right]$$

If we write the RHS as:

$$\rho_i = 1 - \frac{(1-\delta_i)}{\delta_i} \frac{(\overline{u}_i - u_u)}{\overline{u}_i'} \left[\frac{F_{ii} E_i N_i - F_{Ki} K}{F_{ii} \ (\Pi_f - \Pi_f^{-i})} \right], \tag{58}$$

we map the the Nash bargaining weight δ_i into a measure of union power ρ_i, which determines the distribution of surplus. The relationship is given by:

$$\rho_i = \begin{cases} 0 & \text{if} \quad \delta_i \in [0, \delta_i^*), \\ 1 - \frac{(1-\delta_i)}{\delta_i} \frac{(\overline{u}_i - u_u)}{\overline{u}_i'} \left[\frac{F_{ii} E_i N_i - F_{Ki} K}{F_{ii} \ (\Pi_f - \Pi_f^{-i})} \right] & \text{if} \quad \delta_i \in [\delta_i^*, 1]. \end{cases} \tag{59}$$

This expression provides a tractable characterization of how bargaining power shapes the union's ability to extract rents under the hold-up constraint. The role of the firm's idle-capital loss—captured by the term $F_{Ki}K$—is more nuanced and depends crucially on the union's bargaining power:

- **Full holdup**: With complete union dominance $\delta_i = 1$, the adjustment term that captures the firm's idle-capital loss in equilibrium condition (57) vanishes. The bargained wage is thus determined solely by the labor-demand constraint: the utility markup of the marginal worker equals the inverse elasticity of labor demand, regardless of how large the firm's idle-capital exposure might be. In this extreme case the union maximizes worker utility without internalizing any profitability or capital-utilization considerations, so employment contracts sharply, thus creating a larger welfare loss in terms of involuntary unemployment.

- **Partial holdup**: If union bargaining power is intermediate $0 < \delta_i < 1$, an increase in the firm's idle-capital cost significantly reduces the union's ability to push for higher wages. This occurs because unions with moderate power partially internalize the firm's losses from idle capital. Realizing that aggressive wage demands exacerbate capital underutilization and increase involuntary unemployment, these unions willingly moderate wage claims, accepting a lower markup to preserve employment and reduce social welfare losses. Formally, under intermediate bargaining power, the markup decreases strictly when idle-capital losses rise.

Overall, idle-capital losses only constrain the union's ability to demand higher wages if its bargaining power is limited, shaping their incentives to moderate wage demands to reduce involuntary unemployment and minimize efficiency losses.

A.1 Derivation of $w_i'(K)$

This may be found with the help of the FOC of the generalized Nash criterion with respect to the wage (50). Considering the earlier discussion with the voluntary participation constraint not binding (*i.e.*, $\nu_i = 0$), the wage w_i is defined by:

$$\Phi_{w_i}(w_i, K) = \frac{\delta_i \overline{u}_i'}{(\overline{u}_i - u_u)} - \frac{(1-\delta_i)}{(u_f - u_f^{-i})} u_f' N_i E_i + \vartheta_i = 0. \tag{60}$$

Proof of Lemma 2. By the implicit function theorem, the condition $\Phi_{w_i}(w_i, K) = 0$ implies

$$w_i'(K) \;=\; -\frac{\Phi_{w_i K}}{\Phi_{w_i w_i}}.$$

Under $\Phi_{w_i w_i} < 0$[11], $w_i'(K)$ is the sign of $\Phi_{w_i K}$.

Using the wage FOC and the envelope condition for employment at the bargaining stage, the cross partial can be written as

$$\Phi_{w_i K} = -\frac{(1-\delta_i) N_i E_i}{(u_f - u_f^{-i})^2} \left[F_K \underbrace{\left(\Delta u_f \, u_f'' - (u_f')^2 + u_f' u_f'^{-i} \right)}_{\Omega A} - u_f' u_f'^{-i} \underbrace{\left(\Delta F_K + K \Delta F_{KK} \right)}_{\widetilde{\Omega B}} \right], \tag{61}$$

where $\Delta u_f \equiv u_f - u_f^{-i} > 0$ and $\Delta F_K \equiv F_K|_{E_i>0} - F_K|_{E_i=0} > 0$. To determine the sign of $\Phi_{w_i K}$, we analyze ΩA and $\widetilde{\Omega B}$. The term ΩA is influenced by the firm's risk preferences (via the shape of the utility function), while the term $\widetilde{\Omega B}$ is influenced by complementarity between capital and labor. $\widetilde{\Omega B}$ being positive, here we prove a sufficient condition, expressed in terms of the absolute risk aversion $A(c_f) \geq A(c_f^{-i})$ for the term ΩA to be negative or zero to ensure that $\Phi_{w_i K} > 0$.

Step 1: sign of $\widetilde{\Omega B}$ under Cobb–Douglas/CES. Let $S \equiv \sum_i a_i L_i^{1/\theta}$. Under

$$F(K, L_1, ..., L_I) = A\, K^{1-\alpha} S^{\alpha\theta},$$

we have $F_K = (1-\alpha) A K^{-\alpha} S^{\alpha\theta} > 0$ and $F_{KK} = -\alpha(1-\alpha) A K^{-\alpha-1} S^{\alpha\theta} = -\alpha F_K / K < 0$. Hence,

$$\Delta F_{KK} = F_{KK}|_{E_i>0} - F_{KK}|_{E_i=0} = -\alpha \frac{\Delta F_K}{K} < 0,$$

[11]

$$\Phi_{w_i w_i} = \frac{\delta_i}{(\overline{u}_i - u_u)^2} \left[\overline{u}_i''(\overline{u}_i - u_u) - \overline{u}_i'^2 \right] + \frac{(1-\delta_i)}{(u_f - u_f^{-i})^2} (N_i E_i)^2 \left[u_f''(u_f - u_f^{-i}) - u_f'^2 \right] < 0$$

