Trade Unions in an Open Economy – the Case of Firm-specific Bargaining Power

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Abstract

The bargaining power of trade unions is not identical across firms. The empirical evidence suggests that large and productive firms face stronger trade unions than small and less productive firms. Using a Melitz-type model, we reconsider the impact of unionization on the macroeconomic performance of an economy. For a closed economy, we show that, (i) due to a strong deterrence of market entry, more powerful trade unions lower the equilibrium cutoff productivity, (ii) more powerful unions may be good for aggregate employment; (iii) but reduce aggregate output. In the open-economy setting, our focus is on trade liberalization. In a world with uniform (firm-specific) bargaining power, lower trade costs are neutral for (increase) the unemployment rate. Aggregate output always goes up.

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

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1 Introduction

Our work is motivated by the observation that there is a positive relationship between union density and firm size. In Germany, for instance, the fraction of the workforce organized in a trade union increases from 7.6 percent for firms with less than 10 employees to 33.7 percent for firms with more than 2000 employees (Biebeler and Lesch, 2007). Using union membership rates as a proxy for unions’ bargaining power, we conclude from the empirical literature that unions’ bargaining power is increasing in firm size. Since firm size is strongly correlated with firm productivity, we further conclude that high productivity firms will face strong trade unions. In a Melitz-world, where the most productive firms are exporters, the export status of a firm should thus go hand in hand with a strong trade union. This is confirmed by Agell (2002), who, uses data for 20 OECD countries and shows that trade openness is positively and significantly correlated with union density.

In the present study, we design a general equilibrium model to reconsider the impact of trade unions on the macroeconomic performance of an open economy. How does the wage bargain affect variables such as wages, employment, output, exports, and number of active (exporting) firms? The point of departure from the literature is the endogeneity of the bargaining power coefficient; the unions’ bargaining power is firm-specific. More precisely, the bargaining power coefficient is assumed to be increasing in the level of firm productivity. Our results indicate that such a firm-specific split of the quasi-rents allows for new insights into the impact of the unionization in an open economy.

The theoretical literature offers some explanations for the described empirical regularity and these explanations may serve as a microeconomic rationale for the endogeneity of the bargaining strength. Agell (2002) argues that the process of globalization increases the fraction of the workforce that faces uncertainty about their future position in the wage distribution. As a consequence, risk averse workers demand more social insurance, whereby joining a redistributive trade union becomes incentivized. Breda (2015) emphasizes the costs paid by workers to organize at the firm level, which include sunk costs invested in the organization process, costs of getting union recognition, and costs of the work invested by union representatives. The incentive to bear these costs and thus to secure union bargaining power is increasing in the prospects of rent-extraction. The higher the firm productivity, the higher are the firms quasi-rents, and the higher is the incentive for workers to increase their bargaining power.

We replace efficiency wages by a wage bargain at the firm-level. The union bargaining strength is divided into a minimum level, which is identical across all trade unions, and a firm-specific part, which is increasing in firm productivity. Our focus is on the question how an increase in the minimum level of trade union power affects the general equilibrium. To highlight the quantitative importance of our findings, we also solve our model numerically using standard parameter values from the literature.

Our main results are as follows. (i) An increase in the minimum union bargaining power reduces the cutoff productivity (Melitz lottery) and increases the share of low-productivity firms in the economy. Intuitively, there are two countervailing forces. On the one hand, more powerful unions push up the wage level. Firms increase their prices, product demand declines, revenues decline, profits decline, and the cutoff productivity goes up. On the other hand, given the reduction of profits, the mass of firms entering the market decreases. Competition becomes less intense which in turn raises demand, revenues and profits of the incumbents. This effect decreases the cutoff productivity. If the unions bargaining power depends positively on the firms productivity, the latter effect dominates.\textsuperscript{1} A corollary of this finding: the export cutoff decreases too so that the share of exporting firms shifts up.

(ii) The increase in the bargaining power raises unemployment (as it is well documented by the literature) but the negative employment effect is weakened by the decline in the cutoff productivity. In the benchmark case where all unions have the same bargaining power, more powerful trade unions lead to a decline in aggregate employment via a decline in the mass of active firms. In our setting, the decline in the mass of firms is smaller, so that the decline in aggregate employment (increase in unemployment) is smaller. (iii) Regarding aggregate output (which also measures welfare in our model), we find the opposite result. Aggregate output declines in the bargaining power but this reduction is stronger in the case of firm-specific bargaining power. This is a direct consequence of the decline in the cutoff productivity, which reduces the average productivity of the incumbents such that output decreases even further (even if the negative employment effect is less pronounced).

Our paper is related to the strand of literature that investigates the role of unionization in an open economy setting. Some studies, for instance, Koskela and Stenbacka (2009), Lommerud et al. (2009) and Zhao (1995), focus on the effect of unionization on outsourcing. Similarly, Eckel and Eg-

\textsuperscript{1}In the benchmark case where all firms have the same bargaining power, both effects cancel each other out such that the cutoff productivity and thus firm-selection is unaffected by the unions bargaining power (see de Pinto and Michaelis, 2014 for this result).
ger (2009) analyze the interaction between collective bargaining and foreign direct investment. The relationship between collective bargaining and the macroeconomic performance in a trade-liberalized economy (mostly focusing on trade in goods) is also analyzed from various perspectives. For example, Kreickemeier and Meland (2013) investigate how trade liberalization affects wages, employment and welfare with (partly) unionized labor markets. Montagna and Nocco (2013) study the effect of different union bargaining levels on the competition between heterogeneous firms. Most recently, Egger et al. (2015) analyze the influence of unionization on inter-industry trade and welfare in a situation where differences in the degree of unionization between countries imply comparative advantages. All these studies focus on the role of unions bargaining power. However, at least to the best of our knowledge, no study considers the empirical regularity that union bargaining power differs across firms. The present paper aims to fill this gap.

2 Model

2.1 Production

We consider an open economy model with two symmetric countries. Each economy consists of two sectors: a final goods sector and an intermediate goods sector. In the final goods sector, markets are perfectly competitive and the final good $Y$ is given by a CES-aggregator over all available intermediate goods:

$$Y = M_t^{-\frac{1}{\sigma}} \left[ \int_0^M q(\omega)^{\rho} d\omega + \int_0^{M_m} q_m(\nu)^{\rho} d\nu \right]^{\frac{1}{\rho}}.$$  \hspace{1cm} (1)

$M$ ($M_m$) denotes the mass of varieties produced in the home (foreign) country. The mass of all available varieties is given by $M_t = M + M_m$. $q(\omega)$ represents the used quantity of variety $\omega$, which is produced in the home country, while $q_m(\nu)$ stands for the imported quantity of variety $\nu$, which is produced in the foreign country. $\rho \equiv \sigma/(\sigma - 1)$ measures the 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.

\footnote{As we introduce labor market imperfections into an intra-industry trade model with heterogeneous firms, our paper also contributes to the large and still growing strand of literature in which the Melitz (2003) framework is extended by different frictions. For the implementation of efficiency wages see, for instance, Amiti and Davis (2012), Davis and Harrigan (2011) and Egger and Kreickemeier (2012). For the use of search and matching frictions compare Helpman and Itskhoki (2010) as well as Helpman et al. (2010).}
In the intermediate goods sector, firms have to bear fixed costs $F_e$ (measured in units of the final good) to enter the market. After entry, firms draw a productivity level from a Pareto distribution with $G(\phi) = 1 - \phi^{-k}$ and the support $\phi \in [1, \infty]$, where $k$ denotes the shape parameter of the distribution. 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 $\tau \geq 1$: $q_x = \tau^{-1} \phi h_x$. Firms can either produce only for the domestic market or serve the home and foreign market. Total output and employment are given by, respectively; $q_t = q + I q_x$ and $h_t = h + I h_x$, 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, respectively (see Melitz, 2003):

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

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

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 $\pi_t = \pi + I \pi_x$.

