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The Impact of Organization Costs when Firm-selection Matters

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The Impact of Organization Costs when Firm-selection Matters*

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Preliminary and incomplete

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Abstract

How does an increase in organization costs (i.e. costs which arise when labor unions organize firms' workforces) affect the industry structure, wage inequality and welfare? In the present paper, we build a model with costly and endogenous unionization, heterogeneous firms as well as free market entry/exit. In such a setting, we show that the share of low-productive firms operating in the market decreases (increases) in organization costs if those costs are relatively low (high). If more low-productive firms are active in the market, consumption and hence welfare decline because prices are, on average, higher (vice versa). As such, an increase in organization costs and thus a decline in unionization rates could be welfare-reducing. In addition, we find a hump-shaped relationship between organization costs and wage inequality. These results suggest that a policy aiming to reduce unionization by an increase in organization costs can but not necessarily have to be an improvement of the economic performance.

Keywords: organization costs, endogenous unionization, firm-selection, welfare, wage inequality

JEL Classification: J51, L11, L16

1 Introduction

In the last two decades, unionization (measured by the share of union members among employees) has substantially declined in most OECD countries (see Visser, 2013). As recently pointed out by the Economist (2013), one reason of this reduction might be that organizing a workforce is costly for the union. Organization costs include direct costs, e.g. salaries and expenses of the union's representatives, indirect costs, e.g. unpaid time which current members spend to organize new members, and institutional costs (see Voos, 1983). The latter component is mainly determined by policy makers who set the legal framework under which unionization take place. There are several examples showing that a decline in unionization rates is a political goal that can be realized by increasing the legal barriers to unionization.¹

In the literature, organization costs are often used (i) to explain why large and more productive firms in particular are unionized (see, for instance, Dinlersoz et al., 2014, Kuhn, 1998), (ii) to show that the unions' bargaining power increase with firms' rents (see Breda, 2015) and (iii) in models that investigate the determinants of union density (see Corneo, 1993, 1995). However, only little is known about the 'direct' effects of organization costs. A government which increases legal barriers to unionization and hence raises organization costs might presume that a lower union density and thus more competitive labor markets are welfare-improving. In a world with heterogeneous firms and free market entry, an increase in organization costs could, however, imply market entry of low-productive firms with adverse effects on welfare.

In this paper, we contribute to the existing literature by analyzing the impact of organization costs in a theoretical framework that allows for firm-selection, i.e. the endogenous market entry and exit of firms. In particular, we ask: How does an increase in organization costs affect a.) the distribution of active firms in an industry, b.) wage inequality within an industry and c.) welfare? To that end, we build a model in which firms are heterogeneous in productivity, operate under conditions of monopolistic competition and face market entry as well as fixed production costs (see Melitz, 2003 for the same approach). Unions act at the firm-level as monopoly unions and face costs for organizing the firm's workforce which depend on the number of union members and on an exogenous parameter (see Kuhn, 1998). The latter is

¹One of the more recent and prominent examples of attempts to change barriers to unionization was the discussion of the Employee Free Choice Act in the USA. But also the ban on closed shop unions in the UK in the late 1980s or more recently the "Tarifeinheitsgesetz" in Germany (which only allows the largest union in a firm to set the wage) can be interpreted as changes in organization costs.

used to model an increase in organization costs e.g. caused by policy makers. A firm-level union organizes the firm's workforce if and only if the acquired rent is at least as high as the organization costs. Otherwise, the workforce is not unionized and the firm pays the competitive wage. As usual, the general equilibrium is calculated by the free-entry and the zero-profits-cutoff conditions. In addition, we simulate our model using parameter values drawn from the literature in order to analyze the quantitative effects of changing organization costs and to measure wage inequality by the Gini coefficient.²

Solving our model shows that only sufficiently productive firms can cover fix production costs and are thus active in the market. There is a marginal active firm that makes zero-profits. The workforce of that firm cannot be unionized because the union cannot acquire any rent to cover organization costs. This also holds for the least-productive firms in the market where (positive) profits are still too low to support unionization. Firms with intermediate productivity levels are, in contrast, unionized. However, the union follows a second-best or limiting wage strategy because setting the optimal wage would imply that these firms would make a loss. In this case, firms exit the market leaving the union with no rent at all. Therefore, the union sets a limit wage rate such that firms face zero-profits. Note that the limit wage increases with the firm's productivity.³ For the most productive firms, i.e. firms with the highest profits, the union organizes the firm's workforce and can set the first-best or unconstrained wage.

An increase in organization costs, e.g. because the government changes the legal framework for unionization, has the following implications. First, there is a u-shaped relationship between the cutoff productivity, i.e. the productivity of the marginal active firm, and organization costs. There are two countervailing effects. On the one hand, unions increase the unconstrained wage which causes high-productive firms to raise their prices.

²Our model has several simplifying features. First, we assume that productivities are Pareto distributed (Axtell, 2001, Helpman et al., 2004). Second, we abstract from wealth effects (following Chor, 2009 and Cole and Davies, 2011, among others). Third, we follow recent literature in assuming firm-level unions. In OECD countries, union wage bargaining occurs on several levels, including the national, sectoral, and the firm level. However, there is a tendency towards more decentralized wage determination also in countries where wages traditionally are determined at the sectoral level (see, e.g., Ochel, 2005 and Gürtzgen, 2009 for Germany). Fourth, we consider monopoly unions as done by MacDonald and Robinson (1992) but show that a Nash bargaining approach does not alter our qualitative findings. Fifth, we assume that marginal and average organization costs are constant. As a robustness check, we simulate our model with convex and concave cost functions which lead to qualitatively similar results.

³This is in line with Freeman and Kleiner (1999) and Hirsch (2004), who find that unions generally reduce firms' profits, but only to an extent that prevents firm failure.

As a consequence, competition becomes less intense and more of the least-productive firms are able to cover fix production costs. On the other hand, the share of unionized firms decreases because the profits of some (relatively low-productive) firms are not sufficiently large to cover the increased organization costs. Wages and prices, c.p., decline such that competition becomes more severe. Consequently, more of the least-productive firms exit the market. If organization costs are low (high), the first (second) effect dominates and the cutoff productivity decreases (increases). This result may help to justify similar productivity patterns in industries with vastly different degrees of unionization, and may also be relevant for guiding empirical studies.

Second, there is also a u-shaped relationship between welfare and organization costs. We measure welfare by the equilibrium consumption of the differentiated good (which is produced in the sector with monopolistic competition) and of the homogenous numeraire good (which is produced in a second sector with perfectly competitive goods and labor markets). If an increase in organization costs reduces (raises) the cutoff productivity, active firms are on average less (more) productive. The price index rises (falls) such that the consumption of the differentiated good decreases (increases). In contrast, equilibrium consumption of the homogenous good monotonously declines with organization costs because income decreases.⁴ If both the cutoff productivity and income decline, welfare falls if organization costs are increased. If, however, the cutoff productivity rises and if this increase is sufficiently large, welfare rises if organization costs are increased. The latter (former) holds for relatively low (high) values of organization costs.

Finally, we find that wage inequality in the differentiated goods sector increases for low values of organization costs, reaches a maximum and decreases from there on. Starting at a point where all firms are unionized because organizing the firms' workforces is costless, an increase in organization costs implies that high-productive firms have to pay higher wages (the unconstrained wage increases), while some low-productive firms are not unionized and can reduce their wage payments. The (limit) wage paid by intermediate productive firms is not affected. Consequently, wage inequality rises. With further increases in organization costs, more and more firms are not unionized and pay the competitive wage, while only few firms pay the limit wage and even fewer the (relatively high) unconstrained wage. This makes the wage distribution more equal. If organization costs go to infinity, all firms pay the competitive wage and wage inequality vanishes. To sum

⁴Note that income affects only the consumption of the homogenous good because both goods are valued by a quasi-linear utility function. Moreover, income monotonously decreases in organization costs as shown in our numerical solution, while the analytical solution indicates that even non-monotonic relationships are theoretically possible.

up, our results suggest that restricting unionization e.g. by changing the legal framework can but not necessarily have to be an improvement of the economic performance which policy makers should be aware of.

