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Unionisation, International Integration and Selection

By

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Abstract:

We study how unionisation affects competitive selection between heterogeneous firms when wage negotiations can occur at the firm or at the profit-centre level. With productivity specific wages, an increase in union power has: (i) a selection-softening; (ii) a counter-competitive; (iii) a wage-inequality; and (iv) a variety effect. In a two-country asymmetric setting, stronger unions soften competition for domestic firms and toughen it for exporters. With profit-centre bargaining, we show how trade liberalisation can affect wage inequality among identical workers both across firms (via its effects on competitive selection) and within firms (via wage discrimination across destination markets).

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Outline

Non-Technical Summary

Recent empirical evidence points to existence of substantial intra-industry heterogeneity in performance across firms, with a relatively small number of firms being more productive and larger than others and also paying higher wages. Consistent with this evidence, the link between international trade and wage dispersion appears to works through the wage differentials between exporters and non-exporters, suggesting that firm heterogeneity and competitive selection processes may be a key channel through which trade liberalisation contributes to the increasing wage inequality observed across countries – particularly in light of the fact that a large proportion of this inequality occurs in most countries within-groups and not only between groups of workers with different observable characteristics (such as skills and education). The effects of international trade on the equilibrium size-distribution and export status of firms, however, also appear to be influenced by other factors such as changes in the market power of firms or labour market liberalisation. In particular, across the OECD as a whole, increases in wage dispersion have been paralleled by a widespread tendency towards a reduction in the degree of centralisation of collective wage bargaining. Even in countries with traditionally centralised industrial relation systems such as Germany and Italy, the importance of industry level negotiations has diminished and the prominence of firm-level and plant-level agreements has increased since at least the mid 1990s. The decentralisation of wage setting has typically been motivated by the argument that in the interest of international competitiveness wage settlements ought to reflect variations in productivity and profitability across both firms and profit-centres (or divisions) within individual firms -- which industry level agreements fail to recognize.

To capture these stylised facts, we develop a framework in which the competitive pressure (and hence markup) is both firm-specific and market-specific, and wages are set via a bargaining process between unions and firms which can occur at the firm or at the sub-firm (i.e. at the profit-centre) level. We then examine how the interplay between unionization and international trade affects industry performance and selection within environments characterized by different degrees of integration between countries as well as by other inter-country asymmetries.

Bargaining between heterogeneous firms and firm specific unions in the presence of firm specific markups results in wages differing across firms – and thus between ex-ante identical workers. This result hinges on the role of unionisation as a rent-sharing mechanism between workers and firms. Additionally, decentralisation of bargaining at the profit-centre level results in two firm-specific wages related to production for the domestic and export markets, respectively. We show that whilst both wages are always higher in high productivity firms than in low productivity ones, within a firm, the export wage is lower than the domestic wage. This is because sub-firm level agreements result in a stronger link between wage demands and the different degrees of market power that firms have in their domestic and export markets -- with unions being prepared to moderate rent extraction in those activities that are exposed to more intense product market competition. By protecting employment in the export profit centre of the firm, we show that this behaviour can in turn result in a higher total labour rent being extracted than under firm level negotiations.

These findings suggest that the nature of bargaining is an important channel through which trade liberalisation affects wage inequality. To the extent that operating in different markets exposes a firm to different competitive pressures, the observed tendency to adopt profit-centre level agreements can result in an additional source of wage dispersion.

We identify three main channels through which an increase in the bargaining power of unions affects the nature of the industry equilibrium: (i) a variety effect, (ii) a counter competitive effect, and (iii) a

selection effect. These stem from the fact that, for a given bargaining power, a union's rent extraction ability is higher the higher is the productivity of the firm with which it negotiates. As a result, a given increase in union power will translate in relatively larger wage demand increases in relatively more efficient firms – i.e. it will raise the cost of labour in more efficient firms proportionally more than in less efficient ones – thus pushing up the minimum productivity required to export. A key testable prediction of the model is that countries with stronger unions should be expected to have a lower average productivity – resulting in higher average markups and prices and in lower average quantities and profits – but also offer an easier access to foreign exporters.

1 Introduction

This paper sheds light on how labour market unionisation affects the competitive selection effects of international trade and wage dispersion.

A considerable body of work highlights the role of intra-industry competitive selection in determining aggregate export performance – whereby the bulk of exports are accounted for by a relatively small number of firms that are more productive and larger than others, but that also pay higher wages (e.g. Mayer and Ottaviano 2008). Consistent with these stylised facts, existing empirical evidence suggests that firm heterogeneity may be a key channel through which trade liberalisation contributes to the increasing wage inequality observed internationally[1] – particularly in light of the fact that a large proportion of this inequality occurs in most countries within-groups and not only between groups of workers with different observable characteristics (such as skills and education).[2] The effects of international trade on the equilibrium size-distribution and export status of firms, however, also appear to be influenced by other factors such as changes in the market power of firms (e.g. Wälde and Weiß 2007), or labour market liberalisation (e.g. Coşar *et al* 2010).

A key stylised fact that motivates this paper is that across the OECD rising wage dispersion has been paralleled by falling degrees of centralisation of collective bargaining (OECD 1994,1997, 2004). Even in countries with traditionally centralised industrial relation systems such as Germany and Italy, industry level negotiations have increasingly given way to firm and plant-level agreements since at least the mid 1990s.[3] The adoption of highly decentralised bargaining practices has typically been motivated by the need to ensure, in the interest of international competitiveness, that wage settlements reflect variations in productivity and profitability across both firms and profit-centres (or divisions) within individual firms – which industry level agreements are perceived as failing to recognize.

To capture these stylized facts, we develop a framework in which competitive pressure, and hence markups, are both firm-specific and market-specific, and wages are set via bargaining between unions and firms which can occur at the sub-firm (i.e. *profit-centre*) level. Specifically, we extend the Melitz and Ottaviano (2008) model to examine how the interplay between unionisation and trade liberalisation affects intra-industry selection.

A large body of literature highlights the effects of inter-firm productivity differences on export performance.[4] Recently, attention has been devoted to the interaction between firms' selection and labour markets, but most papers do not focus on the role of unions as a source of labour market imperfections.[5] Unionization is considered, but with a focus on multinational production, by Eckel and Egger (2009) who find wages to be the same for all firms, with a wage premium paid by exporters. Furthermore, with the exception of Helpman and Itskhoki (2010) and Helpman *et al* (2010) who allow for inter-country asymmetries in the degree of labour market frictions, all the above mentioned works differ from our model by assuming fully symmetric countries. Clearly, any rent-sharing mechanism between workers and firms can lead to the emergence of inter-firm

wage dispersion. Our choice to focus on unionisation is motivated by the key role that unions continue to play, despite a decline in union membership, in most industrial economies (see, e.g., Visser 2006).

Our findings enrich the literature in this area. With endogenous markups and firm-heterogeneity, wage bargaining results in more efficient firms paying higher wages. This is consistent with the results obtained by Egger and Kreickemeier (2009) and others. However, in our model, the rent extracted by a union does not only depend on the productivity of the firm but also on its market power – which is firm specific. Since a firm's price elasticity of demand decreases in its productivity, more efficient firms enjoy a stronger monopoly position in the industry and offer a higher potential for rent extraction to their union. Due to market segmentation, the monopoly power of firms is also market specific – with an exporter having two independent *profit-centres* associated with its domestic and export sales respectively. In this context, a decentralisation of bargaining at the sub-firm (i.e. profit-centre) level alters rent-sharing incentives and results in *wage discrimination* across the different activities of the firm, as unions moderate their export wage requests in order to aid their firm's access to foreign markets. A key implications of our results, therefore, is that trade liberalisation can affect within-group intra-industry wage inequality along two dimensions: *across firms* (via its effects on competitive selection) and *within firms* (via wage discrimination across destination markets). As argued by Egger and Kreickemeier (2009), to the extent that firm-heterogeneity in productivity leads to wage dispersion within industries, workers are not indifferent as to which firm they are employed by. Our analysis further suggests that workers may also not be indifferent as to which operation of an efficient firm they work in.

