JEPS Junior Economists Peer-reviewed Series

Foreign Competition, Multinational Firms, and the Effects of One-Sided Wage Rigidity*

Sebastian Braun†

JEPS Working Paper No. 07-003
http://jeps.repec.org/papers/07-003.pdf
May 2007

Abstract

The paper studies the effects of a one-sided minimum wage in a two-country model of intra-industry trade, in which multinational firms arise endogenously. With positive levels of intra-industry trade the adverse employment and welfare effects of an asymmetric minimum wage are significantly larger than in a non-trading economy. Multinational firms generally mitigate the effect somewhat. Even though factor prices are not equalised across countries, a (binding) wage floor in one country will prop up wages in the other. The flexible wage country is insulated from shocks caused by factor accumulation in the rigid wage country, while an increase in the labour supply of the latter economy may have profound impacts on labour market outcomes in both countries.

Keywords: Intra-Industry trade, wage rigidity, multinational firms, unemployment.

JEL: F12, F16, F23.

*The author is grateful to Michael C. Burda, Albrecht Ritschl, Harald Uhlig, seminar participants at the Humboldt-University of Berlin and two anonymous referees of the Junior Economists Peer-reviewed Series (JEPS) for very helpful comments and suggestions. Katja Hanewald and Björn Ohl provided excellent research assistance. This research was supported by the Deutsche Forschungsgemeinschaft through the SFB 649 'Economic Risk' and by the German Federal Ministry of Education and Research (project 01AK702A). All remaining errors are mine.

†Humboldt University of Berlin, School of Business and Economics, Spandauer Straße 1, D-10099 Berlin, Germany. Email: sbraun@wiwi.hu-berlin.de.

1 Introduction

The closer economic integration of the world economy is viewed with fear and scepticism by many. In particular, the effects for employment and wages of workers in developed countries are controversially discussed in the public debate on the consequences of globalisation. International competitive pressures and footloose multinational enterprises (MNEs) are widely feared to bring down wages and endanger jobs in the western world.[1]

In this context, national regulations that add to the rigidity of the labour market have come under growing pressures. Increasing labour market flexibility has been one of the major goals of recent reforms in OECD countries. The political debates surrounding these reforms frequently discuss the necessity of a flexible labour market for coping successfully with the challenges of globalisation. For instance, the Kok report (2004), designed to monitor the achievements towards the Lisbon goals of the European Union, identifies increased global competition as a major challenge for Europe and calls for finding a new balance between flexibility and security on the labour market. And in a recent report the academic advisory council at the German Federal Ministry of Economics and Technology concludes that globalised markets require additional labour market flexibility in Germany (BMWi, 2006). In this regard, the relatively rigid labour markets in Continental Europe have been contrasted with those of the UK and the US characterised by a high degree of flexibility.

Despite of the great public interest in the issue, academics have typically analysed the effects of labour market regulations in closed economy settings abstracting from international linkages. On the other hand, trade economists almost always rely on models with fully flexible labour markets and ignore possible effects of trade on employment.[2] As a consequence, surprisingly little is known about the effect of national labour market regulation in a globalised world economy.

A notable exception is the important work of Davis (1998). He considers trade between a flexible-wage 'America' and a rigid-wage 'Europe' in a Heckscher-Ohlin framework and shows

[1] Scheve and Slaughther (2001) provide a comprehensive summary of the perceptions of American workers about Globalisation.

[2] See Davidson and Matusz (2004) for a discussion of the likely reasons for the focus on full-employment models.

that factor markets can not be considered in isolation when goods markets are linked globally. In his paper, the global equilibrium is characterised by Factor-Price-Equalisation (FPE) across countries. The minimum wage in Europe pins down wages in both countries. European workers have to absorb the full unemployment level of the integrated economy. Hence, a move from autarky to free trade will prop up American wages and will sharply increase European unemployment. Davis (1998) also shows that the fixed minimum wage in Europe will shield American wages against shocks originating from factor accumulation in Europe while the reverse is not true.

In a recent paper, Kreickemeier and Nelson (2006) consider somewhat less stark institutional assumptions. They postulate the existence of fair wage constraints in both economies. Asymmetries arise due to different attitudes towards wage inequality. The paper develops an integrated equilibrium concept for their type of model and shows that while the central message of Davis persists, some results depend on the specific model framework.