The remainder of our paper is structured as follows. In Section 2, we lay out the basic environment of our model and describe the timing of events. The partial equilibrium is determined in Section 3, while the general equilibrium is described in Section 4. The impact of organization costs on the distribution of active firms, welfare and wage inequality is investigated in Section 5, where we present both an analytical and a numerical solution. We conclude in Section 6.

2 The Model

2.1 Structure of the Economy

We assume that the economy consists of two sectors. In one sector, a homogeneous good Y is produced and sold under conditions of perfect competition. We choose good Y as the numeraire and normalize its price to one: $P_Y \equiv 1$. The production of one Y -unit requires one unit of labor. The labor market in this sector is perfectly competitive such that the competitive wage is given by: $\hat{w} = 1$. In the other sector, a mass of M firms produce varieties of a (horizontally) differentiated good X . There is monopolistic competition at the goods market and each firm produces one particular variety. Moreover, firm-level unions could (but not necessarily have to) organize the firm's workforce.

There is an exogenously given mass of workers L who are homogeneous and mobile across sectors. Each worker inelastically supplies one unit of labor. Note that workers who are not employed in the X -sector find a job in the Y -sector such that the economy wide unemployment rate is zero.

2.2 Consumers and Demand

To describe the demand side of the model, we consider a representative consumer who values the two goods X and Y according to the following quasi-linear utility function:

$$U = \nu \ln X + Y, \quad X \equiv \left[\int_0^M x(\omega)^\rho d\omega \right]^{\frac{1}{\rho}}. \quad (1)$$

We assume that X is a CES index of all varieties in the differentiated good sector that are available. The relative market size of this sector is captured by

ν with $\nu > 0$. Varieties are consumed in quantity $x(\omega)$, where ω is the index for the firm producing this variety. Varieties are substitutes which implies $0 < \rho < 1$. The elasticity of substitution is given by $\sigma = 1/(1 - \rho) > 1$.

The representative consumer maximizes utility by choosing X , Y and $x(\omega)$ subject to $\int_0^M p(\omega)x(\omega)d\omega + Y = I$, where $p(\omega)$ and I denote the price of variety ω and income, respectively. The demand for the homogenous and the differentiated good is thus given by:

$$X = \frac{\nu}{P}, \quad (2)$$

$$Y = I - \nu, \quad (3)$$

which shows that the expenditures for the differentiated good X are fixed at ν such that income effects are fully absorbed by a change in the consumption of the homogenous good.⁵

Moreover, utility maximization yields isoelastic demand functions for each variety:

$$x(\omega) = \nu p(\omega)^{-\sigma} P^{\sigma-1}, \quad (4)$$

where P represents the CES price index for good X which is given by:

$$P = \left[\int_0^M p(\omega)^{-\frac{\rho}{1-\rho}} d\omega \right]^{-\frac{1-\rho}{\rho}}. \quad (5)$$

The price index is an inverse measure of (horizontal) competition. If P increases (decreases), demand increases (decreases) implying that competition between operating firms becomes less intense (more severe).

2.3 Firms and Production

In the X -sector, there is an unbounded pool of potential entrants which we call entrepreneurs. Following Melitz (2003), we assume that each entrepreneur makes two decisions. First, he decides whether to enter the market and second, conditional on market entry, he decides whether to become an active firm and produce or to leave the market immediately.

Market entry requires that the entrepreneur pays fixed costs F_e (measured in units of the homogeneous good) which are sunk thereafter. Once F_e has been paid, the entrepreneur is endowed with a productivity level ϕ which is drawn from a given distribution. Intuitively, F_e could measure (non-reversible) costs for research and development, which firms have to bear in

⁵This simplifying result of the quasi-linear preference structure has been exploited by Chor (2009), Cole and Davies (2011), and others.

advance of production and which determine their productivity. Note that M_e represents the mass of entrepreneurs which enters the market. Furthermore, we assume that productivities are Pareto distributed with the distribution function:

$$G(\phi) = 1 - \left(\frac{\phi_{min}}{\phi} \right)^k, \quad (6)$$

where $\phi_{min} \geq 1$ is the lower bound of the support and $k > \sigma - 1$ is the shape parameter.

After the entrepreneur has received its productivity, he decides about production which, however, requires fixed costs F (measured in units of the homogenous good). There is a marginal firm with productivity ϕ^* which is indifferent between production and market exit. Hence, entrepreneurs become an active firm if and only if $\phi \geq \phi^*$ and leave the market otherwise. Therefore, the mass of active firms is given by: $M = (1 - G(\phi^*))M_e$.

In the X -sector, labor l is the only input. The production function reads:

$$x = \phi \cdot l, \quad (7)$$

and profits are defined as:

$$\pi = px - wl - F = \left(p - \frac{w}{\phi} \right) x - F, \quad (8)$$

where w represents the wage rate which the firm has to pay to its workers.

2.4 Unions and Organization Costs

We assume that one union is allocated to each active firm in the X -sector.⁶ Each firm-level union decides whether to organize the firm's workforce and thus to become active or to leave the market immediately. In the latter case, the firm pays the competitive wage. In the former case, we assume that the union unilaterally sets the wage on behalf of its members, i.e. the firm's workforce, while the firm has the right to manage employment.

In contrast to standard approaches of modeling unionization, we assume that organizing workers of a firm is costly for the union. As argued by Voos (1983), organization costs consist of direct costs, e.g. salaries and expenses of the union's representatives, and indirect costs, e.g. unpaid time which

⁶The benefit of this stylized approach is that we do not need to make critical assumptions about how workers are allocated to firms initially, or how workers allocated to a given firm would make and respond to the unionization decision. Basically, we assume that the separate institutional body 'firm-level' union cares about workers in general, but not about specific workers.

current members spend to organize new members. In addition, organization costs include institutional costs due to legal barriers to unionization, which can be influenced by policy makers. These costs are summarized in a union cost function denoted by $C(l)$.

In general, various specifications of C appear plausible. To keep our model analytically tractable, we assume that marginal organization costs, Θ , and average organization costs, Av , are constant. Hence, we model organization costs as:

$$C(l) = c \cdot l, \quad \frac{\partial C}{\partial l} \equiv \Theta = c, \quad \frac{C}{l} \equiv Av = c, \quad (9)$$

with $c > 0$ being a parameter through which we model an exogenous increase in organization costs e.g. caused by the government.

We assume that the union is utilitarian and that the union's utility function is given by:

$$V = l(w - 1) - cl. \quad (10)$$

As shown by Eq. (10), the outside option of the union members is to be employed in the Y sector and receive a wage payment of $\hat{w} = 1$. As such, we neglect the possibility that a worker might also find a job at another firm in the X -sector, which is a reasonable assumption if the Y -sector is relatively large.

2.5 Timing and Solution Strategy

The timing structure of our model is as follows.

1. Each entrepreneur decides first about market entry, i.e. investing F_e and drawing a productivity level. Conditional on market entry, the entrepreneur decides whether to become active and produce or to exit the market without production.
2. Each union which is allocated to one particular firm decides about organizing the firm's workforce. Conditional on organizing, the union sets the wage rate on behalf of its members.
3. Each active firm chooses its profit-maximizing price, which then determines production and employment. Afterward, consumption takes place.

To determine the partial equilibrium, we consider a firm with productivity ϕ producing the variety ω and solve the aforementioned game by backwards induction. At this stage, we treat the macroeconomic variables P , M , M_e , I

and ϕ^* as exogenously given. To compute the general equilibrium, however, we have to endogenize these measures which requires the aggregation over all active firms.

3 Partial Equilibrium

3.1 The Firm's Choices

The firm with productivity ϕ maximizes its profit (8) by choosing the price p subject to the demand function (4) and the wage w which has been determined at stage 2. This yields the profit-maximizing price:

$$p(\phi, w) = \frac{1}{\rho} \frac{w}{\phi}, \quad (11)$$

which is a constant mark-up $1/\rho$ (due to CES preferences) over firm-specific variable costs.