The goods market in the intermediate goods sector is monopolistic competitive and each firm produces one variety of the intermediate good.

### 2.2 Workers

Both countries are endowed with a mass of identical workers $L$. Workers inelastically supply one unit of labor at the intermediate goods sector. We assume that labor units are internationally immobile.

Workers’ expected income is defined as $b = u B + (1 - u) w^e$, where $u \in [0, 1]$ denotes the unemployment rate, $B$ stands for lump-sum tax financed unemployment benefits and $w^e$ is the workers’ expected wage rate. We assume that $B$ is a constant share $s$ on the expected wage rate, i.e. $B = s w^e$, with $s \in (0, 1)$. This yields:

$$b = (1 - (1 - s) u) w^e.$$
2.3 Unions

We assume that labor markets in both countries are unionized, i.e. we do not consider an endogenous union formation. We further suppose that unions act at the firm-level and consider post-entry closed-shop unions, i.e. workers who are hired at one particular firm must become a member of the respective union. The utility function of the union is given by:

\[ U = h_t w + (m - h_t)b, \]  

with \( m(> h_t) \) being the union’s membership.

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 \( N = (U - U)\gamma (\pi_t - \pi_t)^{1-\gamma} \), where \( \gamma \in [0, 1] \) denotes the union’s bargaining power, \( U = mb \) is the union’s and \( \pi_t = -F - IF_x \) is the firm’s outside option.

It is commonly assumed in the literature that the union’s bargaining strength is equal across firms. We pursue a different approach and assume that the bargaining power is divided into two components: a parameter \( \bar{\gamma} \), which is identical across all trade unions, and a firm-specific part, which is increasing in firm productivity. Formally, we assume:

\[ \gamma(\phi, \bar{\gamma}) = \bar{\gamma} (1 - \chi \phi^{-1}) \],

where \( \chi \) is an indicator variable. If \( \chi = 0 \), bargaining power depends only on \( \bar{\gamma} \). If \( \chi = 1 \), bargaining power increases in productivity. Note that \( \bar{\gamma} \) can be interpreted as the bargaining power of the most productive firm because \( 1 - \phi^{-1} \to 1 \) if \( \phi \to \infty \).

2.4 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. Conditional on entry, firms decide about 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.
3 Closed Economy

In this section, we analyze the consequences of collective bargaining without trade, i.e. we assume $I = 0$ and $M_t = M$.

3.1 Partial Equilibrium

The partial equilibrium is determined by solving the aforementioned game by backwards induction and taking the macroeconomic variables $b$ and $M$ as given. At stage four, the final goods producer maximizes $Y$ (which is equal to its profits) by choosing $q(\omega)$ subject to $PY = \int_0^M q(\omega)p(\omega)d\omega$. Using the autarky level of (1) yields:

$$q(\omega) = p(\omega)^{-\frac{\sigma}{\gamma}}Y.$$ (7)

Firms in the intermediate goods sector maximize profits over $p$ subject to the final goods producer’s demand (7) at the third stage. Due to the CES assumption, profit-maximizing prices are a constant mark-up over (firm-specific) variable costs:

$$p(\phi, w) = \frac{1}{\rho} w \phi.$$ (8)

Inserting (8) into (7) leads to the profit-maximizing output $q(\phi, w) = p(\phi, w)^{-\sigma}Y/M$. This pins down labor demand as $h(\phi, w) = \phi^{-1} p(\phi, w)^{-\sigma}Y/M$. Revenues are defined as $r(\phi, w) = q(\phi, w)p(\phi, w)$ and the profit function reads:

$$\pi(\phi, w) = (1 - \rho)r(\phi, w) - F.$$ (9)

The Nash-wage bargaining takes place at stage two. Maximizing the Nash-product over $w$ subject to the firm’s optimal choices at stage three leads to the bargained wage:

$$w(\phi) = \theta(\phi, \gamma)b,$$ (10)

$$\theta(\phi, \gamma) \equiv \frac{\sigma - 1 + \gamma(\phi, \gamma)}{\sigma - 1} > 1,$$ (11)

with $\theta$ representing the wage markup.

Lemma 1 For $\chi = 1$, the bargained wage is increasing in the firm’s productivity because high-productive firms face unions with higher bargaining power, which bargain higher wage-markups. For $\chi = 0$, wages are identical for all firms because unions have the same bargaining power and bargain the same wage markup.
At stage one, firms enter the market as long as expected profits are high enough to cover entry costs. Due to free entry, we get:

\[ \frac{1}{\delta} \int_1^\infty (1 - \rho) (r(\phi, w(\phi)) - F) dG(\phi) = F_e, \]  

(12)

where \( \delta \) denotes the exogenously given death probability of firms. Once a firm has entered the market and received a productivity, it starts producing if and only if profits are non-negative. The marginal firm with productivity \( \tilde{\phi} \) has zero-profits:

\[ (1 - \rho)r(\tilde{\phi}, w(\tilde{\phi})) - F = 0. \]  

(13)

### 3.2 General Equilibrium

#### 3.2.1 Cutoff Productivity

The equilibrium cutoff productivity is determined by the free-entry condition (12) and the zero-profit cutoff condition (13). As shown in the Appendix A.1.1, we can rewrite both equations as:

\[ \frac{Y}{M} = \frac{\sigma}{1 - G(\phi)} \left( \delta F_e + (1 - G(\tilde{\phi}))F \right), \]  

(14)

\[ \frac{Y}{M} = \left( \frac{\theta(\tilde{\phi}, \gamma)}{\tilde{\phi}} \right)^{\sigma^{-1}} \frac{\sigma F}{1 - G(\phi)} \int^\infty_{\tilde{\phi}} \left( \frac{\phi}{\theta(\phi, \gamma)} \right)^{\sigma^{-1}} dG(\phi). \]  

(15)

Combining (14) and (15), we obtain:

\[ E \equiv \left( \frac{\theta(\tilde{\phi}^*, \gamma)}{\tilde{\phi}^*} \right)^{\sigma^{-1}} \int^\infty_{\tilde{\phi}^*} \left( \frac{\phi}{\theta(\phi, \gamma)} \right)^{\sigma^{-1}} dG(\phi) - (\tilde{\phi}^*)^{-k} - \frac{\delta F_e}{F} = 0, \]  

(16)

which implicitly pins down the equilibrium cutoff productivity \( \tilde{\phi}^* = \tilde{\phi}^*(\gamma) \), where * indicates an equilibrium outcome.

