Labour Market Imperfections, International Integration and Selection.*

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Abstract

Although a large body of literature has focused on the effects of intra-firm differences on export performance, relatively little attention has been devoted to the interaction between firms' selection and international performance and labour market institutions – in contrast with the centrality of the latter to current policy and public debates on the implications of economic globalisation for national policies and institutions. In this paper, we study the effects of labour market unionisation on the process of competitive selection between heterogeneous firms and analyse how the interaction between the two is affected by trade liberalisation between countries with different unionisation patterns.

Keywords: firm selection, labour market unionisation, gains from trade
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1 Introduction

In recent years the focus of debates about the determinants of countries' international *competitiveness* has shifted from the relative performance of sectors and industries to that of firms within sectors. The increasing availability of good quality firm-level data has highlighted the existence of substantial heterogeneity in virtually all performance indicators across firms within industries and has drawn attention to the role played by intra-sectoral firm level adjustments and reallocations in determining the export performance of industries and countries. A recent report by Bruegel and CEPR ([10]) offers a systematic, cross-country, firm-level evidence of the internationalisation of European firms. It finds that the international performance of European countries is essentially driven by a relatively small number of high-performance firms[1], with international markets liberalisation inducing a selection process whereby the most productive firms substitute the least productive ones within sectors. A key stylised fact emerging from the empirical literature is that differences in bilateral export volumes between countries (resulting from standard 'gravity' factors such as distance and country size) reflect both an 'extensive margin' effect of gravity (with more firms exporting to closer and larger countries) and an 'intensive margin' one (with a similar number of firms each exporting a larger average quantity to the closer/larger market), with the former being often stronger than the latter (as highlighted for Europe by the Bruegel and CEPR report, [10]).

This evidence has potentially important implications for both the effects of continuing international liberalisation of markets and for the policy actions that might be undertaken by governments concerned on promoting national industries.

In response to these observed stylised facts, recent theoretical developments have provided microfundations for the existence of inter-firm differences in productivity, performance and behaviour. Montagna offers an early analysis of the effects of inter-firm cost heterogeneity on the effects of monopolistically competitive market structures [11] and later highlights the effects of trade liberalisation on firms' selection [12] in the presence of inter-country differences in firms' efficiency distributions. Melitz [8] introduces a fixed export cost in an environment characterised by uncertainty about after-entry efficiency and shows how firms with different efficiencies self-select into different behaviours, with only more productive firms choosing to become exporters.[2]

Although a large body of literature has focused on the effects of intra-firm differences on export performance, relatively little attention has been devoted to the interaction between firms' selection and international performance and labour market institutions – in contrast with the centrality of the latter to

[1] In general, the top 1%, 5% and 10% exporters account for no less than 40%, 70% and 80% of aggregate exports, what is referred to as the 'superstars exporters' phenomenon (Bruegel and CEPR Report, 2007).

[2] A large body of literature has originated that extends Melitz seminal contribution. In a different class of models, e.g. Bernard et al [1] and Eaton and Kortum [4] stochastic firm productivity are introduced into a multi-country Ricardian framework, with firms using different technology to produce the same good in the presence of market segmentation.

current policy and public debates on the implications of economic globalisation for national policies and institutions.[3] Conventional wisdom in this area rests on traditional views of the standard distortions resulting from labour market imperfections – views contending that labour markets deregulation is a necessary response to globalisation.

Labour market imperfections, however, may have not entirely obvious effects on the equilibrium efficiency distribution of firms. In this paper, we study the effects of labour market unionisation on the process of competitive selection between heterogeneous firms and analyse how the interaction between the two is affected by trade liberalisation between countries characterised by different unionisation patterns. To this end, we develop a model characterised by imperfect competition in both goods and factor market in which firms are heterogeneous. Specifically, we assume that labour markets are unionised and analyse the effects of the bargaining power of firm specific unions on industry selection and on the effects of trade liberalisation between two countries characterised by different labour union strenghts. The endogenous determination of wages via bargaining between heterogeneous firms and firm specific unions implies that wages will differ between firms – and that ex-ante identical workers will perceive different equilibrium wages. We are therefore able to examine the effects of union's bargaining power on the distribution of firms productivities. We show that more powerful unions will allow more entry of less efficient firms. The intuition for this result is that, for a given bargaining power, a union's rent extraction ability will be higher the higher is the productivity of the firm with which it negotiates. As a result, a given increase in the bargaining power of unions will translate in proportionally higher wage demand in relatively more efficient firms – i.e. an increase in v will hurt (via a higher wage) more efficient firms proportionally more than less efficient ones.

The paper is organized as follows. Section 2 introduces the setup of the model for the closed economy analysis. Then, Section 3 discusses the long run equilibrium properties of the model, with Section 4 focusing on the welfare analysis. The framework is extended to the open economy analysis in Section 5, while Section 6 presents the long run equilibrium results for this latter case.

2 The closed economy

We consider an economy populated by L identical households supplying labour services hired to produce two kinds of goods: a differentiated good, produced in a monopolistic sector, and a homogeneous good, produced in a competitive sector. Workers in the monopolistic sectors are organised in firm specific unions which bargain with firms over the wage. A firm entering the monopolistic sector

[3] Notable exceptions are Egger and Kreickemeier [5] – who analyse the impact of trade liberalisation on firms' selection in the presence of a fair-wage effort mechanism – and Helpman and Itskhoki [6] – who focus on the effects of hiring and firing rigidities on trade and unemployment in the presence of heterogeneous firms. Cunat and Melitz [2] provide evidence on the impact of labour market institutions.

faces a fixed cost in order to develop a new product and start its production, which, subsequently, occurs according to a constant returns to scale technology. The outcome of the initial R&D activity is uncertain and firms learn about their actual production cost levels (productivities) only (i) after making the irreversible investment required for entry, and (ii) before bargaining with the union over the wage level. The firm specific unions also know firms' productivity levels before bargaining. Hence, after having discovered their productivity levels and conducted the bargaining process with the unions, firms that can cover their marginal cost will survive and produce, while all other firms will exit the industry. Note that, as is standard in the monopolistic competition literature, we assume there to be a continuum of N potential firms, each sufficiently small so as to ignore the impact of its actions on the behaviour of its competitors. Thus, while firms in this sector enjoy, by virtue of product differentiation, some monopoly power, there is no strategic interaction between them.

2.1 Preferences

Consumer preferences, defined over both the differentiated good and the homogeneous good, are described by the following quadratic quasilinear utility function[4]

$$U(q_0^{\zeta}; q^{\zeta}(i), i \in [0, N]) = q_0^{\zeta} + \alpha \int_0^N q^{\zeta}(i)di - \frac{1}{2}\delta \int_0^N q^{\zeta}(i)^2 di - \frac{1}{2}\eta \left(\int_0^N q^{\zeta}(i)di \right)^2 \tag{1}$$

where $q^{\zeta}(i)$ is a typical household ζ's consumption level of variety i of the differentiated good, q_0^{ζ} is its consumption of the homogeneous good, and N is the mass of varieties of the differentiated good; α, δ and η are positive preference parameters. Specifically, δ captures the degree of consumers' bias towards product differentiation (i.e. towards a dispersed consumption of varieties); both α and η capture the intensity of preferences for the differentiated good with respect to the numeraire (this intensity increases in α and decreases in η); a higher η also reflects a higher degree of substitutability between varieties.