Inserting the optimal price (11) into the demand function (4) leads to the firm's output: $x(\phi, w) = \nu p(\phi, w)^{-\sigma} P^{\sigma-1}$. To produce this output, the firm sets employment equal to: $l(\phi, w) = x(\phi, w)/\phi = \nu \phi^{-1} p(\phi, w)^{-\sigma} P^{\sigma-1}$. Inserting (4) into the definition of the firm's revenues, $r \equiv px$, and observing (11) yield the profit-maximizing revenue:

$$r(\phi, w) = \nu p(\phi, w)^{-(\sigma-1)} P^{\sigma-1}. \quad (12)$$

Substituting (11) and the profit-maximizing output into (8) leads to the following profit function:

$$\pi(\phi, w) = (1 - \rho)r(\phi, w) - F. \quad (13)$$

For later use, we define a feasible wage rate $\tilde{w}(\phi)$ at which profits of a firm with productivity ϕ are zero: $\pi(\phi, \tilde{w}(\phi)) = 0$. If the wage rate which the union has been set at the previous stage would be higher than $\tilde{w}(\phi)$, the firm would face a loss and hence exit the market. We can explicitly calculate the feasible wage as:

$$\tilde{w}(\phi) = \rho \phi P \left(\frac{\sigma F}{\nu} \right)^{-\frac{1}{\sigma-1}}. \quad (14)$$

Note that the firm's feasible wage is upward sloping in (\tilde{w}, ϕ) -space because more productive firms survive at higher wage costs.

3.2 The Union's Choices

Suppose that the union has decided to organize the firm's workforce. Then, the union sets the wage rate w to maximize utility (10) subject to the firm's employment choice. In addition, the union has to take into account that the wage must not exceed the firm's feasible wage $\tilde{w}(\phi)$ because a firm's market exit would leave the union with zero utility. Formally, we can write the union's optimization problem as:

$$\begin{aligned} \max_w V &= l(w - 1) - cl \\ \text{s.t.} \quad & l = l(\phi, w) \quad \text{and} \quad w \leq \tilde{w}(\phi). \end{aligned}$$

The Lagrange function of that problem is given by:

$$L = l(\phi, w)(w - 1) - cl(\phi, w) + \eta(\tilde{w}(\phi) - w), \quad (15)$$

where η is the shadow value associated with the wage constraint. The first-order conditions read:

$$w + c\sigma - \sigma(w - 1) - \eta \frac{w}{l(\phi, w)} = 0, \quad (16)$$

$$\tilde{w}(\phi) - w \geq 0 \quad \text{with} \quad \eta \geq 0 \quad \text{and} \quad \eta \frac{\partial L}{\partial \eta} = 0, \quad (17)$$

where we have used the fact that the labor demand elasticity is constant and given by $-\sigma$ under CES preferences.

When the wage constraint is not binding, i.e. $\tilde{w}(\phi) - w > 0$ (which implies $\eta = 0$ by complementary slackness), we find that the wage rate is a constant mark-up over the sum of the competitive wage and the marginal organization costs (i.e. the opportunity costs of working in the specific firm and of being unionized, respectively):

$$w^u \equiv w = \frac{1}{\rho}(1 + c). \quad (18)$$

We refer to this wage rate as the unconstrained wage rate denoted by w^u in the following. Note that in our benchmark model with $C = cl$, w^u is independent of the firm's productivity.

If the wage constraint is binding, the union sets the wage rate equal to the feasible wage rate as shown by (17). Hence, the union follows a limiting-wage strategy which leaves the firm with zero profits. Then, by complementary slackness, $\eta > 0$ holds. Solving (16) with respect to η and noting $w = \tilde{w}(\phi)$ yield:

$$\eta = l(\phi, \tilde{w}(\phi)) \left[1 - \sigma \frac{\tilde{w}(\phi) - 1 - c}{\tilde{w}(\phi)} \right]. \quad (19)$$

In Appendix A.1, we show that the shadow value is positive and decreasing in ϕ as long as the wage constraint is binding. Thus, there exists a threshold productivity ϕ^+ at which the wage constraint stops binding, i.e. $\eta(\phi^+) = 0$. Using (19) and (14), we can calculate this threshold productivity as:

$$\phi^+ = \frac{1}{\rho^2} \frac{1+c}{P} \left(\frac{\sigma F}{\nu} \right)^{\frac{1}{\sigma-1}}. \quad (20)$$

This yields the following Lemma.

Lemma 1 (Union wage setting) *Firms with $\phi < \phi^+$ face the limit-wage $\tilde{w}(\phi)$ while firms with $\phi \geq \phi^+$ face the unconstrained union wage w^u .*

The union organizes the firm's workforce and sets the wage rate if and only if this would be profitable. This means that the associated utility stream of organizing the workforce and setting the wage according to Lemma 1 must be non-negative: $V(w) \geq 0$. We can define a feasible wage of the union, w^c , for which the union is indifferent between organizing the workers and market exit:

$$V(w^c) = 0 \Leftrightarrow w^c = 1 + c. \quad (21)$$

This implies that the wage rate set by the union must be at least as high as w^c to cover union members' opportunity costs of working and the costs of being unionized, i.e. average organization costs. Note that w^c is independent of the firm's productivity and employment in our benchmark model with $C = cl$.

Because the union anticipates the wage outcome (see Lemma 1), it will organize the firm's workforce if $w \geq w^c$ holds. Comparing (18) and (21), we find that $w^u > w^c$. If the union can set the unconstrained wage, unionization is always profitable. Consequently, high-productive firms with $\phi \geq \phi^+$ are unionized. This is, however, not necessarily true for firms that pay the limit wage. Because $\tilde{w}(\phi)$ increases in productivity while w^c is constant, the limit wage falls short of the union's minimum wage for firms that are equipped with relatively low productivity levels. The firm's profit is so low that it cannot support the organization of the workforce. The firm's productivity which leads to organization of workers at the margin – denoted by ϕ^- – is calculated by the intersection of w^c and the limit wage $\tilde{w}(\phi^-)$. Using (14) and (20), we obtain:

$$\phi^- = \rho \phi^+. \quad (22)$$

This leads to the following Lemma:

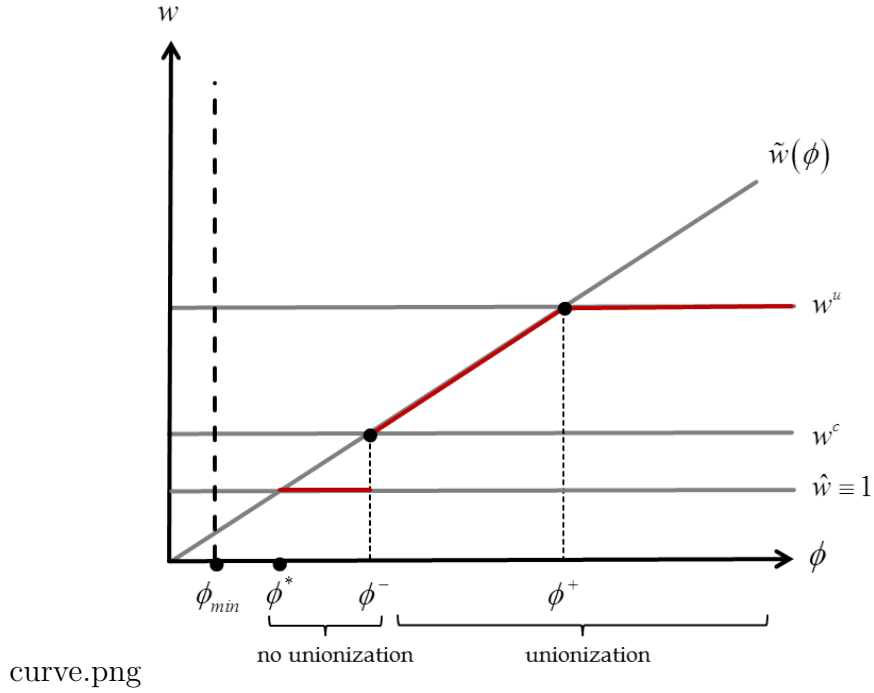
Lemma 2 (Union formation) *For $\phi < \phi^-$, the union leaves the market such that there is no unionization, while the workforce of firms with $\phi \geq \phi^-$ is organized by a union.*

Recall that firms produce if and only if $\phi \geq \phi^*$. Since the marginal firm with productivity ϕ^* has zero profits by definition, the union is not able to adopt (at least parts of) the marginal firm's profits to cover their costs. This implies that the marginal firm is not unionized, which results in the wage curve $w(\phi)$ illustrated in Figure 1 by the red line and summarized in the following Lemma.

