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Labour Market Imperfections, International  
Integration and Selection

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# Labour Market Imperfections, International Integration and Selection.\*

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Comments are welcome.

## 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

**J.E.L. Classification:** F12, R13, J51

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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 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 a recent Bruegel and CEPR report, [12]. This report offers a systematic, cross-country, firm-level evidence of the internationalisation of European firms. Specifically, it finds that the international performance of European countries is essentially driven by a relatively small number of high-performance firms<sup>1</sup>, with international markets liberalisation inducing a selection process whereby the most productive firms substitute the least productive ones within sectors. The report ([12], p. 1) underlines that internationalized firms in the covered European countries "belong to an exclusive club. They are different from other firms. They are bigger, generate higher value added, pay higher wages, employ more capital per worker and more skilled workers and have higher productivity". For instance, the wage premium of exporters over non exporters is: 1.02 for Germany, 1.07 for Italy, 1.08 for Norway, 1.09 for France, 1.15 for the United Kingdom, 1.26 for Belgium, and 1.44 for Hungary.<sup>2</sup>

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 microfoundations 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 [13] and later highlights the effects of trade liberalisation on firms' selection [14] in the presence of inter-country differences in firms' efficiency distributions. Melitz [10] 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,

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<sup>1</sup>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, [12]).

<sup>2</sup>See Table 4 in the Bruegel and CEPR Report, [12])

with only more productive firms choosing to become exporters.<sup>3</sup>

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.<sup>4</sup> Conventional wisdom in this area rests on traditional views of the standard distortions resulting from labour market imperfections – views contending that, in the interest of 'competitiveness', labour markets deregulation is a necessary response to globalisation.

Labour market imperfections, however, may not have 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 markets and by firms heterogeneity. 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 strengths. 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 demands in relatively more efficient firms – i.e. an increase in the bargaining power of unions will hurt (via a higher wage) more efficient firms proportionally more than less efficient ones.

The paper is organized as follows. Section 2 sets out a closed economy version of the model. Its long run equilibrium properties are discussed in Section 3 while Section 4 focuses on the welfare analysis. The framework is extended to a two-country world in Section 5, while Section 6 derives and discusses its long run equilibrium properties.

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<sup>3</sup>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 [5], 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.

<sup>4</sup>There are some notable exceptions. Egger and Kreickemeier [6] analyse the impact of trade liberalisation on firms' selection in the presence of a fair-wage effort mechanism. Helpman and Itskhoki [7] focus on the effects of hiring and firing rigidities on trade and unemployment in the presence of heterogeneous firms. Within a similar framework, Helpman et al [8] analyse the distributional consequences of international trade. Cuñat and Melitz [2] study the relationship between volatility, labor market flexibility, and international trade.

## 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 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. We think of the fixed entry cost as including the cost of setting up plants and production lines, as well as R&D activity aimed at both product and process development. 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 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 quasi-linear utility function:<sup>5</sup>

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

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

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<sup>5</sup>A major drawback of using the quasi-linear utility function is that it rules out general equilibrium income effects. However, one important advantage 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.

The budget constraint of a typical household is given by:

$$\int_0^N p(i)q^\zeta(i)di + p_0q_0^\zeta = I_\zeta + p_0\bar{q}_0, \quad (2)$$

where  $p_0$  and  $\bar{q}_0$  are respectively the price and the household initial endowment of the competitive good, and  $I_\zeta$  is the household's 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. Denoting, with  $w_m$  and  $w_c$  the wage rate paid by firms in the monopolistic sector and by firms in the competitive sector respectively, the expected income of a typical household  $\zeta$  employed by firm  $i$  will then be given by:

$$I_\zeta = w_m(i)l_m^\zeta(i) + w_cl_c^\zeta(i),$$

where  $l_m^\zeta(i)$  is the amount of work performed in firm  $i$  of the monopolistic sector by household  $\zeta$ , and  $l_c^\zeta(i) = 1 - l_m^\zeta(i)$  is the amount of work it performs in the competitive sector.<sup>6</sup> 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; the remaining labour supply is absorbed by the competitive sector which will clear the labour market.<sup>7</sup>

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

$$p(i) = \alpha - \delta q^\zeta(i) - \eta Q^\zeta, \quad (3)$$

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:

$$p(i) = \frac{1}{\eta N + \delta} (\delta\alpha + \eta N\bar{p}), \quad (4)$$

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

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<sup>6</sup>It is of course possible to envisage different employment configurations for the typical household (e.g. with employment in only one of the sectors, or even with employment in more than one monopolistic firm). For simplicity, we rule out these cases by assumption as they would not substantially alter the qualitative nature of the results.

<sup>7</sup>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).