The budget constraint of a typical household is given by

$$\int_0^N p(i)q^{\zeta}(i)di + p_0 q_0^{\zeta} = I_{\zeta} + p_0 \bar{q}_0 \tag{2}$$

where p_0 is the price of the competitive good, $\bar{q}_0$ is the household's initial endowment, and I_{ζ} is its income. We shall assume that a typical household supplies one unit of labour inelastically and that its labour services can be hired by both a firm in the monopolistic sector and by producers in the competitive sector.

[4] The major drawback of using the quasi-linear utility function is that it rules out general equilibrium income effects. However, one important advantages of the linear model is that, by endogenising the optimal price-cost mark-up of firms, it allows for the identification of pro-competitive effects that emerge from the interaction between goods and factor markets.

Denoting, with w_m and w_c the wage rate paid by firms in the monopolistic sector by firms in the competitive sector respectively, the expected income of a typical household ζ employed by firm i will then be given by:[5]

$$I_\zeta = w_m(i) l_m^\zeta(i) + w_c l_c^\zeta(i)$$

where $l_m^\zeta(i)$ is the amount of work performed in firm i of the monopolistic sector by household ζ, and $l_c^\zeta(i) = 1 - l_m^\zeta(i)$ is the amount of work it performs in the competitive sector. It is obvious that when $w_m(i) > w_c$ a consumer strictly prefers to work for a firm in the monopolistic sector, and the condition to have at least some workers employed in this sector requires that $w_m(i) \geq w_c$.

The level of employment in the monopolistic sector is determined by demand, and then the remaining labour supply is employed by the competitive sector.[6]

Maximisation of consumer's utility yields the inverse of the individual demand of each variety produced by the monopolistic sector:

$$p(i) = \alpha - \delta q^\zeta(i) - \eta Q^\zeta \tag{3}$$

where $Q^\zeta = \int_0^N q^\zeta(i) di$ is total individual consumption of the differentiated good.

The price threshold for positive demand for variety i is

$$p(i) = \frac{1}{\eta N + \delta} \left(\delta\alpha + \eta N \bar{p}\right) \tag{4}$$

where $\bar{p}$ is the average price of varieties sold in the economy. A price above this threshold wold result in a firm having to exit the market.

Finally, the aggregate demand function for each firm can be written as follows

$$q(i) = L \left\{ \frac{\alpha}{(\delta + \eta N)} - \left[\frac{1}{(\delta + \eta N)} + \frac{\eta}{\delta(\delta + \eta N)} N \right] p(i) + \frac{\eta}{\delta(\delta + \eta N)} P \right\} \tag{5}$$

with $q(i) = L q^\zeta(i)$ and $P = \int_0^N p(i) di$.

2.2 Production

In both sectors, all goods are produced with labour as the only factor of production. In the competitive sector, the production of one unit of the homogeneous good requires one unit of labour. Given that when discussing the properties of the open economy we shall assume that the good produced in the competitive

[5] It is of course possible that a household labour may be employed in only one of the sectors.

[6] Note that household incomes should be increased (reduced) by profits (losses) gained (suffered) by workers as owners of shares of firms in the monopolistic sector. However, given that in the long run the expected (and actual) total profits are equal to the fixed costs of innovation, they do not appear into (2).

sector is freely traded, it is convenient to use this good as the numeraire and set its price at unity, i.e. $p_0 = 1$.

In order to start producing, each firm i entering the monopolistic sector bears a fixed cost f_E in terms of the homogeneous good that covers both the cost of entry and of the innovation required in developing the variety of the good. This cost is sunk after entry. To produce a quantity $q(i)$ of the good, a typical firm i needs $l_m(i)$ units of labour, as described by the following production function

$$q(i) = \theta(i) l_m(i) \tag{6}$$

where $\theta(i)$ is a measure of the productivity of firm i and our source of heterogeneity. In particular, $c(i) = \theta(i)^{-1}$ is the quantity of labour required to produce one unit of $q(i)$. Therefore, after developing a new variety, subsequent production by a firm in this sector exhibits constant returns to scale. The wage perceived by the workers employed in the monopolistic sector is set in a bargaining process involving firm specific unions, and we recall that the wage paid by firm i is denoted by $w_m(i)$. We will return later to the bargaining process that determines $w_m(i)$. Prior to entry, all firms are identical. Since R&D is an uncertain activity, however, it is plausible to assume that it is only after making the irreversible investment f_E required for entry and product development, that a firm learns how productive its technology, as measured by the parameter $\theta(i)$, is. Thus the sunk investment delivers a new horizontally differentiated variety with a random unit labour requirement $c(i)$ drawn from some cumulative distribution, $G(c)$. As a result, R&D generates a distribution of entrants across marginal costs, and a firm i producing in the economy faces the marginal cost of production $w_m(i)c(i) = w_m(i)/\theta(i)$. Thus, the variable cost function of a firm supplying variety i is

$$VC(i) = \frac{w_m(i)q(i)}{\theta(i)} \tag{7}$$

and its operating profits, $\pi(i)$, are given by

$$\pi(i) = p(i)q(i) - VC(i)$$

After substituting (7) into the previous equation we obtain

$$\pi(i) = \left[p(i) - \frac{w_m(i)}{\theta(i)}\right] q(i) \tag{8}$$

Hence, the price and the quantity which maximize the profit of firm i must satisfy the following relationship

$$q(i) = \frac{L}{\delta}\left[p(i) - \frac{w_m(i)}{\theta(i)}\right] \tag{9}$$

Maximizing operating profits (after maximisation with respect to $q(i)$) yields

$$\pi(i) = \frac{L}{\delta}\left[p(i) - \frac{w_m(i)}{\theta(i)}\right]^2 \tag{10}$$

Hence, from equations (6) and (9) we derive the quantity of labour demanded by firm i, $l_m(i)$,

$$l_m(i) = \frac{L}{\theta(i)\delta}\left[p(i) - \frac{w_m(i)}{\theta(i)}\right] \tag{11}$$

Note that using equations (6) and (11), we can rewrite the profit function in (8) in terms of $l_m(i)$, that is

$$\pi(i) = \frac{\delta}{L}\theta^2(i)l_m^2(i) \tag{12}$$

Finally, maximizing profits (8) with respect to price subject to the aggregate demand (5), we get the price set by each firm

$$p(i) = \frac{w_m(i)}{2\theta(i)} + \frac{P\eta + \alpha\delta}{2(\delta + N\eta)} \tag{13}$$

2.3 Unions

In the homogenous perfectly competitive good sector, the labour market is also perfectly competitive and all employers pay the same wage. Hence, since the price of the good and the value of the marginal product of labour in this sector are both fixed at unity, the wage rate perceived by the labour employed in the production of the homogeneous good w_c, is also equal to 1. In contrast, labour in the monopolistic sector is unionised, with wages set by a bargaining process between firm specific unions and firms. We focus on the right to manage model, which, for an appropriate parameter value, collapses in the monopoly model. More precisely, in the right to manage model, employment is determined unilaterally by each firm (the employer) and the wage is determined in a bargaining process between the firm specific union and the firm.[7]

The Nash bargaining solution to the firm specific right to manage model is obtained by

$$\max_{w_m(i)} \Pi_i = v\log\left[V_i\left(w_m(i), l_m(i)\right)\right] + (1-v)\log\left[\pi\left(w_m(i), l_m(i)\right) - \pi_0(i)\right] \tag{14}$$

subject to the labour demand in (11) and to the price given by equation (13), where $0 < v \leq 1$ represents the bargaining power of the union. Notice that when $v = 1$, we fall back to the monopoly model in which employment is unilaterally determined by the employer, and the wage is unilaterally fixed by the union taking into account the effect of changes in wages on employment and on prices.