Lemma 3 (Wage curve) *Firms with productivity*

- $\phi^* \leq \phi < \phi^-$ are not unionized and pay the competitive wage $w = 1$,
- $\phi^- \leq \phi < \phi^+$ are unionized and pay the limit wage $w = \tilde{w}(\phi)$,
- $\phi \geq \phi^+$ are unionized and pay the unconstrained wage $w = w^u$.

Figure 1: Wage curve



3.3 The Entrepreneur's Choices

Suppose that the entrepreneur has decided to enter the market, i.e. he invests F_e and receives productivity ϕ from the draw. As stated before, the

entrepreneur chooses to produce if and only if $\phi \geq \phi^*$. The cutoff productivity ϕ^* can be calculated by the zero-profits cutoff condition (ZPC): $\pi(\phi^*, 1) = 0$. Using (13), we can rewrite ZPC as:

$$(1 - \rho)r(\phi^*, 1) - F = 0. \quad (23)$$

The entrepreneur, however, will only enter the market if this would be profitable. This means that expected profits must be at least as high as the entry costs F_e . Due to free-entry, this holds by equality in the equilibrium, which leads to the free-entry condition (FE):

$$\int_{\phi^*}^{\infty} ((1 - \rho)r(\phi, w) - F) g(\phi) d\phi = F_e. \quad (24)$$

4 General Equilibrium

4.1 Aggregation

To determine the general equilibrium, we follow the approach commonly used in the literature and aggregate prices over productivities instead of over varieties. Taking into account that each firm produces one variety but that firms could have the same productivity, we can rewrite the CES price index (5) as:

$$P = M_e^{-\frac{1}{\sigma-1}} \left[\int_{\phi^*}^{\infty} p(\phi, w(\phi))^{-(\sigma-1)} g(\phi) d\phi \right]^{-\frac{1}{\sigma-1}}. \quad (25)$$

Income I consists of the wage income earned in the Y -sector, W_Y , and the wage income earned in the X -sector, W_X . Both are given by:

$$W_Y = L - L_X, \quad (26)$$

$$\begin{aligned} W_X = & M \int_{\phi^*}^{\phi^-} l(\phi) \mu(\phi) d\phi \\ & + M \left[\int_{\phi^-}^{\phi^+} \tilde{w}(\phi) l(\phi) \mu(\phi) d\phi + w^u \int_{\phi^+}^{\infty} l(\phi) \mu(\phi) d\phi - c \int_{\phi^-}^{\infty} l(\phi) \mu(\phi) d\phi \right], \end{aligned} \quad (27)$$

where L_X is the mass of workers employed in the X -sector and $\mu(\phi) = g(\phi)/(1 - G(\phi^*))$ denotes the distribution of productivities of active firms. Note that the first term of the RHS of (27) measures aggregate wage payments by firms that are not unionized, while the second term is the aggregate

wage payments of unionized firms net of the aggregate organization costs. Additionally, income is made up of aggregate profits in the X -sector, Π , less the aggregate payments for the (sunk) market entry costs. This leads to:

$$I = W_Y + W_X + \Pi - M_e F_e. \quad (28)$$

4.2 Cutoff Productivity and Mass of Entrants

In analogy to Melitz (2003), we can determine the cutoff productivity and the mass of entrants in the equilibrium by using the ZPC and FE conditions. Inserting (12) and (11) into the ZPC condition (23) and rearranging yield:

$$\phi^* = \frac{1}{\rho P} \left(\frac{\sigma F}{\nu} \right)^{\frac{1}{\sigma-1}}, \quad (29)$$

which implies that $\phi^+ = \rho^{-1}(1+c)\phi^*$ and $\phi^- = (1+c)\phi^*$ (see (20) and (22)). However, as shown by (25), P also depends on ϕ^* and M_e . Inserting the price index into (29) and solving the resulting expression with respect to M_e lead to:

$$M_e(\phi^*) = \frac{\nu}{\sigma F} A(\phi^*)^{-1}, \quad (30)$$

$$A(\phi^*) \equiv p(\phi^*)^{\sigma-1} \int_{\phi^*}^{\infty} p(\phi, w(\phi))^{-(\sigma-1)} g(\phi) d\phi. \quad (31)$$

Inserting (12) and (25) into the FE condition (24), we find:

$$M_e(\phi^*) = \frac{\nu}{\sigma} \frac{1}{F_e + (1 - G((\phi^*))) F}. \quad (32)$$

Thus, we can use (30) and (32) to determine the equilibrium cutoff productivity, $\bar{\phi}^*$, and obtain (see Appendix A.2 for the proof):

$$\bar{\phi}^*(c) = \phi_{min} \left[(\Gamma_1(c) + \Gamma_2(c)) \frac{F}{F_e} \right]^{\frac{1}{k}}, \quad (33)$$

$$\begin{aligned} \Gamma_1(c) &\equiv (w^c(c))^{-k} - \frac{k}{k-\xi} (w^c(c))^{-(k-\xi)}, \\ \Gamma_2(c) &\equiv \frac{\xi}{k-\xi} (1 + (w^u(c))^{-k}), \end{aligned} \quad (34)$$

with $\xi \equiv \sigma - 1$ and $k > \xi$. Note that if organization costs are zero, i.e. all firms in the X -sector are unionized, we have $w^c(c=0) = 1$ and $w^u(c=$

0) = ρ^{-1} . The equilibrium cutoff productivity is then given by: $\bar{\phi}^*(c=0) = \phi_{min}\rho[\xi F/(F_e(k-\xi))]^{1/k}$. If, in contrast, no firm is unionized, i.e. $c \rightarrow \infty$, w^c and w^u go to infinity as well and we find $\bar{\phi}^*(c \rightarrow \infty) = \rho^{-1}\bar{\phi}^*(c=0)$. The equilibrium mass of entrants, $\bar{M}_e(\bar{\phi}^*(c))$, follows directly from (32). Inserting this into $M = 1 - G(\phi^*)M_e$ pins down the equilibrium mass of active firms (and hence the mass of available varieties) as:

$$\bar{M}(c) = \frac{\nu}{c} \frac{1}{(1 - G(\bar{\phi}^*(c)))^{-1} F_e + F}. \quad (35)$$

4.3 Consumption and Welfare

Equilibrium consumption in the X -sector, \bar{X} , is given by (2) and depends negatively on the equilibrium price index, \bar{P} : $\bar{X} = \nu/\bar{P}$. The latter can be computed from (29):

$$\bar{P}(c) = \frac{1}{\rho\bar{\phi}^*(c)} \left(\frac{\sigma F}{\nu} \right)^{\frac{1}{\xi}}. \quad (36)$$

Equilibrium consumption in the Y -sector is determined by (3) and depends positively on equilibrium income, \bar{I} : $\bar{Y} = \bar{I} - \nu$. As shown in Appendix A.3, \bar{I} is given by:

$$\bar{I}(c) = L + \xi F \phi_{min}^k (\bar{\phi}^*(c))^{-k} \bar{M}_e(c) [\Upsilon_1(c) + \Upsilon_2(c)], \quad (37)$$

where Υ_1 and Υ_2 are defined in the Appendix. Note that $I(c \rightarrow \infty) = L$ holds, i.e. income is determined by the labor endowment if labor markets are perfectly competitive (see Melitz, 2003 for the same result).

Welfare is measured by the equilibrium utility level $W \equiv U(\bar{X}, \bar{Y})$ and can be written as:

$$W(c) = \nu \ln(\bar{X}(c)) + \bar{Y}(c) = \nu \ln \left(\frac{\nu}{\bar{P}(c)} \right) + \bar{I}(c) - \nu. \quad (38)$$

5 The Impact of Organization Costs

5.1 Analytical Solution

Suppose that organization costs c are increased, e.g. because the governments sets higher legal barriers to unionization.