The rest of the paper is organized as follows. Section 2 sets out a closed economy version of the model and derives its long-run equilibrium properties. Section 3 extends the framework to a two-country world. Section 4 concludes the paper and draws out some of the key testable hypotheses that emerge from the analysis.

2 Autarky

We consider an economy populated by L identical households supplying labour services to a competitive industry, that produces a homogeneous good (used as the numeraire), and to a monopolistically competitive industry, that produces a horizontally differentiated good. The model is based on Melitz and Ottaviano (2008) which we extend by assuming that workers in the monopolistic sector are organized in firm-specific unions that bargain with firms over the wage.

2.1 Preferences

The utility function of the representative household is:

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

where $q^\zeta(i)$ is household ζ's consumption of variety $i \in \Omega$ of the differentiated good and q_0^ζ is its consumption of the homogeneous 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 relative to the homogeneous good (which increases in α and decreases in η); a higher η also reflects a higher degree of substitutability between varieties.

Denoting with $\tilde{\Omega} \subset \Omega$ the subset of varieties that are consumed, and setting the price of the homogenous good at unity, the budget constraint of a typical household is given by $\int_{i\in\tilde{\Omega}} p(i)q^\zeta(i)di + q_0^\zeta = I_\zeta + \bar{q}_0$, where I_ζ and $\bar{q}_0$ are its income and initial endowment of the numeraire, and $p(i)$ is the price of variety i.[6] Each household supplies one unit of labour inelastically that can be hired by both a firm in the monopolistic sector and by producers in the competitive sector,[7] obtaining an income $I^\zeta = w(i)l^\zeta(i) + w_0 l_0^\zeta$ – where w and $l^\zeta(i)$, and w_0 and $l_0^\zeta = 1 - l^\zeta(i)$ are the wage rate and the amount of work performed in the monopolistic sector and in the competitive sector, respectively.[8]

Constrained maximisation of (1) yields the inverse individual demand for each differentiated variety; inverting it and aggregating over households gives the demand function facing each firm i:

$$q(i) = L\left[\frac{\alpha}{(\delta + \eta N)} - \frac{1}{\delta}p(i) + \frac{\eta}{\delta\,(\delta + \eta N)}N\bar{p}\right], \quad (2)$$

where $q(i) = Lq^\zeta(i)$, and N is the measure of consumed varieties in $\tilde{\Omega}$ with average price $\bar{p} = \frac{1}{N}\int_{i\in\tilde{\Omega}} p(i)di$. The price threshold for the demand for a variety to be positive is:

$$p_{\max} \equiv \frac{(\alpha\delta + \eta N\bar{p})}{\delta + \eta N}, \quad (3)$$

which can be interpreted as an inverse measure of the toughness of competition in the industry and is positively related to $\bar{p}$ and negatively related to N. Demand is independent of income. However, the price elasticity of demand, $\epsilon_{q,p}(i)$, is not constant and does not solely depend on the degree of product differentiation, as in the CES framework, but is also increasing in the toughness of competition in the industry: from (2) and (3), for a given price $p(i)$, $\epsilon_{q,p}(i) = |\partial \log q(i)/\partial \log p(i)| = [(p_{\max}/p(i)) - 1]^{-1}$ which falls in $p_{\max}$. For a given $p_{\max}$, $\epsilon_{q,p}(i)$ will be higher the higher is $p(i)$.

2.2 Production

Labour is the only factor of production. In the competitive sector, one unit of good requires one unit of labour.

Prior to entry into the monopolistic sector, ex-ante identical firms incur a fixed cost f_E in terms of the homogeneous good to set up plants and production lines and to perform the research and development (R&D) activity underpinning the introduction of a new variety. f_E is an irreversible investment, identical for all entrants, which is sunk after entry. Given the uncertainty characterising the outcome of R&D efforts, it is only after paying f_E that a firm learns how productive its technology is by drawing c from a cumulative distribution, $G(c)$. Since firms with the same cost parameter c are symmetric, we index firms by c alone. After entry, production occurs according to a constant returns to scale technology $q(c) = l(c)/c$, where l is the firm's labour demand and c is its unit labour requirement. A typical firm then has marginal production cost $w(c)c$ and operating profits $\pi(c) = [p(c) - w(c)c]\, q(c)$, where $w(c)$ is the wage it pays its workers. Due to the assumption of a continuum of firms in the industry, a firm takes the number of competitors and the industry average price as given. The price and the quantity which solve the firm's maximisation problem must satisfy the following relationships:

$$q(c) = \frac{L}{\delta}\left[p(c) - w(c)c\right]. \tag{4}$$

Given the demand equation in (2), (4) then implies the optimal price:

$$p(c) = \frac{w(c)c}{2} + \frac{\alpha\delta + \eta N\bar{p}}{2\left(\delta + \eta N\right)}. \tag{5}$$

Substituting (4) into $\pi(c)$, maximized operating profits are:

$$\pi(c) = \frac{L}{\delta}\left[p(c) - w(c)c\right]^2. \tag{6}$$

The firm's labour demand is obtained by substituting equation (4) into the production function:

$$l(c) = \frac{Lc}{\delta}\left[p(c) - w(c)c\right], \tag{7}$$

which can then be used to rewrite (6) as:

$$\pi(c) = \frac{\delta}{Lc^2} l^2(c). \tag{8}$$

Given that f_E is sunk after entry, only firms capable of covering their marginal cost (i.e. with $p(c) \geq w(c)c$) survive in the market. For active firms, $p(c) \leq p_{\max}$ which, given (5), requires $w(c)c \leq p_{\max}$. Thus, the lower is $p_{\max}$ (and the tougher is competition in the industry), the lower is the marginal cost that allows firms to break-even.

2.3 Unions

In the homogenous good sector, the labour market is perfectly competitive and all employers pay the same wage w_0.[9] Since the price of the good and the unit labour requirement are both unity, $w_0 = 1$. Labour in the monopolistic sector is unionized according to a right-to-manage model in which employment is determined unilaterally by the firm and the wage is determined via negotiation with a firm-specific union by solving the following Nash bargain subject to (8), (7), and (5):

$$\max_{w(c)} \Pi = v \log \left[V \left(w(c), l(c) \right) \right] + (1 - v) \log \left[\pi \left(w(c), l(c) \right) - \pi_0(c) \right], \tag{9}$$

where $0 < v \leq 1$ is the union's bargaining power[10], $V \left(w(c), l(c) \right) = l(c)[w(c) - 1]$ is its total labour rent above the competitive wage paid to non-unionized workers, and $\pi_0(c)$ is the firm's reservation profit. Without loss of generality, we set $\pi_0(c) = 0$.[11] The resulting optimal wage rule is then:

$$w(c) = 1 + \frac{2v}{(v+2)\, c} \left[p(c) - c \right]. \tag{10}$$

For expressions (4) and (6) to be positive, it must be the case that $p(c) \geq w(c)c$ which, given (10), holds if and only if $p(c) \geq c$. This, in turn, implies that $w(c) \geq w_0 = 1$. As is clear from (10), there emerges a distribution of firm specific wages (above the reservation wage) that depend on the cost parameter of firms.