#### 3.2.2 Labor and Goods Market

The labor market equilibrium is characterized by the expected wage rate \( w^e \), the expected income \( b \) and the unemployment rate \( u \). By definition, the expected wage rate is given by:

\[ w^e = \left( 1 - G(\tilde{\phi}) \right)^{-1} \int^\infty_{\tilde{\phi}} w(\phi) dG(\phi). \]  

(17)
In the equilibrium,

\[(1 - u) L w^e = W = \rho Y \]  

(18)

holds, where we have used the fact that total wage income \( W \) is a constant share \( \rho \) of total revenues \( R = PY = Y \) due to monopolistic competition. Total employment is given by:

\[(1 - u) L = M \left(1 - G(\tilde{\phi})\right)^{-1} \int_{\tilde{\phi}}^{\infty} h(\phi) dG(\phi) = \rho Y \left(1 - G(\tilde{\phi})\right)^{-1} \int_{\tilde{\phi}}^{\infty} \phi^{\sigma - 1} w(\phi)^{-\sigma} dG(\phi), \]  

(19)

where the second line follows from inserting the technology and the optimal output of firms. Substituting (19) into (18) yields:

\[w^e = \rho^{-(\sigma - 1)} \left(1 - G(\tilde{\phi})\right) \left[\int_{\tilde{\phi}}^{\infty} \phi^{\sigma - 1} w(\phi)^{-\sigma} dG(\phi)\right]^{-1}. \]  

(20)

By combining (17) and (20) as well as inserting (10), we can solve for the equilibrium expected income as:

\[b^*(\tilde{\phi}^*, \gamma) = \rho \left[\Gamma_1(\tilde{\phi}^*, \gamma) \cdot \Gamma_2(\tilde{\phi}^*, \gamma)\right]^{\frac{1}{\sigma - 1}}, \]  

(21)

\[\Gamma_1(\tilde{\phi}^*, \gamma) \equiv \left(1 - G(\tilde{\phi}^*)\right)^{-1} \int_{\tilde{\phi}^*}^{\infty} \phi^{\sigma - 1} \theta(\phi, \gamma)^{-\sigma} dG(\phi), \]  

(22)

\[\Gamma_2(\tilde{\phi}^*, \gamma) \equiv \left(1 - G(\tilde{\phi}^*)\right)^{-1} \int_{\tilde{\phi}^*}^{\infty} \theta(\phi, \gamma) dG(\phi). \]  

(23)

Inserting (10) and (21) into (17), we obtain the equilibrium expected wage:

\[w^{es}(\tilde{\phi}^*, \gamma) = \rho \Gamma_1(\tilde{\phi}^*, \gamma)^{\frac{1}{\sigma - 1}} \Gamma_2(\tilde{\phi}^*, \gamma)^{-\sigma}. \]  

(24)

With \( b^* \) and \( w^{es} \) at hand, we can compute the equilibrium unemployment rate. Substituting (24) and (21) into (4) and rearranging yield:

\[u^*(\tilde{\phi}^*, \gamma) = \frac{1}{1 - s} \left(1 - \frac{1}{\Gamma_2(\tilde{\phi}^*, \gamma)}\right). \]  

(25)

Finally, we use the equilibrium condition (18) to calculate equilibrium output as:

\[Y^*(\tilde{\phi}^*, \gamma) = \left(1 - u^*(\tilde{\phi}^*, \gamma)\right) w^{es}(\tilde{\phi}^*, \gamma) \frac{L}{\rho}. \]  

(26)

Note that we use aggregate output per capita \( Y^*/L \) as a measure for welfare as usually done in these class of models (see Egger and Kreickemeier, 2009).³

³To complete the determination of the general equilibrium, we can use (12) to pin
3.3 The Role of the Bargaining Power

3.3.1 Analytical Solution

In this section, we analyze the effect of an increase in the union’s bargaining power. Specifically, we consider a rise of the parameter $\tau$, i.e. all unions in the economy become more powerful, and distinguish between an economy where firm-level trade unions have the same bargaining strength ($\chi = 0$) and an economy where the unions’ bargaining power is firm-specific ($\chi = 1$).

Regarding the effect on the equilibrium cutoff productivity $\tilde{\phi}^*$, we find:

**Proposition 1** For $\chi = 1$, $\tilde{\phi}^*$ is decreasing in $\tau$, i.e. $d\tilde{\phi}^*/d\tau < 0$. For $\chi = 0$, $\tilde{\phi}^*$ is not affected by $\tau$.

**Proof 1** See Appendix A.1.2

An increase in $\tau$ raises wage payments of all operating firms. This has two countervailing effects. On the one hand, profits of the least productive firms, c.p., decline such that they are forced out of the market. On the other hand, expected profits decrease which lowers the incentive to enter the market. The mass of operating firms decline, which increases the demand for varieties produced by the incumbent firms. Profits raise and more low-productive firms are able to produce without a loss. If the bargaining power is firm-specific ($\chi = 1$), the second effect dominates the first such that the cutoff productivity decreases. If the bargaining power is equal across firms ($\chi = 0$), both effects cancel out and the cutoff productivity remains constant.

An increase in the unions’ bargaining power has the following impact on the equilibrium expected wage rate $w^e$.

**Proposition 2** For $\chi = 1$, an increase in $\tau$ has an ambiguous effect on $w^e$. For $\chi = 0$, an increase in $\tau$ does not affect $w^e$.

**Proof 2** See Appendix A.1.3

In a world where unions have identical bargaining strength, an increase in the bargaining power is fully absorbed by a decrease in the unemployment rate (see de Pinto and Michaelis, 2014). As such, the equilibrium expected wage rate remains constant. With firm-specific bargaining power, the effect is not clear-cut. The expected wage rate, c.p., increases because of the rise of down the equilibrium mass of operating firms $M^e$. The equilibrium mass of entrants is then given by $M^e_\tau = (1 - G(\tilde{\phi}^*))^{-1} M^e$. 

9
the bargained wage, but, c.p., declines because of the reduction of the cutoff productivity.

The effect on the equilibrium unemployment rate \( u^* \) can be summarized as:

**Proposition 3** For \( \chi = 1 \), the effect of an increase in \( \bar{\gamma} \) on \( u^* \) is parameter-dependent. For \( \chi = 0 \), an increase in \( \bar{\gamma} \) unambiguously increases \( u^* \).

**Proof 3** Differentiating (25) with respect to \( \bar{\gamma} \) leads to:

\[
\frac{du^*}{d\bar{\gamma}} = \frac{\partial u^*}{\partial \tilde{\phi}^*} \frac{d\tilde{\phi}^*}{d\bar{\gamma}} + \frac{\partial u^*}{\partial \bar{\gamma}} > 0.
\]

As shown in Appendix A.1.4, \( \frac{\partial u^*}{\partial \tilde{\phi}^*} > 0 \) and \( \frac{\partial u^*}{\partial \bar{\gamma}} > 0 \) hold. Inserting the respective expressions imply:

\[
\frac{du^*}{d\gamma} \left\{ \begin{array}{l} < \text{ or } \geq \end{array} \right\} 0 \iff \epsilon \left\{ \begin{array}{l} < \text{ or } \geq \end{array} \right\} 1 - \frac{k + 1}{k \phi^*},
\]

\[
\epsilon \equiv \frac{\bar{\gamma}}{\phi^*} \frac{d\tilde{\phi}^*}{d\bar{\gamma}} < 0,
\]

which proves the first part of the Proposition. If \( \chi = 0 \), we have \( \frac{d\tilde{\phi}^*}{d\bar{\gamma}} = 0 \) (see Lemma 1), which proves the second part of the Proposition.

An increase in \( \bar{\gamma} \) raises the bargained wage. Operating firms respond to such an increase of their marginal costs by a price hike, which, c.p., reduces demand and employment and thus increases the unemployment rate. If the bargaining power is firm-specific (\( \chi = 1 \)), there is a countervailing effect. An increase in \( \bar{\gamma} \) reduces the cutoff productivity (as argued above), which, c.p., raises the mass of active firms and decreases the unemployment rate. The strength of the latter effect is measured by the bargaining power elasticity of the cutoff productivity \( \epsilon \). If this elasticity would be sufficiently high in absolute terms, the unemployment rate could eventually decrease in \( \bar{\gamma} \).