Proposition 1 *The equilibrium cutoff productivity is u-shaped in organization costs, i.e. it is decreasing in c at zero and low organization costs, reaches a minimum at $c = c^{crit}$ and is increasing from there on.*

Proof 1 Differentiating $\bar{\phi}^*$ with respect to c (see Appendix A.4) yields

$$\frac{\partial \bar{\phi}^*}{\partial c} = \frac{1}{k} \frac{\bar{\phi}^*}{\Gamma_1 + \Gamma_2} \left[\underbrace{\frac{\partial \Gamma_1(w^c)}{\partial c}}_{>0} + \underbrace{\frac{\partial \Gamma_2(w^u)}{\partial c}}_{<0} \right]. \quad (39)$$

Using (34), we obtain:

$$\begin{aligned} \frac{\partial \bar{\phi}^*}{\partial c} \left\{ \begin{array}{l} < \\ \geq \end{array} \right\} 0 &\Leftrightarrow c \left\{ \begin{array}{l} < \\ \geq \end{array} \right\} c^{crit}, \\ c^{crit} &\equiv \left(1 + \frac{\xi \rho^k}{k - \xi} \right)^{\frac{1}{\xi}} - 1. \end{aligned}$$

There are two countervailing effects. First, an increase in c raises the minimum wage w^c for unionization. Holding everything else constant, this implies that a higher share of firms is not unionized such that more firms pay the competitive wage (instead of the union wage). Those firms can reduce their prices such that competition becomes more severe and the least productive firms are driven out of the market; $\bar{\phi}^*$ increases. Second, an increase in c raises the unconstrained wage set by the union. (High-productive) Firms that face this wage increase set higher prices such that competition becomes less intense and more firms with lower productivities are able to start production; $\bar{\phi}^*$ decreases. The second (first) effect dominates if organization costs are relatively low (high).

The u-shape relationship between the organization costs and the cutoff productivity has another implication. Looking at the two extreme scenarios ‘no unionization’ ($c \rightarrow \infty$) and ‘full unionization’ ($c = 0$), we find that both are conducive towards high cutoff productivity levels. In addition, we find:

Proposition 2 *The cutoff productivity in an industry with no unionization ($c \rightarrow \infty$) is higher than in an industry with full unionization ($c = 0$).*

Proof 2 Using (33), we obtain:

$$\frac{\bar{\phi}_{c \rightarrow \infty}^*}{\bar{\phi}_{c=0}^*} = \rho^{-1} > 1.$$

An increase in organization costs has also implications for the mass of entrants and the mass of available varieties:

Proposition 3 (i) *The equilibrium mass of entrants is u-shaped in organization costs. (ii) The equilibrium mass of available varieties is hump-shaped in organization costs, i.e. it is increasing in c at zero and low organization costs, reaches a maximum at $c = c_M^{crit}$ and is decreasing from there on.*

Proof 3 Using (32) and (35), we find:

$$\begin{aligned}\frac{\partial \bar{M}_e}{\partial c} &= \underbrace{\frac{\partial \bar{M}_e}{\partial \bar{\phi}^*}}_{>0} \frac{\partial \bar{\phi}^*}{\partial c}, \\ \frac{\partial \bar{M}}{\partial c} &= \underbrace{\frac{\partial \bar{M}}{\partial \bar{\phi}^*}}_{<0} \frac{\partial \bar{\phi}^*}{\partial c}.\end{aligned}$$

Together with Proposition 1, this proves the Proposition.

To gain an intuition, assume that the cutoff productivity increases. This raises expected profits such that the mass of entrepreneurs that enters the market increases. Therefore, there is a u-shape relationship between c and \bar{M}_e . With respect to the mass of active firms and hence available varieties \bar{M} , an increase in ϕ^* implies that more entrepreneurs enter the market but also that a lower fraction of those becomes active and starts producing. Analytically, we can show that the latter effect dominates such that the relation between the \bar{M} and c is hump-shaped.

Regarding the effects on consumption and welfare, we find:

Proposition 4 *The equilibrium consumption in the X-sector, \bar{X} , is u-shaped in organization costs.*

Proof 4 From (2) and (36), we obtain:

$$\frac{\partial \bar{X}}{\partial c} = \underbrace{\frac{\partial \bar{X}}{\partial \bar{P}}}_{<0} \underbrace{\frac{\partial \bar{P}}{\partial \bar{\phi}^*}}_{<0} \frac{\partial \bar{\phi}^*}{\partial c}.$$

Together with Proposition 1, this proves the Proposition.

Proposition 5 *The equilibrium consumption in the Y-sector, \bar{Y} , decreases in organization costs c if $c \geq c^{crit}$. Otherwise, the effect of c on \bar{Y} is ambiguous.*

Proof 5 see Appendix A.5

Proposition 6 *The effect of an increase in organization costs c on welfare W is ambiguous.*

Proof 6 *Differentiating (38) with respect to c leads to:*

$$\frac{\partial W}{\partial c} = \frac{\nu}{\bar{X}} \frac{\partial \bar{X}}{\partial c} + \frac{\partial \bar{Y}}{\partial c}.$$

Together with Propositions 4 and 5, this proves the Proposition.

Consumption in the X -sector varies with organization costs because they affect the cutoff productivity which in turn influence the price index. Intuitively, an increase in the cutoff productivity has two effects on \bar{P} . On the one hand, operating firms are on average more productive such that the price index decreases. On the other hand, the mass of available varieties decreases which raises the price index. Analytically, the former effect dominates such that an increase in the cutoff productivity reduces \bar{P} and hence raises \bar{X} . Consequently, the relation between \bar{X} and c is u-shaped. Note that an increase (decrease) in \bar{X} increases (decreases) welfare.

Consumption in the Y -sector is affected by changes in organization costs because they have an impact on equilibrium income. There are three effects. First, an increase in c , c.p., raises aggregate organization costs, which reduces wage payments in the X -sector and thus \bar{I} . Second, the share of unionized firms decreases which, c.p., also reduces wage payments in the X -sector and \bar{I} . Third, the unconstrained wage increases which has, c.p., a positive effect on \bar{I} . If $\bar{\phi}^*$ increases in c , the second effect dominates the third (see above) and equilibrium income as well as equilibrium consumption in the Y -sector unambiguously decrease. If, however, $\bar{\phi}^*$ decreases in c , the effect of an increase in c on \bar{I} and \bar{Y} is not clear-cut. Note that an increase (decrease) in \bar{Y} increases (decreases) welfare.

If organizations costs are relatively high, i.e. $c > c^{crit}$, there are two countervailing effects on welfare. On the one hand, an increase in c causes \bar{X} to rise which, c.p., increases welfare. On the other hand, consumption in the Y -sector declines because of reduced income which c.p. decreases welfare. If organization costs are relatively low, i.e. $c < c^{crit}$, consumption in the X -sector declines in c which c.p. reduces welfare. If income also declines, welfare would certainly be reduced through an increase in organization costs. If income rises, the effect is not clear-cut.

5.2 Numerical Solution

5.2.1 Calibration

The numerical solution of our model shows the quantitative importance of our results and, in particular, indicates which of the aforementioned countervailing effects dominate. We follow a frequently used approach and calibrate

our model with parameter values drawn from the literature. As such, our results are comparable with other studies that use the same parameter values.

Specifically, we take up the calibrations by Bernard et al. (2007) and Felbermayr et al. (2011) and set $F = 1.77$, $F_e = 39.57$, $\delta = 0.01$, $\sigma = 3.4$, $\phi_{min} = 1$ and $k = 3.4$. Note that these parameter values are for monthly time periods and based on the US economy. We normalize labor endowment and the relative size of the X -sector as follows: $L \equiv 1.5$ and $\nu \equiv 0.5$. The former ensures that $L_X < L$ such that there are labor units left to produce Y . The latter implies that the X -sector is relatively small compared to the Y -sector.

5.2.2 Results

As shown by Figure 2, an increase in c leads to the u-shape relationship between c and $\bar{\phi}^*$ respectively c and \bar{X} (see Propositions 1 and 4). In addition, we find that $c^{crit} = 0.42$. This implies that the equilibrium cutoff productivity and equilibrium consumption in the X -sector increase in c if $c > 0.42$.

In Figure 3, the effects of organization costs on equilibrium consumption of good Y and on welfare are illustrated. It is thus evidently that \bar{Y} decreases in c which is driven by the fact that income monotonously declines in c . This has, c.p., a welfare-reducing effect which turns out to be relatively strong for low values of organization costs. With respect to welfare, we find that W decreases for relatively low values of c because both \bar{Y} and \bar{X} decline. If $c > c_W^{crit} = 0.55$, welfare increases in c because the reduction of \bar{Y} is then overcompensated by the increase in \bar{X} .