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

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

with  $q(i) = Lq^\zeta(i)$  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 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 (e.g. the cost of setting up plants and production lines) and that 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:

$$q(i) = \frac{l_m(i)}{c(i)}, \quad (6)$$

where  $c(i)$ , the quantity of labour required to produce one unit of the good, is an inverse measure of the productivity of firm  $i$  and is our source of heterogeneity. 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 by firm  $i$  in the monopolistic sector,  $w_m(i)$ , is set in a bargaining process involving firm specific unions – 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, plants and product development, that a firm learns how productive its technology, as measured by the parameter  $1/c(i)$ , is. Thus, we assume that 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, with a firm  $i$  that produces in the economy facing the marginal cost of production  $w_m(i)c(i)$ . Thus, the variable cost function of a firm supplying variety  $i$  is:

$$VC(i) = w_m(i)c(i)q(i), \quad (7)$$



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

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

which, using (7), can be re-written as:

$$\pi(i) = [p(i) - w_m(i)c(i)]q(i). \quad (8)$$

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

$$q(i) = \frac{L}{\delta} [p(i) - w_m(i)c(i)]. \quad (9)$$

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

$$p(i) = \frac{w_m(i)c(i)}{2} + \frac{P\eta + \alpha\delta}{2(\delta + N\eta)}. \quad (10)$$

Using (9) into (8), we obtain maximised operating profits:

$$\pi(i) = \frac{L}{\delta} [p(i) - w_m(i)c(i)]^2. \quad (11)$$

Finally, note that, from equations (6) and (9), we can derive the quantity of labour demanded by firm  $i$ ,  $l_m(i)$ :

$$l_m(i) = \frac{Lc(i)}{\delta} [p(i) - w_m(i)c(i)]. \quad (12)$$

Then, using equations (6) and (12), it will prove useful to rewrite the profit function in (8) in terms of  $l_m(i)$ , to obtain:

$$\pi(i) = \frac{\delta}{Lc^2(i)} l_m^2(i). \quad (13)$$

### 2.3 Unions

In the homogenous perfectly competitive good sector, the labour market is perfectly competitive and all employers pay the same wage. 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 adopt the right to manage model, which, for appropriate parameter values, collapses into the monopoly model. 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.

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

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

subject to the labour demand in (12) and to the price given by equation (10), 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 we set at zero without loss of generality. A union  $i$  will maximize the total *labour rent* above the constant wage paid to non-unionised workers, given by:

$$V_i(w_m(i), l_m(i)) = l_m(i) [w_m(i) - w_c], \quad (15)$$

where  $w_c = 1$ .

Hence, substituting the operating profits in (13) 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:

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

subject to the labour demand equation in (12) and the equilibrium price in (10).

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

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

From the labour demand equation in (12) we obtain:

$$\frac{dl_m(i)}{dw(i)} = \frac{Lc(i)}{\delta} \left[ \frac{dp(i)}{dw(i)} - c(i) \right], \quad (17)$$

where  $\frac{dp(i)}{dw(i)}$  can be derived from equation (10) as:

$$\frac{\partial p(i)}{\partial w(i)} = \frac{c(i)}{2}. \quad (18)$$

Then, using equations (17), (18) and (12), the first order condition in (16) can be solved to derive the following wage equation:

$$w_m(i) = 1 + \frac{2v}{(v + 2)c(i)} [p(i) - c(i)]. \quad (19)$$

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:  $p(i) \geq c(i)$ . However, note that for expressions (9) and (11) to be positive, it must be the case that  $p(i) \geq w_m(i)c(i)$ ; making use of the wage equation in (19), this condition is satisfied if and only if:

$$p(i) \geq c(i), \quad (20)$$

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  $c_D$ . Firms with a level of  $c(i) = c_D$  will just break even. Thus, the cut-off level,  $c_D$ , is defined by the following equivalent zero profit condition:

$$c_D = \sup \{c : \pi(c_D) = 0\}, \quad (21)$$

which describes the indifference condition of marginal firms (i.e. the firms that are just able to cover their effective marginal costs of production). Using equations (19) and (11) in (21), we obtain:

$$\pi(c_D) = 0 \iff p(c_D) = c_D w_{mD}, \quad (22)$$

where  $w_{mD}$  is the wage paid by marginal firms with productivity  $1/c_D$ . Thus,  $c_D$  denotes the upper limit of the range of  $c$  of firms actually producing in the economy. More productive entrants with a value of  $c(i) < c_D$  will start producing, while entrants with a value of  $c > c_D$  will exit the market.