2.4 The long-run autarkic equilibrium

Entry into the industry continues until a firm's expected profits are driven to zero, i.e.: $\int_0^{c_D} \pi(c) dG(c) = f_E$. This entry condition identifies a cut-off level, c_D, of c at which a firm just breaks-even, defined by the zero-profit condition:

$$c_D \equiv \sup \left\{ c : \pi(c_D) = 0 \right\}. \tag{11}$$

Substituting (10) into (6), and the resulting expression into (11) yields:

$$\pi(c_D) = 0 \Longleftrightarrow p(c_D) = c_D w(c_D), \tag{12}$$

where $p(c_D)$ and $w(c_D)$ are the price and wage of marginal firms with $c = c_D$. Entrants with $c \leq c_D$ remain in the market and start producing: of these, the non-marginal firms (with $c < c_D$) earn gross (of the entry cost) positive profits. Entrants with $c > c_D$ exit the market and forego the entry cost.

The wage paid by the marginal firms equals the competitive wage, i.e. $w(c_D) = 1$, as is evident by substituting (12) into (10). Thus, recalling that $\pi(c_D) = 0$ implies $p(c_D) = c_D$, the optimal prices, output levels, profits, markup (defined as the difference between price and marginal cost) and wage can now

be written as functions of c_D:

$$\begin{aligned} p(c) &= \frac{(v+2)\,c_D + (2-v)\,c}{4},\ q(c) = \frac{(2-v)\,L}{4\delta}\,(c_D - c)\,, \\ \pi(c) &= \frac{L\,(2-v)^2\,(c_D-c)^2}{16\delta},\ \mu(c) = \frac{1}{4}\,(2-v)\,(c_D-c)\,, \\ w(c) &= 1 + \frac{v}{2}\left(\frac{c_D}{c} - 1\right) \end{aligned} \tag{13}$$

Clearly, for a given v, firms with a lower c set lower prices, sell larger quantities, and have higher profits and markups than less productive firms, despite the fact that they also pay higher wages. The intuition for the negative relationship between w and c is that more productive firms, that have lower price elasticities of demand (since: $\partial\epsilon_{q,p}(c)/\partial c > 0$), enjoy a stronger monopoly positions in the product market and offer their unions a higher potential for rent extraction. Furthermore, unions in lower cost firms face a lower wage elasticity of labour demand – i.e. $\partial\epsilon_{l,w}(c)/\partial c > 0$, where $\epsilon_{l,w}(c) = |\partial \log l(c)/\partial \log w(c)|$; hence, given the trade-off between wage and employment, the incentive for unions to bid up wages increases as c falls. Thus, unionisation weakens the relative cost advantage of high productivity firms.

We adopt a Pareto distribution as the specific parameterization of $G(c)$, with: $G(c) = (c/c_M)^{\kappa}$, $c \in [0, c_M]$, where c_M is the upper bound of c and the shape parameter $\kappa \geq 1$ indexes its dispersion. The average draw of entrants is then: $\bar{c} = c_M\kappa/(\kappa+1)$, with variance $\bar{c}/[\kappa(\kappa+2)]$. Making use of this parametarisation in the zero-profit free-entry condition we obtain the cut-off level of c:[12]

$$c_D = \left[\frac{8\delta\,(\kappa+1)\,(\kappa+2)\,f_E c_M^{\kappa}}{L\,(2-v)^2}\right]^{1/(\kappa+2)}, \tag{14}$$

and the average levels of all firm performance variables:

$$\begin{aligned} \bar{c} &= \frac{\kappa}{\kappa+1}c_D,\quad \bar{p} = \frac{(4\kappa+v+2)}{4\,(\kappa+1)}c_D,\quad \bar{\mu} = \frac{1}{4}\,(2-v)\,\frac{c_D}{(\kappa+1)} \\ \bar{q} &= \frac{(2-v)\,L}{4\delta\,(k+1)}c_D,\ \bar{\pi} = \frac{L\,(v-2)^2\,c_D^2}{8\delta\,(\kappa+1)\,(\kappa+2)},\ \bar{w} = 1 + \frac{v}{2\,(\kappa-1)}. \end{aligned} \tag{15}$$

Noting that for the marginal firms it must be the case that $p_D = p_{\max} = c_D$, substitution of $\bar{p}$ from (15) into (3) allows to determine the number of firms selling in the economy as $N = [4\,(\kappa+1)\,\delta]\,(\alpha - c_D)\,/\,[\eta\,(2-v)\,c_D]$, with $N > 0$ iff $\alpha > c_D$, and the number of entrants from $N_E = N/G(c_D)$.

The effects of an increase in union power on the industry equilibrium are summarised in the following proposition.

Proposition 1 *An increase in the bargaining power of unions v:* (i) *increases the cut-off value of c;* (ii) *increases average prices, and reduces average markups, and profits;* (iii) *increases wage dispersion; and* (iv) *increases the mass of firms selling in the economy, if $\alpha > (\kappa+2)\,c_D/\kappa$.*

Proof. (i) and (ii) follow from inspection of (14) and (15); (iii) is evident using $\bar{w}$ from (15) to obtain the variance of wages, $\sigma_w^2 = v^2\kappa/\left[4(\kappa-1)^2(\kappa-2)\right]$, which increases in v; (iv) follows from inspection of the expression for N. ■

Thus, the stronger are unions the lower is the minimum level of productivity required to survive in equilibrium. This amounts to a *selection-softening effect* of union power via a reduction in the toughness of competition within the industry which leads to greater entry of relatively less efficient firms. The intutition for this is that not only do more productive firms pay higher wages, but their wage is also more responsive to changes in v (i.e. the elasticity of $w(c)$ with respect to v falls in c: $\partial\epsilon_{w,v}(c)/\partial c < 0$, where: $\epsilon_{w,v}(c) = \partial \log w(c)/\partial \log v$). Thus, for a given c_D, a higher v leads to relatively larger wage demand increases in relatively more productive firms – i.e. it hurts (via higher costs) these firms relatively more than less efficient firms, redistributing market shares towards the latter. This change in the efficiency composition of the industry, in turn, is accompanied by a *counter-competitive effect* reflected in a lower average level of productivity (i.e. a higher $\bar{c}$), higher average prices ($\bar{p}$), lower average quantities ($\bar{q}$), and a reduction in both the average markup ($\bar{\mu}$) and profit ($\bar{\pi}$). Through its effect on c_D, an increase in v also has a *wage inequality effect* reflected in greater intra-industry wage dispersion. However, if the preference for varieties (reflected by α) is sufficiently strong, an increase in v may also have a *pro-variety effect* by allowing a larger mass of firms to survive in equilibrium.

The implication of this analysis is that, as we show in Appendix A1, the effects of an increase in union power on welfare (measured by the indirect utility function associated with (1)) are not unambiguous. This is because when preferences for variety are sufficiently strong, the pro-variety effect of an increase in v works towards an increase in consumer welfare (and in higher average household incomes) and thus goes towards offsetting its selection-softening and counter-competitive effects (that result in a lower average productivity and hence in higher average prices) on welfare.[13]

3 Two-Country World

In this section we examine how international differences in union bargaining power between two countries (home and foreign) affect inter-market linkages and relative performance. An asterisk refers to foreign variables and the subscripts D and X denote variables associated with domestic and export sales, respectively. For ease of exposition, whenever appropriate, the model will be discussed with reference to the home country only.