To sum up, the numerical solution of our model provides evidence that an increase in c might reduce welfare (which could be against the goal of policy makers) but that this welfare-reducing effect only appears for relatively low values of organization costs.

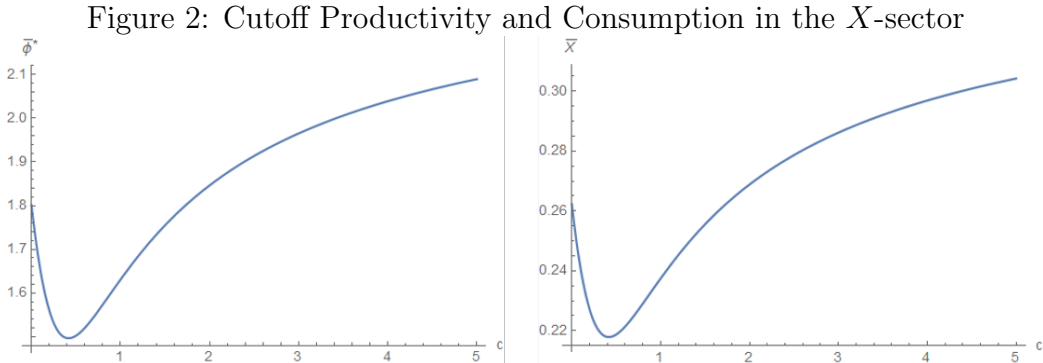
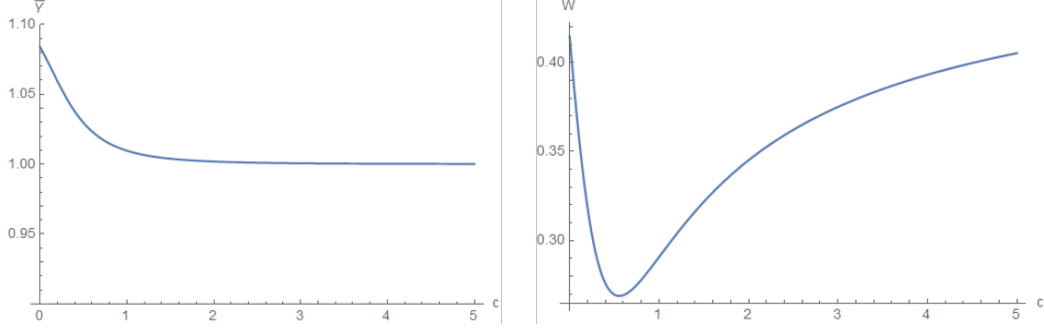


Figure 3: Consumption in the Y-sector and Welfare



5.2.3 Wage Inequality

With the calibrated model at hand, we can also analyze the effect of organization costs on wage inequality in the X -sector. We choose the Gini coefficient as the measure of wage inequality (see Egger and Kreickemeier, 2012, Helpman et al., 2010 for a similar approach). To determine the Gini coefficient, we at first calculate the Lorenz curve, which gives the share of wage income $Q(\theta)$ attributed to the bottom θ percent of employed workers in the X -sector. However, we have to take into account that wage payments are made by three different wage profiles: the least productive firms pay the competitive wage, intermediate productive firms pay the limit wage and the most productive firms pay the unconstrained wage. As done by Egger and Kreickemeier (2012), we thus divide the Lorenz curve into three segments.

The cumulative wage income of workers that are employed in firms with a productivity level $\check{\phi} \in [\phi^*, \phi^-)$ and the mass of workers employed in these firms are given by, respectively:

$$\check{W}_X^1(\check{\phi}) = M \int_{\phi^*}^{\check{\phi}} \hat{w}l(\phi)\mu(\phi)d\phi, \quad (40)$$

$$\check{L}_X^1(\check{\phi}) = M \int_{\phi^*}^{\check{\phi}} l(\phi)\mu(\phi)d\phi. \quad (41)$$

The share of workers that receives this income is defined as:

$$\theta(\check{\phi}) \equiv \frac{\check{L}_X^1(\check{\phi})}{L_X} \quad \text{if} \quad \check{\phi} \in [\phi^*, \phi^-). \quad (42)$$

By solving (42) with respect to $\check{\phi}$ and inserting the resulting expression into (40), we get rid of $\check{\phi}$ and can formulate the cumulative wage income as a

function of θ : $\check{W}_X^1 = \check{W}_X^1(\theta)$. The first segment of the Lorenz curve then reads:

$$Q^1(\theta) \equiv \frac{\check{W}_X^1(\theta)}{W_X}. \quad (43)$$

Note that the first segment ends at $\Theta^1 \equiv \theta(\phi^-)$ which implies $Q^1(\Theta^1) = W_X^1/W_X$, where W_X^1 denotes aggregate wage income of firms paying the competitive wage.

The cumulative wage income of workers that are employed in firms that pay the competitive wage and in firms with a productivity level $\check{\phi} \in [\phi^-, \phi^+]$ and the mass of workers employed in these firms are given by, respectively:

$$\check{W}_X^2(\check{\phi}) = W_X^1 + M \int_{\phi^-}^{\check{\phi}} \tilde{w}(\phi) l(\phi) \mu(\phi) d\phi, \quad (44)$$

$$\check{L}_X^2(\check{\phi}) = L_X^1 + M \int_{\phi^-}^{\check{\phi}} l(\phi) \mu(\phi) d\phi. \quad (45)$$

The share of workers that receives this income is defined as:

$$\theta(\check{\phi}) \equiv \frac{\check{L}_X^2(\check{\phi})}{L_X} \quad \text{if} \quad \check{\phi} \in [\phi^-, \phi^+]. \quad (46)$$

Solving (46) with respect to $\check{\phi}$ and inserting the resulting expression into (44) implies: $\check{W}_X^2 = \check{W}_X^2(\theta)$. The second segment of the Lorenz curve then reads:

$$Q^2(\theta) \equiv \frac{\check{W}_X^2(\theta)}{W_X}. \quad (47)$$

The boundary of this segment is located at $\Theta^2 \equiv \theta(\phi^+)$ which implies $Q^2(\Theta^2) = (W_X^1 + W_X^2)/W_X$, where W_X^2 denotes aggregate wage income of firms paying the limit wage.

The cumulative wage income of workers that are employed in firms that pay the competitive wage as well as the limit wage and in firms with a productivity level $\check{\phi} \in [\phi^+, \infty]$ and the mass of workers employed in these firms are given by, respectively:

$$\check{W}_X^3(\check{\phi}) = W_X^1 + W_X^2 + M \int_{\phi^+}^{\check{\phi}} w^u l(\phi) \mu(\phi) d\phi, \quad (48)$$

$$\check{L}_X^3(\check{\phi}) = L_X^1 + L_X^2 + M \int_{\phi^+}^{\check{\phi}} l(\phi) \mu(\phi) d\phi. \quad (49)$$

The share of workers that receives this income is defined as:

$$\theta(\check{\phi}) \equiv \frac{\check{L}_X^3(\check{\phi})}{L_X} \quad \text{if} \quad \check{\phi} \in [\phi^+, \infty]. \quad (50)$$

Solving (50) with respect to $\check{\phi}$ and inserting the resulting expression into (48) implies: $\check{W}_X^3 = \check{W}_X^3(\theta)$. This yields:

$$Q^3(\theta) \equiv \frac{\check{W}_X^3(\theta)}{W_X}. \quad (51)$$

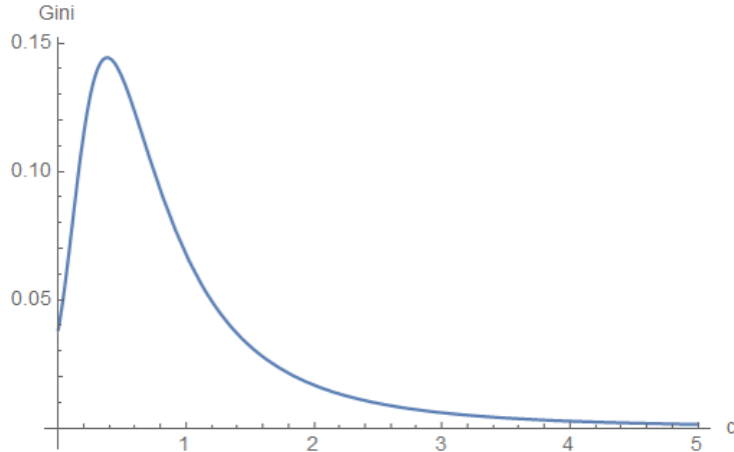
Note that $\theta(\check{\phi} \rightarrow \infty) = 1$ and $Q^3(1) = 1$ hold.

