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ABSTRACT

Product Market Integration, Wages and Inequality*

International integration strengthening intra-industrial trade may have important implications for employment, wages and inequality. The reason is that product market integration enhances export possibilities through easier access to foreign markets, but also import threats arising from foreign firms entering the domestic market. We explore the implications of these mechanisms in a general equilibrium version of a Ricardian trade model allowing for heterogeneity and imperfect competition in both product and labour markets. International integration is interpreted as a reduction in trade frictions. We find that wage dispersion in general tends to be U-shaped, at first falling and then increasing in product market integration. This finding has important implications not only for the 'globalization' debate, but also for empirical analysis.

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1 Introduction

One of the most debated issues in relation to globalization is whether it leads to more inequality. While there is wide consensus that there are aggregate welfare gains to be reaped by international integration, there is less agreement on the distributional consequences. Possible adverse effects on inequality are often perceived as one of the main costs of further international integration, which must be weighted against other gains accruing in the process. In the debate some have focussed on the possibility that increased inequality would backlash the integration process, while others have pointed to the fact that it necessitates policy reforms coping with possible adverse distributional consequences. A central question is therefore how international integration affects labour markets not only in the aggregate but also across various groups.

The debate is fuelled by the fact that some countries have experienced increasing inequality, especially over the period from the mid 1980s to the mid 1990s (see Williamson (2002) and Alderson and Nielsen (2002)). It has been hypothesized that after the inverted V or Kuznets relation between inequality and economic development has been unfolding, many countries are now facing an epoque with a U-shaped relation. Such a U-shaped relation is found for some OECD countries (see e.g. Atkinson (2003) and Alderson and Nielsen (2002)). Globalization has been advanced as a possible explanation since increased international integration in particular of product and capital markets has been experienced over the same period[1].

Much of the inequality cum globalization debate has in particular centred on how integration of low wage countries in the international economic sphere via trade and foreign direct investments affects the relative wages of unskilled to skilled workers. A significant deterioration in the relative wage of unskilled relative to skilled workers has been observed over the last couple of decades for the US and also other countries like the UK, while some European countries have seen increasing unemployment among unskilled workers. This has by many observers been taken as an indication of the well-known Stolper-Samuelson proposition according to which integration of countries with an abundant supply of unskilled workers (relative to skilled) would imply a deteriorating position of unskilled workers and an improved situation for skilled workers in the incumbent countries. Extensive research on this issue has been performed (see e.g. Slaughter and Swagel (1997) or Ethier (2002)), and the consensus view is that trade has played a much smaller role for these changes than technological changes biased to the favour of skilled workers.[2]

[1] It is difficult to infer anything on the role of international integration for inequality since it is also affected by other factors such as unionization, skill distribution, non-labour income and welfare policies. Hence changes in inequality measures do not only arise from changes in labour market income and this makes it very hard to draw precise conclusions. Moreover part of the increase in labour earnings inequality from the mid 1980s to the mid 1990s can be explained by changes in employment and working hours since full-time labour earnings stayed rather constant (Williamson (2002)).

[2] Feenstra and Hansson (2001) contest this conclusion arguing that trade with low-wage countries can be a motive for outsourcing or production sharing, which in turn is consistent

This paper takes a different perspective on the distributional consequences of international integration to cope with a number of stylized facts, which are not well represented in the Heckscher-Ohlin model underlying the Stolper-Samuelson proposition. Specifically, we take outset in the following stylized facts concerning international integration.

First, while there has been an increase in the level of trade between high wage and low wage countries it is relatively modest compared to the increase in trade between the developed countries, i.e. "North-North" integration has played at least as large a role as "South-North" integration in recent years. As a case in point, trade has grown substantially relative to GDP in recent years for all EU-15 countries, but the consolidated trade share for EU-15 countries is not significantly larger today than it was about 40 years ago (see e.g. OECD (2004)). This raises the question through which channels integration among fairly similar countries as the (old) EU countries can affect inequality.

Secondly, not only has the importance of trade grown substantially in quantitative terms, but the qualitative changes may be potentially more important. Trade is changing from inter-industrial towards intra-industrial trade, i.e. trade within industries in final or intermediary products rather than trade between industries. This suggests that differences in aggregate factor endowments do not play a dominant role for the integration process experienced in e.g. European countries. Rather we observe growth in trade between relatively similar countries, which is driven by product differentiation, specialization, economies of scale, innovations etc. It has been documented that European countries tend to specialize production (Midelfart-Knarvik et al. (2000)), and recent empirical work also attributes a central role to specialization and comparative advantages as driving forces for the growth in trade (see e.g. Davis and Weinstein (2002) and Yi (2003)).

Thirdly, the labour market consequences do not primarily derive from increased mobility of labour. Although labour mobility is part of e.g. the European integration process, there has so far been no significant changes in mobility patterns (OECD (1999)). Potential labour market consequences therefore have to arise via the interaction between labour and product markets. Product markets are significantly affected by integration, and these changes may have important labour market implications since product market conditions are important both for employment creation and the rents to be bargained over in wage negotiations (see e.g. Dowrick (1981)). To capture this situation it is necessary to account for imperfect competition in both product and labour markets to address how product market integration affects employment creation and wage formation and therefore in turn wage dispersion. This also matches the perception that European labour markets are best characterized as markets with various forms of imperfections, including imperfect competition (see e.g. OECD (2002)). International integration may have distributional consequences since it creates both opportunities and threats, and it is unlikely that these are

with intra-industrial trade as well as widening relative wages. Moreover, this line of reasoning shows that it can be very difficult to separate trade from technological changes.

equally shared across all groups in the labour market.

One central mechanism through which product market integration affects labour markets is via a simultaneous creation of export possibilities by supplying to foreign markets and import threats arising from foreign firms penetrating domestic markets. The former tends to improve labour market possibilities, and the latter to deteriorate them. If market shares – in domestic or foreign markets – can be gained at the expense of foreign firms, it follows that production and thus employment prospects improve, and vice versa. Put simply one might conjecture that export possibilities in general improve wage and employment prospects, while the import threat does the opposite. Recent empirical work also supports these links. Bernard and Jensen (1999, 2001) and Bernard et al. (2003) find that exporting firms tend to have higher productivity and pay higher wages, with the causality running from productivity to exports. Interestingly, they also find that export tends to drive out less productive firms and induce a reallocation of production to more efficient firms. Schank, Scnabel and Wagner (2004) list 18 empirical studies using data from 20 countries supporting that exporting firms tend to pay higher wages. Empirical studies have also found that import penetration tends to lower wages (see e.g. Revenga (1992), Nicolletti et al. (2001), Jean and Nicoletti (2002) and Edin, Fredriksson and Lundborg (2004)). Moreover evidence shows that a huge part of changes in wage differences/dispersion are due to unobserved attributes of workers belonging to the same demographic or educational group (see e.g. Juhn, Murphy and Pierce (1993) or Prasad (2002)). Accordingly it seems to be as important to consider with-in group inequality as to consider the increasing skill-premia in order to understand aggregate inequality. Several empirical analysis (see e.g. Blanchflower et.al. (1996), Nickell (1999)) highlights the importance of rent-sharing and thereby firm specific factors in wage formation. Since the wage formation process is also observed to become more decentralized in many countries (see e.g. Boeri et al. (2001)), it may be conjectured that these effects will work even more strongly in the future. Therefore this paper considers these issues by focussing on how changes in export opportunities and import threats affect wage formation in sectors potentially affected by product market integration, but also in "home" sectors which are not directly affected. Moreover in modelling imperfectly competitive markets we allow for both centralized and decentralized elements in wage formation as observed in many European countries.

The aim of this paper is thus to address how product market integration affects labour markets and the distribution of gains and losses across different groups or types of labour in a setting capturing the stylized facts outlined above. To this end we use a Ricardian trade model[3], which can account for intra-

[3]Labour market consequences in a setting of intra-industrial trade have been fairly extensively addressed within the framework of the reciprocal dumping model (see Brander (1981)) in which firms enter foreign markets (Cournot competition) to obtain a share of the product market rents. Lower trade frictions facilitate such reciprocal dumping, which affects both the position and the slope of the labour demand, both of which are crucial for wage formation (see e.g. Andersen and Sørensen (2000)). While providing important insights on how product market integration may affect incentives in wage formation, the models crucially rely on

industrial trade and specialization alongside a process of further product market integration. We present a general equilibrium model, which allows for imperfect competition in both product (Bertrand competition) and labour markets, and consider how product market integration lowering various trade frictions affects wages, employment and the distribution of wage income. This paper is a general equilibrium extension of Andersen and Sørensen (2003), which allows us to analyze distributional and other aggregate consequences of international product market integration. The overall structure of the model is also closely related to Bernard et al. (2003).

The main finding of this paper is that international integration does not unambiguously lead to more wage dispersion or inequality despite the presence of some of the factors outlined above. In fact the relation tends to be U-shaped with the interesting property that if countries are not too similar in terms of productivity the "right leg" of the U dominates (integration tending to increase inequality), and oppositely the "left leg" dominates if countries are fairly similar in terms of productivity. The intuition behind the possible U-shaped path is twofold. First rents in the product market and accordingly high wages shift from being created mainly by protections caused by trade barriers towards being created by comparative advantages. Second, the wage in sectors completely shielded from international integration increases (a positive spill-over effect due to higher activity) and in some cases even by more than in sectors exposed to international competition. This finding has important implications not only for the "globalization" debate, but also for the interpretation of empirical findings[4].