The two economies are assumed to be symmetric both in consumer preferences and in production technologies, but we allow for asymmetries in population size, trade barriers and union bargaining power. The numeraire good is assumed to be freely traded. Thus, the wage in the perfectly competitive sector will equal one in both countries. In the monopolistic sector, markets are segmented and trade occurs at a per-unit cost $\tau > 1$ and $\tau^* > 1$ incurred

by domestic and foreign exporters, respectively. Hence, the delivery cost of a variety produced with cost $w(c)c$ is $\tau w(c)c$.

In each country, firms entering the monopolistic sector draw their unit labour requirement coefficients c simultaneously from an identical Pareto distribution $G(c)$ after having paid the fixed entry cost f_E; a firm then decides whether to produce or not, and whether to export or not, depending on the profits it expects to earn at home and abroad, conditional on the productivity distribution of the successful entrants.

Due to market segmentation, the price threshold for positive demand is market-specific:

$$p_{\max} \equiv \frac{(\alpha\delta + \eta N \bar{p})}{\delta + \eta N} \quad \text{and} \quad p^*_{\max} \equiv \frac{(\alpha\delta + \eta N^* \bar{p}^*)}{\delta + \eta N^*}. \tag{16}$$

i.e. a firm faces different competitive pressures, and enjoys different monopoly powers, on its domestic and export markets. Given the constant returns to scale technology, an exporter has two separate *profit centres* and maximises two independent profits, $\pi_D(c)$ and $\pi_X(c)$, linked to production for the domestic and export market respectively. The resulting prices, markups and price elasticities of demand are profit-centre (or market) specific. The firm's labour demands to produce for the two markets are:

$$l_D(c) = \frac{Lc}{\delta}\left[p_D(c) - w(c)c\right] \quad \text{and} \quad l_X(c) = \frac{\tau L^* c}{\delta}\left[p_X(c) - \tau w(c)c\right], \tag{17}$$

which can be used to write the maximized profits as:

$$\pi_D(c) = \frac{\delta\left[l_D(c)\right]^2}{Lc^2} \quad \text{and} \quad \pi_X(c) = \frac{\delta\left[l_X(c)\right]^2}{\tau L^* c^2}. \tag{18}$$

Firms produce for the domestic market if, and only if, $\pi_D(c) \geq 0$, and export to the foreign market if, and only if, $\pi_X(c) \geq 0$.

3.1 Unions

The market-specificity of an exporter's monopoly power implies that not only will the rent extraction ability of unions vary between firms but also between the different activities (or profit centres) of a firm.

The need for wage settlements to reflect variations in profitability not only among firms but also between profit-centres within individual firms has motivated the drive across the OECD towards a decentralisation of wage bargaining, with individual firms signing different contracts with unions (Kamakura 2006). Above-average numbers of agreements per-firm (with their number typically increasing in the size of the establishment) can be found in the chemical, electricity, energy, metalworking, telecommunications and electronics industries; for example, in Finland 90% of chemical firms have on average 13 contracts (Kamakura 2006).[14] Local bargaining is particularly dominant in the export sector, where the perceived competitive pressure on firms is higher (Jackson 2006).

Existing analyses of decentralised wage bargaining have mostly focussed on *firm level bargaining*, in which negotiations result in a unique wage for all the labour employed by the firm. To capture the stylised facts discussed above, we instead consider primarily the *profit-centre level bargaining* regime, in which each firm-union pair bargains separately over the wage paid to workers employed in the domestic and in the export profit centres respectively. The two regimes are compared in Appendix A4.[15]

The Nash bargaining problem for firms producing only for the domestic market is given by (9) which is solved subject to the profit in (18) and the union's total labour rent to yield:

$$w_D(c) = 1 + \frac{2v}{(v+2)c}\left[p_D(c) - c\right], \tag{19}$$

that has the same functional form as the autarkic wage.

For exporting firms, profit-centre level bargaining results in a *domestic* and in an *export* wage, $w_D(c)$ and $w_X(c)$ respectively. The former, determined by solving the same bargaining problem of a non-exporter, is given by (19). The wage paid to workers producing for the export market is obtained by solving:

$$\max_{w_X(c)} \Pi_X = v \log\left[l_X(c)\left(w_X(c) - 1\right)\right] + (1-v)\log\left[\frac{\delta\left[l_X(c)\right]^2}{\tau L^* c^2}\right],$$

subject to (17):

$$w_X(c) = 1 + 2\frac{v}{(v+2)\,c}\left(\frac{p_X(c)}{\tau} - c\right). \tag{20}$$

It is easy to verify that $p_X(c) \geq \tau c$; (20) then implies that $w_X(c) \geq 1$.

3.2 The long-run two-country equilibrium

As in autarky, free entry and exit into the industry drive expected profits to zero in equilibrium. The possibility of exporting, however, results in the emergence of two cut-offs for c, c_D and c_X, associated with the marginal domestic-only firms and with the marginal exporters, respectively. For a given mass of entrants N_E, a mass of firms $N_D = G(c_D)N_E$ sells only in the domestic market and a mass of firms $N_X = G(c_X)N_E$ also exports. Imposing the (zero-profit) conditions for the two sets of marginal firms yields:

$$\begin{aligned} \pi_D(c_D) &= 0 \Longleftrightarrow p_D(c_D) = w_D(c_D)c_D, \\ \pi_X(c_X) &= 0 \Longleftrightarrow p_X(c_X) = \tau w_X(c_X)c_X, \end{aligned} \tag{21}$$

where $p_D(c_D)$ and $w_D(c_D)$, and $p_X(c_X)$ and $w_X(c_X)$, are prices and wages of the marginal domestic-only and exporting firms, respectively. From (21), it is clear that both types of marginal firms pay the competitive wage, i.e.: $w_D(c_D) = w_X(c_X) = 1$, which in turn implies that (21) can be rewritten as:

$$p_D(c_D) = c_D \quad \text{and} \quad p_X(c_X) = \tau c_X. \tag{22}$$

Given (22), the wages in (19) and (20), the optimal domestic and export prices and output levels can be written as functions of the cut-offs:

$$\begin{aligned} p_D(c) &= \frac{(v+2)\,c_D + (2-v)\,c}{4}, \quad q_D(c) = \frac{(2-v)\,L}{4\delta}\,(c_D - c)\,, \\ p_X(c) &= \frac{\tau\left[(v+2)\,c_X + (2-v)\,c\right]}{4}, \quad q_X(c) = \frac{\tau\,(2-v)\,L^*}{4\delta}\,(c_X - c)\,, \end{aligned} \tag{23}$$

with maximized profit levels respectively given by:

$$\pi_D(c) = \frac{L\,(2-v)^2\,(c_D - c)^2}{16\delta} \quad \text{and} \quad \pi_X(c) = \frac{\tau^2 L^*\,(2-v)^2\,(c_X - c)^2}{16\delta} \tag{24}$$

Similarly, the absolute markups obtained from domestic and export sales can be written as $\mu_D(c) = (2-v)\,(c_D - c)/4$ and $\mu_X(c) = \tau\,(2-v)\,(c_X - c)\,/4$. Substituting prices from (23) into (19) and (20), yields:

$$w_D(c) = 1 + \frac{v}{2}\left(\frac{c_D}{c} - 1\right) \quad \text{and} \quad w_X(c) = 1 + \frac{v}{2}\left(\frac{c_X}{c} - 1\right). \tag{25}$$

For given v and τ, a lower c gives firms a stronger monopoly position in their market (be it domestic or foreign) and thus offers their unions a higher potential for rent extraction and, due to a lower wage elasticity of labour demand, a higher incentive to set higher wages. Despite this, however, firms with a lower c set lower prices, sell larger quantities, have higher profits and charge higher (absolute) markups than less efficient firms in both their domestic and export markets.