The Gini coefficient is given by:

$$Gini \equiv 1 - 2 \left(\int_0^{\Theta_1} Q^1(\theta) d\theta + \int_{\Theta_1}^{\Theta_2} Q^2(\theta) d\theta + \int_{\Theta_2}^1 Q^3(\theta) d\theta \right),$$

with $Gini \in [0, 1]$. The higher the Gini coefficient the more unequal the wage distribution is. In Figure 4, we present the numerical computation of the Gini coefficient for different values of organization costs.

Figure 4: Wage Inequality in the X -sector



As a result, there is a hump-shaped relationship between the Gini coefficient and c with a maximum at $c_{Gini}^{crit} = 0.38$. Starting at a point where all firms are unionized ($s = 0$), an increase in organization costs implies that high-productive firms have to pay higher wages (the unconstrained wage increases), while some low-productive firms are not unionized and can reduce their wage payments. The (limit) wage paid by intermediate productive firms is not affected. Consequently, wage inequality rises. With further increases in organization costs, more and more firms are not unionized and pay the competitive wage, while only few firms pay the limit wage and even fewer the (relatively high) unconstrained wage. This makes the wage distribution more equal. If organization costs go to infinity, all firms pay the competitive wage and wage inequality vanishes.

6 Summary

In this paper, we analyze how an increase in organization costs affect the distribution of firms within an industry, sectoral wage inequality and welfare. Our theoretical framework combines the Melitz (2003) model with heterogeneous firms, monopolistic competition and free market entry/exit with labor unions that set wages at the firm-level. Because organizing the firms' workforces is associated with organization costs, unionization is an endogenous outcome. Similar to Kuhn (1998), we find that only sufficiently productive firms are unionized while low-productive firms pay the competitive wage.

As our main results, we find that the relationship between the cutoff productivity and organization costs is u-shaped and that the relationship between sectoral wage inequality and organization costs is hump-shaped. If organization costs are relatively low at the outset, i.e. a relatively large number of firms is unionized, an increase of these costs imply that many (unionized) firms have to increase their wage payments while only a few (low-productive) firms are not unionized and can pay the competitive wage instead of the wage set by the union. As such, wages and prices (on average) increase, competition becomes less intense and more low-productive firms can survive at the market. This implies also that wage inequality rises. With further increases in organization costs, the number of firms paying the high unconstrained wage decreases while there are more and more firms for which the workforce is not unionized (because of too high costs) and that pay the competitive wage. This reduces wage inequality as well as wages and prices on average. Competition becomes more severe and less low-productive firms are active at the market.

Welfare, measured by the equilibrium consumption of the differentiated good and the homogenous good, can also decrease in organization costs. This is caused by two effects. First, income and thus the consumption of the homogenous good monotonously decrease in organization costs. Second, if organization costs are low, the reduced cutoff productivity implies that firms are on average less productive which raises the price index and thus reduces consumption of the differentiated good. Only if organization costs are sufficiently high, is there a welfare-enhancing effect of lower unionization due to the implied (strong) increase in the cutoff productivity and thus the (strong) increase in consumption of the differentiated good.

From a policy perspective, these results should be taken into account when deciding about a change in the legal barriers to unionization. Making the labor market more competitive by restricting unionization, as frequently observable in the developed countries, can but not necessarily have to be an improvement of economic performance in terms of sectoral wage inequality

and welfare.

A Appendix

A.1 Shadow Value of the Wage Constraint

Observing (19), we find that $\eta > 0$ if and only if:

$$\begin{aligned} 1 - \sigma \frac{\tilde{w}(\phi) - 1 - c}{\tilde{w}(\phi)} &> 0 \\ \Leftrightarrow \tilde{w}(\phi) &< \frac{\sigma}{\sigma - 1}(1 + c) = \frac{1}{\rho}(1 + c). \end{aligned}$$

Given the unconstrained wage (18), this condition holds in case of $\tilde{w}(\phi) < w^u$ and thus as long as the wage constraint is binding.

To determine the slope of the shadow value in the (ϕ, η) -space, we first use $\pi(\phi, \tilde{w}(\phi)) = 0$ and (13) to compute:

$$l(\phi, \tilde{w}(\phi)) = \frac{(\sigma - 1)F}{\tilde{w}(\phi)}. \quad (\text{A-1})$$

Inserting (A-1) into (19), we can rewrite the shadow value as:

$$\eta(\phi) = (\sigma - 1)F \left[\frac{(1 + c)\sigma}{\tilde{w}(\phi)^2} - \frac{\sigma - 1}{\tilde{w}(\phi)} \right]. \quad (\text{A-2})$$

Differentiating (A-2) with respect to ϕ leads to:

$$\frac{\partial \eta}{\partial \phi} = \left(\frac{\sigma - 1}{\tilde{w}(\phi)} \right)^2 F \underbrace{\frac{\partial \tilde{w}(\phi)}{\partial \phi}}_{>0} \underbrace{\left[1 - 2 \underbrace{\frac{w^u}{\tilde{w}(\phi)}}_{>1} \right]}_{<0} < 0$$

if $\tilde{w}(\phi) < w^u$, i.e. in case the wage constraint is binding.

A.2 Equilibrium Cutoff Productivity

Using (30) and (32), we can determine the equilibrium cutoff productivity as the solution of:

$$A(\phi^*) = \frac{F_e}{F} + (1 - G(\phi^*)). \quad (\text{A-3})$$

Due to the pricing rule (11), the definition of A can be rewritten as:

$$A = p(\phi^*)^\xi \left[\int_{\phi^*}^{\phi^-} p(\phi)^{-\xi} g(\phi) d\phi + \int_{\phi^-}^{\phi^+} p(\phi, \tilde{w}(\phi))^{-\xi} g(\phi) d\phi + \int_{\phi^+}^{\infty} p(\phi, w^u)^{-\xi} g(\phi) d\phi \right],$$

$$A = (\phi^*)^{-\xi} \left[\int_{\phi^*}^{\phi^-} \phi^\xi g(\phi) d\phi + \int_{\phi^-}^{\phi^+} \left(\frac{\tilde{w}(\phi)}{\phi} \right)^{-\xi} g(\phi) d\phi + (w^u)^{-\xi} \int_{\phi^+}^{\infty} \phi^\xi g(\phi) d\phi \right].$$

Using (14) and (29), we obtain: $\tilde{w}/\phi = 1/\phi^*$. This leads to:

$$A = (\phi^*)^{-\xi} \left[\int_{\phi^*}^{\phi^-} \phi^\xi g(\phi) d\phi + (\phi^*)^\xi \int_{\phi^-}^{\phi^+} g(\phi) d\phi + (w^u)^{-\xi} \int_{\phi^+}^{\infty} \phi^\xi g(\phi) d\phi \right]. \quad (\text{A-4})$$

Noting $\phi^+ = w^u \phi^*$ as well as $\phi^- = w^c \phi^*$, we can solve the integrals and obtain:

$$\int_{\phi^*}^{\phi^-} \phi^\xi g(\phi) d\phi = \frac{k}{k-\xi} \phi_{min}^k (\phi^*)^{-(k-\xi)} (1 - (w^c)^{-(k-\xi)}),$$

$$\int_{\phi^-}^{\phi^+} g(\phi) d\phi = \phi_{min}^k (\phi^*)^{-k} [(w^c)^{-k} - (w^u)^{-k}],$$

$$\int_{\phi^+}^{\infty} \phi^\xi g(\phi) d\phi = \frac{k}{k-\xi} \phi_{min}^k (w^u \phi^*)^{-(k-\xi)}.$$

Inserting these expressions into (A-4), we find after some rearrangements:

$$A = \phi_{min}^k (\phi^*)^{-k} \left[(w^c)^{-k} - \frac{k}{k-\xi} (w^c)^{-(k-\xi)} + \frac{\xi}{k-\xi} (w^u)^{-k} + \frac{k}{k-\xi} \right]. \quad (\text{A-5})$$

Combining (A-5) and (A-3) leads to the equilibrium cutoff productivity as given by (33).