Finally, an increase in \( \bar{\gamma} \) affects aggregate output (and hence welfare):

**Proposition 4** For \( \chi = 1 \), an increase in \( \bar{\gamma} \) has an ambiguous effect on the equilibrium output. For \( \chi = 0 \), an increase in \( \bar{\gamma} \) unambiguously decreases equilibrium output.
Proof 4 Differentiating (26) with respect to $\bar{\gamma}$ leads to:

$$\frac{dY^*}{d\bar{\gamma}} = \frac{dY^*}{dw^*} \frac{dw^*}{d\bar{\gamma}} + \frac{dY^*}{dw^{es}} \frac{dw^{es}}{d\bar{\gamma}}. \quad (28)$$

If $\chi = 1$, the sign of (28) is ambiguous because the employment effect is parameter-dependent (see Proposition 3) and the effect on the expected wage rate is not clear cut (see Proposition 2). This proves the first part of the Proposition. If $\chi = 0$, the employment effect is negative (see Proposition 3) and the expected wage does not depend on $\bar{\gamma}$ (see Proposition 2), which proves the second part of the Proposition.

Intuitively, a higher unemployment rate reduces equilibrium output because the production factor labor is used less, while higher expected wage rate increases $Y^*$ because consumers have more wage income. The effect on a higher bargaining power thus depends on the the effects on $u^*$ and $w^{es}$ and their interdependencies.

3.3.2 Numerical Solution

To quantify the impact of an increase in $\bar{\gamma}$ on $w^{es}$, $u^*$ and $Y^*$, we solve our model numerically. For that purpose, we rely on calibrations by Bernard et al. (2007) and set $\sigma = 3.8$, $\delta = 0.025$ 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 $F = 0.25$ (which is the average value of estimated fix costs in the US and Europe). For the replacement ratio, we assume $s = 0.6$. The country's labor endowment $L$ is normalized at unity without loss of generality.

The simulations results for the labor market are illustrated in Figure 1. We find that the equilibrium expected wage rate monotonously decreases in $\bar{\gamma}$ if the bargaining power is firm-specific ($\chi = 1$). The decline in the cutoff productivity and the resulting reduction of $w^e$ is strong enough to overcompensate the increase in $w^e$ due to higher bargained wages. In the limiting case of $\bar{\gamma} = 1$, the expected wage rate is about 11% lower compared to a situation where all firms have identical bargaining strengths ($\chi = 0$). The unemployment rate monotonously increases in $\bar{\gamma}$. The positive employment effect of a decrease in the cutoff productivity is not high enough to compensate for the negative employment effect of higher wages. Compared to the $\chi = 0$ case, however, the unemployment rate is significantly lower. For $\bar{\gamma} = 1$, for example, this reduction is about 50%.
Figure 1: Labor Market

Figure 2 depicts the simulations results for the goods market. As the expected wage rate decreases and the unemployment rate rises, it is not surprising that the equilibrium output montonously declines in $\gamma$. In a world with firm-specific bargaining power, however, this reduction is up to 72\% lower, compared to a world where unions have identical bargaining powers. This is because the negative employment effect is substantially mitigated, as shown before.
Figure 2: Goods Market
4 Open Economy

To analyze the effects of trade unions in an open economy, we consider the full model with bilateral trade between both countries in the following. We are in particular interested in the implications of an increase in the unions’ bargaining power and on how trade liberalization affects the equilibrium outcomes.

4.1 Equilibrium

The partial equilibrium is determined by solving the four-stage game analogously to the closed economy. Demand for the domestic and export market are given by, respectively:

\[ q(\omega) = p(\omega)^{-\sigma} \frac{Y}{M_t}, \quad \text{(29)} \]

\[ q_x(\omega) = p_x(\omega)^{-\sigma} \frac{Y}{M_t}. \quad \text{(30)} \]

Prices, output and employment for the export market are shares of the respective domestic outcomes (which are identical to the closed economy counterparts when replacing \( M \) with \( M_t \)):

\[ p_x(\phi, w) = \tau p(\phi, w), \quad q_x(\phi, w) = \tau^{-\sigma} q(\phi, w) \]

\[ h_x(\phi, w) = \tau^{-(\sigma-1)} h(\phi, w) \] (see Melitz (2003) for the same result). Revenues and profits from exporting thus read:

\[ r_x(\phi, w) = \tau^{-(\sigma-1)} r(\phi, w) \quad \text{and} \quad \pi_x(\phi, w) = (1 - \rho) \tau^{-(\sigma-1)} r(\phi, w) - F_x. \]

The solution of the Nash-bargaining yields the same wage rate as before such that the bargained wage is given by (10).

The zero-profit cutoff condition is identical to (13), while the free-entry condition changes to:

\[ \frac{1}{\delta} \int_{\phi_x}^{\infty} ((1 - \rho)r(\phi, w(\phi)) - F_x) \ dG(\phi) \]

\[ + \frac{1}{\delta} \int_{\phi_x}^{\infty} ((1 - \rho)\tau^{-(\sigma-1)} r(\phi, w(\phi)) - F_x) \ dG(\phi) = F_e, \quad \text{(31)} \]

where \( \tilde{\phi}_x \) denotes the cutoff productivity for exporting defined by:

\[ \pi_x(\tilde{\phi}_x, w(\tilde{\phi}_x)) = (1 - \rho) \tau^{-(\sigma-1)} r(\tilde{\phi}_x, w(\tilde{\phi}_x)) - F_x = 0. \quad \text{(32)} \]

Firms with productivities lower than \( \tilde{\phi}_x \) serve only the domestic market, while firms with productivities higher than \( \tilde{\phi}_x \) additionally export. We can define
such that the mass of exporters is given by $M$ (see Appendix A.2.1):

$$\alpha(\bar{\phi}, \bar{x}) \equiv \frac{1 - G(\bar{\phi})}{1 - G(\phi)}, \quad (33)$$

such that the mass of exporters is given by $M_x = \alpha M$.

The determination of the general equilibrium is conceptually identical to the procedure described in Section 3.2. As shown in Appendix A.2.1, we can compute two Eqs. which simultaneously determine the equilibrium cutoff and export cutoff productivity as a function of the bargaining power and trade costs: $\bar{\phi}^* = \phi^*(\gamma, \tau, F_x)$ and $\bar{\phi}^*_x = \phi^*_x(\gamma, \tau, F_x)$. These Eqs. read:

$$E^1 \equiv \left( \frac{\theta(\bar{\phi}, \gamma)}{\bar{x}} \phi \right)^{-\gamma-1} - \frac{F}{\tau^{\gamma-1}F_x} = 0, \quad (34)$$

$$E^2 \equiv E(\bar{\phi}, \gamma) + \left( \frac{\theta(\bar{\phi}, \gamma)}{\phi} \right)^{\gamma-1} \tau^{-\gamma} \int_{\phi_x}^{\infty} \left( \frac{\phi}{\theta(\phi, \gamma)} \right)^{\gamma-1} dG(\phi) - \bar{\phi}_x^{-\gamma} F_x = 0, \quad (35)$$

with $E$ given by (16). Note that we are not able to find closed-form solutions for $\bar{\phi}^*$ and $\bar{\phi}^*_x$. When analyzing the effects on both productivities analytically, we focus on the partial effects only, i.e. we look at the effects on $\bar{\phi}$ for any given level of the export cutoff productivity, $\phi(\bar{x})$, respectively on the effects on $\bar{x}$ for any given level of the cutoff productivity, $\phi(\tilde{\phi})$.