The papers mentioned make use of the Heckscher-Ohlin model with perfectly competitive product markets and, hence, focus on inter-industry trade. However, trade flows between developed countries and regions, such as Europe and the US, are largely characterised by simultaneous exports and imports of similar products. This is generally attributed to the existence of scale economies. A second distinctive feature of the modern world economy is the widespread importance of Foreign Direct Investment (FDI). Over the last two decades or so FDI has risen sharply, both in absolute terms but also relative to the levels of GDP and trade.[3] In this context, concerns haven been raised that multinational activity of firms could have detrimental effects on the regulatory capacities of countries competing for FDI. Importantly, modelling (horizontal) multinational enterprises (MNEs) requires positive trade costs which cause the Factor-Price-Equalisation Theorem invoked by Davis (1998) to break down.

Against this background, the present paper adds to the scarce existing literature by studying labour market outcomes in a model of intra-industry trade between a rigid-wage Europe and a flexible-wage America, in which multinational enterprises arise endogenously. Downward wage rigidity is simply modelled as a lower bound on wages and might reflect various institutions such

[3]For an overview of stylised facts on FDI see, for instance, chapter 1 of Navaretti and Venables (2004).

as explicit minimum wages, unemployment benefits, unions etc. Trade costs are non-negligible and the model therefore concentrates on the empirically important case where factor prices do not equalise across trading partners.[4] The basic framework is adopted from Markusen and Venables (1998) who study the model under perfectly competitive factor markets. Firms can either enter as national enterprises producing in one country and possibly exporting to the other. Alternatively, multinational enterprises will set up a headquarter in one country but maintain production facilities in both. Hence, the focus lies on horizontal direct investment which represents the bulk of FDI and is of particular importance in the analysis of similar developed countries.

The effects of divergent national labour market institutions in the globalised economy are contrasted with those derived in a closed economy setting and those without allowing for the presence of multinational firms. The results suggest that the negative effect of a one-sided wage floor on unemployment in Europe is much larger with positive levels of intra-industry trade than in a closed economy framework. Domestic production is substituted by imports from America. Hence, labour demand falls more rapidly and unemployment soars. The problem exacerbates itself as income and, hence, demand will fall more rapidly with higher unemployment rates causing a further decline in European production.

Interestingly, multinational firms do not worsen this effect but generally help to mitigate it. They are less affected by the one-sided minimum wage than European national firms as parts of their costs are incurred in terms of foreign labour. This allows them to operate for a wider range of (implicit) minimum wages. European labour benefits as consumption is met with local production. Hence, in contrast to public perception the study suggest that (horizontal) MNEs can actually help to alleviate negative effects arising from global competition in the presence of one-sided labour market institutions.

Even though factor prices are not equalised across countries, America sees its wage rate rising in

[4] Oslington (2002) analyses asymmetric wage rigidity in a Heckscher-Ohlin model in which Europe is specialised in the skill-intensive industry. FPE then also breaks down and Europe is left with a lower skill premium than America. The paper shows that some of Davis' results will no longer hold in that case but confirms the overarching message that factor markets can not be considered in isolation when goods markets are global. In contrast to the present paper, Oslington (2002) considers inter-industry trade and abstracts from MNEs. Moreover, in a model of two developed countries (Europe and America) non-negligible trade frictions may arguably be a more important reason for factor prices not to be equalised than dissimilar endowments.

the open economy setting with the introduction of a minimum wage in Europe. Owing to a sort of home market effect, American wages can actually rise above the minimum wage rate even though countries are otherwise identical. The exact magnitude of these effects depends crucially on the level of trading barriers and the rate of the minimum wage. In particular, one-sided labour market rigidities are likely to have more severe effects when trading barriers are low and, hence, foreign competition is fierce. However, trade liberalization can in principle also lower unemployment when the market is dominated by exporting firms only.

The paper also illustrates that America is indeed insulated from any shocks caused by European factor accumulation. On contrary, factor accumulation in America has marked impacts on both countries with the exact direction depending on the level of the minimum wage and the types of firms active in the corresponding equilibrium. In fact, increases in American labour supply can actually *boost* American wages by enhancing the competitiveness of national firms in a globalised world.

While national labour market institutions are typically examined in closed economy models, the present analysis therefore suggests that their effects do strongly depend on global goods market linkages. Divergent institutional features markedly influence each other in a globalised world economy even if factor markets are fully national.

The remainder of the paper is structured as follows. Section 2 presents the basic model framework. Partial equilibrium results are derived in section 3, while section 4 presents the numerical simulation of the general equilibrium. In the following section, the effects of the level of trading costs on the key results are considered. Section 6 analyses the impact of local factor accumulation on labour market outcomes in the two countries. Finally, section 7 concludes.