A firm i will maximize its profits above its reservation utility, $\pi_0(i)$, which is equal to 0. Instead, a union i will maximize the total *labour rent* above the constant wage paid to non-unionised workers, given by

$$V_i\left(w_m(i), l_m(i)\right) = l_m(i)\left[w_m(i) - w_c\right] \tag{15}$$

[7] Eventually, in the future we could generalize the model in order to consider a more general sequential bargaining model. See Manning (1987).

where $w_c = 1$.

Hence, substituting the operating profits in (12) and the union's payoff in equation (15) into the Nash bargaining product in (14), the bargaining problem of a firm/union pair can be rewritten as follows

$$\max_{w_m(i)} \Pi_i = v \log \{l_m(i)\,[w_m(i) - 1]\} + (1-v) \log \left[\frac{\delta}{L} \theta\,(i)^2\, l_m(i)^2 \right]$$

subject to the labour demand equation in (11) and the equilibrium price in (13).

The first order condition $\partial \Pi_i / \partial w_m(i) = 0$ requires that

$$\frac{dl_m(i)}{dw(i)}(2-v) + v\frac{l_m(i)}{[w_m(i)-1]} = 0 \tag{16}$$

From the labour demand equation in (11) we obtain

$$\frac{dl_m(i)}{dw(i)} = \frac{L}{\theta(i)\delta}\left[\frac{dp(i)}{dw(i)} - \frac{1}{\theta(i)}\right] \tag{17}$$

where $\frac{dp(i)}{dw(i)}$ can be derived from equation (13) as

$$\frac{\partial p(i)}{\partial w(i)} = \frac{1}{2\theta(i)} \tag{18}$$

Then, using equations (17), (18) and (11), the first order condition in (16) can be solved to derive the wage equation as follows

$$w_m(i) = 1 + 2\frac{v}{v+2}\theta(i)\left(p(i) - \frac{1}{\theta(i)}\right) \tag{19}$$

Since $w_m(i) \geq w_c = 1$ must hold in equilibrium, the wage equation in (19) implies that the following condition must also hold: $p(i) \geq \theta(i)^{-1}$. However, note that for expressions (9) and (10) to be positive, it must be the case that $p(i) \geq w_m(i)/\theta\,(i)$; making use of the wage equation in (19), this condition is satisfied if and only if

$$p(i) \geq \frac{1}{\theta(i)} \tag{20}$$

which, in turn, always implies that $w_m(i) \geq w_c = 1$.

3 The long run equilibrium

Prior to entry, a firm's expected profit is $\int_0^{c_D} \pi(c)dG(c) - f_E$. If expected profits were negative, no firm would enter the market. With unrestricted entry, firms would however continue to enter till expected profits are driven to zero, that is until the 'zero-profit' entry condition below is satisfied

$$\int_0^{c_D} \pi(c)dG(c) = f_E$$

If (after paying the fixed cost f_E) a firm draws a low productivity, it may decide to exit immediately and not produce. The entry condition above identifies a threshold, or cut-off, level of technical efficiency at which a firm will be indifferent between staying in the market or exiting, which we shall denote by $c_D = \theta_D^{-1}$. Firms with a level of $c(i) = c_D$ (or $\theta(i) = \theta_D$) will just break even. Thus, the cutoff level, θ_D, and equivalently c_D, are defined by the following equivalent zero profit conditions

$$\begin{aligned} \theta_D &= \inf\{\theta : \pi(\theta_D) = 0\} \qquad (21) \\ c_D &= \sup\{c : \pi(c_D) = 0\} \qquad (22) \end{aligned}$$

which describe the indifference condition of marginal firms (i.e. the firms that are just able to cover their effective marginal costs of production). Using (21), equations (19) and (10) in (21), we obtain

$$\begin{aligned} \pi(\theta_D) &= 0 \Longleftrightarrow p(\theta_D) = \frac{w_{mD}}{\theta_D} \qquad (23) \\ \pi(c_D) &= 0 \Longleftrightarrow p(c_D) = c_D w_{mD} \qquad (24) \end{aligned}$$

where w_{mD} is the wage paid by marginal firms with productivity θ_D. Thus, c_D denotes the upper limit of the range of c of firms actually producing in the economy (equivalently, θ_D denotes the lower limit of θ). More productive entrants with a value of $c(i) < c_D$ (or $\theta(i) > \theta_D$) will start producing, while entrants with a value of $c < c_D$ (or $\theta > \theta_D$) will exit the market.

Note that using the price from equation (23) into the wage equation in (19) we obtain

$$w_{mD} = 1 \qquad (25)$$

that is, the marginal firms will pay a wage that equals the competitive wage.

The optimal prices, $p(i)$, and output levels, $q\,(i)$, can now be written as functions of the cutoff

$$p(i) = \frac{(v+2)\,c_D + (2-v)\,c(i)}{4} \quad \text{and} \quad q(i) = \frac{(2-v)\,L}{4\delta}\,[c_D - c(i)] \qquad (26)$$

Similarly, maximized profit levels are given by

$$\pi(i) = \frac{L\,(2-v)^2}{16\delta}\,[c_D - c(i)]^2 \qquad (27)$$

Defining the absolute markup of a firm with a unit labour requirement of $c(i)$ as $\mu(i) = p(i) - \frac{w_m(i)}{\theta(i)}$, we can write it in terms of the cutoff point as

$$\mu(i) = \frac{1}{4}\,(2-v)\,[c_D - c(i)] \qquad (28)$$

Moreover, revenues of a firm of type i are given by

$$r(i) = \frac{(2-v)\,L\,[(v+2)\,c_D + (2-v)\,c(i)]\,[c_D - c(i)]}{16\delta}$$

Finally, note that, substitution of $p(i)$ from (26) into (19) yields:

$$w_m(i) = 1 + \frac{v}{2}\left[\frac{c_D}{c(i)} - 1\right] \tag{29}$$

Thus, for a given v, firms with lower unit labour requirement will set lower prices, sell larger quantities, earn higher revenues and have larger profits than less efficient firms.[8] Their absolute markup will also be higher, even though they pay higher wages, as a result of the higher rent extraction ability that their higher relative efficiency allows their firm specific unions.

Following Melitz and Ottaviano [9], we adopt a Pareto distribution as the specific parametrisation of $G(c)$. This distribution has a higher unit labour requirement bound $c_M = 1/\theta_L$ and shape parameter $k \geq 1$:

$$G(c) = \left(\frac{c}{c_M}\right)^{\kappa}, \ c \in [0, c_M] \tag{30}$$

The implication of this parametrisation is that large firms are less frequent than small firms, with the shape parameter κ indexing the dispersion of unit labour requirement draws. When $\kappa = 1$, the unit labour requirement distribution is uniform on $[0, c_M]$. As κ increases, the relative number of high unit labour requirement firms increases, and the distribution is more concentrated at higher c levels. As κ goes to infinity, the distribution becomes degenerate at c_M. Given (30), the average unit labour requirement of entrants evaluates to $\overline{c} = c_M\kappa/(\kappa+1)$ with variance equal to $\overline{c}/[\kappa(\kappa+2)]$. Thus, the higher c_M, the higher the mean and the variance of the unit labour requirement draws.