The rest of the paper is organized as follows: Section 2 develops the general equilibrium model and details the interaction between price and wage formation and product market integration. Section 3 presents the main results on the effects of product market integration on aggregate wages and employment as well as dispersion of wages. Section 4 concludes and briefly discusses possible extensions.

2 The Model

Consider an economy in which a part is not directly affected by product market integration (the traditional or home part) and a part which is affected by product market integration (the modern or globalized part). The product market

Cournot competition, and the empirical relevance of two-way trade in identical commodities is an open question (see Krugman (1995)). The assumption of Cournot competition has also been questioned since Bertrand competition seems more relevant in the context of international trade. Ben-Zvi and Helpman (1992) show that the model cannot generate two-way trade under Bertrand competition, whereas Gürtzen (2002) presents a version with Bertrand competition when domestic and foreign commodities are not perfect substitutes. Moreover, this framework does not readily allow for an analysis of the distributional consequences of product market integration.

[4] Hence, if countries are close to the bottom of the U, it may be difficult to identify an effect of integration on inequality by assuming a linear relation between the two, because the relation is non-linear.

effects arise via the implications potential market penetration has for competition and specialization in production. The traditional sector has decreasing returns and the modern/globalized sector constant returns to scale in production[5] and therefore integration affects two dimensions of reallocation, namely, between the two parts of the economy and between firms in the globalized segment. This clearly affects labour markets and thus wage setting.

Consider for simplicity a two-country setting (foreign variables are denoted by $*$) where there in the globalized segment of the economy is a continuum of sectors and goods. Each good is consumed and can in principle be produced in either country (production does not rely on specific factor endowments). It is endogenous whether a given good turns out to be produced only at home (an exportable), only abroad (an importable) or in both countries (a non-tradeable)[6]. Trade involves various frictions in the form of explicit or implicit trade costs. Assume that the trade frictions can be captured by Samuelson's iceberg costs denoted $z \geq 0$ (See e.g. Dornbusch, Fischer and Samuelson (1977)). Hence in order to deliver one unit on the market abroad, one has to produce $1 + z$ (≥ 1) units. Trade frictions are assumed to be symmetric with respect to the direction of trade. To simplify the analysis it is assumed that trade frictions are constant across goods. Integration of product markets can now be analyzed by a reduction in z.

To simplify the analysis, the two countries are identical at the aggregate level, that is, they have the same aggregate income, price levels and demand functions. This assumption highlights the point that the results are not driven by aggregate differences in factor endowments. The countries are thus completely identical (symmetric structure) except that productivity in producing a given good may differ (comparative advantages), cf. below. Finally, note that the model is real disregarding the financial sector.

2.1 Households

The utility function of a representative household is given by

$$U = \frac{1}{\lambda^{\lambda}(1-\lambda)^{1-\lambda}} H^{1-\lambda} G^{\lambda} - \kappa L$$

where H is the consumption of home goods which are not under any circumstances traded, and G is a consumption bundle for global commodities referring to the fact that they in principle can be produced everywhere and that they are consumed by both domestic and foreign households. Labour is assumed to be indivisible, and working hours are exogenously given and the disutility of work (κ) is constant. We normalize both the number of work hours and households

[5] Increasing returns has played an important role in recent international trade models, and also in models of sectoral reallocation and growth, see e.g. Agell and Lommerud (1993). We maintain the implication of wider scope for expansion of activity in the globalized part but avoids a number of technical difficulties by assuming constant returns.

[6] Trade frictions preclude two-way trade in identical commodities.

to one. The consumer price index is given by

$$Q = P_G^{\lambda} P_H^{1-\lambda}$$

The consumption bundle of globalized goods is defined as

$$G = \left(\int_0^1 C_j^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}} \qquad , \epsilon > 1 \tag{1}$$

where C_j is consumption of goods from sector j. Accordingly, we have the following demand functions

$$C_j^d = \left(\frac{P_j}{P_G} \right)^{-\epsilon} \frac{\lambda I}{P_G} \qquad \forall\, j \in [0,1]$$

where I is aggregate nominal income, P_j is the price index for sector j, and P_G is the price index of globalized goods defined as

$$P_G = \left(\int_0^1 P_j^{1-\epsilon} dj \right)^{\frac{1}{1-\epsilon}}$$

For each sector j, there exists a continuum of goods $i \in [0,1]$ over which the agents have the following preferences[7]

$$C_j = \left(\int_0^1 C_{ji}^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}$$

and accordingly we have the following demand functions

$$C_{ji}^d = \left(\frac{P_{ji}}{P_j} \right)^{-\epsilon} \left(\frac{P_j}{P_G} \right)^{-\epsilon} \frac{\lambda I}{P_G} = \left(\frac{P_{ji}}{P_G} \right)^{-\epsilon} \frac{\lambda I}{P_G} \qquad \forall\, (i,j) \in [0,1] \,\mathrm{x}\, [0,1] \tag{2}$$

and the price indices for each sector and for the entire tradeable sector can be rewritten as

$$P_j = \left(\int_0^1 P_{ji}^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}} \qquad \forall\, j \in [0,1]$$

$$P_G = \left(\int_0^1 \left(\int_0^1 P_{ji}^{1-\epsilon} di \right) dj \right)^{\frac{1}{1-\epsilon}} \tag{3}$$

Note that the nesting of sectors and commodities allow us to have commodities in a given industry/sector to be either non-traded or traded (exported or imported), i.e. it allows for intra-industrial trade. To simplify, the goods are here presented as differentiated final consumption goods. Trade in intermediaries could be introduced by interpreting (1) as a production function for the consumption good, which depends on the input of various intermediaries with a production structure as assumed here, cf. e.g. Yi (2003). Since this would not add insights, but make the model presentation more complicated, we simplify by not modelling this structure explicitly. Since we will assume that all sectors are identical we will from now on drop the j subscript.

[7] The elasticity of substitution is set to be the same between sectors and between products within sectors to simplify calculations.

2.2 Firms in the H sector

The H sector produces a homogenous good specific to the home market in the sense that this commodity is not exposed to any potential foreign competition (foreign producers do not produce this commodity, and foreign consumers do not consume it). Firms in this sector are price takers and have a production function given as

$$Y_H = \beta L_H^{\delta} \qquad , \delta \in (0,1)$$

that is, there is decreasing return to scale wrt. the only input labour (L_H). Accordingly the profit function is

$$\Pi_H = P_H Y_H - W L_H$$

where W is the competitive market clearing wage for workers in the H sector. We can now easily derive the demand for labour and the supply of goods in the H sector

$$L_H^d = \left(\frac{P_H \beta \delta}{W}\right)^{\frac{1}{1-\delta}}$$

$$Y_H^s = \beta \left(\frac{P_H \beta \delta}{W}\right)^{\frac{\delta}{1-\delta}}$$

2.3 Firms in the G sector

Assume that for each good $i \in [0,1]$ there is one potential producer in each country. The production technique of the home firm potentially producing good i is given by a constant return to scale production function with labour as the only input

$$Y_i = A_i L_i \tag{4}$$

where L_i is the sector-specific input of labour, and A_i is the (exogenous) firm-specific efficiency/productivity parameter. Note that A_i can be interpreted as capturing different education, ability, or training levels of labour or as reflecting a different capital-labour ratio across firms/commodities/sectors. Differences in A across firms can be considered as reflecting differences related to technological advances, learning, economies of scale etc..

Foreign production technology is similarly given as

$$Y_i^* = A_i^* L_i^* \tag{5}$$

where foreign productivity A_i^* may differ from domestic productivity A_i in producing commodity i (see below).

Firms are in Bertrand competition (see below), and we denote the revenue and employment generated by a firm charging a price P_i by $R_i(P_i)$ and $L_i(P_i)$, respectively.

2.4 The labour market

Workers are all ex-ante alike, and for a real wage above the reservation wage (κ) the labour supply equals the number of households (normalized to unity), i.e. the clearing condition for the labour market reads

$$1 = L_H^d + L_G^d$$

where L_H^d is labour demand in the H sector and L_G^d is total labour demand from firms in the G sector. Workers are organized in unions, and the H sector is a (competitive) buffer sector in the sense that those who do not manage to find a job in one of the (higher paying) firms in the G sector take a job in the H sector (at a lower wage). One can think of the H sector as a service sector ("taxi drivers") or home production for which it is always possible to find a job. In this sense there is always full employment.

Wage setting in the G sector has both a centralized and decentralized element. This captures both actual wage setting institutions (cf Boeri, Brugviani and Calmfors(2001) and the fact that wage setting depends on both firm/sector specific conditions and the aggregate labour market stance. The centralized union in each sector[8] stipulates a wage B for which no G firm can offer a wage below. Workers choose a particular firm (branch) for which to search for work knowing that the alternative is to work in the H sector. The choice of firm can be interpreted as acquisition of firm specific skills or qualifications, and the choice is irreversible leaving work in the H sector as the default option if failing to become employed in the firm. Wages at the decentralized level are determined in negotiations between the firm and workers given the minimum wage stipulated at the centralized level.

Centralized wage setting

All workers in a given sector j are organized in a union assumed to be utilitarian. The union determines a minimum wage B so as to maximize the income generated above the reservation wage (since utility is linear in consumption) perceiving how the minimum wage affects subsequent decentralized wage setting, i.e. B is set so as to maximize

$$\int_0^1 L_i \left(W_i - W\right) di$$

subject to $B \geq W$, where W is the wage in the H sector. Note that W_i denotes the wage rate and L_i the employment level in firm i conditional on B. Since all sectors are identical, the minimum wage is the same across all sectors j in the G-segment of the economy.