Note that using the price from equation (22) into the wage equation in (19) we obtain:

$$w_{mD} = 1, \quad (23)$$

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 cut-off:

$$p(i) = \frac{(v+2)c_D + (2-v)c(i)}{4} \quad \text{and} \quad q(i) = \frac{(2-v)L}{4\delta} [c_D - c(i)]. \quad (24)$$

Similarly, maximized profit levels can be written as:

$$\pi(i) = \frac{L(2-v)^2}{16\delta} [c_D - c(i)]^2. \quad (25)$$

Defining the absolute markup of a firm that has a unit labour requirement of  $c(i)$  as  $\mu(i) = p(i) - w_m(i)c(i)$ , we can write it in terms of the cut-off point as:

$$\mu(i) = \frac{1}{4} (2-v) [c_D - c(i)]. \quad (26)$$

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 (24) into (19) yields:

$$w_m(i) = 1 + \frac{v}{2} \left[ \frac{c_D}{c(i)} - 1 \right]. \quad (27)$$

Thus, for a given  $v$ , firms with lower unit labour requirements will set lower prices, sell larger quantities, earn higher revenues and have larger profits than less efficient firms.<sup>8</sup> 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 [11], we adopt a Pareto distribution as the specific parametrisation of  $G(c)$ .<sup>9</sup> This distribution has a higher unit labour requirement bound  $c_M$  and shape parameter  $\kappa \geq 1$ :

$$G(c) = \left( \frac{c}{c_M} \right)^\kappa, \quad c \in [0, c_M]. \quad (28)$$

The implication of this parametrisation is that large firms are less frequent than small firms, with the shape parameter  $\kappa$  indexing the dispersion of unit labour requirement draws. When  $\kappa = 1$ , the unit labour requirement distribution is uniform on  $[0, c_M]$ . As  $\kappa$  increases, the relative number of high unit labour requirement firms increases, and the distribution is more concentrated at higher values of  $c$ . As  $\kappa$  goes to infinity, the distribution becomes degenerate at  $c_M$ . Given (28), the average unit labour requirement of entrants evaluates to  $\bar{c} = c_M \kappa / (\kappa + 1)$ , with variance equal to  $\bar{c} / [\kappa(\kappa + 2)]$ . Thus, the higher  $c_M$ , the higher the mean and the variance of the unit labour requirement draws.

Using the chosen parametrization in (28) and the optimized profits in (25), the free-entry condition then results in the following closed form solution for the cut-off level:

$$c_D = \left[ \frac{8\delta(\kappa+1)(\kappa+2)f_E c_M^\kappa}{L(2-v)^2} \right]^{1/(\kappa+2)}, \quad (29)$$

<sup>8</sup>For  $v = 0$ , results correspond to those in Melitz and Ottaviano (2008).

<sup>9</sup>Del Gatto, Mion and Ottaviano [3] show that the Pareto distribution is a good approximation for 11 European Countries.

which implies that the elasticity of the long-run cut-off level  $c_D$  with respect to  $v$  will be given by:

$$\frac{\partial c_D}{\partial v} \frac{v}{c_D} = \frac{2v}{(\kappa + 2)(2 - v)} > 0. \quad (30)$$

This means that an increase in the bargaining power of unions,  $v$ , results in an increase in the cut-off  $c_D$  (that is, in a reduction of the productivity cut-off level). 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.<sup>10</sup>

Consistently, using equations (24), (25), (26) and (28) to compute producer average performance measures, we find that whilst our results coincide with those in Melitz and Ottaviano [11] 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:

$$\bar{c} = \frac{\kappa}{\kappa + 1} c_D, \quad \bar{p} = \frac{(4\kappa + v + 2)}{4(\kappa + 1)} c_D, \quad \bar{\mu} = \frac{1}{4} (2 - v) \frac{c_D}{(\kappa + 1)} \quad (31)$$

$$\bar{\pi} = \frac{L(v - 2)^2 c_D^2}{8\delta(\kappa + 1)(\kappa + 2)}. \quad (32)$$

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

Turning to the individual firm, 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  $c(i) = c_D$ ) and imposing the zero-profit condition

<sup>10</sup> A sufficient condition that ensures that  $c_D < c_M$  is that  $\sqrt{[8\delta(\kappa + 1)(\kappa + 2)f_E]/[L(2 - v)^2]} < c_M$ .

in (22) to obtain:

$$c_D = \frac{1}{\eta N + \delta} (\delta \alpha + \eta N \bar{p}). \quad (33)$$

Substituting  $\bar{p}$  from equation (31) into equation (33), the number of firms selling in the economy can be determined as:

$$N = \frac{4(\kappa + 1)\delta}{\eta(2 - v)} \frac{\alpha - c_D}{c_D}. \quad (34)$$

Clearly, for  $N$  to be positive,  $\alpha$  needs to be greater than  $c_D$ . Furthermore, a ceteris paribus increase in the bargaining power of unions will have an ambiguous effect on the population of surviving firms. Specifically, an increase in  $v$  will result in an increase in  $N$  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  $\alpha$ ) is sufficiently strong.

