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Marco de Pinto and Jochen Michaelis

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Marco de Pinto[†]

IAAEU Trier and Trier University

Jochen Michaelis[‡]

University of Kassel

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Abstract

Empirical evidence suggests that high-productivity firms face stronger trade unions than low-productivity firms. Then a policy that puts all unions into a better bargaining position is no longer neutral for firm selection as in models with a uniform bargaining strength across firms. Using a Melitz-type model, we show that firm selection becomes less severe. Since more low-productivity firms enter the market, the negative employment effect of unionization is mitigated. Neglecting inter-union differences in bargaining power leads to an overestimation of the negative labor market effects. However, trade liberalization increases unemployment because firms with the least powerful labor unions have to leave the market.

Keywords: Trade Unions, Bargaining Power,
  Firm Heterogeneity, International Trade, Unemployment

JEL Classification: F 1, F 16, J 5

1   Introduction

The wage bargaining power of trade unions differs across both countries and firms/ sectors. The cross-country variability of unions' bargaining strength is commonly attributed to different wage setting institutions, labor laws and other policy parameters set at the national level (see Manning, 2011). But about of equal size is the cross-sector variability of the bargaining strength within a country, see Table 1. These differentials may be caused by sectoral unemployment rates (Svejnar, 1986), the sector-specific impact of the globalization process (Brock and Dobbelaere, 2006), and/or firm productivity (Dinlersoz et al., 2017). The empirical finding of union heterogeneity suggests that the impact of trade unions on wages, employment and output is sector-specific, too. Using a Melitz (2003) type model, this paper shows how differences in the union bargaining power create a link between unionization and firm selection and how the partial equilibrium effects carry over to the aggregate level.

Table 1: Variability of Union Bargaining Power

Study	Country	Time	Bargaining Power	
			γ_{min}	γ_{max}
Svejnar (1986)	US	$1955 - 1979$	0.06	0.72
Veugelers (1989)	Belgium	1978	0.03	0.50
Brock and Dobbelaere (2006)	Belgium	$1987 - 1995$	0.00	0.31
Moreno and Rodríguez (2011)	Spain	$1990 - 2005$	0.00	0.42
Boulhol et al. (2011)	UK	$1988 - 2003$	0.19	0.56
Amador and Soares (2017)	Portugal	$2006 - 2009$	0.00	0.30
	Belgium		0.40	0.65
	France		0.60	0.75
Dumont et al. (2006)	Germany	$1994 - 1998$	0.46	0.70
	Italy		0.20	0.32
	UK		0.37	0.52

Notes: Most of the studies use data of the manufacturing industries. Exceptions are Veugelers (1989) and Amador and Soares (2017). The former compares 30 different sectors, while the latter includes a sector of non-tradables. Higher values of $\gamma \in [0, 1]$ indicate higher bargaining power. γ_{min} refers to the lowest level of bargaining power, while γ_{max} denotes the highest level. Dumont et al. (2006) use the firm's value added as proxy for rents, whereas others use the firm's revenue. This explains the higher levels of estimated bargaining power in their study.

Our framework picks up the observation that union activity is unevenly distributed across firms. For the United States, Dinlersoz et al. (2017) show that union activity is concentrated in large and productive establishments. High-productivity

firms are high rent firms and high rents incentivize unions to organize the workforce. Farber (2015) gets a very similar result. Changes in the National Labor Relations Act in the late 1990s have forced US unions to cut back their activities particularly in small and less productive plants. Using French data, Breda (2015) establishes that high rent firms face stronger trade unions, these firms pay higher union wages. These insights motivate our key assumption: we split the unions' bargaining power coefficient into two parts. The first part is uniform across all unions and captures the policy parameters set at the national level. The second part is firm-specific, and we assume that the union's bargaining coefficient is increasing with firm productivity, so that large and productive firms face stronger trade unions than small and less productive ones.[1]

Our focus will be on two issues. First, we investigate the employment effects of a symmetric increase in the unions' bargaining power. More restrictive rules for a lockout or the decisions of the US National Labor Relations Board in the 2010s to ease the union election process may serve as examples. Textbook models predict higher wages, lower employment and lower output. Our model confirms these results, but argues that repercussions from firm selection and export selection change the quantitative importance of these effects significantly. Second, we consider a liberalization of trade and re-assess its effects on equilibrium unemployment.

Suppose that all unions became more powerful so that wages rise. This has two countervailing effects on firm selection. Because of a higher wage bill, firms' profits decline and the cutoff productivity increases. But, given the decline in profits, the mass of firms entering the market decreases. Competition becomes less intense, profits of the incumbents rise and the cutoff productivity decreases. If all unions in the economy were equally powerful, the two effects would offset each other. If, however, the unions' bargaining power depends positively on firm productivity, the reduction of profits is less pronounced in low-productivity firms. The latter effect then dominates, firm selection becomes less intense, more low-productivity firms

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[1]In a globalized world, a subset of (high-productivity) firms may improve their threat point in the wage bargain via international offshoring (see, for instance, Zhao, 1998, or Egger and Kreickemeier, 2009). This would imply that unions in high-productivity firms have lower bargaining power. We discuss this issue and possible implications in Section 5.

enter the market, these firms increase labor demand thereby mitigating the negative employment effect of unionization. Neglecting union heterogeneity thus leads to an overestimation of the negative employment effect of unionization. A baseline calibration of our model indicates that a 10% increase in the union bargaining power increases the unemployment rate by about 8.6% in the case of a uniform bargaining power and about 7.9% in the case of union heterogeneity.[2] On the other hand, neglecting union heterogeneity leads to an underestimation of the negative output effect. The decline in the average productivity of active firms dominates the positive output effect of the new low-productivity firms.

If trade is liberalized, we find, as in Melitz (2003), that firm selection becomes more severe. The least productive firms with the least powerful trade unions have to leave the market. As a consequence, unions become more powerful on average and set higher wages. This effect causes the unemployment rate to rise, which shows that trade unions are not neutral for the employment effects of trade. Such a conclusion cannot be made without union heterogeneity, as we discuss further below. Despite the decline in employment, trade liberalization raises output, the increase in the average productivity dominates.

Only very few studies examine the link between unionization and firm selection. Most closely related to our approach is Montagna and Nocco (2013). They assume that high-productivity firms face lower price elasticities of product demand, these firms enjoy higher monopoly profits and offer higher wages. In this setting, an increase in the unions' bargaining power reduces firm selection but increases export selection. In a related paper, Montagna and Nocco (2015) consider a two-country model where the unions' bargaining power differs across countries but is identical within a country. An increase in the domestic unions' bargaining power reduces firm selection and increases export selection, too. In contrast to these studies, we get the result that a shift towards more powerful trade unions has an ambiguous effect on export selection.[3] Moreover, we extend these studies by analyzing the employment

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[2]This result is robust to alternative specifications of the bargaining strength across firms. In particular, we get the same result even if the bargaining strength is decreasing with firm productivity.

[3]Note that two further mechanisms establish a link between unionization and firm-selection,

effects of such a shift and by investigating the role of union heterogeneity for the employment effects of trade liberalization.

In this respect, our study is related to two further strands of literature. First, there is a bulk of papers investigating the relationship between bargaining power and unemployment. This has also been done in models which explicitly take firm heterogeneity into account, as, for instance, in Eckel and Egger (2017), Eckel and Egger (2009) and de Pinto and Michaelis (2016). These papers find that more powerful trade unions lead to a rise in unemployment, but since they all assume uniform bargaining strength across firms, all these studies overestimate the negative employment effect of unionization. Second, there is a lively debate on the employment effect of trade liberalization. The last cited studies find that trade liberalization is neutral for aggregate employment. Egger and Kreickemeier (2009), however, find a negative impact on employment in the presence of fair-wage preferences, while Helpman and Itskhoki (2010) derive a positive employment effect in a model with search and matching frictions. As mentioned above, our model of union heterogeneity predicts a negative employment effect, which shows that also collective bargaining (in the presence of union heterogeneity) plays a role for the employment effects of trade.