3.2.1 The efficiency cut-offs and market structure

With international trade, the two countries' efficiency cut-offs are determined jointly. For the home country, the zero expected profit condition is: $\int_0^{c_D} \pi_D(c)dG(c) + \int_0^{c_X} \pi_X(c)dG(c) = f_E$. Given (21) and $w_D(c_D) = w_X(c_X) = 1$, we obtain:

$$c_X^* = \frac{c_D}{\tau^*}. \tag{26}$$

Combining (26) with the zero expected profit conditions for both countries yields their domestic and export cut-offs. For the home country, these are:[16]

$$c_D = \left\{ \frac{8\delta c_M^{\kappa}\,(\kappa+1)\,(\kappa+2)\,f_E\left[(2-v^*)^2 - (2-v)^2\,\rho\right]}{L\,(2-v)^2\,(2-v^*)^2\,(1-\rho\rho^*)} \right\}^{\frac{1}{\kappa+2}}, \tag{27}$$

and

$$c_X = \rho^{\frac{1}{\kappa}} \left\{ \frac{8\delta c_M^{\kappa}\,(\kappa+1)\,(\kappa+2)\,f_E\left[(2-v)^2 - (2-v^*)^2\,\rho^*\right]}{L^*\,(2-v)^2\,(2-v^*)^2\,(1-\rho\rho^*)} \right\}^{\frac{1}{\kappa+2}}, \tag{28}$$

where $\rho \equiv \tau^{-\kappa} \in (0,1)$ measures the 'freeness' of trade.[17] As shown in Appendix A2, $N_E^* > 0$ requires $c_X < c_D$ to hold. Thus, only a subset of more productive firms (with $c \leq c_X$) export. All other firms (with $c_X < c \leq c_D$) sell in the domestic market only. When countries are symmetric, the domestic cut-off under trade is lower than in autarky: by toughening competition, which forces less efficient firms to exit, trade raises aggregate productivity. A better access to the foreign country (i.e. a larger ρ) reduces c_D and increases c_X, whilst easier access to the home country by foreign exporters (i.e. a higher ρ^*) increases c_D and reduces c_X. A larger L and L^* reduce c_D and c_X, respectively. This is because the tougher competition in a larger market forces firms to price on a more elastic segment of their demand curve and to reduce their mark-ups. Hence, a larger destination market (be it domestic or foreign) increases the minimum productivity required to break-even. These results are consistent with those in Melitz and Ottaviano (2008).

The effects of the bargaining power of unions on the cut-offs are summarised in the following proposition:

Proposition 2 *(i) An increase in v increases c_D and reduces c_X; (ii) an increase in v^* reduces c_D and increases c_X.*

Proof. (i) and (ii) follow from inspection of (27) and (28). ■

A rise in v leads to relatively larger wage increases in relatively more efficient firms (since $\partial \epsilon_{w,v}(c)/\partial c < 0$) and hence hurts exporters relatively more than domestic-only firms. Thus, an increase in v has a *selection-softening effect* in the domestic market (where the minimum efficiency required to break even falls), and a *selection-toughening effect* for exporters (since, by increasing wages, it increases the minimum productivity required to export). Thus: (i) firms exporting to a country whose union power has increased face a softer competition from domestic firms in that market; (ii) domestic firms in a market face a tougher competition from exporters whose union power has increased. The market structure effects of an increase in v are summarised in the following proposition.

Proposition 3 *When countries are symmetric, an increase in union bargaining power in one country: (i) reduces the mass of firms entering that country; (ii) reduces the mass of firms exporting from that country; (iii) increases the mass of domestic firms selling in that country, provided that $\alpha > (2+\kappa)c_D/\kappa$.*

Proof. See Appendix A2. ■

To summarize: the opening up of trade does not alter the positive relationship between v and c_D which results in more entry of less efficient firms and in a lower average industry productivity. However, an increase in v reduces c_X, raising the average efficiency of exporters. Qualitatevely, these results are unaffected by the degree of market integration. However, under completely free-trade, $c_D = c_X$ and the effects of union power on the equilibrium productivity distribution is as in autarky.

3.2.2 Wages, incomes and welfare

As is clear from (25), more productive firms pay higher wages in both their profit centres. It is also the case that:

Proposition 4 *Within an exporting firm, the 'export-wage' is lower than the 'domestic-wage'.*

Proof. See Appendix A2. ■

Thus, profit-centre level negotiations result in *'wage-discrimination'* across the different activities of the firm, even though more productive firms pay higher wages in both domestic and export profit-centres. This is because market segmentation implies that firms' price elasticity of demand and their wage elasticity of labour demand are both higher in their export market (see Appendix A2). As a result, by internalising the firm's lower monopoly power in its foreign market and the trade-off that exists between wage and employment, unions have an incentive to moderate their export wage demands to aid their firm's foreign market access.[18] $w_D(c)$ and $w_X(c)$ are plotted in Figure 1 as a function of c.[19] Clearly, whilst for exporters $w_D(c) > w_X(c)$, domestic-only firms pay on average lower wages than exporters. As in Andersen and Sorensen (2008), the export wage for the marginal exporters can be lower than the (domestic) wage paid by the more efficient non-exporting firms.

Figure 1 about here

A key result of our analysis is that trade liberalisation affects intra-industry (and within group) wage inequality *both* across firms (via its effects on competitive selection) *and* within firms (via wage discrimination across destination markets).

Proposition 5 *A trade liberalisation that eases access to foreign markets: (i) reduces intra-firm and (ii) increases industry-wide wage dispersion.*

Proof. See Appendix A3. ■

The intuition for this is as follows. Economic integration narrows the gap in competitive pressure across markets and thus reduces the incentives for wage discrimination within the firm.[20] However, intra-industry wage dispersion (measured by the variance of wages within the industry) increases as the cost of penetrating foreign markets falls. This result reflects the effects of trade liberalisation on the cut-offs: on the one hand, a lower c_D (whereby the least efficient, lower wage, firms exit) works towards a lower wage dispersion. On the other hand, the redistribution of market shares towards the more efficient firms increases wage inequality.[21]

As is shown in Appendix A1, the opening up of trade between two symmetric countries does not qualitatively alter the effects of changes in union power on welfare, which remain ambiguous. The effects of trade liberalisation, however, depend on the size of α – i.e. they are not unabiguous as in Melitz and Ottaviano (2008).

The firm-level bargaining case in which a firm pays the same wage, $w_U(c)$, to all its workers is derived in Appendix A4. The wages for the two bargaining regimes are plotted in Figure A1 for the monopoly union case. The broken dotted line $w_U(c)$ indicates that even with firm-level bargaining the wage of the more efficient non-exporters can exceed that of the least efficient exporters. Furthermore, $w_X(c) < w_U(c) < w_D(c)$. By internalising a firm's lower monopoly power abroad, a union has an incentive to moderate wage demands relative to the domestic profit-centre bargaining (i.e. $w_U(c) < w_D(c)$), but a lower incentive to aid a firm's international competitiveness (thus setting $w_U(c) > w_X(c)$). As a result, firms require a higher minimum productivity to be able to export (i.e. c_X is lower) under firm-level bargaining. Therefore, unions' acceptance of sub-firm level decentralisation of bargaining may reflect their willingness to moderate rent *extraction* in favour of rent *creation* (by protecting employment) in activities exposed to tougher competition.[22] Via a closer link between wages and inter-market differences in competitive pressures, profit-centre level bargaining may then allow unions to extract higher *total rents*. This is shown, with monopoly unions, in Figure A.2 in Appendix A4 that plots total labour rents in the two regimes.[23]

4 Conclusions

We have examined how labour market unionisation and international trade affect intra-industry selection and wage inequality.