.

and therefore

$$\widetilde{\Omega B} = \Delta F_K + K\Delta F_{KK} = (1-\alpha)\Delta F_K > 0.$$

Step 2: sign of ΩA. We can rewrite

$$\Omega A = \Delta u_f\, u_f'' - (u_f')^2 + u_f' u_f'^{-i} = \Delta u_f\, u_f'' - \Delta u_f'\, u_f',$$

where $\Delta u_f \equiv u_f - u_f^{-i}$ and $\Delta u_f' \equiv u_f' - u_f'^{-i}$. Hence,

$$\Omega A \leq 0 \iff \Delta u_f\, u_f'' - \Delta u_f'\, u_f' \leq 0. \tag{62}$$

Let $\Delta c_f \equiv c_f - c_f^{-i} > 0$, if we consider a first-order expansion around c_f^{-i}.

$$u_f \approx u_f^{-i} + u_f'^{-i}\,\Delta c_f, \quad \text{so that} \quad \Delta u_f = u_f - u_f^{-i} \approx u_f'^{-i}\,\Delta c_f,$$

$$\Delta u_f \approx u_f'^{-i}\Delta c_f, \qquad \Delta u_f' \approx u_f''^{-i}\Delta c_f.$$

Substituting these approximations into condition 62 yields the local sufficient condition:

$$u_f'^{-i}\, u_f'' \leq u_f'\, u_f''^{-i}.$$

Since $u_f'' < 0$ and $u_f''^{-i} < 0$, dividing by $u_f'' u_f''^{-i} > 0$ gives

$$\frac{u_f'^{-i}}{u_f''^{-i}} \leq \frac{u_f'}{u_f''},$$

which can be equivalently expressed in terms of absolute risk aversion $A(c) \equiv -u''(c)/u'(c)$:

$$A(c_f) \geq A(c_f^{-i}), \tag{63}$$

This condition ensures that the term $\Omega A \leq 0$.

Risk-neutral Firm-owners If firm owners are risk neutral, $u_f'' = 0$ and $u_f' = u_f'^{-i}$, so $\Omega A = 0$. In this case, condition (63) holds with equality and (61) becomes

$$\Phi_{w_i K} = -\frac{(1-\delta_i)N_i E_i}{\left(u_f - u_f^{-i}\right)^2}\left[-\left[\Delta F_K + \Delta F_{KK}\right]\right) \Bigg] \; > 0, \tag{64}$$

$\Phi_{w_i K}$ being positive indicates that the wage is increasing function of capital investment under risk neutral preference for firm-owners.

Risk-Averse Firm-Owners We assume a constant absolute risk aversion (CARA) utility function given by:

$$u(c_f) = -\frac{1}{\theta}\ \exp^{-\theta c_f}, \qquad \theta > 0. \tag{65}$$

The risk aversion parameter, θ, governs the curvature of the utility function.

$$A(c_f) = \theta = A(c_f^{-i}). \tag{66}$$

This result indicates that wages are an increasing function of capital investment under constant absolute risk aversion (CARA) preferences for firm-owners.

$$w_i'(.) = \frac{(1-\delta_i)N_iE_i}{\left(u_f - u_f^{-i}\right)^2 \underbrace{\Phi_{w_iw_i}}_{<0}} \left[F_K\left(\Delta u_f\, u_f'' - (u_f')^2 + u_f' u_f'^{-i}\right) - u_f' u_f'^{-i} \underbrace{[\Delta F_K + \Delta F_{KK}]}_{>0}\right]. \tag{67}$$

□

B Derivation elasticities

Under Assumptions 1 (independent markets) and Assumption 2 (efficient rationing), we derive the responses of employment and wages to changes in tax instruments, union power (which we consider as policy invariant), and capital (since K is predetermined; already sunk by the bargaining stage). By substituting the labor-demand equation $w_i = F_i$ into equation (17), the equilibrium employment level in sector i is implicitly determined by the following condition:

$$\begin{aligned}\Gamma_i\big(E_i, T_i, T_u, \rho_i\big) \;\equiv\; \rho_i \int_{\underline{\varphi}}^{G_i^{-1}(E_i)} u'\big(F_i(\cdot) \;-\; T_i \;-\; \varphi\big)\, dG_i(\varphi)\; F_{ii}(\cdot)\, N_i \\ +\; \Big(u\big(F_i(\cdot) \;-\; T_i \;-\; G_i^{-1}(E_i)\big) \;-\; u(-\,T_u)\Big) \;=\; 0.\end{aligned} \tag{68}$$

By Assumption 1 (Independent Labour Markets) we have $F_i(.)$ and $F_{ii}(.)$ depend only on $L_i = E_iN_i$. This implies that equilibrium wages and employment in sector i only depend on union power and income taxes in sector i. So, we can write $E_i = E_i(T_i, T_u, \rho_i)$ and $w_i = w_i(T_i, T_u, \rho_i)$ for all sectors i. After substituting $\hat{\varphi} = G_i^{-1}(E_i)$, the comparative statics

can be determined through the implicit function theorem:

$$\frac{\partial E_i}{\partial T_i} = -\frac{\Gamma_{i,T_i}}{\Gamma_{i,E_i}} = \frac{\rho_i E_i\, \overline{u_i''}\, F_{ii}\, N_i + \hat{u}_i'}{\rho_i E_i\, \overline{u_i''}\, (F_{ii}\, N_i)^2 + \rho_i E_i\, \overline{u_i'}\, F_{iii}\, N_i^2 + \hat{u}_i' \left((1+\rho_i) F_{ii} N_i - \frac{1}{G_i'} \right)} < 0, \quad (69)$$