The equilibrium outcomes in the labor and goods market are given by (see Appendix A.2.1):

$$b^*(\bar{\phi}^*, \bar{\phi}^*_x, \gamma) = \rho \left[ (1 + \alpha(\bar{\phi}^*, \bar{\phi}^*_x))^{-1}(\Gamma_1(\bar{\phi}^*, \gamma) + \Gamma_3(\bar{\phi}^*, \bar{\phi}^*_x, \gamma))\Gamma_2(\bar{\phi}^*, \gamma) \right]^{\frac{1}{\sigma-1}}, \quad (36)$$

$$w^{e*}(\bar{\phi}^*, \bar{\phi}^*_x, \gamma) = \rho \left[ (1 + \alpha(\bar{\phi}^*, \bar{\phi}^*_x))^{-\frac{1}{\sigma-1}}(\Gamma_1(\bar{\phi}^*, \gamma) + \Gamma_3(\bar{\phi}^*, \bar{\phi}^*_x, \gamma))^{\frac{1}{\sigma-1}}\Gamma_2(\bar{\phi}^*, \gamma) \right]^{\frac{\sigma-1}{\sigma-1}}, \quad (37)$$

$$u^*(\bar{\phi}^*, \gamma) = \frac{1}{1 - \frac{1}{\Gamma_2(\bar{\phi}^*, \gamma)}}, \quad (38)$$

$$Y^*(\bar{\phi}^*, \bar{\phi}^*_x, \gamma) = \left[ 1 - u^*(\bar{\phi}^*, \gamma) \right] w^{e*}(\bar{\phi}^*, \bar{\phi}^*_x, \gamma) \frac{L}{\rho}. \quad (39)$$

where $\Gamma_3$ is defined as:

$$\Gamma_3(\bar{\phi}^*, \bar{\phi}^*_x, \gamma) \equiv \tau^{-(\gamma-1)}(1 - G(\bar{\phi}^*))^{-1} \int_{\phi_x}^{\infty} \phi^{-\gamma-1} \theta(\phi, \gamma) - \gamma dG(\phi). \quad (40)$$
4.2 The Role of the Bargaining Power

As in the closed economy, we can analyze the effects of an increase in $\gamma$. For the export cutoff productivity $\bar{\phi}$ and the export cutoff productivity $\bar{\phi}_x$, we obtain:

**Proposition 5** For $\chi = 1$, an increase in $\gamma$ increases $\bar{\phi}_x$ for any given level of $\bar{\phi}$ and decreases $\bar{\phi}$ for any given level of $\bar{\phi}_x$. For $\chi = 0$, an increase in $\gamma$ does neither affect $\bar{\phi}_x$ nor $\bar{\phi}$.

**Proof 5** See Appendix A.2.2

An increase in the union’s bargaining power raises the firms’ marginal costs. Holding $\bar{\phi}$ constant, this implies that fewer firms manage to export without a loss and $\bar{\phi}_x$ increases. The intuition for the impact of $\gamma$ on $\bar{\phi}$ is identical to the one in the closed economy. Note that the effect on the equilibrium cutoff productivity (export cutoff productivity) $\bar{\phi}^*$ ($\bar{\phi}_x^*$) includes the repercussion effect through changes in $\bar{\phi}_x$ ($\bar{\phi}$). As shown in Appendix A.2.2, $d\bar{\phi}_x/d\bar{\phi} > 0$ holds. This implies that an increase in $\gamma$ has two countervailing effects on the export cutoff productivity. On the one hand, $\bar{\phi}_x$ increases as argued above. On the other hand, competition and firm-selection becomes less intense ($\bar{\phi}$ decreases) which reduces $\bar{\phi}_x$. The net effect is ambiguous. The same argumentation is true for the impact on the cutoff productivity. However, the sign of $d\bar{\phi}/d\bar{\phi}_x$ is parameter-dependent (see Appendix A.2.2) such that it is ambiguous whether the repercussion effect through the increase in the export cutoff productivity would mitigate or amplify the decline in $\bar{\phi}$.

As in the closed economy case, we are not able to predict the effect on the equilibrium expected wage rate $w^{**}$ (see (37)). With respect to the equilibrium unemployment rate, we obtain the same result as postulated in Proposition 3, with the exception that we cannot analytically compute the sign of $d\bar{\phi}^*/d\gamma$ as argued before. Note that $u^*$ does not depend on the export cutoff productivity such that no additional effects from the selection into the export market work on the equilibrium unemployment rate.

The numerical solution confirms our findings from the closed economy setting, both in qualitative and quantitative terms. In particular, we find that the equilibrium export cutoff productivity $\bar{\phi}_x^*$ increases in $\gamma$ and that the equilibrium cutoff productivity $\bar{\phi}^*$ decreases in $\gamma$. Taking the repercussion effects into account thus does not alter our finding in Proposition 5.
4.3 Trade Liberalization

4.3.1 Analytical Solution

How does trade liberalization by either a reduction of variable trade costs $\tau$ or fix trade costs $F_x$ affect the equilibrium outcomes? In this section, we answer this question and distinguish again between an economy where all firm-level unions have identical bargaining power ($\chi = 0$) and economy where the bargaining strength depends on the firm’s productivity ($\chi = 1$). This provides deeper insights about the role of trade unions in an open economy setting.

Regarding the cutoff productivity $\bar{\phi}$ and the export cutoff productivity $\bar{\phi}_x$, we find:

**Proposition 6** For $\chi = 1$, a decrease in $\tau$ or $F_x$ decreases $\bar{\phi}_x$ for any given level of the cutoff productivity and increases $\bar{\phi}$ for any given level of the export cutoff productivity. For $\chi = 0$, the same results hold.

**Proof 6** see Appendix A.2.3

Trade liberalization implies that more firms export, i.e. $\bar{\phi}_x$ decreases. This raises competition and firm-selection becomes more severe, i.e. $\bar{\phi}$ increases. Since both cutoff productivities are interdependent, repercussion effects must be taken into account in the equilibrium (as explained for case of an increasing bargaining power). To simplify the following argumentation, we assume that these repercussion effects do not change the sign of the initial effects:

**Assumption 1** Trade liberalization increases the equilibrium cutoff productivity $\phi^*$ and decreases the equilibrium export cutoff productivity $\phi^*_x$.

This assumption corresponds to the usual finding in the literature.

The impact of trade liberalization on the expected wage rate is ambiguous because we do not know (analytically) the sign of $du^*/d\phi^*$. With respect to the equilibrium unemployment rate $u^*$, we find:

**Proposition 7** For $\chi = 1$, a decrease in $\tau$ or $F_x$ increases $u^*$. For $\chi = 0$, a decrease in $\tau$ or $F_x$ has no effect on $u^*$.

**Proof 7** Differentiating (38) with respect to $\bar{\phi}^*$ and taking Assumption 1 into account leads to:

$$\frac{du^*}{d\tau} = \frac{du^*}{d\phi^*} \frac{d\phi^*}{d\tau} < 0, \quad \frac{du^*}{dF_x} = \frac{du^*}{d\phi^*} \frac{d\phi^*}{dF_x} > 0,$$

which proves the first part of the Proposition. For the second part, note that $\Gamma_2(\chi=0) = \theta$. 

17
Suppose that unions have identical bargaining power. In this case, the assumption of CES implies that the equilibrium unemployment rate is independent of the cutoff productivity and thus the distribution of firms. As such, neither $\tau$ nor on $F_x$ have an effect on $u^*$ (see Eckel and Egger, 2009). In contrast, the distribution of firms play a role for the equilibrium unemployment rate if the bargaining power is firm-specific. An increase in firm-selection raises the unemployment rate because, intuitively, unions bargain higher wages (on average) which reduces labor demand. Since trade liberalization increases the equilibrium cutoff productivity, unemployment rises.

Regarding equilibrium output $Y^*$ (and hence welfare), the effect of trade liberalization is ambiguous because it is not clear how the increase in $\bar{\phi}^*$ affects $Y^*$, see the analog result in the closed economy.