The remainder of the present paper is structured as follows. In Section 2, we describe the set-up of the model, which we solve in Section 3. The impact of more powerful trade unions and trade liberalization is analyzed in Section 4. Section 5 provides a discussion, Section 6 concludes.

2 Model

2.1 Production

We consider an open economy model with two symmetric countries. There is a final good Y which is sold under conditions of perfect competition and defined as a

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namely a variation of the level of the wage bargain (see Braun, 2011 and de Pinto, 2017) and the incorporation of unionization costs (see de Pinto and Lingens, 2017).

CES-aggregator over all available intermediate goods:

$$Y = M_t^{-\frac{1}{\sigma-1}} \left[\int_0^M q(\omega)^\rho d\omega + \int_0^{M_{im}} q_{im}(\nu)^\rho d\nu \right]^{\frac{1}{\rho}}. \tag{1}$$

M (M_{im}) denotes the mass of varieties produced in the home (foreign) country. The mass of all available varieties is given by $M_t = M + M_{im}$. $q(\omega)$ represents the used quantity of variety ω, while $q_{im}(\nu)$ stands for the imported quantity of variety ν, which is produced in the foreign country. $\rho \equiv \sigma/(\sigma - 1)$ measures love of variety, where $\sigma > 1$ equals the elasticity of substitution between any two varieties. We choose Y as the numeraire and normalize the corresponding CES price index P at unity.

Intermediate goods are sold under conditions of monopolistic competition. To enter the market, firms have to bear fixed costs F_e (measured in units of the final good). After entry, firms draw a productivity level from a Pareto distribution with $G(\phi) = 1 - (1/\phi)^k$ and $g(\phi) = k\phi^{-k-1}$ and the support $\phi \in [1, \infty]$, where k denotes the shape parameter of the distribution. Firms can either produce only for the domestic market or serve the home and foreign market. Production for the domestic market is given by $q = \phi h$, with h denoting employment. Production for the export market (indexed by x) is associated with iceberg transport costs $\tau \geq 1$: $q_x = \tau^{-1}\phi h_x$. Total output and employment are given by, respectively, $q_t = q + Iq_x$ and $h_t = h + Ih_x$, where I is an indicator variable which equals one, if firms export, and zero otherwise.

Both the production for the domestic and export market require (overhead) fixed costs F and F_x (measured in units of the final good). Profits from domestic and export sales are given by:

$$\pi = \left(p - \frac{w}{\phi} \right) q - F, \tag{2}$$

$$\pi_x = \left(p_x - \frac{\tau w}{\phi} \right) q_x - F_x, \tag{3}$$

respectively, with p (p_x) denoting the price for the variety that is sold in the domestic

(export) market and w representing the wage rate. We assume that all employees of a firm receive the wage w, i.e. we do not allow wage differentiation within firms. Total profits read $\pi_t = \pi + I\pi_x$. Note that each firm produces one variety of the intermediate good.

2.2 Trade Unions

Both countries are endowed with a mass of identical workers L. Workers inelastically supply one unit of labor and are internationally immobile. Abstracting from the existence of unemployment benefits, the expected income is given by $b = (1-u)w^e$, where u denotes the unemployment rate and w^e is the workers' expected wage rate.

Labor markets are unionized, unions are organized at firm-level. Workers who are hired by a particular firm must become a member of the respective union.[4] The union utility function reads:

$$U = h_t(w - b). \tag{4}$$

There is a Nash-bargain over w between the firm-specific union and the firm, while the firm has the right to manage employment. The Nash-product is defined as $NP = (U - \overline{U})^\gamma (\pi_t - \overline{\pi}_t)^{1-\gamma}$, where $\gamma \in [0,1]$ denotes the union's bargaining power, $\overline{\pi}_t = -F - IF_x$ is the firm's and $\overline{U} = 0$ is the union's outside option.[5]

To capture union heterogeneity, the bargaining power coefficient is assumed to depend on an economy-wide and a firm-specific variable:

$$\gamma = \gamma(\overline{\gamma}, \phi). \tag{5}$$

The parameter $\overline{\gamma}$ is uniform across all unions and captures the policy parameters set at national level, we assume $d\gamma(\overline{\gamma}, \phi)/d\overline{\gamma} \equiv \gamma_{\overline{\gamma}} > 0$. If, for example, policy makers ban a lockout, all unions become more powerful, $\overline{\gamma}$ increases. For the modeling of the firm-specific part, we pick up the empirical findings by Boulhol et al. (2011), Breda

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[4]If a worker loses a job at one particular firm, s/he also leaves the union and applies for jobs elsewhere. If the worker finds a new job, s/he has to join the corresponding firm-level union.

[5]If the bargain fails, workers are allowed to leave the union and to search for a job elsewhere, implying zero utility for the union.

(2015), Farber (2015) and Dinlersoz et al. (2017) and assume that the bargaining coefficient depends positively on firm productivity ϕ, i.e. $d\gamma(\overline{\gamma}, \phi)/d\phi \equiv \gamma_\phi > 0$.[6]

The elasticity of the bargaining power with respect to firm productivity, $\epsilon_{\gamma\phi} \equiv d\gamma/d\phi \cdot \phi/\gamma$, is positive. To ensure an inner solution, we assume $\epsilon_{\gamma\phi} \leq 1$. Moreover, the cross derivative $\gamma_{\phi\overline{\gamma}} \equiv d\gamma_\phi/d\overline{\gamma}$ is assumed to be positive, i.e. a given increase in $\overline{\gamma}$ is more severe for high-productivity firms. For $\gamma_\phi = 0$, our model collapses to the benchmark case in the literature where inter-firm differences in the bargaining strength are not taken into account.

2.3   Timing

The timing of events is as follows:

1. Firms decide about market entry, i.e. paying the entry costs F_e and drawing a productivity level. After entry, firms decide whether to produce for the domestic market, to serve additionally the foreign market or to leave the market without production.

2. Unions and firms Nash-bargain over wages.

3. Firms decide about employment (which is equivalent to the choice of the profit-maximizing price).

4. The final goods are produced.

This four-stage game is solved by backwards induction, where macroeconomic variables are taken as given.

3   Equilibrium

3.1   Product and Labor Demand

The final goods producers maximize profits by choosing $q(\omega)$ and $q_{im}(\nu)$ subject to $PY = \int_0^M q(\omega)p(\omega)d\omega + \int_0^{M_{im}} q_{im}(\nu)p_{im}(\nu)d\nu$. Demand for home and foreign

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[6]In Section 5, we consider a scenario with $\gamma_\phi < 0$.

varieties are given by:

$$q(\omega) = p(\omega)^{-\sigma} \frac{Y}{M_t}, \tag{6}$$

$$q_{im}(\nu) = p_{im}(\nu)^{-\sigma} \frac{Y}{M_t}, \tag{7}$$

where Y/M_t denotes the market share.

Next, consider a firm which produces variety ω and has drawn the productivity ϕ. Note that, due to the assumption of symmetric countries, $q_x = q_{im}$ holds. Maximizing profits over p subject to (6) and (7) yields:

$$p(\phi) = \frac{1}{\rho} \frac{w}{\phi} \qquad \text{and} \qquad p_x(\phi) = \tau p(\phi). \tag{8}$$

Due to the CES assumption, profit-maximizing prices are a constant markup over (firm-specific) variable costs.