[8] Defining centralized wage setting at the sector level rather at the economy wide level has the advantage of avoiding complications arising when union decisions affect aggregate conditions in the economy. Since there is a continuum of sectors j in the G-segment none of them perceive to have any effect on economy wide conditions.

Decentralized wage setting

The decentralized negotiation is modelled as a so-called efficient bargaining between the firm and the workers[9] (see also Blanchard and Giavazzi (2003) and Kramarz (2003)). Since firms are in Bertrand competition in product markets, the negotiation settles both the wage and the price, and utilizing the Nash bargaining model we find that the bargaining outcome is given as the solution to

$$\max_{W_i \geq B_i, P_i} \left[R_i(P_i) - W_i L_i(P_i) \right]^{1-\alpha} \left[L_i(P_i) \left(W_i - B \right) \right]^{\alpha} \tag{6}$$

where $\alpha \in [0,1]$ is the relative bargaining power of the workers (see e.g. Moene and Wallerstein (1993)), the threat point of the firm is set to zero, and the revenue function $R_i(P_i) = P_i \frac{L_i(P_i)}{A_i}$ is implicitly assumed to be differentiable[10]. The first order conditions to this problem read

$$(1-\alpha) \frac{-L_i}{R_i - W_i L_i} + \alpha \frac{L_i}{L_i \left(W_i - B \right)} = 0 \tag{7}$$

$$(1-\alpha) \frac{\frac{\partial R}{\partial P_i} - W_i \frac{\partial L_i}{\partial P_i}}{R_i - W_i L_i} + \alpha \frac{\left(W_i - B \right) \frac{\partial L_i}{\partial P_i}}{L_i \left(W_i - B \right)} = 0 \tag{8}$$

Therefore the nominal wage can be written as

$$W_i = \alpha \frac{R_i}{L_i} + (1-\alpha) B \tag{9}$$

which implies revenue sharing in the sense that the wage is determined as a weighted average of revenue per worker (weighted by the bargaining power of unions) and the minimum wage (weighted by the bargaining power of employers)[11]. It follows that the market position of firms, including its trade position, may affect wage formation. Finally, note for later reference that the relevant labour cost in deciding on prices and thus production is the minimum wage B determined by the labour union (see also Blanchard and Giavazzi (2003)). This follows since (7) and (8) imply that prices are set so that the marginal revenue equals marginal costs evaluated at the minimum wage of the workers B, i.e.

$$\frac{\partial R_i}{\partial P_i} - B \frac{\partial L_i}{\partial P_i} = 0$$

[9] In an earlier version of this paper we show that the same outcome would arise in a right to manage model with the following sequencing of decisions: firms hire labour and determine prices, and subsequently wages are negotiated in a decentralized Nash bargaining between the firm and the workers.

[10] Strictly, this assumption is not fulfilled, but we choose for expositional purposes this short-cut. However, using the wage relation to restate the profit expression, one finds that the relevant cost of labour is the minimum union wage, as implied by the procedure adopted here.

[11] Empirical evidence supports that wage setting reflects rent sharing see e.g. Blanchflower, Oswald and Sanfey (1996).

The intuition is that since workers and the firm are sharing the rents via the wage agreement, the minimum wage of the workers is the relevant marginal cost. To put it differently, wages only play a role in sharing the rents between workers and the firm, but do not affect the price and thus production decision.

Finally, note that wage differences across firms are consistent with ex ante perfect mobility of identical workers across firms[12]. The reason is that there is a risk of not finding a job and higher paying firms will tend to attract a larger labour pool (potentially interested workers) and the employment probability is correspondingly smaller. That is the expected utility of applying for a job must be the same for all jobs, and hence jobs with higher wages are harder to get (higher non-employment risk)[13]. Note it is important that there is no ex post mobility of labour between firms in the G sector (no ex-post undercutting), i.e. worker can only qualify for jobs at one firm at a time[14] and therefore the alternative employment possibility is in the H sector.

2.5 Directions of trade

Under the assumption of Bertrand competition it is fairly easy to determine the direction of trade, i.e. which commodities are produced in the home country and in the foreign country. To this end start by using the wage relation (9), to write profits as

$$\Pi_i = R_i - W_i L_i = (R_i - BL_i)(1-\alpha)$$

Note that maximizing profits is equivalent to maximizing the surplus of production and hence the relevant marginal cost of production is

$$MC_i = \frac{B}{A_i} \equiv \underline{P}_i$$

Since prices are determined in Bertrand competition, the firm with the lowest costs corrected for trade frictions supplies the market. To clarify the optimal pricing policy of the firm, it is useful first to consider two limiting cases, namely, marginal cost pricing and monopoly pricing. Pricing at marginal costs is equivalent to charging the minimal price at which production is profitable. Due to the

[12] Firms in the G sector always pays higher wages than offered in the H sector due to the reservation wage set at the centralized level. Hence, all workers have an interest in searching for jobs in the G sector even though there is a risk of not finding a job.

[13] That is we must have

$$V_i = \frac{L_i}{\bar{L}_i} W_i + \left(1 - \frac{L_i}{\bar{L}_i}\right) W = V \text{ for all } i$$

where V_i is the value of applying for a given job, $\bar{L}_i$ the number of workers seeking jobs in firm i, and $\frac{L_i}{L}$ is the probability of getting the job. Hence

$$\frac{L_i}{\bar{L}_i} = \frac{V - W}{W_i - W}$$

implying that the employment probability is smaller in firms offering a high wage.

[14] This is a straightforward implication of interpreting the choice of firm as an acquisition of firm specific skills. Alternatively, it can be interpreted in the sense that job searches are costly.

trade frictions, the marginal costs of supplying to the home market are smaller than the marginal costs of supplying to the foreign market ($z > 0$), and this gives a basic reason for price differentiation between the two markets. Hence, marginal cost pricing gives the minimum price at which domestic firm i can supply to the two markets as

$$\begin{aligned} &\underline{P}_i \text{ in the home market} \\ &\underline{P}_i\,(1+z) \text{ in the foreign market} \end{aligned} \tag{10}$$

Consider next the monopoly prices giving the maximal price the firm would ever charge, which is

$$\begin{aligned} &m\underline{P}_i \text{ in the home market} \\ &m\underline{P}_i\,(1+z) \text{ in the foreign market} \end{aligned} \tag{11}$$

where m is the monopoly mark-up ratio defined as $m \equiv \frac{\epsilon}{\epsilon-1} > 1$. Again the presence of the trade friction implies price differentiation between the home and foreign markets. With the help of these two reference prices, we are able to derive the optimal pricing strategies.

In a Bertrand game it is well known that the firm offering the commodity at the lowest price captures the entire market (in the absence of capacity constraints). Hence, it is crucial at what terms market entry is possible across markets. The decisive factors in the present setting are the trade frictions and the marginal costs at which the commodities can be produced in the two countries. Obviously, marginal cost pricing cf (10) gives the lowest prices at which firms can offer their commodities to the markets, and therefore determines how aggressively firms can underbid their competitors. It is therefore straightforward to work out when market penetration is possible. The domestic firm can penetrate into the foreign market (the export option) if the marginal costs at which the foreign market can be served are lower than the marginal costs of foreign firms, i.e.[15]

$$\underline{P}_i(1+z) < \underline{P}_i^*$$

or

$$1 + z < a_i \tag{12}$$

where $a_i \equiv \frac{A_i}{A_i^*}$ defines the relative productivity/efficiency between domestic and foreign firms (comparative advantage).

Foreign firms can penetrate into the home market (the import threat) if

$$\underline{P}_i > \underline{P}_i^*(1+z)$$

or

$$a_i < (1+z)^{-1} \tag{13}$$

[15] For simplicity it is assumed that if the marginal cost of supplying a market is identical for the firms, then only the domestic firm supplies the market.

Finally, the commodity is a non-tradeable in the sense that the domestic firm serves the domestic market, and the foreign firm the foreign market if

$$\underline{P}_i^*(1+z)^{-1} \leq \underline{P}_i \leq \underline{P}_i^*(1+z)$$

or

$$(1+z)^{-1} \leq a_i \leq 1+z \tag{14}$$

Hence (12), (13) and (14) imply that if the domestic firm has a high relative efficiency (a_i) relative to the trade friction (z) it supplies both markets (the case of exportables), if it has an "intermediary" relative efficiency it supplies the home market only (the case of non-tradeables) and if the relative efficiency is low the firm does not produce at all, and the product is imported (the case of importables).

Lower trade frictions imply both an export possibility and an import threat. The export possibility arises for firms with relatively high productivity who become exporters, i.e. it becomes profitable to penetrate into the foreign market. The import threat arises for less efficient non-tradeable firms being driven out of the market by foreign firms. Lower trade frictions thus imply that the more productive firms expands while less productive firms are driven out of business. It is an implication that the average productivity across operating firms increases when trade frictions fall. These implications of the model fit empirical evidence quite well (see e.g. Bernard, Jensen and Schott (2003)).

Table 1: Relative productivity, trade frictions and trade position

Trade position	a_i
Import	$a_i < (1+z)^{-1}$
Non-traded	$a_i \in \left[(1+z)^{-1}, 1+z\right]$
Export	$a_i > 1+z$

Table 1 summarizes the conditions determining whether commodities would be traded (tradeables vs. non-tradeables), and the direction of trade (exportables vs. importables), but they do not determine the optimal price to charge. Pricing decisions are influenced by both the presence of trade frictions and the differences in productivity (comparative advantage). We turn in the next section to the optimal prices to charge for the firm.

