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Abstract

Empirical evidence suggests that the bargaining power of trade unions differs across firms and sectors. Standard models of unionization ignore this pattern by assuming a uniform bargaining strength. In this paper, we incorporate union heterogeneity into a Melitz (2003) type model. Union bargaining power is assumed to be firm-specific and varies with firm productivity. This framework allows us to re-analyze the labor market effects of (i) a symmetric increase in the bargaining power of all unions and (ii) trade liberalization. We show that union heterogeneity unambiguously reduces the negative employment effects of stronger unions. Firm-specific bargaining power creates a link between unionization and the entry and exit of firms, implying a reduction of the unions' expected bargaining power. Moreover, union heterogeneity constitutes an (un)employment effect of trade liberalization. If unions are most powerful in the high-productivity (low-productivity) firms, trade liberalization will increase (decrease) unemployment.

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

JEL Classification: F 1, F 16, J 5

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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). Of about equal size, however, 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).

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
Dumont et al. (2006)	Belgium	$1994 - 1998$	0.40	0.65
	France		0.60	0.75
	Germany		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. In contrast, the literature on the impact of globalization on wage bargaining suggests that the international integration process has eroded the unions' bargaining power in general and, in particular, the unions' bargaining power in (more productive) exporting firms (see Abraham et al., 2009 and Dumont et al., 2006). As such, there is strong evidence for (firm-level) union heterogeneity where both an increasing and decreasing bargaining power across the firm distribution can occur.

The usual modeling approaches of trade unions ignore, to the best of our knowledge, this empirical pattern. Our paper fills this gap in the literature. Taking union heterogeneity into account allows us to re-assess the wage, market entry, employment and output effects of two widely studied policy experiments: a symmetric increase in the unions' bargaining power and a liberalization of trade. To that end, we use a Melitz (2003) type model with heterogeneous firms, endogenous market entry and exit, monopolistic competition and CES demand.

We incorporate trade unions at the firm-level into this framework and introduce union heterogeneity. The aforementioned empirical 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 depends on firm productivity. Our modeling approach covers both the scenario where large and productive firms face stronger trade unions than small and less productive firms face, and the scenario where union bargaining power decreases in firm productivity. Union heterogeneity creates then a link between unionization and firm selection, where the sign of this interrelatedness depends on the scenario considered.[1]

Regarding the analysis of our first policy experiment, a key finding is that union heterogeneity always reduces the negative employment effect of more powerful trade

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[1]Braun (2011) and de Pinto (2018) emphasize that the wage markup varies with the level of wage bargaining, which also creates a link between unionization and firm selection. By the incorporation of unionization costs, de Pinto and Lingens (2017) provide a more micro-founded analysis of this link.

unions. Suppose that the bargaining power of all unions increases 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 enter the market. The unions at these firms have less than average bargaining power. This implies that the expected bargaining power declines and employment, c.p., increases. If the bargaining strength is decreasing in firm productivity, firm selection becomes more severe because the reduction of market entrants is less pronounced. Low-productivity firms with the most powerful trade unions are driven out of the market, which again reduces expected bargaining power and increases, c.p., employment.

This result serves as a complement to the literature on the relationship between union bargaining power and unemployment. Taking firm heterogeneity explicitly into account, Eckel and Egger (2017), Eckel and Egger (2009) and de Pinto and Michaelis (2016) find that more powerful trade unions lead to a rise in unemployment. But since all these studies assume uniform bargaining strength across firms, they overestimate the negative employment consequences of unionization. How strong is the employment enhancing effect due to union heterogeneity? 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 8% in the case of union heterogeneity.

Our paper is also related to Montagna and Nocco (2013) and Montagna and Nocco (2015). In the former study, 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. In the latter study, a two-country model is considered where the unions' bargaining power differs across countries but is identical within a country. An increase in the domestic unions' bargaining power again reduces firm selection. Similar to our approach, these studies endogenize the price and/or the wage markup. They do not, however, investigate the employment and output effects of unionization.

Our second policy experiment is trade liberalization. How does the employment effect of lower trade costs depend on union heterogeneity? For a uniform bargaining strength across firms, we confirm a result already obtained by, for instance, Eckel and Egger (2009, 2017): even in the presence of trade unions, the lowering of trade costs is neutral for aggregate employment. This result, however, does not carry over to a world with union heterogeneity. The sign of the employment effect depends on the assumption of how the bargaining strength varies with firm productivity.

Suppose that high-productivity firms face stronger trade unions. As in Melitz (2003), trade liberalization leads to a more severe firm selection. 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. If the bargaining strength decreases in firm productivity, the firms with the most powerful trade unions have to leave the market, the expected union bargaining strength and hence the wage level declines, as does the unemployment rate. These effects are also sizable, as we can show in our numerical solution where we consider a reduction of variable trade costs from 1.7 to 1.3. If unions are most powerful in the high-productivity (low productivity) firms, unemployment increases (decreases) by about 4.5% (3.5%).

Union heterogeneity constitutes an employment effect of trade liberalization. Unfortunately, the sign of the employment effect is not robust to seemingly slight modifications in the modeling of the labor market. This result is very much in line with the literature. Take, on the one hand, Egger and Kreickemeier (2009), who develop a model with fair-wage preferences: their model predicts a negative employment effect of lower trade costs. On the other hand, Helpman and Itskhoki (2010) derive a positive employment effect in a model with search and matching

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frictions.

Finally, we use our numerical solution to determine the effects of both policy experiments on aggregate output (which we cannot do analytically). Due to the monopolistic competition framework, we can use aggregate output to measure welfare in the economy. As expected, we find that welfare declines when all unions become more powerful and increases when trade is liberalized. The effect sizes depend, however, on union heterogeneity. If the bargaining power increases in firms' productivity, the negative welfare effect of unionization is more pronounced. This is driven by the less intense firm selection, which reduces the workers' average productivity and overcompensates the (partial) employment enhancing effect. If the bargaining power decreases in firms' productivity, workers' average productivity increases, so that the reduction of aggregate output is less pronounced. The welfare increasing effect of trade openness is lower (higher) if high-productivity (low-productivity) firms face stronger unions, which is driven by the respective effects on unemployment.