The nature of bargaining is an important channel through which trade liberalisation affects wage inequality. Unionisation acts as a rent-sharing mechanism between workers and firms and, with firm specific markups, leads to inter-firm wage disparities (with more productive firms paying higher wages) even with ex-ante identical workers. However, decentralisation of bargaining at the profit-centre level, by enabling unions to better exploit the different degrees of market power that firms have in their domestic and export markets, gives rise to *within-firm* wage inequality; by moderating rent extraction, and protecting employment, in activities exposed to more intense foreign competition, a union can then extract a higher total labour rent than under firm level negotiations. Hence, a testable prediction of the model is that, for a given level of openness, decentralisation of bargaining at the sub-firm level ought to result in exporters exhibiting higher intra-firm wage dispersion. Clearly, empirical research is required to investigate the extent to which trade liberalisation affects wage dispersion across (via a competitive selection effect) or within (via a wage discrimination effect) firms.

Since a union's rent extraction ability is higher in more productive firms, an increase in union power in one country leads to relatively larger wage demand increases in more efficient firms, *softening* competition for domestic firms (with more entry of less efficient firms in the domestic market), and *toughening* competition for exporters (by increasing the minimum productivity required to export). Hence, firms exporting to a country with stronger unions face a softer

competition from domestic firms in that market; instead, domestic firms in a market face a tougher competition from exporters located in a country with more powerful unions. Thus, a key testable prediction of the model is that industries in countries where unions are stronger should be expected to have a lower average productivity and also offer an easier access to foreign exporters.

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Appendix

A1. Welfare. Welfare is measured by the average indirect utility $\bar{W} = \bar{q}_0 + B + \bar{I}$, where B and average income $\bar{I}$ are defined as:

$$B \equiv \frac{1}{2}\left(\eta + \frac{\delta}{N}\right)^{-1}(\alpha - \bar{p})^2 + \frac{1}{2}\frac{N}{\delta}\sigma_p^2, \quad \bar{I} \equiv \left(\overline{VC}\ N + L - \bar{l}N\right)/L$$

and where

$$\begin{aligned} \sigma_p^2 &= (2-v)^2\kappa\left(c_D\right)^2/\left[(\kappa+2)(\kappa+1)^2 16\right], \\ \overline{VC} &= L(2-v)(\kappa+v)\left(c_D\right)^2/\left[4\delta(\kappa+1)(\kappa+2)\right] \\ \bar{l} &= L(2-v)\kappa\left(c_D\right)^2/\left[4\delta(\kappa+1)(\kappa+2)\right] \end{aligned}$$

are, respectively, the variance of prices, average variable cost, and average labour demand per-firm in the monopolistic sector. Clearly, $\partial\bar{W}/\partial\bar{p} < 0$, $\partial\bar{W}/\partial N > 0$, $\partial\bar{W}/\partial\sigma_p^2 > 0$. Substituting $\bar{p}$ from (15) and σ_p^2 in B yields: $B = (\alpha - c_D)\left\{2\alpha - \left[c_D(2\kappa + v + 2)\right]/(\kappa+2)\right\}/4\eta > 0$ since $\alpha > c_D$.

The effects of an increase in v on $\bar{W}$ are ambiguous: $\partial\bar{W}/\partial v = \partial B/\partial v + \partial\bar{I}/\partial v$, with $\partial B/\partial v < 0$ and $\partial\bar{I}/\partial v \gtreqless 0$ iff: $\alpha \gtreqless c_D\left[2v + 4 + \kappa(2-v)\right]/[\kappa(2-v)+4]$. For a sufficiently large α, and hence strong pro-variety effects of an increase in v, $\partial\bar{W}/\partial v > 0$ cannot be ruled out.

International trade does not alter the functional form of $\bar{W}$. With symmetric countries, $\overline{VC} = (2-v)(\kappa+v)L(1+\rho)\left(c_D\right)^2/\left[4\delta(\kappa+1)(\kappa+2)\right]$, and $\bar{l} = (2-v)\kappa L(1+\rho)\left(c_D\right)^2/\left[4\delta(\kappa+1)(\kappa+2)\right]$ which in turn imply that $\bar{I}$ is the same as in autarky. As in autarky, the sign of $\partial\bar{W}/\partial v$ is ambiguous. Clearly, since c_D in open economy is smaller than in autarky, the threshold level of α at which $\partial\bar{I}/\partial v > 0$ is lower than in autarky. The welfare effects of trade liberalisation also depend on the size of α; specifically: $\partial\bar{I}/\partial\rho \gtreqless 0$ iff $\alpha \gtreqless 2c_D\left[2(\kappa+1) - 3v\right]/\left[(4\kappa - 3v + 6)\right]$.

A2. Mass of firms and proof of Propositions 3 and 4. Note that $p_D(c_D) = c_D = p_{\max}$. Substituting c_D and c_X^* from (27) and (28) into the expression for $p_D(c)$ (and its equivalent for $p_X^*(c)$) in (23), and making use of (26) yields:

$$\bar{p} = \left[\frac{N_D}{N_D + N_X^*}(4\kappa + v + 2) + \frac{N_X^*}{N_D + N_X^*}(4\kappa + v^* + 2)\right]\frac{c_D}{4(\kappa+1)}. \tag{29}$$

Substituting $N_D = G(c_D)N_E = (c_D/c_M)^{\kappa} N_E$ and $N_X^* = G(c_X^*)N_E^* = (c_X^*/c_M)^{\kappa} N_E^*$ into (29) and given (26), (29) becomes:

$$\bar{p} = \frac{\left[N_E(4\kappa + v + 2) + \rho^* N_E^*(4\kappa + v^* + 2)\right]c_D}{4(\kappa+1)(N_E + \rho^* N_E^*)}. \tag{30}$$

Combining (29) with (16) yields the total number of firms selling in the country:

$$N = N_D + N_X^* = \left(\frac{c_D}{c_M}\right)^{\kappa} \left(N_E + \rho^* N_E^*\right). \tag{31}$$

Substituting (30) and (31) into $c_D = \left(\delta\alpha + \eta N\bar{p}\right)/\left(\eta N + \delta\right)$ (and doing the same for the foreign country) yields a system of two equations in N_E and N_E^* from which, for the home country, we obtain:

$$N_E = \frac{4\delta\left(\kappa+1\right)c_M^{\kappa}}{\eta\left(2-v\right)\left(1-\rho^*\rho\right)}\left[\frac{\left(\alpha - c_D\right)}{\left(c_D\right)^{\kappa+1}} - \rho^*\frac{\left(\alpha - c_D^*\right)}{\left(c_D^*\right)^{\kappa+1}}\right]. \tag{32}$$

Recalling that $c_D = c_X^*\tau^*$, (32) implies that $N_E > 0$ iff $c_X^* < c_D^*$ (and $N_E^* > 0$ iff $c_X < c_D$).