Inserting (8) into the demand functions yields the profit-maximizing output. Combining output with the production function yields labor demand. These are given by:

$$q(\phi) = p(\phi)^{-\sigma} \frac{Y}{M_t} \qquad \text{and} \qquad q_x(\phi) = \tau^{-\sigma} q(\phi), \tag{9}$$

$$h(\phi) = \frac{q(\phi)}{\phi} \qquad \text{and} \qquad h_x(\phi) = \tau^{-(\sigma-1)} h(\phi), \tag{10}$$

respectively. Revenues from domestic and export sales read $r(\phi) = q(\phi)p(\phi)$ and $r_x(\phi) = \tau^{-(\sigma-1)} r(\phi, w)$, respectively. The profit functions are given by:

$$\pi(\phi) = (1 - \rho) \cdot r(\phi) - F \qquad \text{and} \qquad \pi_x(\phi) = (1 - \rho) \cdot r_x(\phi) - F_x. \tag{11}$$

3.2 Collective Bargaining and Unemployment

Maximizing the Nash-product over w subject to the firm's profit-maximizing labor demand leads to the bargained wage:

$$w(\overline{\gamma}, \phi) = \theta(\overline{\gamma}, \phi) \cdot b, \tag{12}$$

$$\theta(\overline{\gamma}, \phi) \equiv \frac{\sigma - 1 + \gamma(\overline{\gamma}, \phi)}{\sigma - 1}, \tag{13}$$

with $\theta \geq 1$ representing the wage markup. For $\gamma_\phi > 0$, high-productivity firms pay higher wages than low-productivity firms, since these firms face more powerful unions. In the benchmark case of $\gamma_\phi = 0$, all firms pay the same wage.

The quantitative effect of the relationship between a firm's productivity and the wage is measured by the elasticity $\epsilon_{\theta\phi} \equiv d\theta/d\phi \cdot \phi/\theta$, which can be written as:[7]

$$\epsilon_{\theta\phi} = \frac{\epsilon_{\gamma\phi}(\overline{\gamma}, \phi)}{1 + (\sigma - 1)/\gamma(\overline{\gamma}, \phi)}. \tag{14}$$

Due to the assumption $\epsilon_{\gamma\phi} \leq 1$, the wage markup and the wage rate vary inelastically with ϕ, i.e. $\epsilon_{\theta\phi} < 1$.

Given the outcome of the wage bargaining, we can compute the unemployment rate. Rearranging the definition of the expected income yields $u = 1 - b/w^e$. The expected wage is defined as $w^e \equiv (1 - G(\phi_c))^{-1} \int_{\phi_c}^{\infty} w(\overline{\gamma}, \phi) g(\phi) d\phi$, where ϕ_c denotes the productivity of the marginal active firm in the market (see below). Inserting (12), we get:

$$w^e = \theta^e(\overline{\gamma}, \phi_c) \cdot b, \tag{15}$$

$$\theta^e(\overline{\gamma}, \phi_c) = 1 + \frac{1}{\sigma - 1} \gamma^e(\overline{\gamma}, \phi_c), \tag{16}$$

where θ^e is the expected wage markup and γ^e is the expected union bargaining power defined as $\gamma^e(\overline{\gamma}, \phi_c) = (1 - G(\phi_c))^{-1} \int_{\phi_c}^{\infty} \gamma(\overline{\gamma}, \phi) g(\phi) d\phi$.

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[7]Because the bargained wage is a markup on expected income, the elasticity of w with respect to $\overline{\gamma}$ equals the elasticity of θ with respect to $\overline{\gamma}$. Note further that the elasticity of θ with respect to γ is $\epsilon_{\theta\gamma} \equiv d\theta/d\gamma \cdot \gamma/\theta$, which increases in γ.

The unemployment rate is then given by:

$$u = 1 - \frac{1}{\theta e(\overline{\gamma}, \phi_c)}. \tag{17}$$

Note that the expected wage markup and the unemployment rate always move in the same direction.

3.3 Firm and Export Selection

After drawing a productivity ϕ, a firm starts production if profits from domestic sales are non-negative. The firm will additionally export if profits from export sales are non-negative. At the margin, we can define two cutoff productivities, ϕ_c and ϕ_x, at which the respective profits are zero:

$$\pi(\phi_c) = (1 - \rho) \cdot r(\phi_c) - F = 0, \tag{18}$$

$$\pi_x(\phi_x) = (1 - \rho) \cdot r_x(\phi_x) - F_x = 0. \tag{19}$$

Firms with productivities lower than ϕ_c do not produce and leave the market. Firms with productivities $\phi_c \leq \phi < \phi_x$ serve only the domestic market, while firms with productivities $\phi \geq \phi_x$ additionally export.

Firms draw a productivity and enter the market as long as expected profits are high enough to cover entry costs. Due to free entry, we get:

$$\frac{1}{\delta} \left[\int_{\phi_c}^{\infty} \pi(\phi)g(\phi)d\phi + \int_{\phi_x}^{\infty} \pi_x(\phi)g(\phi)d\phi \right] = F_e, \tag{20}$$

where $\delta \in (0, 1)$ denotes the exogenously given death probability of firms.

The zero-profit cutoff conditions (18) and (19) and the free-entry condition (20) determine the equilibrium cutoff productivities for domestic production and export, ϕ_c and ϕ_x, respectively, and the equilibrium market share, Y/M_t. Unfortunately, it is not possible to give a closed form solution. In Appendix A.1, we show that these

equations can be rearranged to:

$$D \equiv \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\theta(\overline{\gamma}, \phi_c)} \cdot \frac{\phi_c}{\phi_x} \right)^{\sigma - 1} - \tau^{1-\sigma} \frac{F}{F_x} = 0, \tag{21}$$

$$E \equiv E^1 + E^2 = 0,$$

$$E^1 \equiv k \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \int_{\phi_c}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi - \phi_c^{-k} - \delta \frac{F_e}{F},$$

$$E^2 \equiv k \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \tau^{1-\sigma} \int_{\phi_x}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi - \phi_x^{-k} \frac{F_x}{F}, \tag{22}$$

which implicitly pin down ϕ_c and ϕ_x as functions of the policy variables $\overline{\gamma}$ and τ.

The cutoff productivities are a measure for firm selection and export selection. An increase (decrease) in ϕ_c indicates that less (more) low-productivity firms are able to produce, which raises (reduces) the average productivity of active firms. Similarly, an increase (decrease) in ϕ_x means that, c.p., a lower (higher) fraction of active firms engage in export sales.

# 4 Policy Analysis

4.1 Labor Market Policy

In this section, we analyze how labor market policies affect the equilibrium outcomes. Suppose that policy makers ban a lockout or renew labor law to make it easier for unions to organize (see the decisions of the US National Labor Relations Board in the 2010s) and/or to implement a strike. In our model, these policies are captured by an increase in $\overline{\gamma}$. The wage markup and thus the wage rate goes up in all firms. Note, however, that the wage distribution across firms widens. High-productivity firms face a higher increase in wages than low-productivity firms.

The effect on firm-selection is stated in

Proposition 1

(i) For $\gamma_\phi > 0$, an increase in $\overline{\gamma}$ reduces the cutoff productivity ϕ_c.

(ii) For $\gamma_\phi = 0$, ϕ_c does not change.