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 and 5, respectively. Section 6 provides the numerical solution, Section 7 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 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.[2]

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 ϕ from a Pareto distribution with $G(\phi) = 1 - (1/\phi)^k$, $g(\phi) = k\phi^{-k-1}$ 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.[3] 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.

The production for the domestic and export market require (overhead) fixed costs F and F_x (measured in units of the final good), respectively. 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

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[2]The specification of the CES-aggregator in Eq. (1) implies that a greater variety of inputs does not affect aggregate output.

[3]As in Melitz (2003) and the majority of follow-up studies, we do not consider the case of export specialization. The reasons are twofold: firstly, from an empirical point of view, this scenario is the exception rather than the rule. Exporters typically serve the domestic market as well (see Melitz and Redding, 2014 for an overview). Secondly, from a theoretical point of view, export specialization can only be implemented by introducing some source of comparative advantage (see, for instance, Bernard et al., 2007), which would highly complicate the model.

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 the 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-bargaining 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. When no agreement is reached, employment and production fall back to zero. By assuming that the strike income of a union member is equal to the expected income, as in Binmore et al. (1986), we get $\overline{U} = 0$ as the union's threat point. Because fixed costs must be covered by firms regardless of their bargaining success, the firm's threat point is given by $\overline{\pi}_t = -F - IF_x$.

2.3 Firm-specific Bargaining Power

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

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

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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.

The parameter $\overline{\gamma}$ is uniform across all unions and captures the policy parameters set at national level, we assume $\partial\gamma(\cdot)/\partial\overline{\gamma} \equiv \gamma_{\overline{\gamma}} > 0$. 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 idea put forward by Dinlersoz et al. (2017) and assume that the bargaining coefficient depends on firm productivity ϕ. The partial derivative $\partial\gamma(\cdot)/\partial\phi \equiv \gamma_{\phi}$ is, however, more difficult to sign.[5]

Dinlersoz et al. (2017) favor the assumption $\gamma_{\phi} > 0$, i.e. high-productivity firms face stronger trade unions than low-productivity firms. They show that the firm's profits π and thus the utility U that a union realizes are an increasing and convex function of ϕ. But, as they also emphasize, the process of unionization is a costly activity (for instance salaries and expenses for the union's representatives, costs for conducting elections) and any union has to balance these costs with the benefits. If the benefits are low (low-productivity firms), it may be optimal for the workers not to organize collectively. Since high-productivity firms are high-rent firms, the incentive to establish and to operate a strong trade union is strong. The models developed by Farber (2015) as well as de Pinto and Lingens (2017) confirm this result. Moreover, Boulhol et al. (2011), Breda (2015) and Dinlersoz et al. (2017) have also found empirical evidence for the assumption $\gamma_{\phi} > 0$.

However, there are some counter-arguments. Because the firm's 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 in firm productivity, so that $\gamma_{\phi} < 0$ may also be a plausible assumption. A similar conclusion can be drawn from the literature on the impact of globalization on the wage bargaining (see, for instance, Zhao, 1998 or Eckel and Egger, 2009). 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 breakdown of the wage bargaining arises. And the higher the perceived probability of a breakdown of the bargaining, the

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[5]Charpe and Kühn (2015) choose a different modeling approach, they assume union bargaining power as random variable and look at the demand and supply effects of shocks in bargaining power coefficient.

lower the bargaining power is. 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. These results are more in line with the hypothesis that high-productivity firms face weak trade unions, i.e. $\gamma_\phi < 0$.

In our modeling approach, we consider both scenarios and, in addition, the benchmark case without union heterogeneity ($\gamma_\phi = 0$). Therefore, the elasticity of the bargaining power with respect to firm productivity, $\epsilon_{\gamma\phi} \equiv \partial\gamma/\partial\phi \cdot \phi/\gamma$, may be positive, zero or negative. To exclude economically meaningless parameter constellations, we assume $|\epsilon_{\gamma\phi}| \leq 1$. Moreover, for $\gamma_\phi > 0$, the cross derivative $\gamma_{\phi\overline{\gamma}} \equiv \partial\gamma_\phi/\partial\overline{\gamma}$ is assumed to be positive, i.e. a given increase in $\overline{\gamma}$ is more severe for high-productivity firms. For $\gamma_\phi < 0$, the cross derivative $\gamma_{\phi\overline{\gamma}}$ is assumed to be negative, a given increase in $\overline{\gamma}$ is more severe for low-productivity firms.

In our simulations of the model, we make use of the following functional form:

$$\gamma = \overline{\gamma}\left(1 + \chi - \frac{2\chi}{\phi}\right), \tag{6}$$

where $\chi = \{1, 0, -1\}$ is an indicator variable. For $\chi = 1$, bargaining power is given by $\gamma_{(\chi=1)} = 2\overline{\gamma}(1 - 1/\phi)$, which implies $\gamma_\phi > 0$. For $\chi = 0$, bargaining power equals $\gamma_{(\chi=0)} = \overline{\gamma}$ and is not affected by firm heterogeneity, $\gamma_\phi = 0$. For $\chi = -1$, bargaining power is given by $\gamma_{(\chi=-1)} = 2\overline{\gamma}/\phi$, so that $\gamma_\phi < 0$. Note that $\overline{\gamma} \leq 0.5$ is assumed to hold if $\chi = 1$, while $2\overline{\gamma} < 1$ has to hold if $\chi = -1$. Note further that the analytical results presented in Section 4 and 5 do not depend on the explicit functional form of the bargaining power given by (6).