Finally, the number of entrants will be given by:

$$N_E = N/G(c_D). \quad (35)$$

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

Before proceeding to extending the model to an open economy setting, it is interesting to investigate the effects of the presence of unions, and specifically their bargaining power, on the level of welfare in the closed economy setting.

Since free entry implies that aggregate profits vanish in equilibrium, welfare in the economy is given by consumer surplus only. In particular, consumers'  $\zeta$  surplus,  $W_\zeta$ , is:

$$W_\zeta \equiv I_\zeta + \bar{q}_0 + B, \quad (36)$$

where  $B$  is common to all workers and is defined as:

$$B \equiv \frac{1}{2} \left( \eta + \frac{\delta}{N} \right)^{-1} (\alpha - \bar{p})^2 + \frac{1}{2} \frac{N}{\delta} \sigma_p^2, \quad (37)$$

in which  $\sigma_p^2$  is the variance of prices, given by:

$$\sigma_p^2 = \frac{(2 - v)^2}{16} \frac{\kappa}{(\kappa + 2)(\kappa + 1)^2} (c_D)^2. \quad (38)$$

Note that,  $B$  and, consequently, welfare decrease in  $\bar{p}$ , while they increase in both  $N$  (this is the standard love of variety effect) and  $\sigma_p^2$  (as in Melitz and Ottaviano [11], this last effect reflects consumers's re-optimization and their reallocation of expenditure towards both cheaper varieties and the numeraire good).

It can be readily verified that the average price in (31) is increasing in  $v$ , and that the variance of prices in (38) is decreasing in  $v$ . Therefore, inspection of (37) 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 (31) and  $\sigma_p^2$  from (38), we notice that  $B$  can be rewritten as follows:

$$B = \frac{1}{4\eta} (\alpha - c_D) \left( 2\alpha - \frac{c_D (2\kappa + v + 2)}{(\kappa + 2)} \right), \quad (39)$$

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

$$\frac{\partial B}{\partial v} = -\frac{1}{4\eta} \frac{\partial c_D}{\partial v} \left\{ \left[ 2\alpha - \frac{c_D (2\kappa + v + 2)}{(\kappa + 2)} \right] + (\alpha - c_D) \frac{(2\kappa + v + 2)}{(\kappa + 2)} \right\} < 0. \quad (40)$$

To evaluate the total effect of a change of  $v$  on welfare, we need to consider both its effect on  $B$  – described by (40), which is *common* to all "households" – and that on household income,  $I_\zeta$ . Recalling that households may be employed by different types of firms and thus perceive different incomes, we compute the expected wage paid by firms in the economy, that is:

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

The average surplus in the economy is then 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:

$$\bar{I} \equiv \frac{\overline{VC} N + w_c(L - \bar{l}N)}{L} = \frac{(\overline{VC} - \bar{l})N}{L} + 1. \quad (41)$$

In the above, 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:

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

and

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

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

Thus, it is clear from this analysis that the existence of unionization influences the operation of the standard forces (such as number of firms and prices) that affect welfare in this type of models. Specifically, we find that when the preference for the differentiated good is sufficiently small, that is the value of  $\alpha$  is sufficiently low, an increase in the bargaining power of unions  $v$  will result in a reduction of the welfare level given that it will not only increase the average price, but also reduce the average household's income, the variance of prices and the number of firms. However, for a sufficiently strong preference for the differentiated good, that is for a sufficiently large value of  $\alpha$ , this result can be reversed: in this case the increase in the mass of sellers  $N$  and in the average household's income  $\bar{I}$  that results from a higher bargaining power of unions will have a positive effect on welfare that more than offsets the negative effect of the increase in the average price and the decline in the variance of prices. This is due to the fact that for large values of  $\alpha$ , consumers highly value the consumption of the differentiated good, and therefore an increase in the bargaining power of unions - even though it will favour the entry of less efficient firms - will increase the welfare level because it will extend the mass of firms selling in the market. As a result this will also raise average household's income, as can be seen from equation (41). This suggests that, ultimately via its effects on firm selection, union power does not have unambiguously negative effects on welfare - as implied by the standard 'distortionary' view of unionisation.

## 5 Open Economy

In the previous sections 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 conditions 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 one in both countries. In the differentiated sector, inter-firm productivity differences are modelled as described for the closed economy. In each country, after paying an entry cost and discovering their productivity level, firms bargain with the union over the wage, and then produce. In this sector, markets are segmented, in the sense that firms producing in country



$j = H, F$  incur a per-unit trade cost  $\tau^z > 1$  when selling their production abroad in country  $z = H, F$  with  $j \neq z$ . Therefore, the delivered cost of a unit produced in  $j$  with cost  $w_{mX}^j(i)c(i)$  and sold abroad in country  $z$  is  $\tau^z w_{mX}^j(i)c(i)$ .