2.6 Prices

Prices are determined in Bertrand competition between the home and foreign firm producing a given good. As in the standard Bertrand game with constant returns to scale and perfect substitutes, the firm with the lowest marginal cost captures the market and sets a price equal to the minimum of the monopoly price and the cost of the other firm. The consumers in the home country therefore face the following prices for the goods in the consumption bundle (for proof see appendix A)

$$P_i = \begin{cases} m\frac{B(1+z)}{A_i^*} & \text{if} \quad a_i < (1+z)^{-1} m^{-1} \\ \frac{B}{A_i} & \text{if} \quad a_i \in \left[(1+z)^{-1} m^{-1}, (1+z)^{-1}\right) \\ \frac{(1+z)B}{A_i^*} & \text{if} \quad a_i \in \left[(1+z)^{-1}, m(1+z)^{-1}\right) \\ m\frac{B}{A_i} & \text{if} \quad a_i > m(1+z)^{-1} \end{cases} \tag{15}$$

Change in trade frictions will thus both affect prices directly and indirectly (for given minimum wages). The indirect effects arise because the trade position of commodities may change (non-tradeables affected by the possibility of import or export).

2.7 Wages

The wage schedule linking the wage to (relative) productivity and the trade position of the firm now follows straightforward from (9) and (15) and it can be written as[16] [17](for proof see Appendix A)

$$W_i = \begin{cases} (\alpha(1+z)a_i + 1 - \alpha)B & \text{if} \quad \frac{1}{1+z} \leq a_i \leq 1+z \\ \left(\alpha a_i \frac{(1+z)^{1-\epsilon}+1}{(1+z)^{-\epsilon}+(1+z)} + 1 - \alpha\right)B & \text{if} \quad 1+z < a_i \leq \frac{m}{1+z} \\ \left(\alpha a_i \frac{a_i^{\epsilon-1}m^{1-\epsilon}+1}{m^{-\epsilon}a_i^{\epsilon}+(1+z)} + 1 - \alpha\right)B & \text{if} \quad \frac{m}{1+z} < a_i \leq m(1+z) \\ (\alpha m + 1 - \alpha)B & \text{if} \quad a_i > m(1+z) \end{cases} \tag{16}$$

Figure 1 displays the wage relation (for further interpretation see Andersen and Sørensen (2004)) drawn for a given trade friction. To interpret this consider the relation between wages and (relative) productivity for a given level of trade friction given by the bold line. It has two segments, the first for non-tradeable firms supplying only to the domestic market and the second for exporting firms. In both segments the relation is upward sloping for the basic reason that higher productivity increases profits and therefore via the sharing rule (9) also wages. The wage curve has a discrete downward jump for a productivity level where the firms shifts from being a non-tradeable to being an exporting firm[18]. The reason being that prices and thus revenue per worker are lower when exporting and therefore wages become lower. Hence, incumbent workers may be worse off when a firm shifts from being a non-tradeable to an exportable, but since employment increases it is to the benefit of the union[19].

[16] Note that it is implicitly assumed that $z \leq \sqrt{m} - 1 \equiv \tilde{z}$ that is that firms are able to export before they become able to charge the monopoly price in the home market. Hence, trade frictions are assumed to be small relative to the monopoly markup.

[17] A similar wage schedule can be obtained assuming a right-to-manage structure with firm-specific unions and perfect competition on product markets. In this setting the unions are in Bertrand competition. See appendix B.

[18] Although the wage drop might seem controversial and appear to rely on specific assumptions one would obtain a similar wage drop in a right-to-manage model with perfect competition on the good markets. Furthermore such a wage drop is also found in reciprocal dumping models, cf. eg. Naylor (2000).

[19] Profits always increase when export is possible. However, it may be to the advantage of the incumbent work force not to enter the export market. In the present framework it

Consider next the effects of a fall in trade frictions shifting the wage relation to the thin line in figure 1. For those employed in a non-tradeable firm there is a wage drop reflecting that "protection" rents accruing from being shielded from international competition falls. The reason is that firms lower prices to prevent market entry of foreign firms and therefore the wage falls. For export firms the wage reaction is upward since these firms are already in the international product market and they benefit from lower trade frictions and this results in an increase in the wage rate. This may be termed an increased integration rent. In addition there is the effect that some non-tradeable firms are squeezed out of business because foreign firms penetrate into the domestic market, and the wage drops in firms entering the export market.

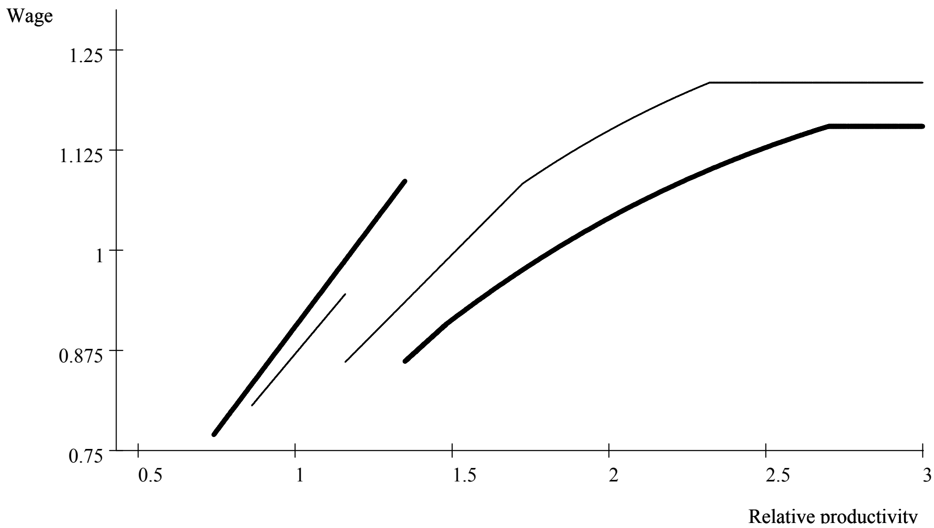


Figure 1: Wage schedule. The thick graph is the one with high trade frictions.

Turning to the general equilibrium effects it follows (see below) that the minimum wage increases when trade frictions are lowered. The reason is that the G sector expands and this increases employment in the sector which in turn leads to an increase in both the minimum wage and the wage in the H sector. This effect tends to moderate the wage decrease for some and reinforce the wage increase for others, making it possible that aggregate wages increase while wage dispersion may increase or decrease, cf below[20].

is assumed that the incumbent work force (insiders) cannot prevent entry of more workers (outsiders) and therefore the firm from entering the export market. Consequently the wage falls (all get the same wage in a given firm). However, the union gains due to a huge increase in employment.

[20] This effect may be so strong that the absolute wage increases although there is a decrease in the relative wage.

3 General Equilibrium Effects

The main interest here is to address how aggregate variables like employment and real wages as well as wage dispersion or inequality are affected by product market integration. Due to the complications involved in the general equilibrium effects few analytical results can be attained, and we therefore present some results based on a simulation of the model[21].

Parameter choices

To this end a number of parameters have to be fixed. The elasticity of substitution between goods is usually set in the range from 2 to 3 (Yi (2003)), and $\epsilon = 2.5$ is therefore chosen[22]. The bargaining power of the firms is assumed to equal that of the workers that is $\alpha = \frac{1}{2}$. It is assumed that the reservation wage (κ) is non-binding. For the H-sector we assume that $\beta = 1$ and $\delta = 0.75$ and that λ (the income share spent on tradeables) is 0.6. For the G-sector productivity we assume symmetry at the aggregate level, implying that $a_i = 1$ for $i = \frac{1}{2}$. Firms are ordered such that a_i is increasing in i, i.e. the higher i the larger the comparative advantage of domestic relative to foreign firms. Domestic firms thus have a comparative advantage in producing all goods $i > \frac{1}{2}$ ($a_i > 1$ for $i > \frac{1}{2}$), and foreign firms have a comparative advantage in producing all goods $i < \frac{1}{2}$ ($a_i < 1$ for $i < \frac{1}{2}$). A key parameter for this exercise is the distribution of productivity and thus comparative advantages. This raises a complicated issue since we need the distribution of productivity of potential production activities, and not the distribution across actual production (which we know theoretically is biased due to endogenous determination of production and trade positions). Specifically, the distribution of productivity is assumed to be lognormal, i.e.

$$\begin{pmatrix} \log A_i \\ \log A_i^* \end{pmatrix} \sim N\left[\begin{pmatrix} \mu \\ \mu \end{pmatrix}, \begin{pmatrix} \sigma^2 & \sigma_{12} \\ \sigma_{12} & \sigma^2 \end{pmatrix}\right]$$

and accordingly relative productivity is also log normally distributed

$$\log a_i \sim N\left[0, 2(1-\rho)\sigma^2\right]$$

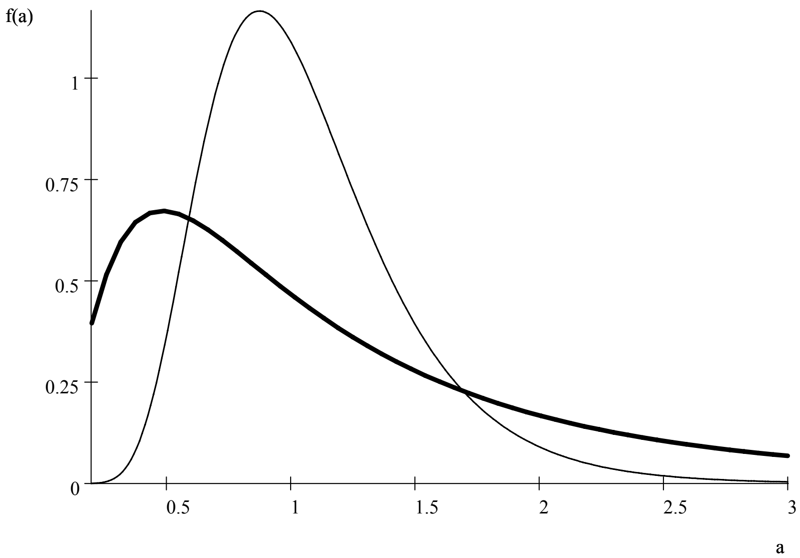
where $\rho = \sigma_{12}/\sigma^2$. Throughout we keep the mean and standard deviation of the productivity fixed such that $E(A_i) = 1$ and $\sigma_{A_i} = 0.75$. Hence, different values of the dispersion of the relative productivity are obtained by changing the correlation (ρ) between productivity in the two countries. To have a lower dispersion of relative productivity we need a high correlation in productivity across countries, and vice versa. For integration across fairly similar countries one would expect the correlation to be high, whereas integration across less similar countries would imply smaller correlation. We consider the two cases in

[21] See appendix C for an outline of the procedure.