2.4 Timing

The timing of events is as follows:

1. Firms decide about market entry, i.e. paying the entry costs 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 varieties are given by:

$$q(\omega) = p(\omega)^{-\sigma}\frac{Y}{M_t}, \tag{7}$$

$$q_{im}(\nu) = p_{im}(\nu)^{-\sigma}\frac{Y}{M_t}, \tag{8}$$

respectively, 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 (7) and (8) yields:

$$p(\phi) = \frac{1}{\rho}\frac{w}{\phi} \qquad \text{and} \qquad p_x(\phi) = \tau p(\phi). \tag{9}$$

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

Inserting (9) into the demand functions yields the profit-maximizing output. Combining output with the production function yields labor demand. These are

given by:

$$q(\phi) = p(\phi)^{-\sigma} \frac{Y}{M_t} \qquad \text{and} \qquad q_x(\phi) = \tau^{-\sigma} q(\phi), \tag{10}$$

$$h(\phi) = \frac{q(\phi)}{\phi} \qquad \text{and} \qquad h_x(\phi) = \tau^{-(\sigma-1)} h(\phi), \tag{11}$$

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:

$$\pi(\phi) = (1 - \rho) \cdot r(\phi) - F \qquad \text{and} \qquad \pi_x(\phi) = (1 - \rho) \cdot r_x(\phi) - F_x. \tag{12}$$

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:

$$w(\overline{\gamma}, \phi) = \theta(\overline{\gamma}, \phi) \cdot b, \tag{13}$$

$$\theta(\overline{\gamma}, \phi) \equiv \frac{\sigma - 1 + \gamma(\overline{\gamma}, \phi)}{\sigma - 1}, \tag{14}$$

with $\theta \geq 1$ representing the wage markup. For $\gamma_\phi > 0$ ($\gamma_\phi < 0$), high-productivity firms pay higher (lower) wages than low-productivity firms, since these firms face more (less) 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 $\epsilon_{\theta\phi} \equiv \partial\theta/\partial\phi \cdot \phi/\theta$, which can be written as:

$$\epsilon_{\theta\phi} = \frac{\epsilon_{\gamma\phi}(\overline{\gamma}, \phi)}{1 + (\sigma - 1)/\gamma(\overline{\gamma}, \phi)}. \tag{15}$$

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 (13), we get:

$$w^e = \theta^e(\overline{\gamma}, \phi_c) \cdot b, \tag{16}$$

$$\theta^e(\overline{\gamma}, \phi_c) = 1 + \frac{1}{\sigma - 1} \gamma^e(\overline{\gamma}, \phi_c), \tag{17}$$

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

The unemployment rate is then given by:

$$u = 1 - \frac{1}{\theta^e(\overline{\gamma}, \phi_c)}. \tag{18}$$

The expected wage markup and the unemployment rate always move in the same direction. From the definition of the unemployment rate, $u = 1 - H/L$, we obtain aggregate employment as $H = (1 - u)L$.

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:

$$\pi(\phi_c) = (1 - \rho) \cdot r(\phi_c) - F = 0, \tag{19}$$

$$\pi_x(\phi_x) = (1 - \rho) \cdot r_x(\phi_x) - F_x = 0. \tag{20}$$

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:

$$\frac{1}{\delta}\left[\int_{\phi_c}^{\infty}\pi(\phi)g(\phi)d\phi + \int_{\phi_x}^{\infty}\pi_x(\phi)g(\phi)d\phi\right] = F_e, \tag{21}$$

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

The zero-profit cutoff conditions (19) and (20) and the free-entry condition (21) 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, we show that these equations can be rearranged to:

$$D \equiv \left(\frac{\theta(\overline{\gamma},\phi_x)}{\theta(\overline{\gamma},\phi_c)}\cdot\frac{\phi_c}{\phi_x}\right)^{\sigma-1} - \tau^{1-\sigma}\frac{F}{F_x} = 0, \tag{22}$$

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

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

$$E^2 \equiv k\left(\frac{\theta(\overline{\gamma},\phi_c)}{\phi_c}\right)^{\sigma-1}\tau^{1-\sigma}\int_{\phi_x}^{\infty}(\theta(\overline{\gamma},\phi))^{1-\sigma}\,\phi^{\sigma-k-2}d\phi - \phi_x^{-k}\frac{F_x}{F}, \tag{23}$$

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 export.[6]

3.4 Aggregate Output

To complete the description of the equilibrium, we have to compute expected income b, aggregate output of the final good Y and the mass of operating firms M_t. As shown

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[6]For a country study on the productivity performance of export market entry and exit see Mallick and Yang (2013).

in Appendix B, we get:

$$b(\overline{\gamma}, \tau) = \left(\frac{\Psi_1(\overline{\gamma}, \tau)}{1 + \alpha(\overline{\gamma}, \tau)} \right)^{\frac{1}{\sigma - 1}}, \tag{24}$$

$$Y(\overline{\gamma}, \tau) = \frac{1 + \alpha(\overline{\gamma}, \tau)}{\Psi_2(\overline{\gamma}, \tau)} H(\overline{\gamma}, \tau), \tag{25}$$

where $\Psi_1(\cdot)$, $\Psi_2(\cdot)$, and $\alpha(\cdot)$ are functions defined in Appendix B.

The equilibrium income b is defined as the expected income which allows workers to buy and consume the final good at the price $P = 1$. Combining (9) and (11) with the definition of aggregate employment delivers aggregate output (25). The term $(1 + \alpha(\cdot))/\Psi_2(\cdot)$ can be interpreted as workers' average productivity. Workers' average productivity is positively correlated with the average productivity of the active firms following from the Pareto distribution, but there is no one-to-one correlation. The direct proportionality breaks down since the wage markup depends on firm productivity.

Aggregate output also measures 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).

Finally, we can use (21) and (25) to pin down the equilibrium mass of operating firms M_t, which also determines M. The equilibrium mass of entrants is then given by $M_e = (1 - G(\phi_c))^{-1} \delta M$.

4 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 implement a strike and/or to organize (see the decisions of the US National Labor Relations Board in the 2010s). In our model, these policies are captured by an increase in $\overline{\gamma}$.

4.1 Firm Selection and Unemployment

If $\overline{\gamma}$ rises, the wage markup and thus the wage rate go up in all firms. In addition, for $\gamma_\phi \neq 0$, the wage distribution across firms widens.

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.*

(iii) *For $\gamma_\phi < 0$, an increase in $\overline{\gamma}$ raises ϕ_c.*

Proof 1

See Appendix C.

On impact, the increase in the wage rate lowers firms' profits. A firm with the initial cutoff productivity now makes losses. For any given market share, Y/M_t, the cutoff productivity ensuring zero profits, ϕ_c, increases. The market share, however, does not remain constant. The free-entry condition states that higher wage payments reduce expected profits, so that fewer firms are willing to enter the market. The market share then increases. As a consequence, firm profits increase, such that ϕ_c can decline.