A.3 Equilibrium Income

Recall that income is defined by:

$$I = (L - L_X) + W_X + \Pi - M_e F_e \quad (\text{A-6})$$

Due to free entry, aggregate profits are equal to the sum of market entry costs in the equilibrium. Thus, we obtain $I = (L - L_X) + W_X$. The mass of workers that are employed in the X -sector is defined as:

$$L_X = M \int_{\phi^*}^{\infty} l(\phi) \mu(\phi) d\phi. \quad (\text{A-7})$$

Inserting (A-7) and (27) into the income definition, we find after some rearrangements:

$$I = L + M \left[\int_{\phi^-}^{\phi^+} \tilde{w}(\phi) l(\phi) \mu(\phi) d\phi + w^u \int_{\phi^+}^{\infty} l(\phi) \mu(\phi) d\phi \right] - (1+c)M \int_{\phi^-}^{\infty} l(\phi) \mu(\phi) d\phi.$$

Using $M\mu(\phi) = M_e g(\phi)$, we can rewrite the last expression as:

$$\begin{aligned} I &= L + M_e(\Delta_1 + \Delta_2), \\ \Delta_1 &\equiv \int_{\phi^-}^{\phi^+} \tilde{w}(\phi) l(\phi) g(\phi) d\phi - (1+c) \int_{\phi^-}^{\phi^+} l(\phi) g(\phi) d\phi, \\ \Delta_2 &\equiv w^u \int_{\phi^+}^{\infty} l(\phi) g(\phi) d\phi - (1+c) \int_{\phi^+}^{\infty} l(\phi) g(\phi) d\phi. \end{aligned}$$

Note that if $c \rightarrow \infty$, i.e. no firm is unionized, Δ_1 and Δ_2 are equal to zero and we find that $I(c \rightarrow \infty) = L$.

Next, recall that employment is given by: $l(\phi, w) = \nu \phi^{-1} p(\phi, w)^{-\sigma} P^\xi$. Inserting (11) and (36), we obtain: $l(\phi, w) = \xi F w^{-\sigma} \phi^\xi (\phi^*)^{-\xi}$. Inserting this into the last expression as well as using $\tilde{w}(\phi) = \phi/\phi^*$, (18) and (21) imply:

$$\begin{aligned} \Delta_1 &= \xi F \left[\int_{\phi^-}^{\phi^+} g(\phi) d\phi - w^c \phi^* \int_{\phi^-}^{\phi^+} \phi^{-1} g(\phi) d\phi \right], \\ \Delta_2 &= \xi F (1-\rho) (w^u)^{-\xi} (\phi^*)^{-\xi} \int_{\phi^+}^{\infty} \phi^\xi g(\phi) d\phi. \end{aligned}$$

Noting $\phi^+ = w^u \phi^*$ as well as $\phi^- = w^c \phi^*$, we can solve the integrals and obtain:

$$\begin{aligned} \int_{\phi^-}^{\phi^+} g(\phi) d\phi &= \phi_{min}^k (\phi^*)^{-k} [(w^c)^{-k} - (w^u)^{-k}], \\ \int_{\phi^-}^{\phi^+} \phi^{-1} g(\phi) d\phi &= \frac{k}{k+1} \phi_{min}^k (\phi^*)^{-(k+1)} [(w^c)^{-(k+1)} - (w^u)^{-(k+1)}], \\ \int_{\phi^+}^{\infty} \phi^\xi g(\phi) d\phi &= \frac{k}{k-\xi} \phi_{min}^k (w^u \phi^*)^{-(k-\xi)}. \end{aligned}$$

This finally leads to:

$$\Delta_1(c) = \xi F \phi_{min}^k (\phi^*)^{-k} \Upsilon_1(c), \quad (\text{A-8})$$

$$\Delta_2(c) = \xi F \phi_{min}^k (\phi^*)^{-k} \Upsilon_2(c), \quad (\text{A-9})$$

with

$$\Upsilon_1(c) = \frac{1}{k+1} (w^c(c))^{-k} - (w^u(c))^{-k} + \frac{k}{k+1} w^c(c) (w^u(c))^{-(k+1)}, \quad (\text{A-10})$$

$$\Upsilon_2(c) = \frac{(1-\rho)k}{k-\xi} (w^u(c))^{-k}, \quad (\text{A-11})$$

which proves that income is given by (37) in the main text.

A.4 Proof of Proposition 1

Differentiating $\bar{\phi}^*$ with respect to c yields

$$\frac{\partial \bar{\phi}^*}{\partial c} = \frac{1}{k} \frac{\bar{\phi}^*}{\Gamma_1 + \Gamma_2} \left[\frac{\partial \Gamma_1}{\partial c} + \frac{\partial \Gamma_2}{\partial c} \right]. \quad (\text{A-12})$$

Using (34), we obtain:

$$\begin{aligned} \frac{\partial \Gamma_1}{\partial c} &= k \underbrace{[(w^c)^\xi - 1]}_{>0} (w^c)^{-k-1} > 0, \\ \frac{\partial \Gamma_2}{\partial c} &= -\frac{k\xi\rho^{-1}}{k-\xi} (w^u)^{-k-1} < 0. \end{aligned}$$

Inserting these expressions into (A-12) shows that:

$$\text{sign} \left[\frac{\partial \bar{\phi}^*}{\partial c} \right] = \text{sign} \left[(1+c)^\xi - \left(1 + \frac{\xi\rho^k}{k-\xi} \right) \right].$$

This pins down the critical level of organization costs, c^{crit} , and thus proves Proposition 1.

A.5 Proof of Proposition 5

Due to (3), equilibrium consumption in the Y -sector is determined by equilibrium income \bar{I} . Inserting (32) into (37) and using the Pareto distribution, we can rewrite equilibrium income as:

$$\bar{I}(c) = L + \rho\nu B(\bar{\phi}^*(c)) [\Upsilon_1(c) + \Upsilon_2(c)], \quad (\text{A-13})$$

$$B(\bar{\phi}^*(c)) \equiv \left(1 + (\bar{\phi}^*(c))^k \frac{F_e}{\phi_{min}^k F} \right)^{-1}. \quad (\text{A-14})$$

From (A-14), (A-10) and (A-11), we obtain:

$$\begin{aligned}\frac{\partial B}{\partial c} &= \underbrace{\frac{\partial B}{\partial \bar{\phi}^*}}_{<0} \frac{\partial \bar{\phi}^*}{\partial c}, \\ \frac{\partial \Upsilon_1}{\partial c} &= (w^u)^{-(k+1)} \left[k(\rho^{-1} - 1) - \frac{k}{k+1}(\rho^{-(k+1)} - 1) \right], \\ \frac{\partial \Upsilon_2}{\partial c} &= -(w^u)^{-(k+1)} k(\rho^{-1} - 1) \frac{k}{k-\xi}.\end{aligned}$$

Combing the last two equations yields:

$$\frac{\partial \Upsilon_1}{\partial c} + \frac{\partial \Upsilon_2}{\partial c} = -(w^u)^{-(k+1)} k \left[\frac{\xi}{k-\xi}(\rho^{-1} - 1) + \frac{1}{k+1}(\rho^{-(k+1)} - 1) \right] < 0.$$

Differentiating (A-13) with respect to c thus leads to:

$$\frac{\partial \bar{I}}{\partial c} = \rho\nu \underbrace{\frac{\partial B}{\partial \bar{\phi}^*}}_{<0} \frac{\partial \bar{\phi}^*}{\partial c} [\Upsilon_1(c) + \Upsilon_2(c)] + \rho\nu \underbrace{\left[\frac{\partial \Upsilon_1}{\partial c} + \frac{\partial \Upsilon_2}{\partial c} \right]}_{<0}. \quad (\text{A-15})$$

Using Proposition 1 and (A-15), we find that equilibrium income decreases in c if $c \geq c^{crit}$ because $\partial \bar{\phi}^*/\partial c \geq 0$ holds, whereas the effect is ambiguous if $c < c^{crit}$ because $\partial \bar{\phi}^*/\partial c < 0$ is then true. This proves the Proposition 5.

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