Proposition 3. Proof. Imposing symmetry on (32), we find: $\partial N_E/\partial v < 0$. Then $N_X = G(c_X)N_E = \left(c_X/c_M\right)^{\kappa} N_E$ implies: $\partial N_X/\partial v < 0$. Substituting (32) into $N_D = G(c_D)N_E = \left(c_D/c_M\right)^{\kappa} N_E$ yields:

$$N_D = \frac{4\delta\left(k+1\right)}{\eta\left(2-v\right)\left(1+\rho\right)}\frac{\left(\alpha - c_D\right)}{c_D}$$

from which: $N_D > 0$ iff $\alpha > c_D$, and $\partial N_D/\partial v > 0$ iff $\alpha > (2+\kappa)c_D/\kappa$. If preference for variety is sufficiently strong, an increase in v results in a larger mass of domestic firms, despite the fact that it reduces the mass of entrants. ■

Propostion 4. Proof. Inspection of (27) and (28) reveals that for $\rho = \rho^*$ and $v = v^*$, $c_X < c_D$ always holds. In the general case: $c_X < c_D$ requires $\left(2-v^*\right)^2 - \left(2-v\right)^2\rho > \rho^{\frac{\kappa+2}{\kappa}}\left[\left(2-v\right)^2 - \left(2-v^*\right)^2\rho^*\right]$, which we impose since $c_X < c_D$ is required for entry to be positive. Then, $c_X < c_D$ implies $w_D(c) > w_X(c)$. ■

Also note that with symmetry: $p_{\max} = p_{\max}^*$ and $c_D = c_D^*$. Thus, $c_X = c_D^*/\tau$ implies that $p_X(c) > p_D(c)$ and hence $\left|\epsilon_{q,p}^D(c)\right| = \left[\left(p_{\max}/p_D(c)\right) - 1\right]^{-1} < \left|\epsilon_{q,p}^X(c)\right| = \left[\left(p_{\max}^*/p_X(c)\right) - 1\right]^{-1}$. For the general case, $p_X(c) > p_D(c)$ and thus $\left|\epsilon_{q,p}^D(c)\right| < \left|\epsilon_{q,p}^X(c)\right|$ hold if $c > \left[\left(v+2\right)\left(c_D - \tau c_X\right)\right]/\left[\left(\tau-1\right)\left(2-v\right)\right]$. Also, $\left|\epsilon_{l,w}^X\right| = 2c/\left[\left(2-v\right)\left(c_X - c\right)\right] + v/\left(2-v\right) > \left|\epsilon_{l,w}^D\right| = 2c/\left[\left(2-v\right)\left(c_D - c\right)\right] + v/\left(2-v\right)$, since $c_X < c_D$.

A3. Proposition 5. Proof. (i): Inspection of (27) and (28) reveals that $\partial c_D/\partial\rho < 0$ and $\partial c_X/\partial\rho < 0$. From (25), this implies that $\partial w_D/\partial\rho < 0$ and $\partial w_X/\partial\rho < 0$. (ii) For symmetric countries, the variance of wages within the industry is obtained by first deriving the average industry wage:

$$\bar{w} = \left[1 + \frac{v}{2\left(\kappa-1\right)}\right]\left(1+\rho\right) \tag{33}$$

which always increases in ρ. Making use of (33), the variance of wages in the monopolistic sector is obtained as:

$$\sigma_w^2 = (\rho+1)\frac{\left[v^2\kappa + \rho^2(\kappa-2)(v+2\kappa-2)^2\right]}{4(\kappa-1)^2(\kappa-2)}$$

which is clearly increasing in ρ. ■

A4. Wage and cut-offs with firm-level bargaining. With firm-level bargaining, the wage $w_U(c)$ an exporter pays in both domestic and export profit-centres is obtained by:

$$\begin{aligned}\max_{w_U(c)}\Pi_U &= v\log\left[\left(l_D(c)+l_X(c)\right)\left(w_U(c)-1\right)\right]+\\ &\quad (1-v)\log\left[\pi_D\left(w_U(c),l(c)\right)+\pi_X\left(w_U(c),l_X(c)\right)\right]\end{aligned}$$

subject to (17) and (18). Analytical solutions for $w_U(c)$ can only be found for $v=1$:

$$w_U(c) = \frac{1}{3}+\frac{2}{3c}\frac{Lp_D(c)+\tau L^* p_X(c)}{L+L^*\tau^2}. \tag{34}$$

For given productivity cut-offs, $w_U(c)$ can be written as a convex combination of the profit-centre level bargaining wages:

$$w_U(c) = \Phi w_D(c) + (1-\Phi)w_X(c) \tag{35}$$

where $\Phi = L/\left(L+L^*\tau^2\right)$ is the trade-cost-adjusted relative size of the domestic market: the larger is the domestic economy and/or the more accessible is the foreign market (i.e. the larger is L and the smaller is τ), the closer is $w_U(c)$ to $w_D(c)$.

In this regime, the zero-expected-profit free-entry condition is:

$$\int_0^{c_X}\pi_D^x(c)\frac{\kappa c^{\kappa-1}}{c_M^\kappa}dc+\int_{c_X}^{c_D}\pi_D^d(c)\frac{\kappa c^{\kappa-1}}{c_M^\kappa}dc+\int_0^{c_X}\pi_X^x(c)\frac{\kappa c^{\kappa-1}}{c_M^\kappa}dc = f_E$$

where the superscripts d and x refer to the domestic-only/exporting status of the firm. With $L=L^*$ and $v=1$, the cut-offs and wages in the two regimes are plotted together over the distribution of c in Figure A.1.[24] $w_U(c)$ has a discontinuity at $c=c_X$. As with profit-level bargaining, more productive firms pay higher wages. Also: $w_U(c_X)>1$ for $\tau>1$ and $w_U(c_X)=1$ for $\tau=1$.

Figure A.1 about here

Figure A.2 plots unions' total labour rents in the two bargaining regimes, obtained by substituting (34) and firm's employment levels into: $V_U(c) = (w_U(c)-1)\left(l_D(c)+l_X(c)\right)$ and $V_S(c) = (w_D(c)-1)\,l_D(c)+(w_X(c)-1)\,l_X(c)$.[25]

Figure A.2 about here

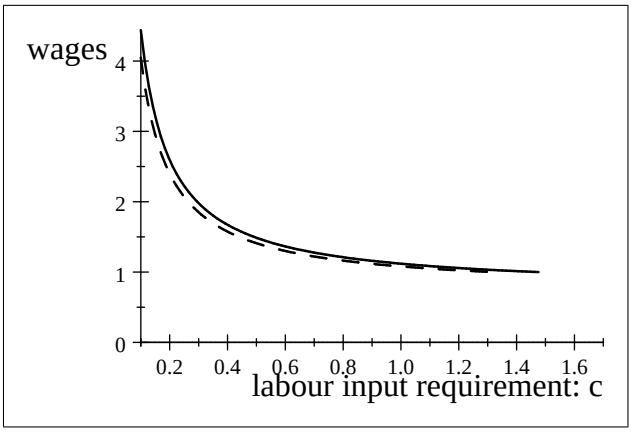

Figure 1. Profit-centre level wages: $w_D(c)$ (continuous line) and $w_X(c)$ (dashed line)

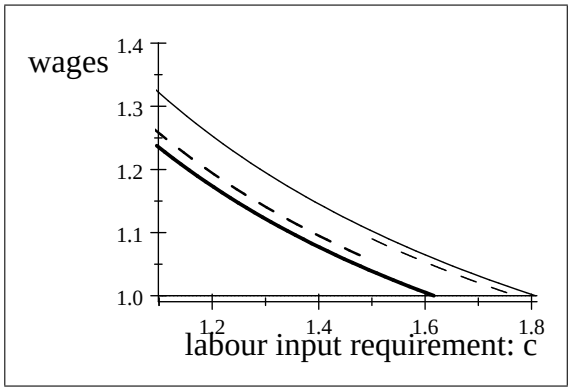

Figure A.1. Wages
Profit-centre level bargaining (solid lines): $w_D(c)$ (thin), $w_X(c)$ (thick)
Firm level bargaining (dashed lines): $w_{U,D}(c)$ (thin) $w_U(c)$ (thick).