In the benchmark case $\gamma_\phi = 0$, the increase in the wage rate and thus the decline in profits is identical across firms. Hence, the reduction of expected profits is identical to the profit decline of the marginal firm. 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.

For $\gamma_\phi > 0$, however, the marginal firm faces the lowest wage increase and thus the lowest decline in profits. The wage increase is more pronounced in high-productivity firms, thereby reducing the attractiveness of a high productivity draw. The decline in expected profits exceeds the profit decline of the marginal firm. 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. Consequently, the equilibrium cutoff productivity ϕ_c declines. For $\gamma_\phi < 0$, the sign of the net effect switches. Now, the marginal firm faces the highest wage increase and the highest profit decline. The profit increasing effect of the lower number of entrants falls short of this profit decline, the marginal firm makes losses and the cutoff productivity increases.

In a next step, we derive the (un)employment effects of an increase in $\bar{\gamma}$. As shown in Appendix D, we get:

$$\frac{du}{d\bar{\gamma}} = \frac{1}{\theta^e(\bar{\gamma}, \phi_c)^2} \frac{1}{\sigma - 1} \frac{\partial \gamma^e(\bar{\gamma}, \phi_c)}{\partial \bar{\gamma}} > 0, \tag{26}$$

$$\text{with } 0 < \frac{\partial \gamma^e(\bar{\gamma}, \phi_c)}{\partial \bar{\gamma}} = 1 + \frac{k}{\phi_c(\bar{\gamma})} [\gamma^e(\bar{\gamma}, \phi_c) - \gamma(\bar{\gamma}, \phi_c)] \frac{\partial \phi_c(\bar{\gamma})}{\partial \bar{\gamma}} \leq 1. \tag{27}$$

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 union heterogeneity.

In the absence of union heterogeneity ($\gamma_\phi = 0$), the multiplier $\partial \gamma^e(\cdot)/\partial \bar{\gamma}$ is equal to one, the increase in the unemployment rate reaches a maximum. Suppose instead that $\gamma_\phi > 0$ holds. As stated in Proposition 1 (i), the cutoff productivity ϕ_c decreases ($\partial \phi_c(\bar{\gamma})/\partial \bar{\gamma} < 0$), firm selection becomes less severe and 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. (26), the multiplier $\partial \gamma^e(\cdot)/\partial \bar{\gamma}$ is less than one. Note that the square bracket in Eq. (27) is positive. The marginal firm with ϕ_c faces the least powerful trade union, so that the expected bargaining power $\gamma^e(\cdot)$ exceeds $\gamma(\cdot)$.

The employment enhancing effect of union heterogeneity also holds for $\gamma_\phi < 0$. In this case, low-productivity firms face stronger unions than high-productivity firms. According to Proposition 1 (iii), firm selection becomes more severe ($\partial \phi_c(\bar{\gamma})/\partial \bar{\gamma} >$

0), firms with the most powerful unions have to leave the market. Again, the expected bargaining power γ^e declines, generating a positive employment effect. Note that the square bracket in Eq. (27) turns to negative. The marginal firm with ϕ_c faces the most powerful trade union, so that the expected bargaining power $\gamma^e(\cdot)$ falls short of $\gamma(\cdot)$.

These results are summarized in:

Proposition 2

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

(ii) *Union heterogeneity ($\gamma_\phi \neq 0$) leads to a decline in the expected union bargaining power, mitigating the increase in u.*

Proof 2 See (26), (27) and text.

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 6, we discuss the quantitative importance of this new channel.

4.2   Export Selection

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

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

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 has the lowest wage increase of all exporters. Since the increase in the expected wage markup $\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)$ exceeds the increase in the wage markup of the marginal exporter $\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x)$, the decline in expected export profits exceeds the profit decline of the marginal exporter. 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 ($\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi) < \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x)$) 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.

For $\gamma_\phi < 0$, the effects change their signs. The initial marginal exporter faces a loss because his wage markup $\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x)$ exceeds the expected wage markup $\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)$. The equilibrium export cutoff productivity ϕ_x, c.p., increases ($\Gamma_1 > 0$). Domestic firms, however, are now in a worse bargaining position (compared to exporters), implying that being an exporter becomes more attractive ($\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x) < \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi)$). The equilibrium export cutoff productivity, c.p., decreases ($\Gamma_2 < 0$). The sign of the net effect ($\Gamma_1 + \Gamma_2$) remains ambiguous.

These results are summarized in

Proposition 3

(i) *For $\gamma_\phi = 0$, more powerful trade unions do not affect the export cutoff productivity ϕ_x.*

(ii) *For $\Gamma_1 + \Gamma_2 < 0$ ($\Gamma_1 + \Gamma_2 > 0$), union heterogeneity ($\gamma_\phi \neq 0$) leads to a decrease (an increase) in ϕ_x.*

Proof 3 See Appendix E.

Our numerical simulation of the model (see Section 6) indicates that the sign of $(\Gamma_1 + \Gamma_2)$ and thus the sign of the effect on ϕ_x is not very robust, i.e. the impact of union heterogeneity on the share of exporting firms is highly parameter dependent.

4.3 Aggregate Output

Finally, we discuss the output effects of an increasing $\overline{\gamma}$. Differentiating (25) with respect to $\overline{\gamma}$ yields

$$\frac{dY}{d\overline{\gamma}} = \frac{Y}{H}\frac{\partial H}{\partial \overline{\gamma}} + H\frac{\partial[(1+\alpha)/\Psi_2]}{\partial \overline{\gamma}}.$$

For $\gamma_\phi = 0$, the workers' average productivity, $(1+\alpha)/\Psi_2$, does not depend on $\overline{\gamma}$. Aggregate output declines because of lower aggregate employment H.

If there is union heterogeneity, $\gamma_\phi \neq 0$, the decline in employment and thus the decline in output is, c.p., lower. But union heterogeneity affects workers' average productivity, too. At least two effects have to be mentioned. First, if firm selection becomes less severe ($\gamma_\phi > 0$), the average productivity of the active firms following from the Pareto distribution decreases. This effect reinforces the decline in output. If, instead, ϕ_c increases ($\gamma_\phi < 0$), the increase in the average productivity of active firms counteracts the decline in output from lower employment. Second, because the effect on the equilibrium export cutoff productivity is ambiguous, we do not know whether a larger part of the intermediate goods melts away via iceberg costs.