In each country, entrants draw their unit labour requirement parameters simultaneously from a Pareto distribution  $G(c)$ . We assume that technology in the two countries is the same, i.e. that they have identical productivity distributions. Therefore, as in autarky, each firm will know its own cost parameter  $c(i)$ , as well as that of all other firms, only after paying the fixed entry cost  $f_E$ . It will then decide whether to produce or not, or whether to export 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.

We shall assume, *by virtue of market segmentation in the final good markets*, that each firm undertakes two separate bargaining processes with unions, one to determine the remuneration of the 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,  $w_{mX}^j(i)$ .<sup>11</sup> It then follows that firms characterized by a cost parameter level  $c(i)$  produce for the local market  $j$  if, and only if:

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

and they export to  $z = H, F$  ( $j \neq z$ ) if, and only if:

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

Hence, given that markets are segmented, firms of type  $i$  will produce 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). These are respectively given by:

$$q_D^j(i) = \frac{L^j \left[ p_D^j(i) - w_{mD}^j(i)c(i) \right]}{\delta} \quad \text{and} \quad q_X^j(i) = \frac{L^z \left[ p_X^j(i) - \tau^z w_{mX}^j(i)c(i) \right]}{\delta}. \quad (42)$$

Given the optimal quantities in (42), the maximized profits of firm  $i$  producing and selling in country  $j$  and exporting to country  $z$  are then respectively given

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<sup>11</sup>The existence of market segmentation in the good markets (due to the transport cost incurred in exporting) implies that unions paired to firms that serve both domestic and foreign consumers will have different rent extraction abilities in the two markets and will thus have an incentive to set operation-specific wages. More specifically, we can think of the firm as having two distinct plants, one used for domestic production and one for producing exports, with bargaining occurring at the *plant*, as opposed to the *firm*, level. It is worth pointing out that allowing for the unions to bargain over a unique wage (for both the domestic and the foreign market) would not alter the qualitative nature of our results, as the wage in this case would be a convex combination of those obtained in the separate bargaining processes.

by:

$$\pi_D^j(i) = \frac{L^j \left[ p_D^j(i) - w_{mD}^j(i)c(i) \right]^2}{\delta} \quad \text{and} \quad \pi_X^j(i) = \frac{L^z \left[ p_X^j(i) - \tau^z w_{mX}^j(i)c(i) \right]^2}{\delta}. \quad (43)$$

Finally, from (6) and (42) we derive firm  $i$ 's labour demand to produce for the domestic market  $j$ ,  $l_{mD}^j(i)$ :

$$l_{mD}^j(i) = \frac{L^j c(i)}{\delta} \left[ p_D^j(i) - w_{mD}^j(i)c(i) \right], \quad (44)$$

and to produce for the export market  $z$ ,  $l_{mX}^{jz}(i)$ :

$$l_{mX}^{jz}(i) = \frac{\tau^z L^z c(i)}{\delta} \left[ p_X^j(i) - \tau^z w_{mX}^j(i)c(i) \right]. \quad (45)$$

Then, using (44), (45) and (6), we can rewrite the maximized profits in (43) in terms of the firm's labour demands,  $l_{mD}^j(i)$  and  $l_{mX}^{jz}(i)$ , that is:

$$\pi_D^j(i) = \frac{\delta \left[ l_{mD}^j(i) \right]^2}{L^j c^2(i)} \quad \text{and} \quad \pi_X^j(i) = \frac{\delta \left[ l_{mX}^{jz}(i) \right]^2}{\tau^z L^z c^2(i)}. \quad (46)$$

We can now move on to consider the wage determination bargaining process. Substituting  $\pi_D^j(i)$  from (46) and (15) into (14), the Nash Bargaining problem for firms producing only for the domestic market  $j$  will be given by:

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

solution of which will yield the wage equation:

$$w_{mD}^j(i) = 1 + 2 \frac{v^j}{(v^j + 2)c(i)} \left[ p_D^j(i) - c(i) \right], \quad (47)$$

which 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:

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

where  $\pi_X^j(i) = \delta \frac{\left[ l_{mX}^{jz}(i) \right]^2}{\tau^z L^z c^2(i)}$ , from which we obtain the wage equation:

$$w_{mX}^j(i) = 1 + 2 \frac{v^j}{(v^j + 2)c(i)} \left( \frac{p_X^j(i)}{\tau^z} - c(i) \right). \quad (48)$$