Using the chosen parametrization in (30) and the optimized profits in (27), the free-entry condition then implies the following closed form solution for the cutoff level

$$c_D = \left[\frac{8\delta\,(\kappa+1)\,(\kappa+2)\,f_E c_M^{\kappa}}{L\,(2-v)^2}\right]^{1/(\kappa+2)} \tag{31}$$

which implies that the elasticity of the long-run cutoff level c_D with respect to v will be given by

$$\frac{\partial c_D}{\partial v}\frac{v}{c_D} = \frac{2v}{(\kappa+2)\,(2-v)} > 0 \tag{32}$$

This means that an increase in the bargaining power of unions, v, results in an increase in the cutoff c_D (that is, in a reduction of the productivity cutoff level, θ_D). In other words, more powerful unions will allow more entry of less efficient firms. The intuition for this result is that, for a given bargaining power, a union's rent extraction ability will be higher the higher is the productivity of the firm with which it negotiates. As a result, a given increase in the bargaining power of unions will translate in proportionally higher wage demand in relatively more efficient firms – i.e. an increase in v will hurt (via a higher wage) more efficient firms proportionally more than less efficient ones.

[8] For $v - 0$, results correspond to those in Melitz and Ottaviano (2005).

Consistently, using equations (26), (27), (28) and (30), to compute producer average performance measures, we find that whilst our results coincide with those in Melitz and Ottaviano [9] when the unions have no bargaining power (that is when $v = 0$), as v increases, the average value of the inverse of productivity ($\bar{c}$) and of prices ($\bar{p}$) increases, while those of the average markup ($\bar{\mu}$) and profits ($\bar{\pi}$) fall – as shown by the expressions below:

$$\bar{c} = \frac{\kappa}{\kappa+1}c_D, \quad \bar{p} = \frac{(4\kappa + v + 2)}{4(\kappa+1)}c_D, \quad \bar{\mu} = \frac{1}{4}(2-v)\frac{c_D}{(\kappa+1)} \tag{33}$$

$$\bar{\pi} = \frac{L(v-2)^2 c_D^2}{8\delta(\kappa+1)(\kappa+2)} \tag{34}$$

Finally, note that, on average, producers (i.e. firms that survive in equilibrium) are more productive than entrants, given that the cutoff c_D is lower than the upper bound c_M. Thus, selection implies that adopted technologies are on average more productive than available technologies.

Turning to the individual firm, we can observe that wages $w_m(i)$ are increasing in the bargaining power of the union v, and that $q(i)$, $\pi(i)$ and $\mu(i)$ are increasing in v only for $c > \kappa/(\kappa+2)c_D$ (or they are decreasing for $c < \kappa/(\kappa+2)c_D$). Moreover, if $c < \kappa/(\kappa+2)c_D$ then $p(i)$ is increasing in v. Otherwise if $c > \kappa/(\kappa+2)c_D$, $p(i)$ is increasing in v only when $v < 2 + \frac{8c_D}{\kappa c_D - c\kappa - 2c} = v^*$, while it is decreasing in v when $v^* < v \leq 1$. It then follows that if, for instance, $v < v^*$, any increase in v will result in an increase in prices. However, since the rent extraction ability of unions increases with firms' productivity, a higher v will result in an increase in markup and profits only for relatively less productive firms, because for them the increase in wages is relatively smaller with respect to the increase in prices, than the increase in wages registered by more productive firms.

The equilibrium mass of sellers N can be found by evaluating equation (4) for the marginal firm (i.e. at $\theta(i) = \theta_D$) and imposing the zero-profit condition in (23) to obtain:

$$c_D = \frac{1}{\eta N + \delta}(\delta\alpha + \eta N \bar{p}) \tag{35}$$

Substituting $\bar{p}$ from equation (33) into equation (35), the number of firms selling in the economy can be determined as

$$N = \frac{4(\kappa+1)\delta}{\eta(2-v)}\frac{\alpha - c_D}{c_D} \tag{36}$$

Clearly, for N to be positive, α needs to be greater than c_D. Furthermore, a ceteris paribus increase in the bargaining power of unions will have an ambiguous effects on the population of surviving firms. Specifically, an increase in v will result in an increase N when $\alpha > (\kappa+2)c_D/\kappa$, and in a fall in N when $\alpha < (\kappa+2)c_D/\kappa$. Hence, even if the increase in v will allow more entry of less efficient firms, it will result in a larger number of firms only if the preference for the differentiated good (as indexed by α) is sufficiently strong.

Finally, the number of entrants will be given by

$$N_E = N/G(c_D) \tag{37}$$

To summarise, an increase in the bargaining power of unions will have three main effects: (i) a *variety effect* – by resulting in an increase in the mass of firms selling in the economy when the preference for the differentiated good is sufficiently strong, (ii) a *counter competitive effect* – since a higher v results in higher average prices, which in turn entail lower average markups and profits for firms, and (iii) a *selection effect* via an increase in c_D, which results from the markups and profits of less productive firms increasing more than those of more productive ones.

4 Welfare

Since free entry implies that aggregate profits vanish in equilibrium, welfare in the economy is given by consumer surplus only. In particular, consumers' ζ surplus, W_ζ, is

$$W_\zeta \equiv I_\zeta + \bar{q}_0 + B \tag{38}$$

with B common to all workers and defined as

$$B \equiv \frac{1}{2}\left(\eta + \frac{\delta}{N}\right)^{-1}(\alpha - \bar{p})^2 + \frac{1}{2}\frac{N}{\delta}\sigma_p^2 \tag{39}$$

where σ_p^2 is the variance of prices, given by

$$\sigma_p^2 = \frac{(2-v)^2}{16}\frac{\kappa}{(\kappa+2)(\kappa+1)^2}(c_D)^2 \tag{40}$$

Note that, B and, consequently, welfare decreases in $\bar{p}$, while they increase in both N (this is the standard love of variety effect) and σ_p^2 (this last effect means that consumers "re-optimize their purchases by shifting expenditures towards lower priced varieties as well as the numeraire good", Melitz and Ottaviano, [9], p. 4)

It can be readily verified that the average price in (33) is increasing in v, and that the variance of prices in (40) is decreasing in v. Therefore, inspection of (39) reveals that B declines with v. This means that the negative effects on B resulting from (i) the increase in the average price and (ii) the decline in the variance of prices more than offset the *eventual* positive effect of an increase in v on variety N.

Moreover, substituting $\bar{p}$ from (33) and σ_p^2 from (40), we notice that B can be rewritten as follows

$$B = \frac{1}{4\eta}(\alpha - c_D)\left(2\alpha - \frac{c_D(2\kappa + v + 2)}{(\kappa+2)}\right) \tag{41}$$

where the condition that $\alpha > c_D$ implies that $B > 0$. From previous expression we derive that

$$\frac{\partial B}{\partial v} = -\frac{1}{4\eta}\frac{\partial c_D}{\partial v}\left\{\left[2\alpha - \frac{c_D\left(2\kappa + v + 2\right)}{\left(\kappa + 2\right)}\right] + \left(\alpha - c_D\right)\frac{\left(2\kappa + v + 2\right)}{\left(\kappa + 2\right)}\right\} < 0 \quad (42)$$

To evaluate the total effect of a change of v on welfare, we need to consider both the effect produced on B described by (42), which is *common* to all *"households"*, and that produced on their income, I_ζ.