Unfortunately, we are not able to sign the net effect on output analytically. In our numerical solution (see Section 6), however, we find that an increase in $\overline{\gamma}$ reduces aggregate output in all specifications studied. We have not found a specification where the increase in workers' average productivity overcompensates the decline in employment.

5 Trade Liberalization

How does trade liberalization, measured by a reduction of variable trade costs τ, affect equilibrium outcomes?[7] In this section, we tackle this question and highlight the role of union heterogeneity.

5.1 Firm and Export Selection

With respect to firm and export selection, we extend the finding of Melitz (2003).

Proposition 4

Even in the presence of union heterogeneity ($\gamma_\phi \neq 0$), trade liberalization raises ϕ_c and reduces ϕ_x.

Proof 4 See Appendix F.

A reduction of variable trade costs strengthens competition. Imported varieties become cheaper and, because of higher 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.

5.2 Unemployment and Aggregate Output

Concerning the unemployment rate u, we get:

Proposition 5

(i) *For $\gamma_\phi > 0$, trade liberalization raises the unemployment rate.*

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

---

[7]We do not distinguish between a reduction in iceberg transport costs and a cut in tariffs. In particular, we ignore changes in tariff revenues, which may affect the equilibrium. To justify this assumption, we refer to Arkolakis et al. (2012), who show that welfare gains of a trade liberalization does not (quantitatively or qualitatively) depend on whether tariffs or trade costs are reduced. For a discussion of this result see Felbermayr et al. (2015).

(iii) For $\gamma_\phi < 0$, trade liberalization reduces the unemployment rate.

Proof 5

Differentiating (17) and (18) 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 $\partial \phi_c / \partial \tau < 0$. For $\gamma_\phi > 0$, we have $\partial \gamma^e / \partial \phi_c > 0$, which implies $du/d\tau < 0$. For $\gamma_\phi = 0$, we get $\partial \gamma^e / \partial \phi_c = 0$ and thus $du/d\tau = 0$. For $\gamma_\phi < 0$, we observe $\partial \gamma^e / \partial \phi_c < 0$, so that $du/d\tau > 0$.

Trade liberalization leads to a sharper firm selection, the least productive firms leave the market. Without union heterogeneity, the change in firm selection has no effect on the unemployment rate because expected union bargaining power does not vary. For $\gamma_\phi > 0$, unions in the least productive firms have less than average bargaining power. As these firms are driven out of the market, the expected bargaining power of the remaining unions increases, which raises the expected wage markup and the unemployment rate. For $\gamma_\phi < 0$, in contrast, unions' bargaining power is highest in the least productive firms. A sharper firm selection implies then that the expected bargaining power of the remaining unions decreases such that u declines.

Similar to fair wage preferences (see Egger and Kreickemeier, 2009) and search and matching frictions (see Helpman and Itskhoki, 2010), union heterogeneity constitutes an employment effect of trade liberalization. Unfortunately, even the sign of the employment effect very much depends on seemingly slight modifications in the modeling of the labor market.

Finally, we again discuss the implications for aggregate output. Differentiating (25) with respect to τ yields:

$$\frac{dY}{d\tau} = \frac{Y}{H} \frac{\partial H}{\partial \tau} + H \frac{\partial [(1 + \alpha)/\Psi_2]}{\partial \tau}.$$

There are two effects. First, employment adjusts (see Proposition 4). Second, the workers' average productivity is affected via three channels: a) Firm selection

becomes more severe, the average productivity of the active firms and thus, c.p., the average productivity of the workers increase. b) The lowering of the trade costs improves the average productivity of the workers, since a lower fraction of the intermediate goods melts away. c) The decline in the export cutoff productivity means that a larger fraction of firms is engaged in export sales. This at least partly offsets the decline in iceberg costs and the corresponding increase in workers' average productivity. The overall effect of lower trade costs on output cannot be signed analytically. However, our simulations in the next section indicate that aggregate output will (most probably) increase. We have not found any specification with a negative overall output effect.

6   Numerical Solution

In the previous sections, we determined analytically how a simultaneous increase in the bargaining power of all unions and trade liberalization affect firm and export selection and the unemployment rate in the presence of union heterogeneity. To analyze the quantitative importance of our results and to calculate the sign of the effects on aggregate output (which we could not do analytically), we solve our model numerically.

6.1   Parameter Choice

Our calibration is based on parameter values predominant in the literature. In our main specification, we rely on the study by Bernard et al. (2007) and set $\sigma = 3.8$, $\delta = 0.025$, $\tau = 1.3$ and $F_e = 2$. These values are also used by Balistreri et al. (2011) who structurally estimate a Melitz (2003) type model. In their preferred specification, they find that the shape parameter of the Pareto distribution is given by $k = 4.6$. In addition, average values of estimated fixed costs of production and export in the US and Europe are equal to $F = 0.25$ and $F_x = 0.22$, respectively. We set these values accordingly.

The union's bargaining power is determined by (6). Note that $\chi = 1$ refers to the

scenario where strong unions bargain with high-productivity firms ($\gamma_\phi > 0$), while $\chi = -1$ implies that unions which face low-productivity firms are more powerful ($\gamma_\phi < 0$). The benchmark case $\gamma_\phi = 0$ is depicted by $\chi = 0$. To construct a reference point in our calculations, we assume that the union's bargaining power is equal to 0.4 if $\chi = 0$, i.e. $\bar{\gamma}_{\chi=0} = 0.4$. This is in accordance with the corresponding literature (see Table 1). The first column of Table 2 provides an overview of the parameter choice in our main specification.

	Main Specification	Robustness I	Robustness II
σ	3.8	3.8	5
δ	0.025	0.025	0.025
τ	1.3	1.3	1.3
F_e	2	2	2
k	4.6	5.17	4.6
F	0.25	0.4	0.25
F_x	0.22	1	0.22
$\bar{\gamma}_{\chi=0}$	0.4	0.4	0.4

Table 2: Parameter Choice

As robustness checks, we consider two additional scenarios. First, Balistreri et al. (2011) find also support for different values of k, F and F_x, which we take into account, too. Second, there is some variation regarding the value of the price elasticity in the literature, implying that also higher values of σ are reasonable. The columns 2 and 3 of Table 2 refer to the two alternative specifications, where the changes (relative to the main specification) are in italic.