### 4.3.2 Numerical Solution

Since the results of changes in $\tau$ and $F_x$ are qualitatively and quantitatively similar, we report only the former. Fix trade costs are set to $F_x = 0.22$, which is the average value of estimated fix trade costs in the US and Europe by Balistreri et al. (2011). The upper bound of the union’s bargaining power, $\bar{\gamma}$, is assumed to be 0.5. Figure 3 shows that the equilibrium cutoff productivity increases if trade is liberalized, while the equilibrium cutoff productivity increases. This confirms Assumption 1. For any given level of $\tau$, the cutoff productivity is lower if the union’s bargaining power is firm-specific, which was explained in Section 3.3.2. We call the difference in the $\chi = 1$ and $\chi = 0$ curves level effect in the following.
The effects on the labor market are illustrated in Figure 4. The equilibrium expected wage rate increases if $\tau$ is reduced irrespective of the union’s bargaining power structure. The level effect is explained by the reduction of $w^e*$ if the union’s bargaining power is firm-specific. With respect to the equilibrium unemployment, the level effect is relatively strong, i.e. $u^*$ is up to 50% lower if we account for differences in the unions’ bargaining strengths. In addition, we see that trade liberalization has a negative employment effect in this case, but this effect is relatively weak. In a world where unions have identical bargaining power, the unemployment increasing effect of trade liberalization disappears.
Finally, we simulate the effect on equilibrium output respectively welfare (see Figure 5). As a result, trade liberalization raises welfare in any cases. This implies that the negative employment effect does not outweigh the positive effect of higher competition. We further see that welfare is higher if unions have firm-specific bargaining powers. This is mainly driven by the higher level of employment which raises output.
5 Conclusion

In the present paper, we have designed a general equilibrium model to analyze the impact of trade unions on the macroeconomic performance of an open economy. The point of departure from the literature is the endogeneity of the bargaining power coefficient, the unions’ bargaining power is firm-specific and it is assumed to increase in the level of firm productivity. We have addressed two questions: first, how does the wage bargain affect variables such as wages, employment, output, exports, and the number of active/exporting firms, and second, how does trade liberalization affect the open economy equilibrium.

Our analysis delivers new insights into the interaction of the rent-shifting effect of a stronger union bargaining power and the impact on the degree of competition via the entry of new firms. We show that the overall effect of stronger trade unions on aggregate employment may be positive, whereas the impact on aggregate output will always be negative. Trade liberalization reduces aggregate employment but increases aggregate output.

Due to the firm-specific bargaining power, wages differ between firms. Our analysis, however, is quiet silent on the question how the wage distribution is affected. Further research is needed to tackle this point.
A Appendix

A.1 Closed Economy

A.1.1 Zero-profit Cutoff and Free-entry Condition

Using \( r(\tilde{\phi}, w(\tilde{\phi})) = p(\tilde{\phi}, w(\tilde{\phi}))^{-\sigma}Y/M, (8) \) and (10), we can rewrite (13) as:

\[
\frac{Y}{M} = \rho^{-(\sigma-1)} \left( \frac{\theta(\tilde{\phi}, \tau)}{\tilde{\phi}} \right)^{-1} b^{\sigma-1} \sigma F. \tag{A.1}
\]

The CES price index is defined as:

\[
P = \left( 1 - G(\tilde{\phi}) \right)^{-1} \left[ \int_{\tilde{\phi}}^{\infty} p(\phi, w(\phi))^{-(\sigma-1)} dG(\phi) \right] ^{\frac{1}{1-\sigma}}. \tag{A.2}
\]

Using \( P \equiv 1 \), (8) and (10), we obtain:

\[
\int_{\tilde{\phi}}^{\infty} \left( \frac{\phi}{\theta(\phi, \tau)} \right)^{-1} dG(\phi) = \rho^{-(\sigma-1)} (1 - G(\tilde{\phi})) b^{\sigma-1}.
\]

Solving this Eq. with respect to \( b \) and inserting the resulting expression into (A.1) yields:

\[
\frac{Y}{M} = \left( \frac{\theta(\tilde{\phi}, \tau)}{\tilde{\phi}} \right)^{-1} \frac{\sigma F}{1 - G(\tilde{\phi})} \int_{\tilde{\phi}}^{\infty} \left( \frac{\phi}{\theta(\phi, \tau)} \right)^{-1} dG(\phi), \tag{A.3}
\]

which is identical to (15) in the main text.

Using \( r(\tilde{\phi}, w(\tilde{\phi})) = p(\tilde{\phi}, w(\tilde{\phi}))^{-\sigma}Y/M \) and noting that only firms with \( \phi \geq \tilde{\phi} \) are operating, we can rewrite (12) as:

\[
\frac{Y}{M} \int_{\tilde{\phi}}^{\infty} p(\phi, w(\phi))^{-(\sigma-1)} dG(\phi) = \sigma \left( \delta F_e + (1 - G(\tilde{\phi})) F \right). \tag{A.4}
\]

Due to \( P \equiv 1 \), we can combine (A.2) and (A.4) to obtain:

\[
\frac{Y}{M} = \frac{\sigma}{1 - G(\tilde{\phi})} \left( \delta F_e + (1 - G(\tilde{\phi})) F \right), \tag{A.5}
\]

which is identical to (14) in the main text.
A.1.2 Proof of Proposition 1

Recall the (implicit) condition of the equilibrium cutoff productivity \( \tilde{\phi}^* \) (16):

\[
E \equiv \left( \frac{\theta(\tilde{\phi}^*, \tau)}{\tilde{\phi}^*} \right) \sigma^{-1} \int_{\tilde{\phi}^*}^{\infty} \left( \frac{\phi}{\theta(\phi, \tau)} \right) \sigma^{-1} dG(\phi) - (\tilde{\phi}^*)^{-k} - \frac{\delta F_e}{F} = 0.
\]

Totally differentiating (with \( dk = dF = dF_e = d\delta = d\sigma = 0 \)) yields:

\[
\frac{d\tilde{\phi}^*}{d\tau} = -\frac{\partial E/\partial \tau}{\partial E/\partial \tilde{\phi}^*}.
\]

Differentiating \( E \) with respect to \( \tilde{\phi} \) implies:

\[
\frac{\partial E}{\partial \tilde{\phi}} = - \left( 1 - \frac{\partial \theta(\phi)}{\partial \phi} \right) \left( \frac{\theta(\phi, \tau)}{\phi} \right) \sigma^{-1} \tilde{\phi}^k(\sigma - 1) \int_{\tilde{\phi}}^{\infty} \left( \frac{\phi}{\theta(\phi, \tau)} \right) \phi^{-k-1} d\phi,
\]

where we have used the Pareto distribution and suppressed the equilibrium indication \( * \) for notational simplification. Using (11) and (6), we get:

\[
\frac{\partial \theta(\phi)}{\partial \phi} \frac{\tilde{\phi}}{\tau} = \frac{\tau}{\sigma - 1 + \tau(1 - \phi^{-1})} \frac{1}{\phi},
\]

which is smaller than one because \( \tilde{\phi}(\sigma - 1 + \tau) > 2\tau \) holds for usual values of \( \sigma \). Therefore, we conclude that \( \partial E/\partial \tilde{\phi} < 0 \).