However, we recall that households may be employed by different types of firms and perceive different incomes. Thus, we compute the expected wage paid by firms in the economy, that is

$$\bar{w}_m = 1 + \frac{v}{2\left(\kappa - 1\right)}$$

Then, we notice that the average surplus in the economy is given by

$$W \equiv \frac{\sum W_\zeta}{L} = \bar{I} + \bar{q}_0 + B$$

where the average household's income, $\bar{I}$, is given by the following expression

$$\bar{I} \equiv \frac{\overline{VC} * N + w_c(L - \bar{l}N)}{L} = \frac{(\overline{VC} - \bar{l})N}{L} + 1$$

In previous expression, the average variable cost of production sustained by a firm, $\overline{VC}$, and the average labour demand of firms, $\bar{l}$, are respectively given by

$$\overline{VC} = \frac{L\left(2 - v\right)\left(\kappa + v\right)}{4\delta\left(\kappa + 1\right)\left(\kappa + 2\right)}\left(c_D\right)^2$$

and

$$\bar{l} = \frac{L\left(2 - v\right)\kappa}{4\delta\left(\kappa + 1\right)\left(\kappa + 2\right)}\left(c_D\right)^2$$

Hence, we find that $\frac{\partial \bar{I}}{\partial v} \gtreqless 0$ if, and only if, $\alpha \gtreqless c_D\left[2v + 4 + \kappa\left(2 - v\right)\right]/[\kappa\left(2 - v\right) + 4]$, meaning that the average household's income increases with v only if the preference for the differentiated good is sufficiently strong.

5 Open Economy

In the previous section we analysed, within a closed economy model, the effects of unionisation and union power on industry structure, performance and selection. In this section we extend the analysis to consider a two country-setting and examine how differences in the two countries' labour market institutions (in the form of union bargaining power) affect inter-market linkages and relative performance.

Consider two open economies, H and F, endowed with L^H and L^F households/workers respectively. Consumers' preferences are assumed to be the same in both countries and are described by the utility function in (1), which leads to the inverse demand function in (4).

On the production side, the homogeneous good is produced under condition of perfect competition and with the same technology in both countries. This good is freely traded. Retaining this good as the numeraire implies that the wage in this sector is equal to unity in both countries. In the differentiated sector, inter-firm productivity differences are modelled as described for the closed economy. Firms make their decisions sequentially: first, they choose where to locate and, then, after paying an entry cost and discovering their productivity level they bargain with the union over the wage, and produce. In this sector, markets are segmented, in the sense firms producing in country $j = H, F$ incur a per-unit trade cost $\tau^j > 1$ when selling their production abroad. Therefore, the delivered cost of a unit produced with cost $w(i)c(i)$ and sold abroad is $w(i)c(i)\tau^j$.

All entrants draw their unit labour requirement parameters simultaneously from a Pareto distribution $G(c)$, after choosing their location. Therefore, each firm knows its own cost parameter $c(i)$, as well as that of all other firms, after paying f_E. It then decides whether to produce or not based on the profits it expects to make at home, $\pi_D^j(c(i))$, and abroad, $\pi_X^j(c(i))$ (where the superscript j refers to the country in which the firm is located), conditional on the productivity distribution of the entrants that will eventually decide to produce. Note that, given that markets are segmented, the profits that firms expect to make at home and abroad respectively depend on the wage. We shall assume, by virtue of market segmentation in the final good markets, that the firms undertakes two separate bargaining processes with unions, one to determine the remuneration of labor employed to produce for the domestic market, that is $w_{mD}^j(i)$, and the other to set the wage for the labor employed to produce for exports, $w_{mX}^j(i)$. More precisely, firms characterized by the cost parameter level $c(i)$ produce for the local market j if, and only if,

$$\pi_D^j(i) = \left[p_D^j(i) - \frac{w_{mD}^j(i)}{\theta(i)}\right] q_D^j(i) \geq 0,$$

and they export to $z = H, F$ with $j \neq z$ if, and only if,

$$\pi_X^j(i) = \left[p_X^j(i) - \frac{\tau^z w_{mX}^j(i)}{\theta(i)}\right] q_X^j(i) \geq 0$$

Note that when we use both j and z, these are such that $j, z = H, F$ and $j \neq z$.

Hence, given that market are segmented, firms of type i produce the quantities $q_D^j(i)$ and $q_X^j(i)$, that, respectively, maximize their local profits at home and abroad when the relative demand functions are given by (4). More precisely, quantities sold in the domestic and foreign market are respectively given by

$$q_D^j(i) = \frac{L^j}{\delta}\left[p_D^j(i) - \frac{w_{mD}^j(i)}{\theta(i)}\right] \quad \text{and } q_X^j(i) = \frac{L^z}{\delta}\left[p_X^j(i) - \frac{\tau^z w_{mX}^j(i)}{\theta(i)}\right] \tag{43}$$

Given the optimal quantities in (43), the maximized profits of firm i producing and selling in country j and exporting to country z are, respectively, given by

$$\pi_D^j(i) = \frac{L^j}{\delta}\left[p_D^j(i) - \frac{w_{mD}^j(i)}{\theta(i)}\right]^2 \quad \text{and} \quad \pi_X^j(i) = \frac{L^z}{\delta}\left[p_X^j(i) - \frac{\tau^z w_{mX}^j(i)}{\theta(i)}\right]^2 \tag{44}$$

Furthermore, from (6) and (43) we derive labour demanded by firm i to produce for the domestic market j, $l_{mD}^j(i)$,

$$l_{mD}^j(i) = \frac{L^j}{\theta(i)\delta}\left[p_D^j(i) - \frac{w_{mD}^j(i)}{\theta(i)}\right] \tag{45}$$

Labour demanded by firm i to produce for the export market z, $l_{mX}^{jz}(i)$, is instead given by

$$l_{mX}^{jz}(i) = \frac{L^z}{\theta(i)\delta}\left[p_X^j(i) - \frac{\tau^z w_{mX}^j(i)}{\theta(i)}\right] \tag{46}$$

Note that using equations (6), (45) and (46), we can rewrite the maximized profits (44) that firms of type i producing in country j obtain respectively from their domestic and export sales in terms of $l_{mD}^j(i)$ and $l_{mX}^{jz}(i)$, that is

$$\pi_D^j(i) = \frac{\delta}{L^j}\theta^2(i)\left(l_{mD}^j(i)\right)^2 \quad \text{and} \quad \pi_X^j(i) = \frac{\delta}{L^z}\theta^2(i)\left(l_{mX}^{jz}(i)\right)^2 \tag{47}$$

Let us first consider firms that produce only for the local market j. Substituting $\pi_D^j(i)$ from (47) and (15) into (14) for economy j, we obtain Π_{iD}^j for firms producing only for the domestic market

$$\max_{w_{mD}^j(i)} \Pi_{iD}^j = v\log\left[l_{mD}^j(i)\left(w_{mD}^j(i) - 1\right)\right] + (1-v)\log\left\{\frac{\delta}{L^j}\theta^2(i)\left(l_{mD}^j(i)\right)^2\right\}$$

The first order condition for the previous problem can be solved to obtain the wage equation

$$w_{mD}^j(i) = 1 + 2\frac{v\theta(i)}{v+2}\left(p_D^j(i) - \frac{1}{\theta(i)}\right) \tag{48}$$

Notice that (48) is similar to the wage equation (19) obtained for the closed economy.