Figure 1: Firm Selection and Export Selection
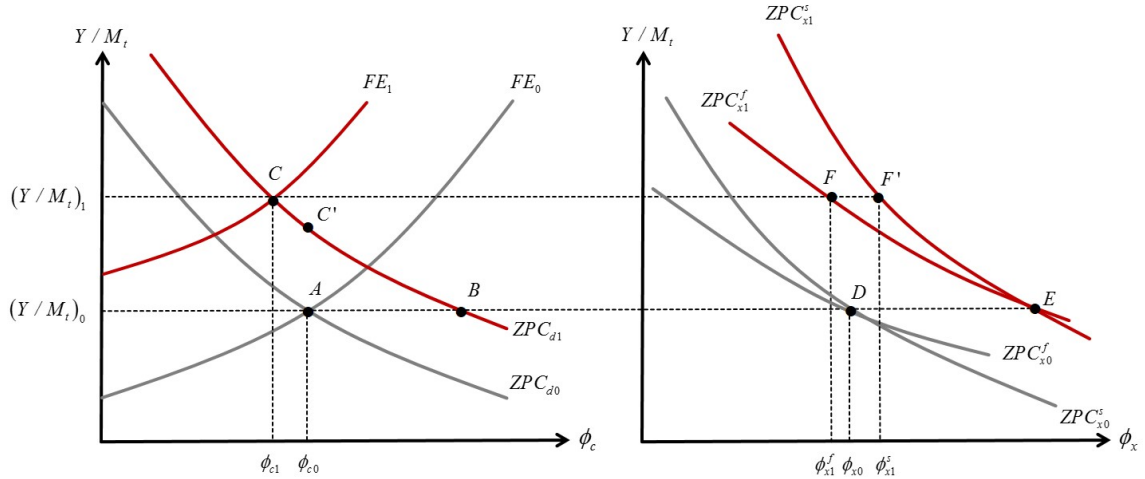
Proof 1 *See Appendix A.2.*

On impact, the increase in the wage rate lowers firm profits. A firm with the initial cutoff productivity ϕ_{c0} (see Figure 1, left panel) now makes losses, the zero-profits cutoff condition (ZPC-curve) shifts to the right. For any given market share, Y/M_t, the cutoff productivity ensuring zero profits, ϕ_c, increases (transition from point A to point B in Figure 1). The market share, however, does not remain constant. The free-entry condition (FE-curve) states that higher wage payments reduce expected profits, so that fewer firms are willing to enter the market. The market share then increases and the FE-curve shifts up. As a consequence, firm profits increase, such that ϕ_c can decline. Starting from point B, we move to the north-west.

In the benchmark case of $\gamma_\phi = 0$, the increase in the wage rate and thus the decline in profits is identical across firms. Hence, the decline in expected profits is identical to the profit decline of the marginal firm with ϕ_{c0}. In this case, the lower number of firms and thus the increase in the market share exactly compensates the initial decline in profits due to more powerful unions. The equilibrium cutoff productivity does not change, the ZPC-curve and the FE-curve shift up proportionally such that point C' would be reached.

For $\gamma_\phi > 0$, however, the marginal firm with ϕ_{c0} faces the lowest wage increase

and thus the lowest decline in profits. The wage increase is more pronounced in high-productivity firms, drawing a high productivity loses attractiveness. The decline in expected profits now exceeds the profit decline of the marginal firm with ϕ_{c0}. We observe a larger reduction of the mass of entrants. For the marginal firm, the profit increasing effect of a lower number of competitors exceeds the profit reducing effect of a more powerful union, the marginal firm now makes profits. The equilibrium cutoff productivity declines. This is depicted in Figure 1, where the shift of the FE-curve is larger than the shift of the ZPC-curve. The new equilibrium C is located to the left of point A, we observe a decline in ϕ_c.

A higher $\overline{\gamma}$ also affects export selection. As shown in Appendix A.3, the sign of the multiplier $d\phi_x/d\overline{\gamma}$ corresponds to the sign of $(\Gamma_1 + \Gamma_2)$ with

$$
\begin{aligned}
\Gamma_1 &\equiv \left(1 + \tau^{1-\sigma}\right) \int_{\phi_x}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)}\right)^{\sigma-1} \phi^{-k-1} \left(\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x) - \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)\right) d\phi \leq 0, \\
\Gamma_2 &\equiv \int_{\phi_c}^{\phi_x} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)}\right)^{\sigma-1} \phi^{-k-1} \left(\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x) - \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)\right) d\phi \geq 0.
\end{aligned}
$$

For the benchmark case $\gamma_\phi = 0$, we get $\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x) = \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)$ for all ϕ and hence $\Gamma_1 = \Gamma_2 = 0$. The multiplier simplifies to $d\phi_x/d\overline{\gamma} = 0$, so that there is no effect on export selection, the equilibrium export cutoff productivity ϕ_x does not change. As above, the lower number of firms and thus the increase in the market share exactly compensates the initial decline in (export) profits due to more powerful unions.

For $\gamma_\phi > 0$, the firm with the initial export cutoff productivity ϕ_{x0} (see Figure 1, right panel) has the lowest wage increase of all exporters. The decline in expected export profits exceeds the profit decline of the marginal exporter with ϕ_{x0}. Because of the large decline of the number of competitors, the marginal exporter makes profits. The equilibrium export cutoff productivity ϕ_x, c.p., decreases. This effect is captured by $\Gamma_1 < 0$. But there is an opposing effect. Firms that produce for the domestic market only ($\phi_c \leq \phi < \phi_x$) are now in a better position than exporters. Because of a lower wage increase and thus a lower profit decline, this segment of the productivity distribution becomes more attractive. Or to put it another way, being an exporter loses attractiveness. The equilibrium export cutoff productivity, c.p.,

goes up, which is captured by $\Gamma_2 > 0$. The sign of the net effect, given by the sign of $(\Gamma_1 + \Gamma_2)$, is ambiguous.

These results are summarized in

Proposition 2

(i) For $\gamma_\phi > 0$ and $\Gamma_1 + \Gamma_2 < 0$ ($\Gamma_1 + \Gamma_2 > 0$), more powerful trade unions decrease (increase) the export cutoff productivity ϕ_x.

(ii) For $\gamma_\phi = 0$, ϕ_x does not change.

Proof 2 *See Appendix A.3 and text.*

Figure 1 illustrates. Assume the economy starts at point A. Given the market share and the zero-profits cutoff condition for the export market, we can pin down the equilibrium export cutoff productivity ϕ_{x0} (point D, right panel). We distinguish between a flat and a steep ZPC_x-curve, ZPC_{x0}^f and ZPC_{x0}^s, respectively. The higher Γ_2, the steeper is the ZPC_x-curve. A given increase in the market share leads to a lower decline of ϕ_x, because of the lower attractiveness of the export status.

An increase in $\overline{\gamma}$ shifts the ZPC_x-curves to the right. For a given market share, an increase in the export cutoff productivity ϕ_x is needed (transition from point D to E). Since fewer firms enter the market, the market share increases, which raises export profits and lowers ϕ_x. We observe an adjustment from point E to the northwest. If $\Gamma_1 + \Gamma_2 < 0$ holds, the movement goes along the flat ZPC_{x1}^f-curve, the new equilibrium is point F with $\phi_{x1}^f < \phi_{x0}$, the export cutoff productivity declines. For $\Gamma_1 + \Gamma_2 > 0$, we observe a movement along the steep ZPC_{x1}^s-curve, the new equilibrium is point F' with $\phi_{x1}^s > \phi_{x0}$, the export cutoff productivity increases.

Our results in Proposition 1 and 2 provide new insights for the relationship between unionization and the distribution of firms. First, an increase in the unions' bargaining power softens firm selection as in Montagna and Nocco (2015) and Montagna and Nocco (2013), but the mechanism is different. In Montagna and Nocco (2013), more productive firms have lower price elasticities of product demand, they enjoy higher monopoly rents in the product market and thus offer a higher wage. The model of Montagna and Nocco (2015) focuses on an increase in relative bar-

gaining power of domestic unions compared to foreign unions. Both studies assume that all firm-level trade unions have the same bargaining power within a country. We instead use variations in the bargaining strength across firms. Second, we show that export selection may become less intense. This is in contrast to the studies just mentioned, which both claim that export selection always becomes more severe.