Differentiating \( E \) with respect to \( \tau \) yields:

\[
\frac{\partial E}{\partial \tau} = k \left( \frac{\theta(\tilde{\phi}, \tau)}{\phi} \right) \sigma^{-1} \left[ (\sigma - 1) A_1(\phi, \tau) \frac{\partial \theta}{\partial \phi} + \frac{\partial A_1(\phi, \tau)}{\partial \tau} \right],
\]

\[
A_1(\phi, \tau) \equiv \int_{\phi}^{\infty} \left( \frac{\phi}{\theta(\phi, \tau)} \right) \phi^{-k-1} d\phi.
\]

Using (11) and solving the partial derivatives on the RHS, we obtain:

\[
\frac{\partial E}{\partial \tau} = k \left( \frac{\theta(\phi, \tau)}{\phi} \right) \sigma^{-1} \left[ \frac{\sigma - 1}{\tau} \left[ A_2(\phi, \tau) - A_3(\phi, \tau) \right] \right],
\]

\[
A_2(\phi, \tau) \equiv \int_{\phi}^{\infty} \left( \frac{\phi}{\theta(\phi, \tau)} \right) \phi^{-k-2} d\phi,
\]

\[
A_3(\phi, \tau) \equiv \int_{\phi}^{\infty} \left( \frac{\phi}{\theta(\phi, \tau)} \right) \phi^{-k-2} \phi^{-k-2} \theta(\phi, \tau) d\phi.
\]
Since \( \theta(\phi, \gamma) > \theta(\tilde{\phi}, \gamma) \), we have \( A_3 > A_2 \) and can thus conclude that \( \partial E/\partial \gamma < 0 \). Using (A.6), we find \( d\tilde{\phi}/d\gamma < 0 \) as postulated in the main text.

If \( \chi = 0 \), (13) can be rewritten as \( Y/M = (\sigma F_k)/(k - \sigma + 1) \). Combining this with (A.5) yields:

\[
\tilde{\phi}^*_{(\chi=0)} = \left( \frac{F}{\delta F e} \frac{\sigma - 1}{k - \sigma + 1} \right)^{\frac{1}{\sigma}},
\]

which is independent of the cutoff productivity as postulated in the main text.

### A.1.3 Proof of Proposition 2

Differentiating (24) with respect to \( \gamma \) yields:

\[
\frac{dw^e}{d\gamma} = \frac{1}{\sigma \gamma} \Gamma_1 \frac{1}{\Gamma_1} \Gamma_2 \frac{x}{\Gamma_2} \left( \frac{\Gamma_1 \gamma}{d\gamma} + \frac{\Gamma_2 \gamma}{d\gamma} \right).
\]

(A.8)

Observing (22) and (23), we obtain:

\[
\frac{d\Gamma_1}{d\gamma} = \frac{\partial \Gamma_1}{\partial \tilde{\phi}} \frac{d\tilde{\phi}}{d\gamma} + \frac{\partial \Gamma_1}{\partial \gamma},
\]

(A.9)

\[
\frac{d\Gamma_2}{d\gamma} = \frac{\partial \Gamma_2}{\partial \tilde{\phi}} \frac{d\tilde{\phi}}{d\gamma} + \frac{\partial \Gamma_2}{\partial \gamma}.
\]

(A.10)

The partial derivatives can be calculated as:

\[
\frac{\partial \Gamma_1}{\partial \tilde{\phi}} = \tilde{\phi}^{k-1} k \left( k \int_{\phi}^{\infty} \frac{\phi}{\theta(\phi, \gamma)} \right)^{\sigma} \phi^{-k-2} d\phi - \left( \frac{\tilde{\phi}}{\theta(\phi, \gamma)} \right)^{\sigma} \tilde{\phi}^{-k-1},
\]

(A.11)

\[
\frac{\partial \Gamma_1}{\partial \gamma} = -\tilde{\phi}^k k \int_{\phi}^{\infty} \theta(\phi, \gamma)^{-\sigma - 1} \frac{d\theta}{d\gamma} \phi^{\sigma - k - 2} d\phi < 0,
\]

(A.12)

\[
\frac{\partial \Gamma_2}{\partial \tilde{\phi}} = \frac{\gamma}{\sigma - 1} k \frac{1}{k + 1} \tilde{\phi}^{-2} > 0,
\]

(A.13)

\[
\frac{\partial \Gamma_2}{\partial \gamma} = \frac{1}{\sigma - 1} \left( 1 - \frac{k}{k + 1} \frac{1}{\tilde{\phi}} \right) > 0,
\]

(A.14)

where we have used the Pareto distribution, (11) and (6) to rewrite (23) as:

\[
\Gamma_2(\tilde{\phi}^*, \gamma) = \frac{1}{\sigma - 1} \left( \sigma - 1 + \gamma \left( 1 - \frac{k}{k + 1} \frac{1}{\tilde{\phi}^*} \right) \right).
\]

(A.15)
Inserting (A.13) and (A.14) into (A.10), we see that the sign of \( d\Gamma_2/d\gamma \) is parameter-depended:

\[
\frac{d\Gamma_2}{d\tau} = \frac{1}{\sigma - 1} \left( 1 - \frac{k}{k + 1} \right) \left( 1 - \frac{\tau \phi}{\phi d\gamma} \right),
\]
(A.16)

\[
\text{sign} \left[ \frac{d\Gamma_2}{d\gamma} \right] = \text{sign} \left[ \frac{\tau \phi}{\phi d\gamma} \right] \left( 1 - \frac{k}{k - 1} \right).
\]
(A.17)

The sign of \( d\Gamma_1/d\tau \) depends on the sign of \( \partial \Gamma_1/\partial \tilde{\phi} \). However, we cannot analytically solve the integral in (A.11) such that we are not able to clarify under which parameter constellations \( \partial \Gamma_1/\partial \tilde{\phi} \) and thus \( d\Gamma_1/d\tau \) would have a positive or negative sign. Therefore, the sign of \( du^*/d\tau \) is ambiguous, which proves the first part of Proposition 2.

For \( \chi = 0 \), we can rewrite (22) and (23) as: \( \Gamma_1(\chi = 0) = \theta^{-\sigma} \tilde{\phi}(\chi = 0) \sigma^{-1} k/(k - (\sigma - 1)) \) and \( \Gamma_2(\chi = 0) = \theta \). This implies \( w^e(\chi = 0) = \rho \tilde{\phi}(k/(k - (\sigma - 1)))^{1/\sigma - 1} \), which does not depend on \( \tau \). This proves the second part of Proposition 2.

A.1.4 Proof of Proposition 3

Differentiating (25) with respect to \( \tau \) yields:

\[
\frac{du^*}{d\tau} = \frac{1}{1 - s \gamma \Gamma_2} \frac{d\Gamma_2}{d\gamma},
\]
(A.18)

This shows that \( \partial u^*/\partial \tilde{\phi}^* = D\partial \Gamma_2/\partial \tilde{\phi}^* > 0 \) (see (A.13)) and \( \partial u^*/\partial \tau = D\partial \Gamma_2/\partial \gamma > 0 \) (see (A.14)). Moreover, it indicates that:

\[
\text{sign} \left[ \frac{du^*}{d\tau} \right] = \text{sign} \left[ \frac{d\Gamma_2}{d\gamma} \right],
\]

where the RHS is given by (A.17). This proves Proposition 3.

A.2 Open Economy

A.2.1 Derivation of the General Equilibrium

To compute the export cutoff productivity, we combine (13) and (32) and obtain:

\[
\frac{r(\tilde{\phi}, w(\tilde{\phi}))}{r(\phi_x, w(\phi_x))} = \frac{F}{\tau^{\sigma - 1} F_x}.
\]
Inserting subsequently the profit-maximizing revenue, price and bargained wage leads to (34).