[22] In Yi (2003) the elasticity of substitution is between inputs in a production function. However, in this model we could construct a competetive sector with firms producing good G with the production function $G = \left(\int_0^1 c_i^{\frac{\epsilon-1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}$ which corresponds to the consumption index. Trade would then be in intermediates and not in consumption goods.

turn. Specifically the high correlation case has $\rho = 0.85$, and the low correlation case has $\rho = 0.5$. Figure 2 shows the density function for relative productivity in the two cases. The high correlation case (thin line) has relative productivity (comparative advantage) much more concentrated than the low correlation case (bold line). We allow the trade friction to fall from 0.5 to 0 to model the process of full international integration of the G sector.

Figure 2: Density function for relative productivity - high and low correlation



In the following we report the following variables. Average real wages

$$\frac{\bar{W}}{Q} \equiv \int_0^1 \frac{W_i}{Q} L_i di + \frac{W}{Q} L_H$$

aggregate real income

$$\frac{I}{Q} = \int_0^1 \left(\frac{W_i}{Q} L_i + \frac{\Pi_i}{Q} \right) di + \frac{P_H}{Q} Y_H$$

and as the measure of inequality we use the standard deviation of real wages, i.e.

$$\sigma_W = \sqrt{\int_0^1 L_i \left(\frac{W_i - \bar{W}}{Q} \right)^2 di + L_H \left(\frac{W - \bar{W}}{Q} \right)^2}$$

Note that in the present setting there is no distinction between the wage rate and wage income, and the two terms are therefore used interchangeably.

We interpret international integration to lower the trade frictions (z). However, since the trade share is monotonously decreasing in the trade friction, we plot the variables of interest as a function of openness defined in the usual way as the trade share. Note that the model has no public sector, and hence the trade measure is for the private sector. We report results for a variation in the trade share or openness[23] from 16% to 60 % in the high correlation case and from 30% to 60% in the low correlation case. Note that an aggregate openness of 60% corresponds to full integration of the G sector ($z = 0$).

Low dispersion of relative productivity

Consider first the case of a relatively high positive correlation (= 0.85) in productivity across the two countries and accordingly a relatively low dispersion of the relative efficiency (comparative advantages). The economies are thus fairly similar which implies that the gains from specialization accruing from further integration may be relatively small. However, integration also affects competition via easier market access and therefore this case can be interpreted as primarily showing the "competition" effect although integration still entails specialization.

In Figure 3 we plot the following key variables: GDP, total employment in G firms, aggregate wages, the minimum wage, the wage in the H sector, the union wage premium (average wages in the G sector relative to the wage in the H sector) as well as some dispersion measures as a function of openness. More openness is driven by lower trade frictions, and therefore the charts show the effects of further product market integration. It is seen that increased openness leads to aggregate gains in terms of increasing GDP. The relative importance of the G firm grows, i.e. a larger fraction of workers are employed in a G firm which also indicates the sectorial reallocation following tighter product market integration. The minimum wage is increasing as is the wage in the H sector. This shows that even though workers in the H sector are not directly affected by international integration they may gain, since the increase in employment in the G sector increases labour demand. The increase in aggregate wages follows straightforward, and it is also an immediate implication that average utility increases in the economy.

Turning to the distributional consequences, figure 3 also shows overall wage dispersion and wage dispersion across G firms as a function of openness. It is seen that overall dispersion is decreasing in openness up to a point from which there is a slight increase in wage dispersion, i.e. it has a U-shape with a strong "left leg". The reason for this is a combination of several factors. First, the increase in wage in the H sector tends to lower overall wage dispersion, since the gap between this wage and average wage in the G-firms is falling in openness. Second across G firms wage dispersion is U-shaped in openness, first falling and then increasing. The fall is generated by the fall in the "protection-rent" in non-tradeable firms and the increase by the "integration" effect in exportable firms outlined in section 2.7. That is, at first an increase in openness reduces pay differences generated by rents which can be appropriated when protected from international competition, and subsequent wage dispersion tends to increase

[23] The trade share or openness is a monotonous function of z. However, the level of openness associated with a given level of z depends on the distribution for relative productivity.

since wages comes to follow (relative) productivity more closely. However, since there in this case is low dispersion in relative productivity, the specialization effect does not carry much weight and therefore the U-shape almost disappear at the aggregate level. Considering the coefficient of variation relating wage dispersion to mean wages we find that this is at first clearly decreasing in openness, and then for higher levels of openness almost unaffected. This highlights that the changes in average wage is quantitatively stronger than the changes in dispersion. Whether this is the politically relevant yardstick is another question.

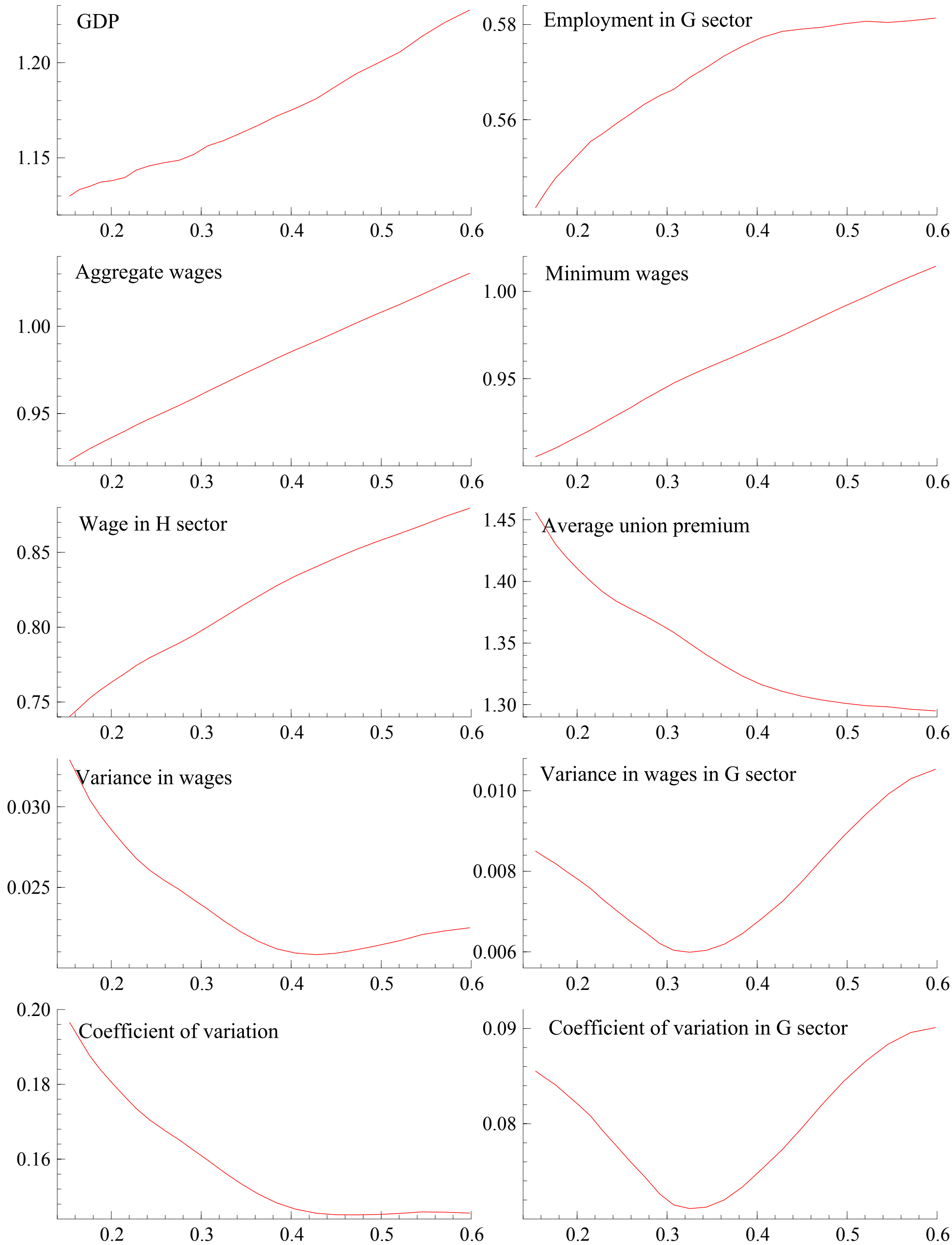


Figure 3: Key variables as a function of openness - high correlation

High dispersion of relative productivity

Considering the case with a moderate positive correlation (= 0.5) in productivity across the two countries implying that there is more dispersion in relative productivity (comparative advantages). Accordingly the specialization effect may play a larger role here.