The wage paid to the workers employed by a firm in j in the production for the export market z is set by solving the following Nash bargaining problem

$$\max_{w_{mX}^j(i)} \Pi_{iX}^j = v\log\left[l_{mX}^{jz}(i)\left(w_{mX}^j(i) - 1\right)\right] + (1-v)\log\left[\pi_X^j(i)\right]$$

that is

$$\max_{w_{mX}^j(i)} \Pi_{iX}^j = v\log\left[l_{mX}^{jz}(i)\left(w_{mX}^j(i) - 1\right)\right] + (1-v)\log\left\{\delta\theta^2(i)\frac{\left[l_{mX}^{jz}(i)\right]^2}{L^z}\right\}$$

The first order condition for the maximisation of this problem can be solved to obtain the wage equation

$$w^j_{mX}(i) = 1 + 2\frac{v\theta(i)}{v+2}\left(\frac{p^j_X(i)}{\tau^z} - \frac{1}{\theta(i)}\right) \tag{49}$$

Since $w^j_{mX}(i) \geq w_c = 1$ must hold in equilibrium, the wage equation in (49) implies that the following condition must also hold: $p^j_X(i) \geq \tau^z\theta(i)^{-1}$. However, note that for expressions (43) and (44) to be positive, it must be the case that $p^j_X(i) \geq \tau^z w^j_{mX}(i)/\theta(i)$; making use of the wage equation in (49), this condition is satisfied if and only if

$$p^j_X(i) \geq \frac{\tau^z}{\theta(i)}$$

which, in turn, always implies that $w^j_{mX}(i) \geq w_c = 1$.

6 The long run equilibrium in the open economy

The free entry and exit condition of firms implies that expected profits are driven to zero, and this allows us to identify two cutoffs for c (or for θ) denoted by c^j_D and c^j_X (or θ^j_D and θ^j_X); specifically, c^j_D (θ^j_D) corresponds to the upper limit of the range of c (or to the lower limit of the range of θ) over which firms produce only for the local market j; c^j_X (θ^j_X) corresponds instead to the upper limit of the range of c (or to the lower limit of the range of θ) over which firms export to country z.

After having determined the number of entrants in country j, N^j_E, we find that a mass $N^j_D = G^j(c^j_D)N^j_E$ of firms sell in the domestic market and a mass $N^j_X = G^j(c^j_X)N^j_E$ of firms export. Given that firms would be forced to leave if their profits were negative, cutoff levels for firms selling in the domestic market only and exporting are defined respectively by the following zero profit conditions

$$\begin{aligned} c^j_D &= \sup\left\{c : \pi^j_D(c^j_D) = 0\right\} \quad \text{or} \quad \theta^j_D = \inf\left\{\theta : \pi^j_D(\theta^j_D) = 0\right\} \\ c^j_X &= \sup\left\{c : \pi^j_X(c^j_X) = 0\right\} \quad \text{or} \quad \theta^j_X = \inf\left\{\theta : \pi^j_X(\theta^j_X) = 0\right\} \end{aligned} \tag{50}$$

Thus, we may determine the domestic cutoff c^j_D (or equivalently θ^j_D) and the export cutoff c^j_X (or equivalently θ^j_X) from (50), which describe the indifference conditions of marginal firms and which imply that the firms that are just able to cover their marginal costs for domestic and export sales are respectively characterized by

$$\begin{aligned} \pi^j_D(c^j_D) &= 0 \Longleftrightarrow p^j(c^j_D) = w^j_{mD}c^j_D \quad \text{or} \quad \pi^j_D(\theta^j_D) = 0 \Longleftrightarrow p^j(\theta^j_D) = \frac{w^j_{mD}}{\theta^j_D} \\ \pi^j_X(c^j_X) &= 0 \Longleftrightarrow p^z(c^j_X) = \tau^z w^j_{mX}c^j_X \quad \text{or} \quad \pi^j_X(\theta^j_X) = 0 \Longleftrightarrow p^z(\theta^j_X) = \frac{\tau^z w^j_{mX}}{\theta^j_X} \end{aligned} \tag{51}$$

where w^j_{mD} is the wage paid by marginal firms with labor requirement c^j_D (or productivity level θ^j_D), and w^j_{mX} is the wage paid by marginal firms with labor requirement c^j_X (or productivity level θ^j_X).

Moreover, note that substitution of the price from (51) into (48) implies that the wage for marginal firms producing for the domestic market only will be given by

$$w^j_{mD} = 1 \tag{52}$$

Similarly, substituting the price from (51) into (49) we obtain that for the marginal firm exporting from j to country z

$$w^j_{mX} = 1 \tag{53}$$

From expressions (51), (52) and (53), we derive the relationship between the two cutoffs for domestic producers c^j_D in country j and foreign exporters c^z_X from country z to country j, which is given by

$$c^z_X = \frac{c^j_D}{\tau^j} \tag{54}$$

Expression (54) shows that the relationship between c^j_D and c^z_X depends on the *accessibility* of country j from z (that is, τ^j).

Moreover, using (52) and (53), $p^j(c^j_D)$ and $p^z(c^j_X)$ in (51) can be rewritten as follows

$$p^j(c^j_D) = c^j_D \quad \text{and} \quad p^z(c^j_X) = \tau^z c^j_X \tag{55}$$

According to (51), (52) and (53), we identify three types of entrant firms in country j. If results for the cutoff levels and wages in (51) are such that $c^j_D > c^j_X$, as it will be shown later, then we have the following three types of firms: (1) less productive firms not producing, with $c > c^j_D$; (2) firms with intermediate productivity producing only for the local market, with $c^j_D > c > c^j_X$; (3) more productive firms producing for both countries, with $c < c^j_X$.

Optimal prices and output levels for domestic and export sales can be written as functions of the cutoffs

$$\begin{aligned} p^j_D(i) &= \frac{\left(v^j+2\right)c^j_D + \left(2-v^j\right)c(i)}{4}, & q^j_D(i) &= \frac{\left(2-v^j\right)L^j}{4\delta}\left[c^j_D - c(i)\right], \\ p^j_X(i) &= \frac{\tau^z\left[\left(v^j+2\right)c^j_X + \left(2-v^j\right)c(i)\right]}{4}, & q^j_X(i) &= \frac{\tau^z\left(2-v^j\right)L^z}{\delta 4}\left[c^j_X - c(i)\right]. \end{aligned} \tag{56}$$

with maximized profit levels respectively given by

$$\begin{aligned} \pi^j_D(i) &= \frac{L^j\left(2-v^j\right)^2}{16\delta}\left[c^j_D - c(i)\right]^2, \\ \pi^j_X(i) &= \frac{\left(\tau^z\right)^2 L^z\left(2-v^j\right)^2}{16\delta}\left[c^j_X - c(i)\right]^2. \end{aligned} \tag{57}$$

Moreover, the absolute markups obtained from domestic and export sales by a firm with the cost parameter $c(i)$ producing in j are given by

$$\mu^j_D(i) = \frac{1}{4}\left(2 - v^j\right)\left[c^j_D - c(i)\right] \quad \text{and} \quad \mu^j_X(i) = \frac{\tau^z}{4}\left(2 - v^j\right)\left[c^j_X - c(i)\right] \tag{58}$$

From previous results, we can notice that, for given values of v^j and τ^z, firms with lower cost parameters $c(i)$ set lower prices, and sell larger quantities with larger profits, getting larger (absolute) markups, even if they pay higher wages, as the substitution of prices from (56) into (48) and (49) shows

$$w^j_{mD}(i) = 1 + \frac{v^j}{2}\left(\frac{c^j_D}{c(i)} - 1\right) \quad \text{and} \quad w^j_{mX}(i) = 1 + \frac{v^j}{2}\left(\frac{c^j_X}{c(i)} - 1\right) \tag{59}$$