Besides the impact on the distribution of firms, we are also interested in the (un)employment effects of an increase in $\bar{\gamma}$. As shown in Appendix A.4, we get:

$$\frac{du}{d\bar{\gamma}} = \frac{1}{\theta^e(\bar{\gamma}, \phi_c)^2}\frac{1}{\sigma - 1}\frac{\partial\gamma^e(\bar{\gamma}, \phi_c)}{\partial\bar{\gamma}}, \tag{23}$$

$$\text{with} \quad \frac{\partial\gamma^e(\bar{\gamma}, \phi_c)}{\partial\bar{\gamma}} = 1 + \frac{k}{\phi_c(\bar{\gamma})}\left[\gamma^e(\bar{\gamma}, \phi_c) - \gamma(\bar{\gamma}, \phi_c)\right]\frac{\partial\phi_c(\bar{\gamma})}{\partial\bar{\gamma}} < 1. \tag{24}$$

An increase in $\bar{\gamma}$ raises the expected union bargaining power γ^e, the expected wage markup θ^e and thus the unemployment rate u. This result does not come as a surprise. More interesting is the employment enhancing effect resulting from the change in the cutoff productivity ϕ_c. Since firm selection becomes less severe, more low-productivity firms enter the market. The unions at these firms have less than average bargaining power. The expected bargaining power γ^e then declines, generating a positive employment effect. In Eq. (23), the multiplier $\partial\gamma^e(\bar{\gamma}, \phi_c)/\partial\bar{\gamma}$ is less than one. Note that the square bracket is positive, the marginal firm with ϕ_c faces the least powerful trade union, so that the expected bargaining power $\gamma^e(\bar{\gamma}, \phi_c)$ exceeds $\gamma(\bar{\gamma}, \phi_c)$. The next proposition summarizes.

Proposition 3

(i) An increase in $\bar{\gamma}$ raises the unemployment rate u.

(ii) For $\gamma_\phi > 0$, the rise in u is mitigated by the entrance of more low-productivity firms.

Our finding sheds new light on the labor market effect of more powerful trade unions. Any (empirical) estimation of the unemployment effect of unionization, which ignores the heterogeneity of the unions' bargaining power, will produce a biased result. More precisely, such an estimation overestimates the increase in unemployment. In Section 5, we discuss the quantitative importance of this new channel.

4.2 Trade Liberalization

How does trade liberalization, measured by a reduction of variable trade costs τ, affect firm/export selection and the unemployment rate? With respect to the former, the effects are in line with previous findings in the literature (see Melitz, 2003).

Proposition 4

Trade liberalization raises ϕ_c and reduces ϕ_x.

Proof 3 *See Appendix A.5.*

A reduction of variable trade costs strengthens competition through two channels. First, imported varieties become cheaper, and second, because of the increase in export profits more firms will enter the market. More severe competition translates into a decline in the market share of the incumbent, the least-productive firms are driven out of the market, ϕ_c increases. Regarding the export cutoff productivity, the reduction of trade costs and the increased number of competitors work in the opposite direction. However, the former effect always dominates, ϕ_x declines unambiguously.

Concerning the unemployment rate u, we get:

Proposition 5

(i) If $\gamma_\phi > 0$, trade liberalization raises the unemployment rate.
(ii) In the benchmark case of $\gamma_\phi = 0$, u does not change.

Proof 4 *Differentiating (16) and (17) with respect to τ and combining the results yields:*

$$\frac{du}{d\tau} = \frac{1}{(\sigma-1)(\theta^e)^2} \frac{\partial \gamma^e}{\partial \phi_c} \frac{\partial \phi_c}{\partial \tau}.$$

Proposition 4 states that $\partial \phi_c / \partial \tau < 0$. Because of $\partial \gamma^e / \partial \phi_c > 0$, this implies $du/d\tau < 0$. For $\gamma_\phi = 0$, we get $\partial \gamma^e / \partial \phi_c = 0$ and thus $du/d\tau = 0$.

Trade liberalization leads to a sharper firm selection, the least productive firms leave the market. Because unions in these firms have less than average bargaining power, the expected bargaining power of the remaining unions increases, which raises

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the expected wage markup and the unemployment rate. In the benchmark case with $\gamma_\phi = 0$, the firm selection has no consequences for the unions' expected bargaining power, so that u does not change.

This result adds an important aspect to the unemployment-trade nexus. Standard models of unionization and firm selection, as for example used by Eckel and Egger (2017), Eckel and Egger (2009) and de Pinto and Michaelis (2016), disregard the role of unions for the employment effects of trade liberalization. This is because the link between unionization and firm selection is missing, as we have proved.

5 Discussion

5.1 Quantitative Assessment

Are the implications of firm-specific bargaining power quantitatively important? To tackle this issue, we solve our model numerically. Relying on calibrations by Bernard et al. (2007), we set $\sigma = 3.8$, $\delta = 0.025$, $\tau = 1.3$ and $F_e = 2$. Additionally, we take the results of the structural estimations by Balistreri et al. (2011) into account and set $k = 4.6$ as well as $F = 0.25$ and $F_x = 0.22$ (which are the average values of estimated fixed costs in the US and Europe). The unions' bargaining power is calculated by:

$$\gamma = \overline{\gamma}\left(1 + \chi - \frac{\kappa\chi}{\phi}\right), \qquad \overline{\gamma} \in [0, 0.5]. \tag{25}$$

χ is an indicator variable which equals one if the bargaining power is firm-specific and zero otherwise. $\kappa \geq 1$ measures how sensitive bargaining power is to firm heterogeneity.

Let us look at the effects of an increase in $\overline{\gamma}$. To compare the $\chi = 1$ scenario with our benchmark case $\chi = 0$, we assume that the expected bargaining power is initially identical and equal to 0.4, i.e. $\gamma_{\chi=1}^e = \gamma_{\chi=0}^e = 0.4$. To ensure this, we set $\overline{\gamma}_{\chi=0} = 0.4$ and $\overline{\gamma}_{\chi=1} = 0.27$. Assuming $\kappa = 2$, we find that a 10% increase of $\overline{\gamma}_{\chi=1}$ implies that ϕ_c decreases by about 0.6% and ϕ_x decreases by about 0.2%. Moreover, the unemployment rate increases by about 7.9%. In the benchmark case, a 10%

increase of $\overline{\gamma}_{\chi=0}$ has no effect on ϕ_c and ϕ_x and raises unemployment by about 8.6%. As such, allowing the bargaining power to be firm-specific leads to a significant lower increase in u. Regarding trade liberalization, we compare an economy with high variable trade costs ($\tau = 1.7$) to an economy with low variable trade costs ($\tau = 1.3$). Trade liberalization leads then to an increase in unemployment of about 4.4% if $\chi = 1$ and $\kappa = 2$ and has no effect on unemployment if $\chi = 0$.