Adopting the same steps as in Appendix A.1.1, we can rewrite the free-entry condition (31) and the zero-profit cutoff condition (13) as:

\[
\frac{Y}{M_t} = \frac{1}{1 + \alpha(\tilde{\phi}, \tilde{\phi}_x)} \frac{\sigma}{1 - G(\tilde{\phi})} \left( \delta F_e + (1 - G(\tilde{\phi})) F + (1 - G(\tilde{\phi}_x)) F_x \right),
\]

(A.19)

\[
\frac{Y}{M_t} = \frac{1}{1 + \alpha(\tilde{\phi}, \tilde{\phi}_x)} \left( \frac{\theta(\tilde{\phi}, \tilde{\gamma})}{\phi} \right)^{\sigma-1} \frac{\sigma F}{1 - G(\tilde{\phi})} \left[ \int_{\tilde{\phi}}^{\infty} \left( \frac{\phi}{\theta(\phi, \tilde{\gamma})} \right)^{\sigma-1} dG(\phi) + \tau^{-\sigma} \int_{\tilde{\phi}_x}^{\infty} \left( \frac{\phi}{\theta(\phi, \tilde{\gamma})} \right)^{\sigma-1} dG(\phi) \right],
\]

(A.20)

where we have used the definition of the price index:

\[
P = \left( (1 - G(\tilde{\phi})) \alpha(\tilde{\phi}, \tilde{\phi}_x) \right)^{\frac{1}{\sigma-1}} \left[ \int_{\tilde{\phi}}^{\infty} p(\phi, w(\phi))^{-(\sigma-1)} dG(\phi) + \tau^{-\sigma} \int_{\tilde{\phi}_x}^{\infty} p(\phi, w(\phi))^{-(\sigma-1)} dG(\phi) \right]^{\frac{1}{\sigma-1}}.
\]

Combining (A.19) and (A.20) yields the (implicit) determination of the cutoff productivity as given by (35).

To determine the labor market equilibrium, we use (17), (18) and the definition of total employment

\[
(1 - u)L = M \left( 1 - G(\tilde{\phi}) \right)^{-1} \left( \int_{\tilde{\phi}}^{\infty} h(\phi) dG(\phi) + \tau^{-\sigma-1} \int_{\tilde{\phi}_x}^{\infty} h(\phi) dG(\phi) \right).
\]

(A.21)

Following the same approach as in Section 3.2.2, we obtain (36), (37) and (38). Solving (18) with respect to \( Y \) leads to the equilibrium output as given by (39). To close the model, we can use (14) to pin down the equilibrium mass of available varieties \( M^*_t \). The equilibrium mass of firms \( M^* \) is determined by rearranging \( M_t = M + M_x = (1 + \alpha(\tilde{\phi}, \tilde{\phi}_x)) M \), which also pins down the equilibrium mass of exporters \( M^*_x \).
A.2.2 Derivation of Proposition 5

Computing partial derivatives from (34) and (35) yields:

\[
\frac{\partial E_1}{\partial \tilde{\phi}} = \sigma - 1 \left( \frac{\theta(\tilde{\phi}, \gamma)}{\theta(\tilde{\phi}_x, \gamma)} \right) \frac{\partial E_1}{\partial \tilde{\phi}} \left( 1 - \frac{\partial \theta(\tilde{\phi}, \gamma)}{\partial \tilde{\phi}} \right) > 0, \quad (A.22)
\]

\[
\frac{\partial E_1}{\partial \tilde{\phi}_x} = -\sigma - 1 \left( \frac{\theta(\tilde{\phi}, \gamma)}{\theta(\tilde{\phi}_x, \gamma)} \right) \frac{\partial E_1}{\partial \tilde{\phi}_x} \left( 1 - \frac{\partial \theta(\tilde{\phi}_x, \gamma)}{\partial \tilde{\phi}_x} \right) < 0, \quad (A.23)
\]

\[
\frac{\partial E_1}{\partial \gamma} = -\sigma - 1 \left( \frac{\phi(\tilde{\phi}, \gamma)}{\phi} \right) \frac{\partial E_1}{\partial \gamma} \left( \phi(\tilde{\phi}_x, \gamma) - \theta(\tilde{\phi}, \gamma) \right) < 0, \quad (A.24)
\]

\[
\frac{\partial E_2}{\partial \tilde{\phi}_x} = \frac{\partial E}{\partial \tilde{\phi}} \left( \frac{\theta(\tilde{\phi}, \gamma)}{\phi} \right) \tau - \sigma \int_{\tilde{\phi}_x}^{\infty} \left( \frac{\phi}{\theta(\phi, \gamma)} \right) \sigma - 1 dG(\phi) < 0, \quad (A.25)
\]

\[
\frac{\partial E_2}{\partial \tilde{\phi}} = -\tau - \sigma \left( \frac{\theta(\tilde{\phi}, \gamma)}{\phi} \right) \sigma - 1 + k\tilde{\phi}^{-k-1}, \quad (A.26)
\]

\[
\frac{\partial E_2}{\partial \gamma} = \frac{\partial E}{\partial \gamma} + \tau - \sigma k \left( \frac{\theta(\tilde{\phi}_x, \gamma)}{\phi} \right) \sigma - 1 \left( A(\tilde{\phi}_x, \gamma) - A_3(\tilde{\phi}_x, \gamma) \right) < 0. \quad (A.27)
\]

Using (A.22), (A.23) and (A.24), we find (by totally differentiating (34)):

\[
\frac{d\tilde{\phi}_x}{d\gamma} = -\frac{\partial E_1}{\partial \tilde{\phi}} > 0, \quad \frac{d\tilde{\phi}_x}{d\phi} = -\frac{\partial E_1}{\partial \tilde{\phi}_x} > 0.
\]

Totally differentiating (35) and observing (A.25), (A.26) and (A.27), we also get:

\[
\frac{d\tilde{\phi}}{d\gamma} = -\frac{\partial E_2}{\partial \tilde{\phi}} < 0,
\]

while the sign of \(d\tilde{\phi}/d\tilde{\phi}_x\) is ambiguous (which is driven by the ambiguous sign of (A.26)). This proves Proposition 5.
A.2.3 Derivation of Proposition 6

Computing partial derivatives from (34) and (35) yields:

\[
\frac{\partial E_1}{\partial \tau} = (\sigma - 1)\tau^{-(\sigma - 1) - 1} \frac{F}{F_x} > 0, \quad (A.28)
\]
\[
\frac{\partial E_1}{\partial F_x} = \tau^{-(\sigma - 1)} \frac{F}{F_x^2} > 0, \quad (A.29)
\]
\[
\frac{\partial E_2}{\partial \tau} = -\sigma \tau^{-\sigma - 1} \left( \frac{\theta(\tilde{\phi}, \bar{\tau})}{\phi} \right)^{\sigma - 1} \int_{\tilde{\phi}_x}^{\infty} \left( \frac{\phi}{\theta(\phi, \bar{\tau})} \right)^{\sigma - 1} dG(\phi) < 0, \quad (A.30)
\]
\[
\frac{\partial E_2}{\partial F_x} = -\tilde{\phi}_x^{-k} F^{-1} < 0. \quad (A.31)
\]

Using (A.28), (A.29), (A.30) and (A.31) as well as (A.22), (A.23), (A.25) and (A.26), we find (by totally differentiating (34) and (35)):

\[
\frac{d\tilde{\phi}_x}{d\tau} = -\frac{\partial E_1}{\partial \tau} \frac{\partial \tilde{E}_1}{\partial \tilde{\phi}_x} > 0, \quad \frac{d\tilde{\phi}_x}{dF_x} = -\frac{\partial E_1}{\partial F_x} \frac{\partial \tilde{E}_1}{\partial \tilde{\phi}_x} > 0,
\]
\[
\frac{d\tilde{\phi}}{d\tau} = -\frac{\partial E_2}{\partial \tau} \frac{\partial \tilde{E}_2}{\partial \phi} < 0, \quad \frac{d\tilde{\phi}}{dF_x} = -\frac{\partial E_2}{\partial F_x} \frac{\partial \tilde{E}_2}{\partial \phi} < 0,
\]

which proves the first part of Proposition 6. For the second part, note that if \(\chi = 0\), the export cutoff productivity is given by:

\[
\tilde{\phi}_{x(\chi=0)} = \tau \left( \frac{F}{F_x} \right)^{-\frac{1}{\sigma - 1}} \tilde{\phi}_{\chi=0}.
\]
References