To derive the two cutoffs we need to solve the following free entry and exit condition for firms producing in j which implies zero expected profits

$$\int_0^{c^j_D} \pi^j_D(c)dG^j(c) + \int_0^{c^j_X} \pi^j_X(c)dG^j(c) = f_E \tag{60}$$

Using the chosen parametrization (30) and the optimized profits (57), the free-entry condition (60) can be rewritten as follows

$$L^j\left(c^j_D\right)^{\kappa+2} + \left(\tau^z\right)^2 L^z\left(c^j_X\right)^{\kappa+2} = \frac{8\delta c^\kappa_M(\kappa+1)(\kappa+2)f_E}{\left(2 - v^j\right)^2} \tag{61}$$

Considering (61) for both countries and, taking into account (54), we obtain the following system

$$\begin{cases} L^j\left(c^j_D\right)^{\kappa+2} + \left(\tau^z\right)^2 L^z\left(c^j_X\right)^{\kappa+2} = \frac{8\delta c^\kappa_M(\kappa+1)(\kappa+2)f_E}{(2-v^j)^2} \\ L^z\left(c^z_D\right)^{\kappa+2} + \left(\tau^j\right)^2 L^j\left(c^z_X\right)^{\kappa+2} = \frac{8\delta c^\kappa_M(\kappa+1)(\kappa+2)f_E}{(2-v^z)^2} \end{cases}$$

that can be solved to get c^j_D and c^z_D. If we define $\rho^j \equiv \left(\tau^j\right)^{-\kappa} \in (0,1)$, which represents an inverse measure of trade costs (i.e. the 'freeness' of trade), then we get that

$$c^j_D = \left\{\frac{8\delta c^\kappa_M(\kappa+1)(\kappa+2)f_E\left[\left(2 - v^z\right)^2 - \left(2 - v^j\right)^2\rho^z\right]}{L^j\left(2 - v^z\right)^2\left(2 - v^j\right)^2\left(1 - \rho^z\rho^j\right)}\right\}^{\frac{1}{\kappa+2}} \tag{62}$$

with $j, z = H, F$ and $j \neq z$.

The sign of $\frac{\partial c^j_D}{\partial v^j}$ and $\frac{\partial c^j_D}{\partial v^z}$ depends on that of $\left(v^z - 2\right)^2 - \left(v^j - 2\right)^2\rho^z$, and we find that

$$\begin{cases} \frac{\partial c^j_D}{\partial v^j} \gtreqless 0 \\ \frac{\partial c^j_D}{\partial v^z} \lesseqgtr 0 \end{cases} \Leftrightarrow \left(v^z - 2\right)^2 \gtreqless \rho^z\left(v^j - 2\right)^2 \tag{63}$$

Thus, for a given accessibility level of country z from j, ρ^z, an increase in the domestic bargaining power of unions, v^j, (or a decrease in the foreign bargaining power of unions, v^z) results in an increase in the cutoff for domestic producers, c_D^j, only provided that the bargaining power of domestic unions, v^j, is sufficiently low with respect to that of the foreign unions, v^z. Moreover, using (63) and the relationship in (54) from which we know that $c_X^j = c_D^z/\tau^z$, we derive that

$$\left\{ \begin{array}{l} \frac{\partial c_X^j}{\partial v^j} = \frac{1}{\tau^z}\frac{\partial c_D^z}{\partial v^j} \lesseqgtr 0 \\ \frac{\partial c_X^j}{\partial v^z} = \frac{1}{\tau^z}\frac{\partial c_D^z}{\partial v^z} \gtreqless 0 \end{array} \right. \Leftrightarrow \left(v^j - 2\right)^2 \gtreqless \rho^j \left(v^z - 2\right)^2 \tag{64}$$

Hence, we find that, for a given level of accessibility of country j from country z, ρ^j, an increase in the bargaining power of domestic unions, v^j, produces an increase in the cutoff of exporters to country z, c_X^j, only provided that the bargaining power of domestic unions, v^j, is sufficiently low with respect to that of foreign unions, v^z.

In particular, we notice that if $v^j = v^z = v$ then the cutoff c_D^j in (62) becomes

$$c_D^j = \left\{ \frac{8\delta c_M^{\kappa} \left(\kappa+1\right)\left(\kappa+2\right) f_E \left(1-\rho^z\right)}{L^j \left(2-v\right)^2 \left(1-\rho^z\rho^j\right)} \right\}^{\frac{1}{\kappa+2}}$$

and using (63) and (64), we know that $\frac{\partial c_D^j}{\partial v^j} > 0$ and $\frac{\partial c_X^j}{\partial v^j} < 0$. Thus, starting from the same level of v, an increase in the domestic bargaining power of unions produces an increase of the cutoff of domestic producers and a decrease in that of domestic exporters to country z, c_X^j. Moreover, given that $\frac{\partial c_D^j}{\partial v^z} < 0$, we know that if $v^j = v^z = v$, the cutoff of domestic producers in j decreases with an increase in the foreign bargaining power of unions because firms in j are forced to compete with more productive firms exporting from z, given that $\frac{\partial c_X^z}{\partial v^z} < 0$. Finally, we find that when $v^j = v^z = v$, then $\frac{\partial c_X^j}{\partial v^z} > 0$.

Using (56) and (54), we compute the average price of varieties sold in country j, that is

$$\bar{p}^j = \left(\frac{N_D^j}{N_D^j + N_X^z}\left(4\kappa + v^j + 2\right) + \frac{N_X^z}{N_D^j + N_X^z}\left(4\kappa + v^z + 2\right) \right) \frac{c_D^j}{4\left(\kappa+1\right)} \tag{65}$$

which in the particular case of $v^j = v^z = v$ becomes

$$\bar{p}^z = \frac{\left(4\kappa + v + 2\right) c_D^j}{4\left(\kappa+1\right)}$$

In general, when $v^j \neq v^z$, we can substitute the number of domestic producers, that is $N_D^j = G^j(c_D^j)N_E^j = \left(\frac{c_D^j}{c_M}\right)^{\kappa} N_E^j$, and the number of producers exporting from z, that is $N_X^z = G^z(c_X^z)N_E^z = \left(\frac{c_X^z}{c_M}\right)^{\kappa} N_E^z$, into (65) and use (54) to rewrite $\bar{p}^j$ as follows

$$\bar{p}^j = \frac{\left(N_E^j\left(4k + v^j + 2\right) + \rho^j N_E^z\left(4\kappa + v^z + 2\right)\right) c_D^j}{4\left(\kappa + 1\right)\left(N_E^j + \rho^j N_E^z\right)} \tag{66}$$

Hence, we notice that using (54), the total number of firms selling in country j is

$$N^j = N_D^j + N_X^z = \left(\frac{c_D^j}{c_M}\right)^\kappa \left(N_E^j + \rho^j N_E^z\right) \tag{67}$$

Substituting (66) and (67) within $c_D^j = \frac{1}{\eta N^j + \delta}\left(\delta\alpha + \eta N^j \bar{p}^j\right)$, where $c_D^j = p^j$ is the price threshold for positive demand in country j, we get an equation for country j that together with the analogous expression obtained for country z forms a system of two equations that can be solved to get N_E^j and N_E^z. In particular, we find that the number of entrants in country j is

$$N_E^j = \frac{4\delta\left(\kappa + 1\right) c_M^\kappa}{\eta\left(2 - v^j\right)\left(1 - \rho^z\rho^j\right)}\left[\frac{\left(\alpha - c_D^j\right)}{\left(c_D^j\right)^{\kappa+1}} - \rho^j\frac{\left(\alpha - c_D^z\right)}{\left(c_D^z\right)^{\kappa+1}}\right] \tag{68}$$

Then, recalling that $c_D^j = c_X^z\tau^j$, we find that $c_X^z < c_D^z$ must hold in order to have a positive value of $N_E^j > 0$.