Figure 4 plots the same variables as figure 3 does for the low dispersion case. The aggregate trends are the same with increasing GDP, employment in G firms, minimum wages and average wages displaying the gains from international integration. Actually the gains are larger in this case since the gains from specialization which can reaped from further integration are larger when relative productivity is more dispersed across countries[24].

The main difference to the low dispersion case arises when considering wage dispersion. It is seen from figure 4 that wage dispersion at first falls slightly, and then increases - again a U-shape but in this case with a strong "right leg". The reason for this is found partly in the fact that wages in G-firms on average first grow less and then more than in the H firms and partly by an increase in wage dispersion across G firms arising because the increase in the "integration rent" plays a much larger role (due to high dispersion of relative productivity). With tighter integration wages follow (relative) productivity more closely, and since there is much more variation in relative productivity in this case it follows that wage dispersion grows. The coefficient of variation has a more U-shaped form at first falling in openness and then over an interval increasing.

[24] For the particular numerical illustration shown here the difference is small. The initial BNP level is 1.16 and the growth effect of going from $z = 0.5$ to zero is 9.08 % whereas in the low dispersion case the initial level is 1.13 and the growth rate is 8.64 %.

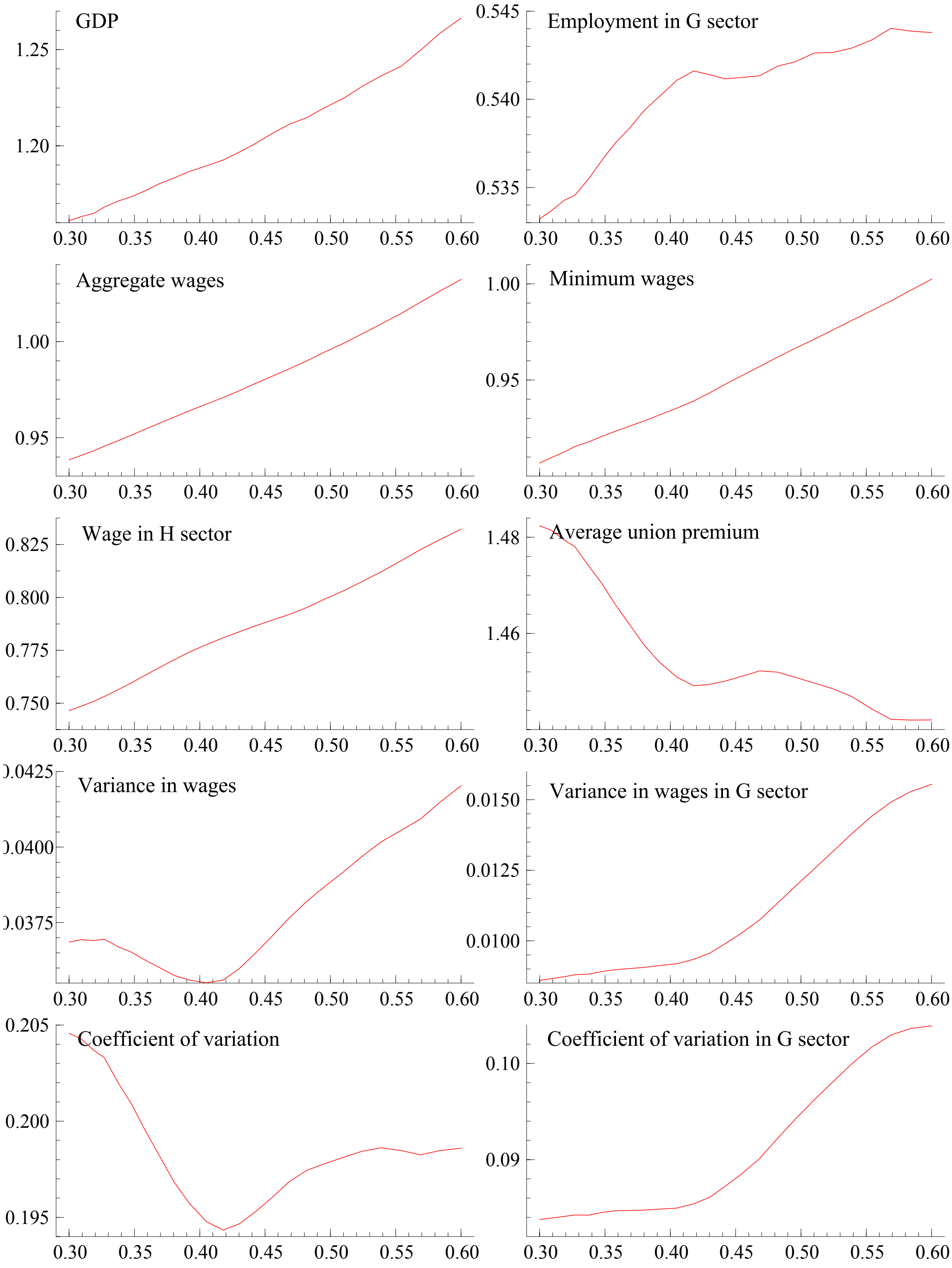


Figure 4: Key variables as a function of openness - low correlation

4 Conclusion and extensions

This paper has taken a first step in considering how inequality is affected by international integration between countries with fairly similar factor endowments. Trade is driven by comparative advantages and the size of trade frictions and product and labour markets are imperfectly competitive. Labour market consequences of product market integration (lower trade frictions) arise via improved possibilities for market penetration which in turn affects the possibilities for rent extraction by both firms and unions.

It is shown that the relation between product market integration and inequality is complex. The reason is the effects on the relative wage between sectors not affected by integration - the H (home) sector - and the sector affected via market penetration and exploitation of comparative advantages - the G (globalized) sector. Interestingly the workers in the shielded H sector unambiguously experience an increase in the real wage, that is, although not directly affect the spill over from higher activity in the G sector leads to wage increases also for the H sector. Within the G sector the relation between wage dispersion may be either U-shaped or increasing in openness. The reason for this ambiguity is that two major effects are at stake. First, workers in non-tradeables firms face lower "protection rents" as market integrate and the threat of market penetration of foreign firms becomes stronger. Second, workers in export firm gain a larger "integration rent" alongside market integration lowering frictions in trade. The sum of these counter-acting effects is that aggregate wage dispersion tends to be U-shaped.

This non-linear relation shows that it is not possible to make unambiguous statements concerning how openness affects inequality. However, it implies that when international integration or openness reaches a sufficiently high level, higher wage inequality is inevitable, irrespective of whether countries are very similar or not. The finding of a non-linear relation is also interesting from an empirical perspective. Both since there is evidence for some countries that inequality follows a U-path, and it points to the danger of using a "linear" approach when trying to explain the development in inequality.

The present analysis has only focussed on the effects on integration on the dispersion or inequality in market incomes. It disregards the public sector and therefore its possible influences on labour market prospects (via the hiring of labour - which could benefit those who loose jobs due to foreign penetration into domestic markets) and various redistributional measures. An interesting topic for future research would be to integrate these aspects both to analyze the implications for the relationship between openness and inequality, but also to address the fundamental question of whether the need for welfare state arrangements become stronger with further integration and in what way the scope for such policies are affected.

While illustrative, the present model rests on a number of simplifying assumptions, which it would be necessary to generalize before proceeding to a genuine calibration. In particular it would be interesting to introduce a richer labour market formulation allowing different types of labour as well as an endogenous determination of training (education). This would allow us to analyze what happens to inequality both between different and identical types of labour, and the short- and long run consequences of international integration for inequality.

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Appendix A

Determining prices

From the standard Bertrand game with perfect substitutes and constant marginal costs, we know that the firm with the lowest marginal costs supplies the market. Since the reservation wage is identical in the two countries differences in marginal costs depend on trade frictions and differences in productivity. The marginal cost of the home firm in the home market is given by

$$MC_{\text{home market}} = \frac{B}{A_{ij}}$$

and for the foreign firm in the home market

$$MC^{*}_{\text{home market}} = \frac{B}{A^{*}_{ij}}(1+z)$$

and accordingly the home firm supplies the home market if

$$MC_{\text{home market}} \leq MC^{*}_{\text{home market}} \Leftrightarrow a_{ij} \geq (1+z)^{-1}$$

and the foreign firm supplies the home market if

$$a_{ij} < (1+z)^{-1}$$

where

$$a_{ij} = \frac{A_{ij}}{A^{*}_{ij}}$$

denotes relative productivity (comparative advantage). From the standard Bertrand game we also know that the firm supplying the market sets the price equal to the smallest of the marginal costs of the other firm and the monopoly price. The monopoly prices for the home firm and foreign firm are given by (note that the consumer price index is normalized to one)

$$\begin{aligned}(P^{*}_{ij})^{\text{monopoly}}_{\text{home market}} &= \arg\max_{P_{ij}} \left(P_{ij} - \frac{B}{A_{ij}}\right) P_{ij}^{-\epsilon} \lambda I P_C^{\epsilon-1} \\ &= \frac{\epsilon}{\epsilon-1}\frac{B}{A_{ij}} = m\frac{B}{A_{ij}}\end{aligned}$$

$$\begin{aligned}(P^{*}_{i})^{\text{monopoly}}_{\text{home market}} &= \arg\max_{P_{ij}} \left(P_{ij} - \frac{B}{A_{ij}}(1+z)\right) P_{ij}^{-\epsilon} \lambda I P_C^{\epsilon-1} \\ &= \frac{\epsilon}{\epsilon-1}\frac{B}{A^{*}_{ij}}(1+z) = m\frac{B}{A^{*}_{ij}}\end{aligned}$$