$$\frac{\partial E_i}{\partial T_u} = -\frac{\Gamma_{i,T_u}}{\Gamma_{i,E_i}} = \frac{-u_u'}{\rho_i E_i\, \overline{u_i''}\, (F_{ii}\, N_i)^2 + \rho_i E_i\, \overline{u_i'}\, F_{iii}\, N_i^2 + \hat{u}_i' \left((1+\rho_i) F_{ii} N_i - \frac{1}{G_i'} \right)} > 0, \quad (70)$$

$$\frac{\partial E_i}{\partial \rho_i} = -\frac{\Gamma_{i,\rho_i}}{\Gamma_{i,E_i}} = -\frac{E_i \overline{u_i'} F_{ii} N_i}{\rho_i E_i\, \overline{u_i''}\, (F_{ii}\, N_i)^2 + \rho_i E_i\, \overline{u_i'}\, F_{iii}\, N_i^2 + \hat{u}_i' \left((1+\rho_i) F_{ii} N_i - \frac{1}{G_i'} \right)} < 0, \quad (71)$$

$$\frac{dE_i}{dK} = -\frac{\Gamma_{iK}}{\Gamma_{iE}} = -\frac{\rho_i E_i \overline{u_i''} F_{ik} F_{ii} N_i + \rho_i E_i \overline{u_i'} F_{iik} N_i + \hat{u}_i F_{ik}}{\rho_i E_i\, \overline{u_i''}\, (F_{ii}\, N_i)^2 + \rho_i E_i\, \overline{u_i'}\, F_{iii}\, N_i^2 + \hat{u}_i' \left((1+\rho_i) F_{ii} N_i - \frac{1}{G_i'} \right)} \overset{?}{\gtrless} 0 \quad (72)$$

The impact on the equilibrium wage w_i follows from the labor-demand condition, $w_i = F_i(\cdot)$:

$$\frac{\partial w_i}{\partial x} = \frac{\partial w_i}{\partial E_i} \frac{\partial E_i}{\partial x} = F_{ii}(\cdot)\, N_i \left. \frac{\partial E_i}{\partial x} \right|_K \quad x \in \{ T_i,\ T_u,\ \rho_i \}. \quad (73)$$

To analyze how the bargained wage would differ under an alternative (predetermined) capital stock, we instead differentiate with respect to K:

$$\frac{\partial w_i}{\partial K} = \frac{\partial w_i}{\partial E_i} \frac{\partial E_i}{\partial K} + \frac{\partial w_i}{\partial K} = F_{ii}(\cdot)\, N_i \frac{\partial E_i}{\partial K} + F_{iK}, . \quad (74)$$

$$\frac{\partial w_i}{\partial T_i} = \frac{(\rho_i E_i\, \overline{u_i''}\, F_{ii}\, N_i + \hat{u}_i') F_{ii} N_i}{\rho_i E_i\, \overline{u_i''}\, (F_{ii}\, N_i)^2 + \rho_i E_i\, \overline{u_i'}\, F_{iii}\, N_i^2 + \hat{u}_i' ((1+\rho_i) F_{ii} N_i - 1/G_i')} > 0, \quad (75)$$

$$\frac{\partial w_i}{\partial T_u} = \frac{-u_u' F_{ii} N_i}{\rho_i E_i\, \overline{u_i''}\, (F_{ii}\, N_i)^2 + \rho_i E_i\, \overline{u_i'}\, F_{iii}\, N_i^2 + \hat{u}_i' ((1+\rho_i) F_{ii} N_i - 1/G_i')} < 0. \quad (76)$$

Setting

$$\frac{\partial E_i}{\partial T_i} = -\frac{\partial E_i}{\partial T_u} \quad \text{and} \quad \frac{\partial w_i}{\partial T_i} = -\frac{\partial w_i}{\partial T_u},$$

Then, income effects are absent if:

$$\rho_i E_i\, \overline{u''}_i\, F_{ii}\, N_i + \hat{u}_i' - u_u' = 0 \quad (77)$$

This condition holds if the utility is linear or CARA i.e., $u(.) = -\exp(-\theta(c-\varphi))/\theta$, where $u'(.) = \exp(-\theta(c-\varphi))$. Substituting into expression (68) and then multiplying by $\exp(-\theta T_u)$ implies that the resulting expression depends on the tax instruments solely through the participation tax level $(T_i - T_u)$.

C Optimal Taxation

To determine the optimal tax policies, we formulate the Lagrangian for the government's problem. We assume that the government aims to maximize social welfare $\mathcal{W}$ subject to its budget constraint and the firm's participation constraint. The objective function writes:

$$\max_{T_u,\{T_i-T_u\},T_f} \mathcal{W} = \sum_i \psi_i N_i \Bigg(\int_{\underline{\varphi}}^{G_i^{-1}(E_i)} \underbrace{u\big(w_i - (T_i - T_u) - T_u - \varphi\big)}_{\equiv\, u(c_{i,\varphi})} dG_i(\varphi) + \int_{G_i^{-1}(E_i)}^{\overline{\varphi}} \underbrace{u(-T_u)}_{\equiv\, u(c_u)} dG_i(\varphi) \Bigg) + \psi_f \underbrace{u_f \left(F(.) - \sum_i w_i N_i E_i - T_f \right)}_{\equiv\, u(c_f)}, \tag{78}$$

subject to:

1. *Government Budget Constraint*:

$$\sum_i N_i \Big(T_u + E_i(T_i - T_u) \Big) + T_f = R. \tag{79}$$

2. *Fiscal constraint on firm profits taxation*:

$$\Pi - T_f \geq \underbrace{\Big(F_K(.) - \sum_i w_i'(K) N_i E_i \Big)}_{\phi} K, \tag{80}$$

where we use the optimality condition (18) that determines the level of capital investment to substitute for ϕ at the upper bound. We denote ψ_f and ψ_i as the Pareto weights that the government attaches to firm-owners and individuals type i respectively. Introducing the Lagrange multipliers λ for the government's budget constraint and $\mu \geq 0$ for the firm's entry

constraint, the Lagrangian $\mathcal{L}$ is formulated as:

$$\begin{aligned}\mathcal{L} = &\sum_i \psi_i N_i \left(\int_{\underline{\varphi}}^{G_i^{-1}(E_i)} u\left(w_i - (T_i - T_u) - T_u - \varphi\right) dG_i(\varphi) + \int_{G_i^{-1}(E_i)}^{\overline{\varphi}} u(-T_u) dG_i(\varphi) \right) \\ &+ \psi_f u_f \left(F(.) - \sum_i w_i N_i E_i - T_f \right) + \lambda \left[\sum_i N_i \Big(T_u + E_i(T_i - T_u) \Big) + T_f - R \right] \\ &+ \mu \left[\underbrace{F(.) - \sum_i w_i N_i E_i - T_f}_{\Pi - T_f} - \underbrace{(F_K(.) - \sum_i w_i'(K) N_i E_i)}_{\phi} \; K \right]. \end{aligned} \tag{81}$$

The first-order conditions are:

$$T_u: \quad -\sum_i \psi_i N_i \Big(E_i \overline{u}_i' + (1 - E_i) u_u' \Big) + \lambda \sum_i N_i = 0. \tag{82}$$

$$T_f: \quad -\psi_f u_f' + \lambda - \mu = 0 \iff \mu = \lambda - \psi_f u_f', \tag{83}$$

$$\begin{aligned} T_i - T_u: \quad & N_i E_i \left(\lambda - \psi_i \overline{u}_i' \right) + \sum_j N_j E_j \left(\psi_j \overline{u}_j' - \psi_f u_f' - \mu \right) \frac{\partial w_j}{\partial (T_i - T_u)} \\ & + \sum_j N_j \left[\psi_j \left(\hat{u}_j - u_u \right) + \lambda \left(T_j - T_u \right) \right] \frac{\partial E_j}{\partial (T_i - T_u)} \\ & - \mu \sum_j \left[\left(F_{Kj} N_j - w_j'(K) N_j - \sum_i N_i E_i \frac{\partial w_i'(K)}{\partial E_j} \right) K \right] \frac{\partial E_j}{\partial (T_i - T_u)} = 0. \end{aligned} \tag{84}$$

$$\lambda: \quad \sum_i N_i \Big(T_u + E_i(T_i - T_u) \Big) + T_f - R = 0. \tag{85}$$

$$\mu: \quad \mu \left(\Pi - T_f - \phi K \right) = 0. \tag{86}$$

Let $\mathbf{g}_i$, $\mathbf{g}_f$, and $\mathbf{g}_u$ represent the social welfare weights assigned to the employed individuals in sector i, the firm owners, and the weighted average of the unemployed individuals, respectively. Also, let h_i represent the share of employed workers in sector i, and h_u be the share of the unemployed.

$$\mathbf{g}_i \equiv \frac{\psi_i \overline{u'(c_i)}}{\lambda}, \quad \mathbf{g}_f \equiv \frac{\psi_f u'(c_f)}{\lambda}, \quad \mathbf{g}_u \equiv \frac{\sum_i N_i (1 - E_i) \psi_i u'(c_u)}{\lambda \sum_i N_i (1 - E_i)} \tag{87}$$

$$h_i \equiv \frac{N_i E_i}{\sum_j N_j}, \quad h_u \equiv \frac{\sum_i N_i (1 - E_i)}{\sum_j N_j} \tag{88}$$

Divide (82) by $\lambda \sum_j N_j$, we obtain:

$$\sum_i \left(\underbrace{\frac{N_i E_i}{\sum_j N_j}}_{h_i} \right) \left(\underbrace{\frac{\psi_i \overline{u_i'}}{\lambda}}_{\mathbf{g}_i} \right) + \left(\underbrace{\frac{\sum_i N_i(1-E_i)}{\sum_j N_j}}_{h_u} \right) \left(\underbrace{\frac{\sum_i N_i(1-E_i)\psi_i u_u'}{\sum_i N_i(1-E_i)\lambda}}_{\mathbf{g}_u} \right) = 1. \tag{89}$$

Equation (89) states that a weighted average of the social welfare weights of the employed and unemployed workers equals one.

The complementary slackness condition (86) dictates whether or not the firm's profit constraint is binding. Analyzing the first-order condition (83) with respect to T_f, we have two scenarios:

Binding Constraint (*i.e.*, $\mu \geq 0$) Since the government places greater value on increasing public funds than on the welfare of firm owners, it will implement a stringent profit tax policy that reduces firms' profits to the minimum threshold $\Pi - T_f = \phi K$. If we divide condition (83) by λ, we obtain:

$$\frac{\psi_f u_f'}{\lambda} = 1 - \frac{\mu}{\lambda} \iff \mathbf{g}_f < 1 \tag{90}$$

Importantly, condition (90) implies that the social welfare weight assigned to firm owners is less than one, indicating that the government places relatively lower value on firm owners' welfare compared to other groups (as shown in condition (89)). This lower weight suggests a potential for profit taxation as a means of raising public funds. However, since the firm operates at the minimum profit threshold $\Pi - T_f = \phi K$, the government's ability to increase the profit tax T_f is constrained. Any increase in T_f would reduce firm's profit below ϕK, thereby violating the entry constraint and risking the firm's exit from the market. Thus, while $\mathbf{g}_f < 1$ supports taxing firm profits, the binding nature of the entry constraint restricts the government's capacity to do so.