These results depend, however, on the level of κ. The lower (higher) κ, the lower (higher) is the effect of firm-specific bargaining power on u. Finding the relevant empirical value of κ is thus a task for future research. With respect to changes of the other parameters, we find that our results are quite robust.[8]

5.2 Aggregate Output

Our model also allows for the computation of aggregate output in equilibrium. In a first step, we use the normalization of the price index P to calculate the expected income as:

$$b(\overline{\gamma}, \tau) = \left(\frac{\Gamma_3(\overline{\gamma}, \tau)}{1 + \alpha(\overline{\gamma}, \tau)} \right)^{\frac{1}{\sigma-1}}, \tag{26}$$

$$\Gamma_3(\overline{\gamma}, \tau) \equiv \rho^{\sigma-1} \phi_c(\overline{\gamma}, \tau)^k k \times$$

$$\left[\int_{\phi_c(\overline{\gamma}, \tau)}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi + \tau^{1-\sigma} \int_{\phi_x(\overline{\gamma}, \tau)}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi \right],$$

$$\alpha(\overline{\gamma}, \tau) \equiv \frac{1 - G(\phi_x(\overline{\gamma}, \tau))}{1 - G(\phi_c(\overline{\gamma}, \tau))} = \left(\frac{\phi_c(\overline{\gamma}, \tau)}{\phi_x(\overline{\gamma}, \tau)} \right)^k.$$

The equilibrium b is thus defined as the expected income which allows workers to buy and consume the final good at the price $P = 1$. Combining (8) and (10) with the definition of aggregate employment delivers aggregate output:

$$Y(\overline{\gamma}, \tau) = \frac{1 + \alpha(\overline{\gamma}, \tau)}{\Gamma_4(\overline{\gamma}, \tau)} (1 - u(\overline{\gamma}, \tau)) L, \tag{27}$$

$$\Gamma_4(\overline{\gamma}, \tau) \equiv k \phi_c(\overline{\gamma}, \tau)^k \times$$

$$\left[\int_{\phi_c}^{\infty} p(\phi, b(\overline{\gamma}, \tau))^{-\sigma} \phi^{-k-2} d\phi + \tau^{1-\sigma} \int_{\phi_x(\overline{\gamma}, \tau)}^{\infty} p(\phi, b(\overline{\gamma}, \tau))^{-\sigma} \phi^{-k-2} d\phi \right].$$

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[8]Robustness checks are available upon request.

Analyzing the effect of variations in $\overline{\gamma}$ and τ analytically, we are not able to get meaningful insights. Relying on our numerical solution, however, we find that an increase in $\overline{\gamma}$ decreases Y. Comparing the output reduction in case of $\gamma_\phi > 0$ with the benchmark setting $\gamma_\phi = 0$, we observe two countervailing effects. On the one hand, average productivity declines, which, c.p., reduces Y. On the other hand, the employment reduction is mitigated, which, c.p., weakens the output reduction. Simulations show that the former effect dominates, i.e. the reduction of Y is more pronounced with firm-specific bargaining power. On the contrary, trade liberalization raises Y, but the effect is less pronounced if $\gamma_\phi > 0$ because of the implied decrease in employment.

Note that aggregate output measures also welfare in our setting because aggregate profits are zero in equilibrium (due to free entry) and aggregate wage income is a constant share of Y (due to monopolistic competition and CES demand). The aforementioned findings can thus be interpreted as welfare implications of labor market policies and trade liberalization.

5.3 Alternative Specification of the Bargaining Power

Throughout our paper, we have assumed $\gamma_\phi > 0$ to model heterogeneity of the unions' bargaining power across heterogeneous firms. While this assumption is backed up by empirical evidence, there is an obvious counter-argument. Since the firms' profits are an increasing and convex function of firm productivity, high-productivity firms also have a high incentive to resist unionization. As already pointed out by Freeman and Kleiner (1990), management opposition is increasing with firm productivity, so that $\gamma_\phi < 0$ may be also possible. A similar conclusion can be drawn from the literature on the impact of globalization on the wage bargain. If a subset of high-productivity firms can credibly threaten to relocate production to a foreign country or to diversify internationally, the credible threat of a break-down of the wage bargain arises. It is well known from Binmore et al. (1986) that the higher the perceived probability of a breakdown of the bargain, the lower the union's bargaining power. Abraham et al. (2009) as well as Dumont et al. (2006)

found some evidence for the hypothesis that the globalization process has indeed eroded the union bargaining power.

This begs the question how our findings change if we assume $\gamma_\phi < 0$. First, an increase in $\overline{\gamma}$ would then lead to an *increase* in the cutoff productivity. This is because the implied wage increase is less pronounced in high-productivity firms, such that drawing a high productivity is still relatively attractive. The decline in expected profits thus falls short of the profits decline of the marginal firm and the reduction of the mass of firms is relatively low. Compared to the benchmark case $\gamma_\phi = 0$, competition is more severe and ϕ_c rises. Second, the effect on the export cutoff productivity remains ambiguous. Third, the increase in unemployment is lower compared to the benchmark case. For $\gamma_\phi < 0$, the expected bargaining power, c.p., decreases if the average productivity rises. Since ϕ_c increases, firms become more productive on average, the expected bargaining power declines and so does the unemployment rate. As in the setting with $\gamma_\phi > 0$, union heterogeneity implies a (partial) employment enhancing effect.

Finally, we find that trade liberalization decreases u in the case of $\gamma_\phi < 0$. Intuitively, lower trade costs raise firm selection, the average productivity of firms increases, implying that the expected bargaining power and the unemployment rate decline. Regarding the large academic (and non-academic) discussion on the labor market effects of trade, our paper provides a new insight because it shows that the implications on u depend a.) on labor market institutions, here trade unions, and b.) on the interrelatedness between bargaining power and firms' productivity.

6 Conclusion

Almost all theoretical studies on the impact of unionization make use of the simplifying assumption that union bargaining power is identical across firms. The empirical evidence, however, indicates that high-productivity firms face stronger trade unions than low-productivity firms. We incorporate union heterogeneity into a Melitz–type model and reassess the impact of unionization. In our framework, unionization is

no longer neutral for firm selection, but firm selection becomes less intense. More low-productivity firms enter the market, these firms mitigate the negative employment effect of stronger trade unions. In a similar vein, trade liberalization is no longer neutral for the unemployment rate but the exit of low-productivity firms raises unemployment.

The literature has only recently recognized that the economic impact of firm heterogeneity goes beyond firm selection. Our study picks up this idea by discussing the link between firm heterogeneity and union heterogeneity. Focusing on the labor market too, Baumann and Brändle (2017) discuss the link between firm heterogeneity and the level of the wage bargain. Helpman et al. (2010) as well as de Pinto and Michaelis (2014) allow for worker heterogeneity, workers are assumed to differ with respect to their abilities. Autor et al. (2017) analyze the macroeconomic impact of superstar firms, Acemoglu and Hildebrand (2017) investigate the relationship between monopoly rents and innovations. These studies may serve as a starting point for an approach to endogenize firm productivity in order to overcome the scenario of a Melitz-lottery. More generally, the modeling of heterogeneous agents in a general equilibrium framework is no easy task, but from our point of view it is the most promising line of research.

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A Appendix

A.1 Derivation of (21) and (22)

The zero-profits cutoff condition reads $\pi(\phi) = (1-\rho)r(\phi) - F = (1-\rho)p(\phi)q(\phi) - F = (1-\rho)p(\phi)^{1-\sigma}\frac{Y}{M_t} - F = 0$. Inserting the optimal price (8) and the bargained wage (12) yields:

$$\frac{Y}{M_t} = KF\left(\frac{\theta(\overline{\gamma},\phi_c)}{\phi_c}\right)^{\sigma-1},\tag{A.1}$$

with $K \equiv \sigma(b/\rho)^{\sigma-1}$. The zero-profits cutoff condition for export sales $\pi_x(\phi) = (1-\rho)r_x(\phi) - F_x$ can be rearranged in a similar way:

$$\frac{Y}{M_t} = K\tau^{\sigma-1}F_x\left(\frac{\theta(\overline{\gamma},\phi_x)}{\phi_x}\right)^{\sigma-1}.\tag{A.2}$$

Combining (A.1) and (A.2) leads to (21).