Now consider the cases where the home firm supplies the home market, that is $a_{ij} \geq (1+z)^{-1}$ then the price is given by

$$P_{ij} = \min\left(\frac{B}{A^{*}_{ij}}(1+z), m\frac{B}{A_{ij}}\right) = \begin{cases} m\frac{B}{A_{ij}} & \text{if} \quad a_{ij} > \frac{m}{1+z} \\ \frac{B}{A^{*}_{ij}}(1+z) & \text{if} \quad a_{ij} < \frac{m}{1+z} \end{cases}$$

Consider now the cases in which the foreign firm supplies the home market, that is $a_{ij} < (1+z)^{-1}$ then the price is given by

$$P_{ij} = \min\left(\frac{B}{A_{ij}}, m\frac{B}{A^{*}_{ij}}(1+z)\right) = \begin{cases} m\frac{B}{A^{*}_{ij}}(1+z) & \text{if} \quad a_{ij} < \frac{1}{(1+z)m} \\ \frac{B}{A^{*}_{ij}}(1+z) & \text{if} \quad a_{ij} > \frac{1}{(1+z)m} \end{cases}$$

and hence we have

$$P_{ij} = \begin{cases} m\frac{B(1+z)}{A^*_{ij}} & \text{if} \quad a_{ij} < (1+z)^{-1} m^{-1} \\ \frac{B}{A_{ij}} & \text{if} \quad a_{ij} \in \left[(1+z)^{-1} m^{-1}, (1+z)^{-1}\right) \\ \frac{(1+z)B}{A^*_{ij}} & \text{if} \quad a_{ij} \in \left[(1+z)^{-1}, m(1+z)^{-1}\right) \\ m\frac{B}{A_{ij}} & \text{if} \quad a_{ij} > m(1+z)^{-1} \end{cases}$$

which is the prices in the paper. In exactly the same way we calculate the prices in the foreign market.

Real wages
Note from the wage equation we have

$$W_{ij} = \alpha\frac{R_{ij}}{L_{ij}} + (1-\alpha)B$$

and hence we need to calculate revenue and employment for each firm. Both can be calculated from the demand functions (note that all aggregate variables are identical in the two markets due to the aggregate symmetry assumption)

$$C^d_{ij} = \lambda I P_C^{\epsilon-1} P_{ij}^{-\epsilon}$$

$$\left(C^d_{ij}\right)^* = \lambda I P_C^{\epsilon-1}\left(P^*_{ij}\right)^{-\epsilon}$$

after correction for productivity and prices. Consider home firms and consider first a non-traded good, that is $a_{ij} \in \left[(1+z)^{-1}, 1+z\right]$ then

$$L_{ij} = \lambda I P_C^{\epsilon-1} P_{ij}^{-\epsilon}\frac{1}{A_{ij}}$$

$$R_{ij} = \lambda I P_C^{\epsilon-1} P_{ij}^{-\epsilon} P_{ij}$$

$$W_{ij} = \alpha\frac{P_{ij}^{-\epsilon}\lambda I P_C^{\epsilon-1} P_{ij}}{P_{ij}^{-\epsilon}\lambda I P_C^{\epsilon-1}\frac{1}{A_{ij}}} + (1-\alpha)B = \alpha A_{ij} P_{ij} + (1-\alpha)B$$

where P_i is determined in the paragraph above. Consider now a home firm exporting

$$L_{ij} = P_{ij}^{-\epsilon}\lambda I P_C^{\epsilon-1}\frac{1}{A_{ij}} + \left(P^*_{ij}\right)^{-\epsilon}\lambda I P_C^{\epsilon-1}\frac{1+z}{A_{ij}}$$

$$R_{ij} = \lambda I P_C^{\epsilon-1} P_{ij}^{-\epsilon} P_{ij} + \lambda I P_C^{\epsilon-1}\left(P^*_{ij}\right)^{-\epsilon} P^*_{ij}$$

$$W_{ij} = \alpha\frac{P_{ij}^{-\epsilon} P_{ij} + \left(P^*_{ij}\right)^{-\epsilon} P^*_{ij}}{P_{ij}^{-\epsilon}\frac{1}{A_{ij}} + \left(P^*_{ij}\right)^{-\epsilon}\frac{1+z}{A_{ij}}} + (1-\alpha)B$$

where $\left(P_{ij}, P_{ij}^*\right)$ is determined in the paragraph above. Inserting prices one obtains

$$W_{ij} = \begin{cases} \left(\alpha\left(1+z\right)a_{ij} + 1 - \alpha\right)B & \text{if} \quad \frac{1}{1+z} \leq a_{ij} \leq 1+z \\ \left(\alpha a_{ij}\frac{(1+z)^{1-\epsilon}+1}{(1+z)^{-\epsilon}+(1+z)} + 1 - \alpha\right)B & \text{if} \quad 1+z < a_{ij} \leq \frac{m}{1+z} \\ \left(\alpha a_{ij}\frac{a_{ij}^{\epsilon-1}m^{1-\epsilon}+1}{m^{-\epsilon}a_{ij}^{\epsilon}+(1+z)} + 1 - \alpha\right)B & \text{if} \quad \frac{m}{1+z} < a_{ij} \leq m(1+z) \\ \left(\alpha m + 1 - \alpha\right)B & \text{if} \quad a_{ij} > m(1+z) \end{cases}$$

if $z \leq \tilde{z} = \sqrt{m} - 1$ and

$$W_{ij} = \begin{cases} \left(\alpha\left(1+z\right)a_{ij} + 1 - \alpha\right)B & \text{if} \quad \frac{1}{1+z} \leq a_{ij} \leq \frac{m}{1+z} \\ \left(\alpha m + 1 - \alpha\right)B & \text{if} \quad \frac{m}{1+z} < a_{ij} \leq 1+z \\ \left(\alpha a_{ij}\frac{a_{ij}^{\epsilon-1}m^{1-\epsilon}+1}{m^{-\epsilon}a_{ij}^{\epsilon}+(1+z)} + 1 - \alpha\right)B & \text{if} \quad 1+z < a_{ij} \leq m(1+z) \\ \left(\alpha m + 1 - \alpha\right)B & \text{if} \quad a_{ij} > m(1+z) \end{cases}$$

if $z > \tilde{z}$ (this condition determines whether a firm becomes able to charge the monopoly price in the domestic market before it becomes able to export).

Appendix B

Right-to-manage structure with perfect competition on product markets

With at right-to-manage structure, unions set wages, and firms set employment and prices. Since a firm's marginal cost is determined by the wage, we now have a Bertrand game between unions. In order to simplify the analysis, to avoid a double Bertrand game, we assume that product markets are perfectly competitive. The object function of the (subsector specific) union is given by

$$\Psi_{ij} = L_{ij}\left(W_{ij} - B\right)$$

where L_{ij} is determined as in appendix A.

Marginal cost of a home firm given by

$$MC_{\text{home market}} = \frac{W_{ij}}{A_{ij}}$$

$$MC_{\text{foreign market}} = \frac{W_{ij}}{A_{ij}}\left(1+z\right)$$

and for the foreign firm we have

$$MC_{\text{home market}}^* = \frac{W_{ij}^*}{A_{ij}^*}\left(1+z\right)$$

$$MC^*_{\text{foreign market}} = \frac{W^*_{ij}}{A^*_{ij}}$$

and accordingly home firms export if

$$MC_{\text{foreign market}} < MC^*_{\text{foreign market}} \Leftrightarrow W_{ij} < W^*_{ij} a_{ij} (1+z)^{-1}$$

and foreign firms export if

$$MC_{\text{home market}} > MC^*_{\text{home market}} \Leftrightarrow W_{ij} > W^*_{ij} a_{ij} (1+z)$$

Hence when a union sets wages, it has to consider a trade-off between wages and employment. Note that employment effects arise from both access to markets and from the elasticity of substitution. The problem of the union is more difficult than that of the firm in the other model. The reason is that the union cannot diferentiate prices (except for trade costs) across markets. Accordingly to make the model very tractable we assume $\epsilon \to 1$ and we normalize the consumer price index to one (just as in the other model). Hence the union does not take the elasticity of substitution into account (the monopoly wage/price $\to \infty$), but only focus on access to markets.