Define η_{ji} and κ_{ji} as the employment and wage elasticities in sector j with respect to the

employment taxes $T_i - T_u$ weighted with relative net wages.

$$\eta_{ji} \equiv -\left(\frac{\partial E_j}{\partial\left(T_i - T_u\right)}\frac{w_i - (T_i - T_u)}{E_j}\right)\frac{w_j\left(1-t_j\right)}{w_i\left(1-t_i\right)}, \tag{91}$$

$$\kappa_{ji} \equiv \left(\frac{\partial w_j}{\partial\left(T_i - T_u\right)}\frac{w_i - (T_i - T_u)}{w_j}\right)\frac{w_j}{w_i\left(1-t_i\right)} \tag{92}$$

If we substitute the above definitions, as well as for μ using condition (83) in equation (84) and divide by $\lambda\sum_j N_j$, we obtain:

$$\begin{aligned}
&\frac{N_i E_i}{\sum_j N_j}\left(1 - \frac{\psi_i \overline{u}_i'}{\lambda}\right) + \sum_j \frac{N_j E_j}{\sum_j N_j}\left(\frac{\psi_j \overline{u}_j'}{\lambda} - \frac{\psi_f u_f'}{\lambda} + \frac{\psi_f u_f'}{\lambda} - \frac{\lambda}{\lambda}\right)\kappa_{ji}\frac{w_j}{w_i - (T_i - T_u)}\frac{w_i(1-t_i)}{w_j} \\
&- \sum_j \frac{N_j E_j}{\sum_j N_j}\left[\frac{\psi_j(\hat{u}_j - u_u)}{\lambda} + \frac{\lambda(T_j - T_u)}{\lambda}\right. \\
&\qquad \left. - \frac{(\lambda - \psi_f u_f')}{\lambda}\left(F_{Kj} - w_j'(K) - \sum_i E_i \frac{\partial w_i'(K)}{\partial E_j}\right)K\right]\eta_{ji}\frac{w_i(1-t_i)}{w_j(1-t_j)}\frac{1}{w_i - (T_i - T_u)} = 0.
\end{aligned} \tag{93}$$

Define t_j as the employment tax rate in sector j, and τ_j is the union wedge in sector j, and $\tau_{Kj}^{\text{implicit}}$ as the implicit capital–bargaining wedge under constrained profit taxes.

$$t_j \equiv \frac{T_j - T_u}{w_j}, \quad \tau_j \equiv \frac{\psi_j\left(\hat{u}_j - u_u\right)}{w_j\lambda} = \frac{\rho_j\,\mathbf{g}_j}{\varepsilon_j} \tag{94}$$

$$\tau_{Kj}^{\text{implicit}} \equiv \frac{(1 - \mathbf{g}_f)}{w_j}\left(F_{Kj} - w_j'(K) - \sum_i E_i \frac{\partial w_i'(K)}{\partial E_j}\right)K \tag{95}$$

By substituting the above definitions and rearranging, I obtain equation (27).

D Simulation

D.1 Derivation labor-demand elasticity

To allow for interdependent labor markets with general-equilibrium effects on the wage structure, we assume the following CES production function, which is defined over aggregate capital K and labor L_i in each sector i:

$$Y = F(K, L_1, ..., L_I) = AK^{1-\alpha}\left(\sum_i a_i L_i^{\frac{1}{\delta}}\right)^{\alpha\delta}, \;\; \delta \equiv \frac{\sigma}{\sigma - 1}\;, \tag{96}$$

where $\sigma > 0$ is the constant elasticity of substitution between different labor types, and $\alpha \in (0, 1)$ is the aggregate labor share. The derivatives are given by:

$$w_i = F_i = AK^{1-\alpha}\;\alpha\left(\sum_j a_j L_j^{\frac{1}{\delta}}\right)^{\alpha\delta-1} a_i L_i^{\frac{1}{\delta}-1} \tag{97}$$

$$\begin{aligned} F_{ii} = \alpha(\frac{\alpha\delta - 1}{\delta})AK^{1-\alpha}\left(\sum_j a_j L_j^{\frac{1}{\delta}}\right)^{\alpha\delta-2} a_i^2 L_i^{2(\frac{1}{\delta}-1)} \\ + \alpha(\frac{1}{\delta} - 1)AK^{1-\alpha}\left(\sum_j a_j L_j^{\frac{1}{\delta}}\right)^{\alpha\delta-1} a_i L_i^{\frac{1}{\delta}-2} \end{aligned} \tag{98}$$

This can be written as:

$$F_{ii} = AK^{1-\alpha}\;\alpha\left(\sum_j a_j L_j^{\frac{1}{\delta}}\right)^{\alpha\delta-1} a_i L_i^{\frac{1}{\delta}-2}\Big[(1/\delta - 1) + (\alpha - 1/\delta)\iota_i\Big], \tag{99}$$

where ι_i denotes the share of aggregate labor income that goes to workers in sector i:

$$\iota_i \equiv \frac{w_i L_i}{\sum_j w_j L_j} = \frac{a_i L_i^{\frac{1}{\delta}}}{\sum_j a_j L_j^{\frac{1}{\delta}}}. \tag{100}$$

Hence, using $\delta \equiv \frac{\sigma}{\sigma-1}$ the elasticity of labor demand in sector i is thus equal to:

$$\varepsilon_i = -\frac{F_i}{F_{ii} L_i} = \frac{\sigma}{1 + \iota_i\big[\sigma(1-\alpha) - 1\big]}. \tag{101}$$

D.2 Numerical Optimization of Taxes with the Holdup Problem

The optimal tax problem is given by

$$\max_{T_u,T_i,E_i} \mathcal{W} = \sum_i N_i \left[\int_0^{G_i^{-1}(E_i)} u\big(F_i(.) - T_i - \varphi\big) g(\varphi)\, d\varphi + (1 - E_i)\, u(-T_u) \right] \tag{102}$$