6.2 Results

Let us first look at the effects of an increase in $\bar{\gamma}$. To compare the $\chi = 1$ and $\chi = -1$ scenarios with our benchmark case $\chi = 0$, we assume that the expected bargaining power is initially identical, i.e.

$$\gamma^e_{\chi=1} = \gamma^e_{\chi=-1} = \gamma^e_{\chi=0} = \bar{\gamma}_{\chi=0} = 0.4.$$

To ensure this, we set $\bar{\gamma}_{\chi=1} = 0.42$ and $\bar{\gamma}_{\chi=-1} = 0.43$. We subsequently consider a 10% increase of $\bar{\gamma}_{\chi=1}$, of $\bar{\gamma}_{\chi=0}$ and $\bar{\gamma}_{\chi=-1}$ and analyze how the equilibrium outcomes

are affected. For instance, $\Delta\phi_c(\chi = 1)$ measures the resulting percentage change of the cutoff productivity if high-productivity firms face stronger unions.

Table 3 (column 1) reports our findings in the main specification. As shown in Proposition 1, ϕ_c decreases (increases) if $\chi = 1$ ($\chi = -1$). The percentage change, however, is moderate (-0.64% and 0.49% respectively). We also see that union heterogeneity always has an employment enhancing effect (see Proposition 2). In the benchmark case $\chi = 0$, unemployment increases by about 8.64%, while this increase is about 7.96% (8.19%) if $\chi = 1$ ($\chi = -1$). As such, allowing the bargaining power to be firm-specific leads to a significant lower increase in u.

Interestingly, aggregate output declines for all $\chi \in \{-1, 0, 1\}$. In the benchmark case $\chi = 0$, the reduction is solely driven by the negative employment effect. In the presence of union heterogeneity, the decline in employment is lower, and the workers' average productivity is affected. For $\chi = 1$, the decline in workers' average productivity exceeds the employment enhancing effect, so that the reduction in Y is strengthened. For $\chi = -1$, in contrast, the workers' average productivity increases, which, in addition to the employment enhancing effect, weakens the decline in aggregate output.

Table 3: Labor Market Policy

	Main Specification	Robustness I	Robustness II
$\Delta\phi_c(\chi = 1)$	-0.64	-0.62	-0.39
$\Delta\phi_c(\chi = 0)$	0	0	0
$\Delta\phi_c(\chi = -1)$	0.49	0.41	0.64
$\Delta\phi_x(\chi = 1)$	-0.21	0.36	-0.25
$\Delta\phi_x(\chi = 0)$	0	0	0
$\Delta\phi_x(\chi = -1)$	0.30	-0.06	0.49
$\Delta u(\chi = 1)$	7.96	7.87	8.77
$\Delta u(\chi = 0)$	8.64	8.64	9.00
$\Delta u(\chi = -1)$	8.19	8.26	8.38
$\Delta Y(\chi = 1)$	-1.73	-1.82	-1.25
$\Delta Y(\chi = 0)$	-1.23	-1.23	-0.90
$\Delta Y(\chi = -1)$	-0.80	-0.82	-0.29

The alternative specifications in columns 2 and 3 of Table 3 show that the aforementioned results are robust. One further insight is important: through all con-

sidered specifications, the sign of the effect on the export cutoff productivity ϕ_x changes several times. This is in line with Proposition 3 and highlights that the consequences for the share of exporting firms are highly parameter dependent.

Table 4: Trade Liberalization

	Main Specification	Robustness I	Robustness II
$\Delta\phi_c(\chi = 1)$	4.37	1.31	4.16
$\Delta\phi_c(\chi = 0)$	4.24	1.62	4.01
$\Delta\phi_c(\chi = -1)$	4.14	1.87	3.80
$\Delta\phi_x(\chi = 1)$	-23.30	-24.47	-21.48
$\Delta\phi_x(\chi = 0)$	-20.29	-22.29	-20.46
$\Delta\phi_x(\chi = -1)$	-18.10	-20.43	-18.97
$\Delta u(\chi = 1)$	4.52	1.52	2.35
$\Delta u(\chi = 0)$	0	0	0
$\Delta u(\chi = -1)$	-3.49	-1.61	-3.35
$\Delta Y(\chi = 1)$	3.39	2.75	3.53
$\Delta Y(\chi = 0)$	3.45	3.38	3.49
$\Delta Y(\chi = -1)$	3.78	3.87	3.52

Regarding trade liberalization, we compare an economy with high variable trade costs ($\tau = 1.7$) to an economy with low variable trade costs ($\tau = 1.3$). Again, we assume that the expected bargaining power is initially identical for all $\chi \in \{-1, 0, 1\}$ and set $\overline{\gamma}_{\chi=1} = 0.49$ respectively $\overline{\gamma}_{\chi=-1} = 0.41$. We subsequently calculate the percentage change of the equilibrium outcomes when trade is liberalized. $\Delta\phi_c(\chi = 1)$, for instance, denotes the percentage change of the cutoff productivity due to the reduction of trade costs from $\tau = 1.7$ to $\tau = 1.3$ if high-productivity firms face strong unions.

The results in our main specification are illustrated in column 1 of Table 4. As proved in Proposition 4, ϕ_c (ϕ_x) increases (decreases). Union heterogeneity does not alter the sign of this standard finding but changes its magnitude. For example, the export cutoff productivity decreases by about 23.3% if high-productivity firms bargain with strong unions ($\chi = 1$), while the reduction is lower (18.1%) if low-productivity firms face strong unions ($\chi = -1$). In addition, unemployment is only affected by trade liberalization if union heterogeneity is taken into account (see Proposition 5). The size of the effects is substantial. In case of $\chi = 1$ ($\chi = -1$), u

increases (decreases) by about 4.52% (3.49%). Finally, aggregate output increases for all $\chi \in \{-1, 0, 1\}$, i.e. trade liberalization has a welfare enhancing effect. Union heterogeneity reduces or raises this effect because of the respective implications for the unemployment rate.

Our alternative specifications (columns 2 and 3 of Table 4) show that these results are quite robust, also quantitatively. Only when we vary the values of F, F_x and k (robustness I) are the effects lower but still sizable.