Export decision

We must calculate the utility from the non-traded wage (NT) and the export wage (X). Given the wage of the foreign union the home union will always charge the highest possible wage consistent with either exporting or supplying the home market if the highest of these are above the reservation wage. As a union starts to export, it charges the maximum wage consistent with exporting.

$$W^{\text{Export}}_{ij} = W^*_{ij} a_{ij} (1+z)^{-1}$$

We can now calculate the utility from exporting and not exporting as

$$\Psi_{ij}(\text{Not trade}) = I \left(1 - \frac{B}{W^{\text{NT}}_{ij}}\right)$$

$$\begin{aligned} \Psi_{ij}(\text{Export}) &= \left[\frac{I}{W^{\text{Export}}_{ij}} + \frac{I}{W^{\text{Export}}_{ij}}\right]\left(W^{\text{Export}}_{ij} - B\right) \\ &= 2I\left(1 - \frac{B}{W^{\text{Export}}_{ij}}\right) = 2I\left(1 - \frac{B}{W^*_{ij} a_i (1+z)^{-1}}\right) \end{aligned}$$

and hence a union will export if

$$\begin{aligned} \Psi_{ij}(\text{Export}) &> \Psi_{ij}(\text{Not export}) \\ \Leftrightarrow\ W^*_{ij} &> a^{-1}_{ij} (1+z)^{-1} \frac{2B}{1 + \frac{B}{W^{\text{NT}}_{ij}}} \end{aligned}$$

and similarly the foreign union will export if

$$W_{ij} > a_{ij} (1+z)^{-1} \frac{2B}{1+\frac{B}{\left(W_{ij}^{*}\right)^{\mathrm{NT}}}}$$

In a non-tradeable equilibrium no one must have an incentive to deviate and since unions charge the highest possible wages (given market access) we must have

$$\begin{aligned} W_{ij}^{*} &= a_{ij}^{-1} (1+z)^{-1} \frac{2B}{1+\frac{B}{W_{ij}}} \\ W_{ij} &= a_{ij} (1+z)^{-1} \frac{2B}{1+\frac{B}{W_{ij}^{*}}} \end{aligned}$$

which can be rewritten as

$$\begin{aligned} W_{i} &= Ba_{i} \frac{4(1+z)^{2}-1}{a_{i}+2(1+z)} \\ W^{*} &= Ba_{i}^{-1} \frac{4(1+z)^{2}-1}{a_{i}^{-1}+2(1+z)} \end{aligned}$$

However we must have that $W_{ij} \geq B$ and $W_{ij}^{*} \geq B$ that is

$$a_{ij} \in \left(\frac{1+z}{2(1+z)^{2}-1}, \frac{2(1+z)^{2}-1}{1+z} \right)$$

If $a_{ij} < \frac{1+z}{2(1+z)^{2}-1}$ then foreign exports and

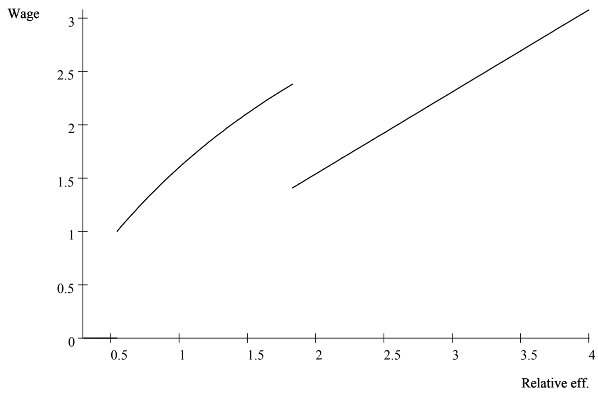
$$W_{ij}^{*} = Ba_{ij}^{-1} (1+z)^{-1}$$

and if $a_{ij} > \frac{2(1+z)^{2}-1}{1+z}$ home exports and

$$W_{ij} = Ba_{ij} (1+z)^{-1}$$

We now have the following wage schedule

$$W_{ij} = \begin{cases} \emptyset & \text{if} \quad a_{ij} < \frac{1+z}{2(1+z)^{2}-1} \\ a_{ij} \frac{4(1+z)^{2}-1}{a_{i}+2(1+z)} B & \text{if} \quad a_{ij} \in \left[\frac{1+z}{2(1+z)^{2}-1}, \frac{2(1+z)^{2}-1}{1+z} \right] \\ a_{ij} (1+z)^{-1} B & \text{if} \quad a_{ij} > \frac{2(1+z)^{2}-1}{1+z} \end{cases}$$



Appendix C

To solve the model it is smart to separate aggregate variables from firm/good specific variables in the G sector. Further we use the fact that at the aggregate level sectors and countries are identical in equilibrium and accordingly all aggregate variables are identical. Before solving the model define

$$b \equiv \frac{B}{Q}$$

as the real minimum wage set by unions. Consider first prices and note that we can write

$$p_{ij} = bQ\tilde{p}_{ij}$$

where $\tilde{p}_{ij} = f_0\left(A_{ij}, A_{ij}^*, \epsilon, z\right)$ and accordingly

$$P_G = bQ\left(\int_0^1 \int_0^1 \tilde{p}_{ij}^{1-\epsilon} dj di\right)^{\frac{1}{1-\epsilon}} = bQ\tilde{P}_G$$

and hence

$$Q = P_G^\lambda P_H^{1-\lambda} = \left(bQ\tilde{P}_G\right)^\lambda P_H^{1-\lambda} = \left(b\tilde{P}_G\right)^{\frac{\lambda}{1-\lambda}} P_H \tag{17}$$

where $\tilde{P}_G = f_1\left(\left\{A_{ij}, A_{ij}^*\right\}_{i,j\in[0,1]\times[0,1]}, \epsilon, z\right)$. Now we do the same for employment

$$\begin{aligned} L_{ij} &= \frac{\lambda I}{P_G}\left(\frac{p_{ij}}{P_G}\right)^{-\epsilon}\tilde{L}_{ij} = \frac{\lambda I}{P_G}\left(\frac{p_{ij}}{P_G}\right)^{-\epsilon}\tilde{L}_{ij} = \frac{\lambda I}{bQ\tilde{P}_G}\left(\frac{bQ\tilde{p}_{ij}}{bQ\tilde{P}_G}\right)^{-\epsilon}\tilde{L}_{ij} \\ &= \frac{\lambda I}{bQ\tilde{P}_G}\left(\frac{\tilde{p}_{ij}}{\tilde{P}_G}\right)^{-\epsilon}\tilde{L}_{ij} = \frac{\lambda I}{bQ}\tilde{P}_G^{\epsilon-1}\tilde{p}_{ij}^{-\epsilon}\tilde{L}_{ij} \end{aligned}$$

$$L_G = \int_0^1 \int_0^1 L_{ij} di dj = \frac{\lambda I}{bQ}\tilde{P}_G^{\epsilon-1}\int_0^1 \int_0^1 \tilde{p}_{ij}^{-\epsilon}\tilde{L}_{ij} di dj = \frac{\lambda I}{bQ}\tilde{L}_G$$

and note again that $\tilde{L}_G = f_2\left(\left\{A_{ij}, A_{ij}^*\right\}_{i,j\in[0,1]\times[0,1]}, \epsilon, z\right)$. Now we have separated firm/good specific variables from aggregate variables and are ready to proceed. Consider now the reaction function of the union

$$\begin{aligned} b_i &= \arg_{b_i} \max\left(\int_0^1 L_{ij}\left(\frac{W_{ij}}{Q} - \frac{W}{Q}\right)dj\right) = \arg_{b_i} \max\left(\int_0^1 \frac{\lambda I}{P_G}\left(\frac{p_{ij}}{P_G}\right)^{-\epsilon}\tilde{L}_{ij}\left(\frac{W_{ij}}{Q} - \frac{W}{Q}\right)dj\right) \\ &= \arg_{b_i} \max\left(\int_0^1 p_{ij}^{-\epsilon}\tilde{L}_{ij}\left(\frac{W_{ij}}{Q} - \frac{W}{Q}\right)dj\right) = b_i\left(b_i^*, \left\{A_{ij}, A_{ij}^*\right\}_{j\in[0,1]}, z, \epsilon, \alpha, \frac{W}{Q}\right) \end{aligned}$$

Note that b_i is only a function of $\frac{W}{Q}, b_i^*$ and underlying parameters. Accordingly the equilibrium union minimum wage can be written as

$$b = b\left(\frac{W}{Q}\right) \tag{18}$$

>From the H-sector we have

$$L_H = \left(\frac{\delta\beta P_H}{W}\right)^{\frac{1}{1-\delta}}$$

and

$$Y_H = \beta\left(\frac{\delta\beta P_H}{W}\right)^{\frac{\delta}{1-\delta}}$$

Now we are ready to consider the equilibrium conditions. First the labour market

$$L_H + L_G = 1 \Leftrightarrow \left(\frac{\delta\beta P_H}{W}\right)^{\frac{1}{1-\delta}} + \frac{\lambda I}{bQ}\tilde{L}_G = 1 \tag{19}$$

and from the good market in the H sector

$$Y_H = \frac{(1-\lambda)\,I}{P_H} \Leftrightarrow \beta\left(\frac{\delta\beta P_H}{W}\right)^{\frac{\delta}{1-\delta}} = \frac{(1-\lambda)\,I}{P_H} \tag{20}$$

Combine (19) and (20)

$$\left(\frac{\delta\beta P_H}{W}\right)^{\frac{1}{1-\delta}} + \frac{\lambda}{1-\lambda}\frac{P_H\beta\left(\frac{\delta\beta P_H}{W}\right)^{\frac{\delta}{1-\delta}}}{bQ}\tilde{L}_G = 1$$

and express in real terms

$$\left(\frac{\delta\beta\frac{P_H}{Q}}{\frac{W}{Q}}\right)^{\frac{1}{1-\delta}} + \frac{\lambda}{1-\lambda}\frac{\frac{P_H}{Q}\beta\left(\frac{\delta\beta\frac{P_H}{Q}}{\frac{W}{Q}}\right)^{\frac{\delta}{1-\delta}}}{b}\tilde{L}_G = 1$$

and insert (17) and (18) to get

$$\left(\frac{\delta\beta\left(b\left(\frac{W}{Q}\right)\tilde{P}_G\right)^{-\frac{\lambda}{1-\lambda}}}{\frac{W}{Q}}\right)^{\frac{1}{1-\delta}}+\frac{\lambda}{1-\lambda}\frac{\left(\left(b\left(\frac{W}{Q}\right)\tilde{P}_G\right)^{-\frac{\lambda}{1-\lambda}}\right)^{\frac{1}{1-\delta}}\beta\left(\frac{\delta\beta}{\frac{W}{Q}}\right)^{\frac{\delta}{1-\delta}}}{b\left(\frac{W}{Q}\right)}\tilde{L}_G=1$$

Now we just have to solve this single equation for $\frac{W}{Q}$. However we cannot solve the model analytically and therefore we must rely on simulations.