Subject to:

$$\sum_i N_i \Big(E_i T_i + (1 - E_i) T_u \Big) + \underbrace{F(.) - \sum_i F_i(.) N_i E_i - \phi K}_{T_f = \ \Pi - \phi K} = R,$$

$$\rho F_{ii}(.) N_i \int_0^{G_i^{-1}(E_i)} u'\big(F_i(.) - T_i - \varphi\big) g(\varphi)\, d\varphi + u\big(F_i(.) - T_i - G_i^{-1}(E_i)\big) - u(-T_u) = 0,$$

We use the labor-demand condition to substitute $F_i(.)$ for w_i. The numerical analysis proceeds under the following assumptions:

- $G_i(\varphi) = G(\varphi)$, $\underline{\varphi} = 0$, and $\rho_i = \rho$ for all i.
- All profits that exceed the initial capital cost flow back to the government.
- To ensure firm's entry, the non-distortionary profit tax is calibrated as follows:

$$T_f = F(.) - \sum_i F_i(.) N_i E_i - \phi K.$$

- Please refer to 4.1.8 for more details on how we solve for equilibrium capital using the firm's capital demand condition:

$$\underbrace{(1 - \alpha) K^{-\alpha} \left(\sum_i a_i L_i^{\frac{1}{\delta}} \right)^{\alpha\delta}}_{F_K(.)} = \sum_i w_i'(K) N_i E_i + \phi, \tag{103}$$

Following Hummel and Jacobs (2023), we employ two algorithms to calculate optimal taxes:

D.2.1 Solving the Unconstrained Optimum

We use the union wage-demand equation to solve for the optimal participation tax, leveraging the CARA utility:

$$T_i - T_u = -\frac{1}{\theta} \ln \left[\frac{\theta \rho w_i}{\varepsilon_i E_i} \int_0^{G^{-1}(E_i)} \exp(-\theta(w_i - \varphi)) g(\varphi) d\varphi + \exp(-\theta(w_i - G^{-1}(E_i))) \right]. \quad (104)$$

Based on that, we then utilize the government budget constraint to calculate the corresponding unemployment benefit:

$$T_u = \frac{1}{\sum_i N_i} \left[R + \sum_i F_i(\cdot) N_i E_i + \phi K - F(\cdot) - \sum_i N_i E_i \left(T_i - T_u \right) \right] \quad (105)$$

D.2.2 Solving first-order conditions

We solve the first-order conditions of the maximization problem (102), including conditions for T_u, T_i, and E_i for each sector i, along with the government budget constraint and the union wage-demand equation. We use the union wage-demand equation and the government budget constraint to solve for T_i and T_u. Then, we numerically compute the vector of employment rates, using the initial rates from the calibrated economy as a starting point. The lagrangian writes:

$$\begin{aligned}
\mathcal{L} = & \sum_i N_i \left[\int_0^{G_i^{-1}(E_i)} u\big(F_i(.) - T_i - \varphi\big) g(\varphi) d\varphi + (1 - E_i)\ u(-T_u) \right] \\
& + \lambda \left[\sum_i N_i \Big(E_i T_i + (1 - E_i) T_u \Big) + F(.) - \sum_i F_i(.) N_i E_i - \phi K - R \right] \\
& + \sum_i \mu_i \left[\rho F_{ii}(.) N_i \int_0^{G_i^{-1}(E_i)} u'(F_i(.) - T_i - \varphi) g(\varphi) d\varphi + u(F_i(.) - T_i - G_i^{-1}(E_i)) - u(-T_u) \right]
\end{aligned} \quad (106)$$

The first-order conditions are then given by:

$$T_u: \quad -\sum_i N_i E_i \overline{u}_i' - \sum_i N_i(1-E_i)u_u' + \lambda \sum_i N_i - \sum_i \mu_i \Big[\rho \overline{u}_i'' F_{ii} N_i E_i + \hat{u}_i' - u_u'\Big] = 0, \tag{107}$$

$$T_i: \quad -N_i E_i(\overline{u}_i' - \lambda) - \mu_i\Big(\rho \overline{u}_i'' F_{ii} N_i E_i + \hat{u}_i'\Big) = 0, \tag{108}$$

$$\begin{aligned} E_i: \quad & N_i(\hat{u}_i - u_u) + N_i \sum_j N_j E_j(\overline{u}_j' - \lambda)F_{ji} + \lambda N_i(T_i - T_u) + \mu_i\Big(\rho \hat{u}_i' F_{ii} N_i - \hat{u}_i'/G'\Big) \\ & + N_i \sum_j \mu_j \Big[\big(\rho E_j \overline{u}_j'' F_{jj} N_j + \hat{u}_j'\big)F_{ji} + \rho E_j \overline{u}_j' F_{jji} N_j\Big] = 0, \end{aligned} \tag{109}$$

$$\lambda: \quad \sum_i N_i\Big(T_u + E_i(T_i - T_u)\Big) + T_f - R = 0, \tag{110}$$

$$\mu_i: \quad \rho \overline{u}_i' F_{ii} N_i E_i + \hat{u}_i - u_u = 0. \tag{111}$$

If we differentiate expression (111) with respect to T_u, and then substitute into expression (107), the multipliers μ_i can be eliminated. Accordingly, we use condition (107) to solve for λ, leading to:

$$\lambda = \frac{1}{\sum_i N_i} \sum_i N_i \Big[E_i \overline{u}_i' + (1-E_i)u_u'\Big] \tag{112}$$

D.3 Numerical Optimization of Taxes without the Holdup

$$\max_{T_u, T_i, E_i} \mathcal{W} = \sum_i N_i \left[\int_0^{G_i^{-1}(E_i)} u\big(F_i(.) - T_i - \varphi\big) g(\varphi)\, d\varphi + (1-E_i)\, u(-T_u)\right] \tag{113}$$