The free-entry condition reads:

$$\int_{\phi_c}^{\infty} \pi(\phi)g(\phi)d\phi + \int_{\phi_x}^{\infty} \pi_x(\phi)g(\phi)d\phi = \delta F_e,$$

$$\int_{\phi_c}^{\infty}\left[(1-\rho)p(\phi)^{1-\sigma}\frac{Y}{M_t} - F\right]g(\phi)d\phi + \int_{\phi_x}^{\infty}\left[(1-\rho)p_x(\phi)^{1-\sigma}\frac{Y}{M_t} - F_x\right]g(\phi)d\phi = \delta F_e.$$

Using the Pareto distribution implies:

$$(1-\rho)\frac{Y}{M_t}k\left[\int_{\phi_c}^{\infty} p(\phi)^{1-\sigma}\phi^{-k-1}d\phi + \int_{\phi_x}^{\infty} p_x(\phi)^{1-\sigma}\phi^{-k-1}d\phi\right] = \delta F_e + \phi_c^{-k}F + \phi_x^{-k}F_x.$$

Inserting the optimal price (8) and the bargained wage (12) leads to:

$$\frac{1}{\sigma}\frac{Y}{M_t}kb^{1-\sigma}\rho^{\sigma-1}\left[\int_{\phi_c}^{\infty}(\theta(\overline{\gamma},\phi))^{1-\sigma}\phi^{\sigma-k-2}d\phi + \tau^{1-\sigma}\int_{\phi_x}^{\infty}(\theta(\overline{\gamma},\phi))^{1-\sigma}\phi^{\sigma-k-2}d\phi\right]$$

$$= \delta F_e + \phi_c^{-k}F + \phi_x^{-k}F_x.$$

Rearrangements imply:

$$\frac{Y}{M_t} = K \left[\delta F_e + \phi_c^{-k} F + \phi_x^{-k} F_x \right] \frac{1}{k} \times$$

$$\left[\int_{\phi_c}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi + \tau^{1-\sigma} \int_{\phi_x}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi \right]^{-1}. \tag{A.3}$$

Equating (A.3) with (A.1) and rearranging yield:

$$kF \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \left[\int_{\phi_c}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi + \tau^{1-\sigma} \int_{\phi_x}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi \right]$$

$$= \delta F_e + \phi_c^{-k} F + \phi_x^{-k} F_x.$$

In a last step, let us simplify notation:

$$E = E^1 + E^2 = 0,$$

$$E^1 \equiv k \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \int_{\phi_c}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi - \phi_c^{-k} - \delta \frac{F_e}{F},$$

$$E^2 \equiv k \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \tau^{1-\sigma} \int_{\phi_x}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi - \phi_x^{-k} \frac{F_x}{F}.$$

This expression is identical to (22).

A.2 Proof of Proposition 1

Totally differentiating (21) and (22) and using Cramer's rule yield:

$$\frac{d\phi_c}{d\overline{\gamma}} = \frac{1}{\Psi} (-D_{\overline{\gamma}} E_{\phi_x} + D_{\phi_x} E_{\overline{\gamma}}), \tag{A.4}$$

where subscripts denote partial derivatives and $\Psi = D_{\phi_c} E_{\phi_x} - D_{\phi_x} E_{\phi_c}$ represents the determinant of the equation system. For the partial derivatives of E, we get:

$$E_{\phi_c}^1 = - \underbrace{(1 - \epsilon_{\theta\phi}(\overline{\gamma}, \phi_c))}_{>0} k(\sigma-1) \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \frac{1}{\phi_c} \times$$

$$\int_{\phi_c}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma-1} \phi^{-k-1} d\phi < 0, \tag{A.5}$$

$$E_{\phi_x}^1 = 0, \tag{A.6}$$

$$E_{\overline{\gamma}}^1 = k(\sigma - 1) \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma - 1} \frac{1}{\overline{\gamma}} \times$$
$$\int_{\phi_c}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma - 1} \phi^{-k-1} (\epsilon_{\theta \overline{\gamma}}(\phi_c) - \epsilon_{\theta \overline{\gamma}}(\phi_x)) d\phi, \tag{A.7}$$

$$E_{\phi_c}^2 = -\underbrace{(1 - \epsilon_{\theta \phi}(\overline{\gamma}, \phi_c))}_{>0} k(\sigma - 1) \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma - 1} \frac{1}{\phi_c} \tau^{-(\sigma-1)} \times$$
$$\int_{\phi_x}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma - 1} \phi^{-k-1} d\phi < 0, \tag{A.8}$$

$$E_{\phi_x}^2 = k \phi_x^{-k-1} \tau^{-(\sigma-1)} \left(\frac{\tau^{\sigma-1} F_x}{F} - \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\theta(\overline{\gamma}, \phi_x)} \frac{\phi_x}{\phi_c} \right)^{\sigma - 1} \right) = 0, \tag{A.9}$$

$$E_{\overline{\gamma}}^2 = k(\sigma - 1) \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma - 1} \frac{1}{\overline{\gamma}} \tau^{-(\sigma-1)} \times$$
$$\int_{\phi_x}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma - 1} \phi^{-k-1} (\epsilon_{\theta \overline{\gamma}}(\phi_c) - \epsilon_{\theta \overline{\gamma}}(\phi)) d\phi. \tag{A.10}$$

This implies $E_{\phi_c} = E_{\phi_c}^1 + E_{\phi_c}^2 < 0$ and $E_{\phi_x} = E_{\phi_x}^1 + E_{\phi_x}^2 = 0$ and $E_{\overline{\gamma}} = E_{\overline{\gamma}}^1 + E_{\overline{\gamma}}^2 < 0$.

The partial derivatives of D are given by:

$$D_{\phi_c} = \frac{\sigma - 1}{\phi_c} \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\theta(\overline{\gamma}, \phi_c)} \frac{\phi_c}{\phi_x} \right)^{\sigma - 1} (1 - \epsilon_{\theta \phi}(\overline{\gamma}, \phi_c)) > 0, \tag{A.11}$$

$$D_{\phi_x} = -\frac{\sigma - 1}{\phi_x} \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\theta(\overline{\gamma}, \phi_c)} \frac{\phi_c}{\phi_x} \right)^{\sigma - 1} (1 - \epsilon_{\theta \phi}(\overline{\gamma}, \phi_x)) < 0, \tag{A.12}$$

$$D_{\overline{\gamma}} = \frac{\sigma - 1}{\overline{\gamma}} \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\theta(\overline{\gamma}, \phi_c)} \frac{\phi_c}{\phi_x} \right)^{\sigma - 1} (\epsilon_{\theta \overline{\gamma}}(\overline{\gamma}, \phi_x) - \epsilon_{\theta \overline{\gamma}}(\overline{\gamma}, \phi_c)) > 0. \tag{A.13}$$

Given the partial derivatives, we obtain $\Psi = D_{\phi_c} E_{\phi_x} - D_{\phi_x} E_{\phi_c} < 0$ and $\frac{d\phi_c}{d\overline{\gamma}} = (-D_{\overline{\gamma}} E_{\phi_x} + D_{\phi_x} E_{\overline{\gamma}})/\Psi < 0$. For the benchmark case $\gamma_\phi = 0$, the elasticity of the wage markup with respect to the bargaining power parameter $\overline{\gamma}$ does not depend on ϕ, so that $E_{\overline{\gamma}} = 0$ and thus $\frac{d\phi_c}{d\overline{\gamma}} = 0$.