Moreover, we are able to show that if the two countries are equal, that is if $v^j = v^z = v$, $L^j = L^z = L$ and $\rho^j = \rho^z = \rho$, then $\frac{\partial N_E^j}{\partial v^j} < 0$. Hence, considering two symmetric countries, an increase in the bargaining power of the unions in a country will always reduce the number of firms entering in country j.

The above discussed relationship between c_X^j and c_D^j implies that the values of $w_{mD}^j(i)$ and $w_{mX}^j(i)$ in (59) are such that $w_{mD}^j(i) > w_{mX}^j(i)$.

Substituting (68) into (67), we derive the number of firms selling in j

$$N^j = \frac{4\delta\left(\kappa + 1\right)\left(c_D^j\right)^\kappa\left\{\frac{\frac{\left(\alpha - c_D^j\right)}{\left(c_D^j\right)^{\kappa+1}} - \rho^j\frac{\left(\alpha - c_D^z\right)}{\left(c_D^z\right)^{\kappa+1}}}{\left(2 - v^j\right)} + \frac{\rho^j\left[\frac{\left(\alpha - c_D^z\right)}{\left(c_D^z\right)^{\kappa+1}} - \rho^z\frac{\left(\alpha - c_D^j\right)}{\left(c_D^j\right)^{\kappa+1}}\right]}{\left(2 - v^z\right)}\right\}}{\eta\left(1 - \rho^j\rho^z\right)}$$

which in the particular case of $v^j = v^z = v$ becomes

$$N^j = \frac{4\delta\left(\kappa + 1\right)}{\eta\left(2 - v\right)}\frac{\left(\alpha - c_D^j\right)}{c_D^j}$$

Which is similar to the solution found for the closed economy case.

Let us recall that the number of producers exporting from j to z is

$$N_X^j = G^j(c_X^j)N_E^j = \left(\frac{c_X^j}{c_M}\right)^\kappa N_E^j$$

Then, we are able to show that if the two countries are equal, that is if $v^j = v^z = v$, $L^j = L^z = L$ and $\rho^j = \rho^z = \rho$, then $\frac{\partial N_X^j}{\partial v^j} < 0$. Hence, considering two symmetric countries, an increase in the bargaining power of the unions in a country will always reduce the number of exporting firms from this countries.

7 Conclusions

Although a large body of literature has focused on the effects of intra-firm differences on export performance, relatively little attention has been devoted to the interaction between firms' selection and international performance and labour market institutions – in contrast with the centrality of the latter to current policy and public debates on the implications of economic globalisation for national policies and institutions. In this paper, we have studied the effects of labour market unionisation on the process of competitive selection between heterogeneous firms and have analysed how the interaction between the two is affected by trade liberalisation between countries with different unionisation patterns. Specifically, we study the impact of decentralised wage bargaining between firm specific unions and final good producers characterised by heterogenous efficiencies on the process of competitive selection between firms. The endogenous determination of wages via bargaining between heterogeneous firms and firm specific unions implies that wages will differ between firms – and that ex-ante identical workers will perceive different equilibrium wages.

We identify three main channels through which an increase in the bargaining power of unions affects the nature of the industry equilibrium, namely: (i) a *variety effect* – by resulting in an increase in the mass of firms selling in the economy, when the preference for the differentiated good is sufficiently strong, (ii) a *counter competitive effect* – since a higher union power results in higher average prices, which in turn entail lower average markups and profits for firms, and (iii) a *selection effect* via a reduction of the industry efficiency cut-off point, which results from the markups and profits of less productive firms increasing more than those of more productive ones. The reason behind this result is that, for a given bargaining power, a union's rent extraction ability will be higher the higher is the productivity of the firm with which it negotiates. As a result, a given increase in the bargaining power of unions will translate in proportionally higher wage demand in relatively more efficient firms – i.e. it will hurt (via a higher wage) more efficient firms proportionally more than less efficient ones.

Consistent with the existing literature on heterogenous firms, within a two country setting, we obtain the emerge of two industry efficiency cutoff points, with only more productive firms engaging in export activity. Starting from a situation in which countries are identical and the bargaining power of unions is the same in both countries, an increase in the bargaining power of unions in one country will always reduce the number of exporting firms from this country. This is because, when the bargaining power of unions is the same in both countries, a higher union power produces a fall in the level of efficiency required to survive in the domestic market and an increase in that required to become exporters from that country. Thus, a higher bargaining power of unions in one country can be thought of as (i) *softening* the competition facing domestic firms (more firms of a lower efficiency enter the domestic market) and (ii) *toughening* the competition in the export sector (by increasing the level of efficiency required to become exporters). Clearly, the effect of an increase in the bargaining power of unions in the home country will have different effects on the efficiency cutoff points in the foreign country; there, firms selling only to the domestic market will face a tougher competition from abroad, while firms that export will face a softer competition in the country whose bargaining power has increased (i.e. the minimum efficiency required to survive in the domestic market increase in the foreign country, while that required to become exporters will fall). In general, when the two countries are asymmetric not only in the bargaining power of unions but also in size and market access, we find that: for a given accessibility level of a country an increase in the bargaining power of its domestic unions results in a fall in the minimum efficiency required both to survive in the domestic market and to export to the foreign country, only provided that the bargaining power of domestic unions is sufficiently low with respect to that of the foreign unions.

References

[1] Bernard, A.B., Eaton, J., Jensen, J.B., and Kortum, S. (2003), "Plants and Productivity in International Trade", *American Economic Review*, 93, 1268-1290.

[2] Cunat, A., and M. Melitz, (2007), "Volatility, Labor Market Flexibility, and the Pattern of Comparative Advantage", NBER Working Paper No. 13062.

[3] Dutt, A. K., and A. Sen (1997), “Union Bargaining Power, Employment and Output in a Model of Monopolistic Competition with Wage Bargaining”, *Journal of Economics*, vol. 65 (1), pp. 1–17.

[4] Eaton J., and Kortum, S.S., *Technology and the Global Economy: A Framework for Quantitative Analysis*, forthcoming, Princeton University Press.

[5] Egger, H., and U. Kreickemeier (2007), "Firm Heterogeneity and Labour Market Effects of Trade Liberalisation", CESifo Working Paper No. 2000.

[6] Helpman, E., and O. Itskhoki (2007), "Labour Market Rigidities, Trade and Unemployment", NBER Working Paper No, 13365.

[7] Manning, A. (1987), “An Integration of Trade Union Models in a Sequential Bargaining Framework”, *The Economic Journal*, vol. 97 (March), No. 385, pp- 121–139.

[8] Melitz, M. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, Vol 71, No. 6, 1695-1725.

[9] Melitz, M., and G. Ottaviano (2008), “Market size, trade, and productivity”, *Review of Economic Studies*, 75, 295–316.

[10] T. Mayer, and G. Ottaviano (2007) "The Happy Few: The Internationalisation of European Firms", BRUEGEL Blueprint Series, Volume III.

[11] Montagna, C. (1995), "Monopolistic Competition with Firm-Specific Costs", *Oxford Economic Papers*, 47, 318-328.

[12] Montagna, C. (2001), "Efficiency Gaps, Love of Variety and International Trade", *Economica*, 68, 27-44.