7 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 (firm-level) unions differ with respect to their bargaining power across the firm distribution. We therefore incorporate union heterogeneity into a Melitz (2003) type model and reassess the impact of unionization and trade liberalization.

In our framework, union heterogeneity mitigates the negative employment effects of stronger trade unions, since the impact on the entry and exit of firms is no longer neutral for the expected union bargaining power. We show that the expected union bargaining power unambiguously declines, so that union heterogeneity, c.p., enhances employment. In a similar vein, trade liberalization is no longer neutral for the unemployment rate, lower trade costs affects the expected union bargaining power through the entry and exit of firms. If unions are most powerful in high-productivity (low-productivity) firms, unemployment increases (decreases). Our numerical solution indicates that these effects are quantitatively important.

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. Also focusing on the labor market, 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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Appendix

A Derivation of (22) and (23)

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 (9) and the bargained wage (13) 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 (22).

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 (9) and the bargained wage (13) 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:

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

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

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 (23).

B Derivation of (24) and (25)

To compute the expected income b, we make use of the definition of the price index P:

$$P = M_t^{\frac{1}{\sigma-1}} \left[\int_{\phi_c}^{\infty} p(\phi)^{1-\sigma} \frac{M}{1 - G(\phi_c)} g(\phi) d\phi + \int_{\phi_x}^{\infty} p_x(\phi)^{1-\sigma} \frac{M_x}{1 - G(\phi_x)} g(\phi) d\phi \right]^{-\frac{1}{\sigma-1}}.$$

Using the Pareto distribution and setting $P = 1$ leads to:

$$M_t = M \phi_c^k k \int_{\phi_c}^{\infty} p(\phi)^{1-\sigma} \phi^{-k-1} d\phi + M_x \phi_x^k k \int_{\phi_x}^{\infty} p_x(\phi)^{1-\sigma} \phi^{-k-1} d\phi. \qquad \text{(B.1)}$$

Next, we can define the ex-ante probability that a firm exports as (see Egger and Kreickemeier, 2009):

$$\alpha(\phi_c, \phi_x) \equiv \frac{1 - G(\phi_x)}{1 - G(\phi_c)} = \left(\frac{\phi_c}{\phi_x}\right)^k, \tag{B.2}$$

such that the mass of exporters is given by $M_x = \alpha M$. Inserting $M_t = M + M_x$, $M_x = \alpha M$, $p_x(\phi) = \tau p(\phi)$ and the optimal price (9) into (B.1) yields:

$$1 + \alpha = \phi_c^k k \int_{\phi_c}^{\infty} \left(\frac{1}{\rho}\frac{w}{\phi}\right)^{1-\sigma} \phi^{-k-1} d\phi + \alpha \phi_x^k k \int_{\phi_x}^{\infty} \left(\tau\frac{1}{\rho}\frac{w}{\phi}\right)^{1-\sigma} \phi^{-k-1} d\phi.$$

Inserting the bargained wage (13) and noting $\alpha \phi_x^k = \phi_c^k$, we obtain:

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

Rearranging implies

$$b = \left(\frac{\Psi_1(\overline{\gamma}, \tau)}{1 + \alpha}\right)^{\frac{1}{\sigma-1}},$$

$$\Psi_1(\overline{\gamma}, \tau) \equiv \rho^{\sigma-1} \phi_c^k k \left[\int_{\phi_c}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi + \tau^{1-\sigma} \int_{\phi_x}^{\infty} (\theta(\overline{\gamma}, \phi))^{1-\sigma} \phi^{\sigma-k-2} d\phi\right],$$

which coincides with (24).

To compute aggregate output Y, we make use of the definition of aggregate employment:

$$H \equiv \frac{M}{1 - G(\phi_c)} \int_{\phi_c}^{\infty} h(\phi)g(\phi)d\phi + \frac{M_x}{1 - G(\phi_x)} \int_{\phi_x}^{\infty} h_x(\phi)g(\phi)d\phi.$$

By inserting $q(\phi) = \phi h(\phi)$, $h_x(\phi) = \tau^{1-\sigma} h(\phi)$ and the demand function (7), we arrive at:

$$H \equiv \frac{M}{\phi_c^{-k}} k \int_{\phi_c}^{\infty} \frac{1}{\phi} p(\phi)^{-\sigma} \frac{Y}{M_t} \phi^{-k-1} d\phi + \frac{M_x}{\phi_x^{-k}} k \int_{\phi_x}^{\infty} \tau^{1-\sigma} \frac{1}{\phi} p(\phi)^{-\sigma} \frac{Y}{M_t} \phi^{-k-1} d\phi$$

$$= Y \phi_c^k \frac{M}{M_t} k \int_{\phi_c}^{\infty} p(\phi)^{-\sigma} \phi^{-k-2} d\phi + Y \phi_x^k \frac{M_x}{M_t} k \tau^{1-\sigma} \int_{\phi_x}^{\infty} p(\phi)^{-\sigma} \phi^{-k-2} d\phi.$$

Observing $M_t = M + M_x$ and $M_x = \alpha M$ as well as $\alpha \phi_x^k = \phi_c^k$, we get:

$$H = Y \frac{\phi_c^k}{1+\alpha} k \left[\int_{\phi_c}^{\infty} p(\phi)^{-\sigma} \phi^{-k-2} d\phi + \tau^{1-\sigma} \int_{\phi_x}^{\infty} p(\phi)^{-\sigma} \phi^{-k-2} d\phi \right].$$

Solving for Y leads to:

$$Y = \frac{1+\alpha}{\Psi_2(\overline{\gamma}, \tau)} H,$$

$$\Psi_2(\overline{\gamma}, \tau) \equiv k \phi_c^k \left[\int_{\phi_c}^{\infty} p(\phi)^{-\sigma} \phi^{-k-2} d\phi + \tau^{1-\sigma} \int_{\phi_x}^{\infty} p(\phi)^{-\sigma} \phi^{-k-2} d\phi \right],$$

which matches to (25).