Subject to:

$$\sum_i N_i\Big(E_i T_i + (1-E_i)T_u\Big) + F(.) - \sum_i F_i(.) N_i E_i - \phi K = R, \tag{114}$$

$$\rho F_{ii}(.) N_i \int_0^{G_i^{-1}(E_i)} u'\big(F_i(.) - T_i - \varphi\big) g(\varphi)\, d\varphi + u\big(F_i(.) - T_i - G_i^{-1}(E_i)\big) - u(-T_u) = 0. \tag{115}$$

The FOC with respect to E_i is given by:

$$E_i : N_i(\hat{u}_i - u_u) + N_i \sum_j N_j E_j (\overline{u}'_j - \lambda) F_{ji} + \lambda N_i (T_i - T_u) + \mu_i \Big(\rho \hat{u}'_i F_{ii} N_i - \hat{u}'_i / G' \Big)$$
$$+ N_i \sum_j \mu_j \Big[\big(\rho E_j \overline{u}''_j F_{jj} N_j + \hat{u}'_j \big) F_{ji} + \rho E_j \overline{u}'_j F_{jji} N_j \Big] = 0. \tag{116}$$

The unemployment benefit thus is given by:

$$T_u = \frac{1}{\sum_i N_i} \left[R + \sum_i F_i(\cdot) N_i E_i + \phi K - F(\cdot) - \sum_i N_i E_i \left(T_i - T_u \right) \right]. \tag{117}$$

D.3.1 Optimal Taxes under Perfect Competition ($\rho = 0$)

Under perfect competition, resources are allocated efficiently, and there are no market power distortions. Firms operate where price equals marginal cost, ensuring that production is socially optimal. Introducing a tax on profits in such a setting can create inefficiencies by reducing firms' incentives to invest, potentially leading to a suboptimal allocation of resources, thus tax on profit T_f is null.

E Bargaining over the wage distribution

We consider a national union characterized by bargaining power denoted by δ, negotiating sectoral wages with the explicit aim of compressing the wage distribution. This aim arises naturally from the concavity of the workers' utility function, implying that aggregate utility is increased by transferring income towards lower-paid workers, thereby equalizing marginal utilities across the labor force. Crucially, achieving such wage compression relies on interdependencies across labor markets: specifically, it requires that the marginal productivity—and thus the wages—of each worker group depend on employment levels in other sectors. A key distinction from traditional sectoral bargaining frameworks is our omission of sector-specific union power measures. Consequently, under national bargaining, equilibrium outcomes for wages and employment become responsive to profit taxation.

E.1 The Wage Bargain in a Two-Sector Economy

Suppose there are two types of labor: low-skilled and high-skilled, with respective wages satisfying $w_L < w_H$. In this setting, the union seeks to redistribute toward lower-paid workers to reduce wage inequality across skill groups. The negotiated wage solves the maximization of the generalized Nash product in logarithmic form:

$$\begin{aligned}\max_{\{w_i,\,E_i\}\ i\in\{L,H\}} \Phi = \delta \log &\left(\sum_i N_i \int_{\underline{\varphi}}^{G_i^{-1}(E_i)} \Big(u(w_i - T_i - \varphi) - u(-T_u) \Big)\, dG_i(\varphi) \right) \\ &+ (1-\delta) \log \Bigg(u_f\big(F(K, E_L N_L, E_H N_H) - \sum_i w_i N_i E_i - T_f\big) \\ &\qquad - \underline{u}_f \Big(\underbrace{F(K,0,0)}_{=0} - \big(F_K(K, E_L N_L, E_H N_H) - \underbrace{F_K(K,0,0)}_{=0}\big) K - T_f \Big) \Bigg) \\ \text{s.t.}\quad & w_i = F_i(K, E_L N_L, E_H N_H), \\ & G_i(w_i - T_i + T_u) - E_i \geq 0. \end{aligned} \tag{118}$$

The firm's fallback utility in the absence of an agreement with the national union is given by

$$\underline{u}_f \left(\underbrace{F(K,0,0)}_{=0} - \Big(F_K(K, E_L N_L, E_H N_H) - \underbrace{F_K(K,0,0)}_{=0}\Big) K - T_f \right),$$

where $F(K,0,0) = 0$ and $F_K(K,0,0) = 0$ reflect the assumption of co-operant factors of production, i.e., production is not feasible without labor. In this case, the firm hires no

labor $E_L = E_H = 0$, generates no output, and bears the full sunk cost of capital investment. The Lagrangian writes as:

$$\begin{aligned}\mathcal{L} = \delta \log \Bigg(\sum_i N_i \int_{\underline{\varphi}}^{G_i^{-1}(E_i)} \Big(u(w_i - T_i - \varphi) - u(-T_u) \Big) \, dG_i(\varphi) \Bigg) \\ + (1-\delta) \log \Bigg(u_f \Big(F(K, E_L N_L, E_H N_H) - \sum_i w_i N_i E_i - T_f \Big) \\ - \underline{u}_f \Big(F(K,0,0) - F_K(K, E_L N_L, E_H N_H) \; K - T_f \Big) \Bigg) \\ + \sum_i \vartheta_i \Big(w_i - F_i(K, E_L N_L, E_H N_H) \Big) + \sum_i \nu_i \Big(G(w_i - T_i + T_u) - E_i \Big) \end{aligned} \tag{119}$$