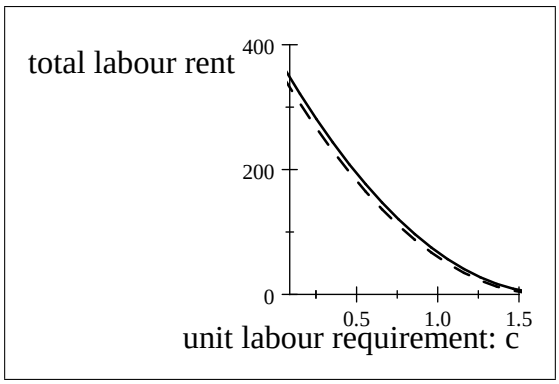

Figure A.2. Total labour rent
Profit-centre level bargaining (solid line), firm-level (dashed line)

Notes

[1] See for instance Menezes-Filho *et al* (2008) and Schank *et al* (2007) and references therein.

[2] See among others: Autor *et al* (2008), McCall (2000), Barth and Lucifora (2006), Goos and Manning (2007) and Dustmann *et al* (2009).

[3] In Germany, *opening clauses* authorise companies to opt-out of national negotiations (Jürgens 2008). In Italy, a progressive decentralisation of bargaining culminated in 2011 in the agreement at FIAT's Mirafiori plant – widely recognised as paving the way to a widespread move towards sub-firm level negotiations outside industry wide frameworks. In the UK, the tendency towards bargaining decentralisation to the sub-firm level is evident since the early 1980s (Brown 1987). Company or plant level bargaining characterise Canada, Japan, Korea, the United States, New Zealand, and in Mexico (e.g. Tuman 2003).

[4] Montagna (2001) studies the effects of trade liberalization on selection with inter-country differences in firms' productivity distributions. Melitz (2003) introduces a fixed export cost in the presence of uncertainty about post-entry efficiency and shows how only more productive firms self-select into an export status. For recent reviews of the literature, see Helpman (2006) and Redding (2010).

[5] Within an efficiency wage model, in Davis and Harrigan (2011) inter-firm wage dispersion arises from different monitoring technologies. In Egger and Kreickemeier (2009), a fair-wage effort mechanism results in productivity specific wages. Hiring and firing rigidities in Helpman and Itskhoki (2010) can result in wage inequality if a non-linear hiring function is assumed; in Helpman *et al* (2010) wage dispersion arises from heterogeneity of workers in unobservable ability. Felbermayr, *et al* (2008), in a model with search frictions, find that firms with different productivities pay similar wages regardless of the bargaining environment.

[6] To ensure positive consumption of the numeraire, we assume: $I^{\zeta} > \int_{i \in \tilde{\Omega}} p(i) q^{\zeta}(i) di$.

[7] Different employment configurations are possible (e.g. with employment in only one of the sectors, or 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.

[8] Income only depends on labour income since no aggregate profits will be shown to persist in equilibrium.

[9] Unionisation could be introduced in this sector as well. However, by absorbing the labour supply in excess of what employed by the monopolistic firms, this sector serves as an 'anchor' in the model and fixes the reservation wage to the level that clears the labour market. Unionisation in this sector would result in aggregate unemployment and require another mechanism to fix the reservation wage – the most plausible being an unemployment benefit which, in turn, would require taxation and a government budget constraint. Although interesting, this case goes beyond the aims of this paper.

[10] The monopoly union model and the no-union case considered in Melitz and Ottaviano (2008) correspond to $v = 1$ and $v = 0$, respectively.

[11] This is equivalent to assuming that a firm would have to stop production in case of a break-down of negotiations.

[12] A sufficient condition for $c_D < c_M$ to hold is that $\sqrt{\left[8\delta\left(\kappa+1\right)\left(\kappa+2\right)f_E\right]/\left[L\left(2-v\right)^2\right]} < c_M$, which we impose.

[13] A key difference with Egger and Kreickemeier (2009) is that welfare here depends on both market size and mass of firms.

[14] The British company Coats Viyella PLC opted out of national industry negotiations in 1989 and decentralised bargaining to 16 '*profit centres*' (covering multiple or individual plants, or only specific production lines within individual plants) defined on the basis of the customer base and market pressures facing the different activities of the firm (Leopold and Jackson 2001).

[15] For a more detailed analysis of the firm-level bargaining regime, see Montagna and Nocco (2011).

[16] For the foreign country the expressions for the cut-offs are symmetric.

[17] The conditions for $c_D > 0$ and $c_X > 0$ are respectively $\left(2-v^*\right)^2 > \left(2-v\right)^2\rho$ and $\left(2-v\right)^2 > \left(2-v^*\right)^2\rho^*$ which we impose.

[18] This result is similar to that obtained in an oligopoly setting by Bastos and Kreickemeier (2009).

[19] These curves are obtained for symmetric countries and for ranges of c over which firms are active: $c \in [0, c_X]$ and $c \in [0, c_D]$. Parameter values are: $v = 0.5$, $\kappa = 2$, $\delta = 0.2$, $\eta = 6$, $c_M = 10$, $L = 100$, $f_E = 1$, $\tau = 1.118$. The cut-offs emerging at these values are: $c_D = 1.4756$ and $c_X = 1.3199$

[20] Whilst an increase in ρ (i.e. a bilateral and symmetric trade liberalisation or a unilateral liberalisation by the foreign country) reduces the difference in demand elasticity in the two markets, an increase in ρ^*, that makes it easier for foreign firms to access the home market increases intra-firm wage inequality. These effects of trade liberalisation on wages are also consistent with those obtained (both theoretically and empirically), by Amiti and Davis (2011).

[21] Egger and Kreickemeier (2009) obtain a similar result. They measure wage dispersion as the ratio of the average to the lowest wage in the industry. Since we have $w_D = w_X = 1$, their measure in our paper corresponds to $\bar{w}$ which is also increasing in ρ.

[22] In Aidt and Sena (2005) incentives for rent creation are higher in firms exposed to more intense market competition. In Naylor (2000) unions trade-off wage reductions for employment gains from foreign markets.

[23] Unions in this model would prefer profit-centre level negotiations. However, if wage inequality was a concern, the two regimes would present them with a trade-off between wage dispersion and total labour rent.

[24] Parameter values: $v = 1$, $\kappa = 2$, $\delta = 0.2$, $\eta = 6$, $c_M = 10$, $L = 100$, $f_E = 1$, $\tau = 1.118$. With profit-centre bargaining: $c_D = 1.8072$ and $c_X = 1.616\,5$; with firm-level bargaining: $c_D = 1.7701$ and $c_X = 1.5002$.

[25] Parameter values: $v = 1$, $\kappa = 2$, $\delta = 0.2$, $\eta = 6$, $c_M = 10$, $L = 100$, $f_E = 1$, $\tau = 1.118$.