Since  $w_{mX}^j(i) \geq w_c = 1$  must hold in equilibrium, the wage equation in (48) implies that the following condition must also hold:  $p_X^j(i) \geq \tau^z c(i)$ . However, note that for expressions (42) and (43) to be positive, it must be the case that  $p_X^j(i) \geq \tau^z w_{mX}^j(i) c(i)$ ; making use of the wage equation in (48), this condition is satisfied if and only if:

$$p_X^j(i) \geq \tau^z c(i),$$

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

## 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 in equilibrium. This allows us to identify two cut-offs for  $c$  that define respectively the upper limit of the range of  $c$  over which firms produce only for the local market  $j$ , and the upper limit of the range of  $c$  over which firms export to country  $z$ . Denoting these two cut-off points as  $c_D^j$  and  $c_X^j$  respectively, for a given number of entrants in country  $j$ ,  $N_E^j$ , a mass  $N_D^j = G^j(c_D^j)N_E^j$  of firms will sell only in the domestic market and a mass  $N_X^j = G^j(c_X^j)N_E^j$  of firms will export. Given that firms would be forced to leave if their profits were negative, the cut-off levels for firms that sell in the domestic market only and for firms that export are defined respectively by:

$$\begin{aligned} c_D^j &= \sup \left\{ c : \pi_D^j(c_D^j) = 0 \right\}, \\ c_X^j &= \sup \left\{ c : \pi_X^j(c_X^j) = 0 \right\}, \end{aligned} \quad (49)$$

which describe the (zero-profit) indifference conditions of marginal firms. The zero profit conditions in (49) imply that the firms that are just able to cover their marginal costs for domestic and export sales are, respectively, characterized by:

$$\begin{aligned} \pi_D^j(c_D^j) &= 0 \iff p^j(c_D^j) = w_{mD}^j c_D^j, \\ \pi_X^j(c_X^j) &= 0 \iff p^z(c_X^j) = \tau^z w_{mX}^j c_X^j, \end{aligned} \quad (50)$$

where  $w_{mD}^j$  is the wage paid by marginal firms with labor requirement  $c_D^j$ , and  $w_{mX}^j$  is the wage paid by marginal firms with labor requirement  $c_X^j$ .<sup>12</sup> By substituting the price from (50) into (47) and (48), it is easy to verify that the wage paid by both types of marginal firms will be equal to one, i.e. to the competitive wage, that is:

$$w_{mD}^j = 1 \quad (51)$$

and

$$w_{mX}^j = 1. \quad (52)$$

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<sup>12</sup>It is clear from (50) that the prices for the domestic and export markets would differ even if the unions were to negotiate a common wage for workers employed to produce for home and foreign consumers.

It then follows that, using (51) and (52), (50) can be rewritten as:

$$p^j(c_D^j) = c_D^j \quad \text{and} \quad p^z(c_X^j) = \tau^z c_X^j. \quad (53)$$

If, as we'll show to be the case, results for the cut-off levels in (53) are such that  $c_D^j > c_X^j$ , then (50) allows us to identify three types of entrants in country  $j$ : (1) less productive firms, with  $c > c_D^j$ , that will not be able to produce - and hence will exit; (2) firms with intermediate productivity levels, with  $c_D^j > c > c_X^j$ , that produce only for the local market; and (3) more productive firms, with  $c < c_X^j$ , producing for both the domestic and export markets.

Optimal prices and output levels for domestic and export sales can be written as functions of the cut-offs:

$$\begin{aligned} p_D^j(i) &= \frac{(v^j + 2) c_D^j + (2 - v^j) c(i)}{4}, & q_D^j(i) &= \frac{(2 - v^j) L^j}{4\delta} [c_D^j - c(i)], \\ p_X^j(i) &= \frac{\tau^z [(v^j + 2) c_X^j + (2 - v^j) c(i)]}{4}, & q_X^j(i) &= \frac{\tau^z (2 - v^j) L^z}{\delta 4} [c_X^j - c(i)], \end{aligned} \quad (54)$$

with maximized profit levels respectively given by

$$\begin{aligned} \pi_D^j(i) &= \frac{L^j (2 - v^j)^2}{16\delta} [c_D^j - c(i)]^2, \\ \pi_X^j(i) &= \frac{(\tau^z)^2 L^z (2 - v^j)^2}{16\delta} [c_X^j - c(i)]^2. \end{aligned} \quad (55)$$

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

$$\mu_D^j(i) = \frac{1}{4} (2 - v^j) [c_D^j - c(i)] \quad \text{and} \quad \mu_X^j(i) = \frac{\tau^z}{4} (2 - v^j) [c_X^j - c(i)]. \quad (56)$$

Finally, substitution of prices from (54) into (47) and (48) yields:

$$w_{mD}^j(i) = 1 + \frac{v^j}{2} \left( \frac{c_D^j}{c(i)} - 1 \right) \quad \text{and} \quad w_{mX}^j(i) = 1 + \frac{v^j}{2} \left( \frac{c_X^j}{c(i)} - 1 \right). \quad (57)$$

It is clear from (57) that, as in the closed economy case, that unions operating in more productive firms have a higher rent extraction ability and thus are able to negotiate higher wages.