C   Proof of Proposition 1

Totally differentiating (22) and (23) and using Cramer's rule yields:

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

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

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

$$E_{\phi_x}^1 = 0, \tag{C.3}$$

$$E_{\overline{\gamma}}^1 = k(\sigma-1) \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \frac{1}{\overline{\gamma}} \times \\ (\epsilon_{\theta\overline{\gamma}}(\phi_c) - \epsilon_{\theta\overline{\gamma}}(\phi_x)) \int_{\phi_c}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma-1} \phi^{-k-1} d\phi, \tag{C.4}$$

$$E_{\phi_c}^2 = - \underbrace{(1 - \epsilon_{\theta\phi}(\overline{\gamma}, \phi_c))}_{>0} k(\sigma-1) \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \frac{1}{\phi_c} \tau^{-(\sigma-1)} \times \\ \int_{\phi_x}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma-1} \phi^{-k-1} d\phi < 0, \tag{C.5}$$

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$$E_{\phi_x}^2 = k\phi_x^{-k-1}\tau^{-(\sigma-1)} \left(\frac{\tau^{\sigma-1}F_x}{F} - \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\theta(\overline{\gamma}, \phi_x)} \frac{\phi_x}{\phi_c} \right)^{\sigma-1} \right) = 0, \tag{C.6}$$

$$E_{\overline{\gamma}}^2 = k(\sigma-1) \left(\frac{\theta(\overline{\gamma}, \phi_c)}{\phi_c} \right)^{\sigma-1} \frac{1}{\overline{\gamma}} \tau^{-(\sigma-1)} \times$$
$$(\epsilon_{\theta\overline{\gamma}}(\phi_c) - \epsilon_{\theta\overline{\gamma}}(\phi_x)) \int_{\phi_x}^{\infty} \left(\frac{\phi}{\theta(\overline{\gamma}, \phi)} \right)^{\sigma-1} \phi^{-k-1} d\phi. \tag{C.7}$$

This implies $E_{\phi_c} = E_{\phi_c}^1 + E_{\phi_c}^2 < 0$ and $E_{\phi_x} = E_{\phi_x}^1 + E_{\phi_x}^2 = 0$. The partial derivatives of D are given by:

$$D_{\phi_c} = \frac{\sigma-1}{\phi_c} \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\theta(\overline{\gamma}, \phi_c)} \frac{\phi_c}{\phi_x} \right)^{\sigma-1} (1 - \epsilon_{\theta\phi}(\overline{\gamma}, \phi_c)) > 0, \tag{C.8}$$

$$D_{\phi_x} = -\frac{\sigma-1}{\phi_x} \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\theta(\overline{\gamma}, \phi_c)} \frac{\phi_c}{\phi_x} \right)^{\sigma-1} (1 - \epsilon_{\theta\phi}(\overline{\gamma}, \phi_x)) < 0, \tag{C.9}$$

$$D_{\overline{\gamma}} = \frac{\sigma-1}{\overline{\gamma}} \left(\frac{\theta(\overline{\gamma}, \phi_x)}{\theta(\overline{\gamma}, \phi_c)} \frac{\phi_c}{\phi_x} \right)^{\sigma-1} (\epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_x) - \epsilon_{\theta\overline{\gamma}}(\overline{\gamma}, \phi_c)). \tag{C.10}$$

Given the partial derivatives, we obtain $\Upsilon = D_{\phi_c}E_{\phi_x} - D_{\phi_x}E_{\phi_c} < 0$.

For $\gamma_\phi > 0$, the wage markup of the marginal exporter exceeds the wage markup of the marginal firm, so that $\varepsilon_{\theta\gamma}(\phi_c) - \varepsilon_{\theta\gamma}(\phi_x) < 0$. Hence, we get $E_\gamma^1 < 0$, $E_\gamma^2 < 0$, $E_\gamma = E_\gamma^1 + E_\gamma^2 < 0$ and $D_\gamma > 0$, implying $\frac{d\phi}{d\gamma} = (-D_{\overline{\gamma}}E_{\phi_x} + D_{\phi_x}E_{\overline{\gamma}})/\Upsilon < 0$. For the benchmark case $\gamma_\phi = 0$, the wage markup does not depend on ϕ, so that $\varepsilon_{\theta\gamma}(\phi_c) - \varepsilon_{\theta\gamma}(\phi_x) = 0$. This leads to $E_\gamma = 0$ and $\frac{d\phi}{d\gamma} = 0$. For $\gamma_\phi < 0$, the marginal firm faces the highest wage increase, we now have $\varepsilon_{\theta\gamma}(\phi_c) - \varepsilon_{\theta\gamma}(\phi_x) > 0$ and thus $E_\gamma > 0$ and $\frac{d\phi}{d\gamma} = (-D_{\overline{\gamma}}E_{\phi_x} + D_{\phi_x}E_{\overline{\gamma}})/\Upsilon > 0$.

D   Proof of Proposition 2

Differentiating (17) and (18) 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:

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

with the derivative

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

Applying the Leibniz rule leads to:

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

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

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

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:

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

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

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

E   Proof of Proposition 3

Totally differentiating (22) and (23) and using Cramer's rule yields:

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

(E.1)

For $\gamma_\phi = 0$, we have $D_{\overline{\gamma}} = E_{\overline{\gamma}} = 0$ and thus $d\phi_x/d\overline{\gamma} = 0$. For $\gamma_\phi \neq 0$, 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:

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

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

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

The sign of the multiplier $\frac{d\phi_x}{d\overline{\gamma}}$ corresponds to the sign of $(\Gamma_1 + \Gamma_2)$, which we cannot determine unambiguously. This proves Proposition 3.

F   Proof of Proposition 4

Totally differentiating (22) and (23) and using Cramer's rule yields:

$$\frac{d\phi_c}{d\tau} = \frac{1}{\Upsilon}(-D_\tau E_{\phi_x} + D_{\phi_x}E_\tau),$$

(F.1)

$$\frac{d\phi_x}{d\tau} = \frac{1}{\Upsilon}(-D_{\phi_c}E_\tau + D_\tau E_{\phi_c}).$$

(F.2)

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

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

(F.3)

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

(F.4)

Because $E_{\phi_x} = 0$, $D_{\phi_x} < 0$ and $\Upsilon < 0$, we find that $d\phi_c/d\tau < 0$. With respect to the sign of (F.2), we have to insert the partial derivatives. Rearranging the resulting expression implies:

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

(F.5)

which proves the Proposition.