A.3   Proof of Proposition 2

Totally differentiating (21) and (22) and using Cramer's rule yields:

$$\frac{d\phi_x}{d\overline{\gamma}} = -\frac{1}{\Psi} \left(D_{\phi_c} E_{\overline{\gamma}} - D_{\overline{\gamma}} E_{\phi_c} \right). \tag{A.14}$$

For $\gamma_\phi = 0$, we have $D_{\overline{\gamma}} = E_{\overline{\gamma}} = 0$ and thus $d\phi_x/d\overline{\gamma} = 0$. For $\gamma_\phi > 0$, the sign of the multiplier corresponds to the sign of $(D_{\phi_c}E_{\overline{\gamma}} - D_{\overline{\gamma}}E_{\phi_c})$. Inserting the partial derivatives and rearranging leads to:

$$D_{\phi_c}E_{\overline{\gamma}} - D_{\overline{\gamma}}E_{\phi_c} = \frac{(1 - \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_c))k(\sigma-1)^2}{\phi_c\overline{\gamma}} \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\phi_x}\right)^{\sigma-1} [\Gamma_1 + \Gamma_2],$$

$$\Gamma_1 \equiv (1 + \tau^{1-\sigma}) \int_{\phi_x}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)}\right)^{\sigma-1} \phi^{-k-1} (\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x) - \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)) d\phi < 0,$$

$$\Gamma_2 \equiv \int_{\phi_c}^{\phi_x} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)}\right)^{\sigma-1} \phi^{-k-1} (\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x) - \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)) d\phi > 0.$$

The sign of $(\Gamma_1 + \Gamma_2)$ and thus the sign of the multiplier $\frac{d\phi_x}{d\overline{\gamma}}$ is ambiguous because we cannot determine the sign of $\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x) - \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)$. This proves Proposition 2.

A.4 Proof of Proposition 3

Differentiating (16) and (17) with respect to $\overline{\gamma}$ and combining the results yields:

$$\frac{du}{d\overline{\gamma}} = \frac{1}{\theta^e(\overline{\gamma}, \phi_c)^2} \frac{1}{\sigma-1} \frac{\partial \gamma^e(\overline{\gamma}, \phi_c)}{\partial \overline{\gamma}}.$$

The expected union bargaining power is defined as:

$$\gamma^e(\overline{\gamma}, \phi_c) = \frac{1}{1 - G(\phi_c)} \int_{\phi_c}^{\infty} \gamma(\overline{\gamma}, \phi) \cdot g(\phi) d\phi$$

Using the Pareto distribution, we get:

$$\gamma^e(\overline{\gamma}, \phi_c) = (\phi_c)^k \int_{\phi_c}^{\infty} \gamma(\overline{\gamma}, \phi) \cdot k\phi^{-k-1} d\phi,$$

with the derivative

$$\frac{\partial \gamma^e(\overline{\gamma}, \phi_c)}{\partial \overline{\gamma}} = k(\phi_c)^{k-1} \frac{d\phi_c(\overline{\gamma})}{d\overline{\gamma}} \int_{\phi_c}^{\infty} \gamma(\overline{\gamma}, \phi) \cdot k\phi^{-k-1} d\phi + (\phi_c)^k \frac{\partial}{\partial \overline{\gamma}} \int_{\phi_c(\overline{\gamma})}^{\infty} \gamma(\overline{\gamma}, \phi) \cdot k\phi^{-k-1} d\phi.$$

Applying the Leibniz rule leads to:

$$
\begin{aligned}
\frac{\partial \gamma^e(\bar{\gamma}, \phi_c)}{\partial \bar{\gamma}} &= k(\phi_c)^{k-1} \frac{\partial \phi_c(\bar{\gamma})}{\partial \bar{\gamma}} \int_{\phi_c}^{\infty} \gamma(\bar{\gamma}, \phi) \cdot k \phi^{-k-1} d\phi \\
&\quad + (\phi_c)^k \left[\int_{\phi_c(\bar{\gamma})}^{\infty} k \phi^{-k-1} \frac{\partial \gamma(\bar{\gamma}, \phi)}{\partial \bar{\gamma}} d\phi - \gamma(\bar{\gamma}, \phi_c) k (\phi_c)^{-k-1} \cdot \frac{\partial \phi_c(\bar{\gamma})}{\partial \bar{\gamma}} \right].
\end{aligned}
$$

Next, observe the definition of $\gamma^e(\bar{\gamma}, \phi_c)$ and rearrange:

$$
\begin{aligned}
\frac{\partial \gamma^e(\bar{\gamma}, \phi_c)}{\partial \bar{\gamma}} &= \frac{k}{\phi_c(\bar{\gamma})} \left[\gamma^e(\bar{\gamma}, \phi_c) - \gamma(\bar{\gamma}, \phi_c) \right] \frac{\partial \phi_c(\bar{\gamma})}{\partial \bar{\gamma}} \\
&\quad + (\phi_c)^k \int_{\phi_c(\bar{\gamma})}^{\infty} k \phi^{-k-1} \gamma(\bar{\gamma}, \phi) \frac{\partial \gamma(\bar{\gamma}, \phi)}{\partial \bar{\gamma}} \frac{\bar{\gamma}}{\gamma(\bar{\gamma}, \phi)} \frac{1}{\bar{\gamma}} d\phi.
\end{aligned}
$$

To simplify, we assume that the bargaining parameter $\gamma(\bar{\gamma}, \phi)$ is linear in $\bar{\gamma}$, so that the elasticity $\frac{\partial \gamma(\bar{\gamma}, \phi)}{\partial \bar{\gamma}} \frac{\bar{\gamma}}{\gamma(\bar{\gamma}, \phi)}$ is equal to one. Then we have:

$$
\frac{\partial \gamma^e(\bar{\gamma}, \phi_c)}{\partial \bar{\gamma}} = \frac{k}{\phi_c(\bar{\gamma})} \left[\gamma^e(\bar{\gamma}, \phi_c) - \gamma(\bar{\gamma}, \phi_c) \right] \frac{\partial \phi_c(\bar{\gamma})}{\partial \bar{\gamma}} + \frac{\gamma^e(\bar{\gamma}, \phi_c)}{\bar{\gamma}}. \tag{A.15}
$$

In order to obtain meaningful comparative static results, the initial equilibrium has to be characterized by identical unemployment rates. This in turn requires $\frac{\gamma^e(\bar{\gamma}, \phi_c)}{\bar{\gamma}} = 1$. Then (A.15) finally becomes:

$$
\frac{\partial \gamma^e(\bar{\gamma}, \phi_c)}{\partial \bar{\gamma}} = 1 + \frac{k}{\phi_c(\bar{\gamma})} \left[\gamma^e(\bar{\gamma}, \phi_c) - \gamma(\bar{\gamma}, \phi_c) \right] \frac{\partial \phi_c(\bar{\gamma})}{\partial \bar{\gamma}} < 1.
$$

A.5 Proof of Proposition 4

Totally differentiating (21) and (22) and using Cramer's rule yield:

$$
\frac{d\phi_c}{d\tau} = \frac{1}{\Psi} (-D_\tau E_{\phi_x} + D_{\phi_x} E_\tau), \tag{A.16}
$$

$$
\frac{d\phi_x}{d\tau} = \frac{1}{\Psi} (-D_{\phi_c} E_\tau + D_\tau E_{\phi_c}). \tag{A.17}
$$

For the partial derivatives with respect to τ, we obtain:

$$E_\tau = -k(\sigma - 1)\tau^{-\sigma} \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \times$$
$$\int_{\phi_x}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma-1} \phi^{-k-1} d\phi < 0, \tag{A.18}$$

$$D_\tau = (\sigma - 1)\tau^{-\sigma} \frac{F}{F_x} > 0. \tag{A.19}$$

Because $E_{\phi_x} = 0$, $D_{\phi_x} < 0$ and $\Psi < 0$, we find that $d\phi_c/d\tau < 0$. With respect to the sign of (A.16), we have to insert the partial derivatives. Rearranging the resulting expression implies:

$$\frac{d\phi_x}{d\tau} = -\frac{1}{\Psi}(1 - \epsilon_{\theta\phi}(\overline{\gamma}, \phi_c))k(\sigma - 1)^2 \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\phi_x} \right)^{\sigma-1} \frac{1}{\phi_c} \tau^{\sigma-1} \times$$
$$\int_{\phi_c}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma-1} \phi^{-k-1} d\phi > 0, \tag{A.20}$$

which proves the Proposition.