$\forall i \in \{L, H\}$, the first-order conditions are given by:

$$w_i : \quad \frac{\delta N_i E_i \overline{u}_i'}{\sum_j N_j E_j (\overline{u}_j - u_u)} - \frac{(1-\delta)}{(u_f - \underline{u}_f)} u_f' N_i E_i + \vartheta_i + \nu_i G' = 0, \tag{120}$$

$$E_i : \quad \frac{\delta N_i (\hat{u}_i - u_u)}{\sum_j N_j E_j (\overline{u}_j - u_u)} + \frac{(1-\delta) \; \underline{u}_f'}{(u_f - \underline{u}_f)} F_{Ki} N_i K - N_i \sum_j \vartheta_j F_{ji} - \nu_i = 0, \tag{121}$$

$$\vartheta_i : \quad w_i - F_i = 0, \tag{122}$$

$$\nu_i : \quad \nu_i (G_i - E_i) = 0. \tag{123}$$

First, when the union has zero bargaining power $\delta = 0$, the equilibrium coincides with the competitive outcome. If we combine equations (120) and (121) to solve for ϑ_i yields:

$$\frac{N_i \; \underline{u}_f'}{(u_f - \underline{u}_f)} F_{Ki} K - \frac{N_i u_f'}{(u_f - \underline{u}_f)} \sum_j N_j E_j F_{ji} + N_i \sum_{j \neq i} \mu_j G_j' F_{ji} + N_i \mu_i G_i' F_{ii} - \nu_i = 0. \tag{124}$$

When firm owners are risk-neutral, they exhibit constant marginal utility, i.e., $u_f' = \underline{u}_f'$. This ensures that profit tax does not affect equilibrium wages and employment. For $i = L$ (i.e., low-skilled), expression (124) can be rearranged:

$$\nu_L \underbrace{(N_L G_L' F_{LL} - 1)}_{<0} + N_L \; \nu_H \underbrace{G_H' F_{HL}}_{\geq 0} = N_L \frac{1}{(\Pi_f - \underline{\Pi}_f)} \underbrace{\Big(\underbrace{\sum_j N_j E_j F_{jL}}_{=-F_{KL}K} - F_{KL} K \Big)}_{=-2F_{KL}K \; <0}. \tag{125}$$

The inequalities arise from the assumptions of non-increasing marginal productivity, together with co-operant production factors, which implies the following inequality: $F_{LL} \leq 0 \leq F_{HL}$,

and constant returns to scale, which imply that:

$$\sum_j N_j E_j F_{jL} = -F_{KL} K \tag{126}$$

Consider the low-skilled sector $j = L$, where the wage w_L is set above the market-clearing level. As a result, labor demand falls short of labor supply, yielding $G_L > E_L$. According to the Kuhn–Tucker conditions, this implies that the associated Lagrange multiplier on the participation constraint must be zero, i.e., $\nu_L = 0$. Given the non-negativity of the other multiplier i.e., ν_H, equation (125) cannot be satisfied unless all labor types are perfect substitutes, i.e., $F_{LL} = F_{HL} = F_{KL} = 0$. This is a contradiction. Therefore, $G_i = E_i$ for all i if $\delta = 0$.

Second, when the union has full bargaining power $\delta = 1$, it acts as a monopoly union and sets wages to maximize the aggregate expected utility of workers, subject to the firm's labor demand conditions:

$$w_L = F_L(K, E_L N_L, E_H N_H), \tag{127}$$

$$w_H = F_H(K, E_L N_L, E_H N_H). \tag{128}$$

Substituting conditions (127)–(128) directly into the union's objective function yields:

$$\Lambda = \sum_{i \in L,H} N_i \int_{\underline{\varphi}}^{G_i^{-1}(E_i)} \Big[u\big(F_i(K, E_L N_L, E_H N_H) - T_i - \varphi\big) - u(-T_u) \Big] \, dG_i(\varphi) \tag{129}$$

This implies that the union's control variables reduce to the employment rates E_L and E_H, which implicitly determine wages through the labor demand system (127)–(128). Given the union's concern for wage compression, it will consider reducing employment in the low-skilled sector, where the marginal utility is highest, i.e., $\overline{u}'_L > \overline{u}'_H$. By doing so, the marginal product of low-skilled labor F_L—hence its wage w_L—increases due to diminishing returns, while wages in high-skilled labor sector fall due to technological interdependencies, i.e., $F_{HL} > 0$. The

[12] This follows by differentiating $F(K, N_L E_L, N_H E_H) = F_K K + \sum_j N_j E_j F_j$ with respect to E_L:

$$F_L N_L = F_{KL} K + F_L N_L + \sum_j N_j E_j F_{jL}.$$

Equating both sides, we obtain:

$$\sum_j N_j E_j F_{jL} = -F_{KL} K.$$

total impact on the union's objective of a small reduction in employment in the low-skilled sector is:

$$d\Lambda = \left(N_L \sum_j N_j E_j F_{jL} \, \overline{u}'_j \right). \, dE_L \tag{130}$$

This expression can be rewritten as:

$$d\Lambda = N_L \left(N_L E_L \underbrace{F_{LL}}_{<0} \overline{u}'_L \; + \; N_H E_H \underbrace{F_{HL}}_{>0} \overline{u}'_H \right) \cdot dE_L. \tag{131}$$

The first term in parentheses is negative due to diminishing marginal returns, i.e., $F_{LL} < 0$, while the second term is positive, reflecting co-operant factors between low- and high-skilled labor inputs, i.e., $F_{HL} > 0$. Under constant returns to scale, the weighted sum of marginal productivity effects with respect to employment in the low type sector is non-positive (see expression (126)). Moreover, the negative component $N_L E_L F_{LL}$ is weighted by the highest marginal utility $\overline{u}'_L$, since low-skilled workers typically have lower wages. All of that makes the negative term unambiguously dominate. Consequently, the union's objective increases, $d\Lambda > 0$, when employment in the low-wage sector is marginally reduced (i.e., $dE_L < 0$). This establishes that, under full union bargaining power, the optimal allocation involves setting the wage for at least one sector above the market-clearing level.