Thus, for given values of  $v^j$  and  $\tau^z$ , firms with lower cost parameters  $c(i)$  set lower prices, and sell larger quantities with larger profits, getting larger (absolute) markups - despite the fact that they pay higher wages.

In a two country setting, the equilibrium cut-off points of one country will depend on its trading partner's parameters. Hence, the two countries' efficiency cut-off points need to be determined jointly. To do so, we need to solve the

following free entry and exit condition for firms producing in  $j = H, F$  which implies zero expected profits:

$$\int_0^{c_D^j} \pi_D^j(c) dG^j(c) + \int_0^{c_X^j} \pi_X^j(c) dG^j(c) = f_E. \quad (58)$$

Using the parametrization in (28) and the optimized profits in (55), the free-entry condition in (58) can be rewritten as follows:

$$L^j \left( c_D^j \right)^{\kappa+2} + (\tau^z)^2 L^z \left( c_X^j \right)^{\kappa+2} = \frac{8\delta c_M^\kappa (\kappa+1)(\kappa+2) f_E}{(2-v^j)^2}. \quad (59)$$

Note that, from expressions (50), (51) and (52), we can derive a relationship between the two cut-offs for domestic producers  $c_D^j$  in country  $j$  and foreign exporters  $c_X^z$  from country  $z$  to country  $j$ :

$$c_X^z = \frac{c_D^j}{\tau^j}, \quad (60)$$

which depends on the *accessibility* of country  $j$  from  $z$  (determined by  $\tau^j$ ). Making use of this relationship in (59) for both countries, we obtain the following system of equations:

$$\begin{cases} L^j \left( c_D^j \right)^{\kappa+2} + (\tau^z)^2 L^z \left( c_X^j \right)^{\kappa+2} = \frac{8\delta c_M^\kappa (\kappa+1)(\kappa+2) f_E}{(2-v^j)^2} \\ L^z \left( c_D^z \right)^{\kappa+2} + (\tau^j)^2 L^j \left( c_X^z \right)^{\kappa+2} = \frac{8\delta c_M^\kappa (\kappa+1)(\kappa+2) f_E}{(2-v^z)^2} \end{cases},$$

that can be solved to derive  $c_D^j$  and  $c_D^z$ . If we define  $\rho^j \equiv (\tau^j)^{-\kappa} \in (0, 1)$ , which represents an inverse measure of trade costs (i.e. the ‘freeness’ of trade), then we obtain:

$$c_D^j = \left\{ \frac{8\delta c_M^\kappa (\kappa+1)(\kappa+2) f_E \left[ (2-v^z)^2 - (2-v^j)^2 \rho^z \right]}{L^j (2-v^z)^2 (2-v^j)^2 (1-\rho^z \rho^j)} \right\}^{\frac{1}{\kappa+2}}, \quad (61)$$

$$c_D^z = \left\{ \frac{8\delta c_M^\kappa (\kappa+1)(\kappa+2) f_E \left[ (2-v^j)^2 - (2-v^z)^2 \rho^j \right]}{L^z (2-v^j)^2 (2-v^z)^2 (1-\rho^j \rho^z)} \right\}^{\frac{1}{\kappa+2}}, \quad (62)$$

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

Using the relationship in (60) and the two countries’ domestic cut-offs in (61) and (62) it is then straightforward to obtain the two countries’ cut-off for exporters. From (61) and (62) the two conditions that must be satisfied in order to have positive values of both  $c_D^j$  and  $c_D^z$  respectively require that  $(2-v^z)^2 > (2-v^j)^2 \rho^z$  and  $(2-v^j)^2 > (2-v^z)^2 \rho^j$ .

Hence, if a country  $j$  benefits from a larger local market (i.e. a larger  $L^j$ ) and/or a better access to the foreign country (i.e. a larger  $\rho^z$ ), it will exhibit

a lower cut-off. On the contrary, an increase in the level of accessibility of the country,  $\rho^j$ , by foreign exporters increases the domestic cut-off,  $c_D^j$ . All these results are in line with those obtained by Melitz and Ottaviano [11]. Furthermore, making use of the condition required to have a positive value of  $c_D^j$ , we are able to show how the cut-off  $c_D^j$  is influenced by the bargaining power of unions in both countries, and find that

$$\begin{cases} \frac{\partial c_D^j}{\partial v^j} > 0 \\ \frac{\partial c_D^j}{\partial v^z} < 0 \end{cases}. \quad (63)$$

Thus, 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 cut-off for domestic producers,  $c_D^j$  – i.e. it makes it easier for firms to survive in equilibrium. It is also easy to examine the effects of unions' bargaining power on each country's exporters cut-off points – using (63), (60) and the condition required to have a positive value of  $c_D^z$ , we can derive that:

$$\begin{cases} \frac{\partial c_X^j}{\partial v^j} = \frac{1}{\tau^z} \frac{\partial c_D^z}{\partial v^j} < 0 \\ \frac{\partial c_X^j}{\partial v^z} = \frac{1}{\tau^z} \frac{\partial c_D^z}{\partial v^z} > 0 \end{cases}, \quad (64)$$

that is, an increase in the bargaining power of domestic unions,  $v^j$ , (or a decrease in the foreign bargaining power of unions,  $v^z$ ) decreases the cut-off of exporters to country  $z$ ,  $c_X^j$ .

To summarize, an increase in the domestic bargaining power of unions  $v^j$  results (i) as in the closed economy case, in an increase in the cut-off of domestic producers,  $c_D^j$ , by softening competition in the domestic country, and (ii) in a fall in the cut-off of domestic exporters to country  $z$ ,  $c_X^j$ , given that they become less competitive in the foreign market. However, an increase in the foreign bargaining power of unions,  $v^z$ , will result in (i) a reduction in the cut-off of domestic producers in  $j$ ,  $c_D^j$ , because firms in  $j$  are forced to compete with more productive firms exporting from  $z$ , given that  $c_X^z$  decreases, and (ii) an increase in the cut-off of domestic exporters to country  $z$ ,  $c_X^j$ , because it results in a softening of competition in the foreign country.

Using (54) and (60), we compute the average price of varieties sold in country  $j$ , that is:

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

Substituting the number of domestic producers,  $N_D^j = G^j(c_D^j)N_E^j = \left(\frac{c_D^j}{c_M}\right)^\kappa N_E^j$ , and the number of producers exporting from  $z$ ,  $N_X^z = G^z(c_X^z)N_E^z = \left(\frac{c_X^z}{c_M}\right)^\kappa N_E^z$ , into (65) and making use of (60), we can rewrite  $\bar{p}^j$  as follows:

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

Hence, we notice that using (60), the total number of firms selling in country  $j$  is:

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

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

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

Recalling that  $c_D^j = c_X^z \tau^j$ , it is then clear that for  $N_E^j > 0$  to hold,  $c_X^z < c_D^z$  must also hold. Hence, the minimum efficiency required to export is higher than that required to operate in the domestic market alone. Moreover, it is clear from (68) that if the two countries are fully symmetric, with identical size, trade costs and unions' power, then  $\frac{\partial N_E^j}{\partial v^j} < 0$  – that is, an increase in the bargaining power of the unions in a country will always reduce the number of firms entering that country.

Turning to the relationship between  $w_{mD}^j(i)$  and  $w_{mX}^j(i)$ , by making use of the finding that  $c_X^j < c_D^j$ , it is easy to verify that it is always the case that  $w_{mD}^j(i) > w_{mX}^j(i)$ . This suggests that all unions operating in exporting firms moderate their wage requests in order to gain a better access to foreign countries – that is, unions internalize the lower market power, resulting from trade frictions, that their firms have in foreign markets.<sup>13</sup>

To find the number of firms operating in country  $j$ , substitute (68) into (67) to obtain:

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

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

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

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

<sup>13</sup>Consistently, it is easy to show that an increase in the level of integration between two symmetric economies will shrink this difference.

Finally, recalling that the number of producers exporting from  $j$  to  $z$  is:

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

it is easy to show that, under full symmetry,  $\frac{\partial N_X^j}{\partial v^j} < 0$ . – that is, an increase in the bargaining power of the unions in a country will always reduce the number of exporting firms from this country.

In summary, the results derived in this section for the open economy with respect to the effects of unionisation on industry equilibrium are consistent with those for the closed economy as far as the productivity cut-off of firms producing only for the domestic market is concerned – as in the autarkic case, an increase in the bargaining power of unions will result in more entry of less efficient firms, i.e. will result in lower average efficiency composition of the industry. However, an increase in unions’ power will have an opposite effect on the cut-off of exporting firms – in this case it will result in a higher level of efficiency required to survive in the export market, i.e. it will raise the average efficiency composition of the exporting population of firms. It is interesting to point out that the nature of these results does not depend on the level of market integration. However, at a maximum level of integration, that is if there is free trade, the cut-off points will coincide and hence the nature of the effect of unions power on the equilibrium distribution of firms’ productivity would be the same for all firms and correspond to that obtained in the closed economy.

## 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 heterogeneous 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 demands 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 cut-off 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. More generally, when the two countries can be asymmetric not only in the bargaining power of unions but also in size and market access, 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 cut-off 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).

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