2 Basic Model

The model[5] studies two countries, which I call in accordance with Davis (1998) 'Europe' (e) and 'America' (a), producing two homogeneous goods, X and Y. Two factors of production exist, labour (L) and resources (R). While resources are specific to the Y sector, labour is mobile

[5] As noted earlier, the model framework draws heavily on Markusen and Venables (1998). The only difference is the introduction of a minimum wage in Europe.

between sectors but immobile across countries.

In the following, countries will be denoted by subscripts (i, j). Good Y is freely traded and chosen as the numeraire of the model; consequently its price is normalised to one. Y is sold in a perfectly competitive market and its production function is assumed to be Cobb-Douglas

$$Y_i = L_{iy}^{\alpha} R_i^{1-\alpha} \text{ with } 0 \leq \alpha \leq 1 \text{ and } i = a, e. \tag{1}$$

where R_i is the resource endowment of country i. Provided that prices are fully flexible, the wage rate w_i and the rental rate on R, r_i, are given by their marginal values in production[6]

$$w_i = \alpha \left(\frac{L_{iy}}{R_i} \right)^{\alpha - 1}, \tag{2}$$

$$r_i = (1 - \alpha) \left(\frac{L_{iy}}{R_i} \right)^{\alpha}. \tag{3}$$

However, while American wages are assumed to be fully flexible, they are subjected to a binding minimum wage in Europe

$$w_e = \overline{w}. \tag{4}$$

Note that this also implies that the labour demand of the Y sector in Europe is fixed by equation (2) and the parameters α, R_e and w_e.

The X good is sold in an imperfectly competitive market. There are four different types of potential entrants in the market; (1) national firms located in America, (2) national firms located in Europe, (3) multinational firms headquartered in America, and (4) multinationals headquartered in Europe. National firms produce in one of the two countries only and potentially export to the other. They are denoted with the superscript n. Horizontal multinationals, marked with the superscript m, have their headquarters in either of the two countries but maintain production facilities in both countries. Fixed costs consist of factor prices for G units of labour for the headquarter and F units of labour for a factory. It is further assumed that producing a

[6] As pointed out in the original work of Markusen and Venables (1998), R serves to add some convexity to the model. Higher levels of X production will increase the cost of labour in terms of Y. Hence, labour supply to the non-competitive sector is increasing in w_i.

unit of X requires c units of labour. Note that production technologies are identical in the two countries. An exporting firm will additionally have to hire t units of labour in order to ship a unit of output across the border.

Let X_{ij}^k denote the amount of output that a type $k = n, m$ firm based in i supplies to country j. Since national enterprises undertake all their production in their base country, the demand of one national firm headquartered in i for country i's labour is

$$cX_{ii}^n + (c+t)X_{ij}^n + G + F \text{ with } i \neq j. \tag{5}$$

On contrary, a national firm based in j will not demand any labour in i. A multinational based in i will use labour for maintaining the headquarter and a factory in i. Additionally, it requires labour for producing output for the i market while supply to the j market is met by local production. Hence, labour demand of one multinational based in i for labour of country i can be written as

$$cX_{ii}^m + G + F. \tag{6}$$

Finally, a multinational enterprise based in j requires labour from country i to support the local factory as well as to produce for the local market. Demand for country i's labour is then

$$cX_{ji}^m + F \ . \tag{7}$$

Let n_i and m_i denote the number of active national firms and multinationals, respectively, with a headquarter in country i. The sum of labour demands from the different types of firms plus the unemployed units of labour, U_i, have to equal the factor endowment. Hence, the labour market clearing condition can be written as

$$L_i = U_i + L_{iy} + n_i(cX_{ii} + (c+t)X_{ij}^n + G + F) + m_i(cX_{ii}^m + G + F) + m_j(cX_{ji}^m + F), \tag{8}$$

where $U_a = 0$ due to the assumption of fully flexible American wages.

Since profits are driven to zero in the (long-run) equilibrium, national income M_i will solely

consist of factor rewards

$$M_i = w_i(L_i - U_i) + r_i R_i, \tag{9}$$

which accrue to a representative consumer in each country. The agent faces a Cobb-Douglas utility function in the two goods

$$Z_i = X_{ic}^{\beta} Y_{ic}^{1-\beta} \tag{10}$$

with Z_i denoting utility. X_{ic} and Y_{ic} are the respective consumption levels of the two goods. Utility maximisation gives rise to the following demand functions

$$X_{ic} = \frac{\beta M_i}{p_i}, \tag{11}$$

$$Y_{ic} = (1-\beta) M_i, \tag{12}$$

where p_i denotes the price of good X in country i. The goods market equilibrium in sector X requires demand X_{ic} to equal total supply. The latter is given by the sum of output levels of the different firm types multiplied by the respective number of firms active in equilibrium

$$X_{ic} = n_i X_{ii}^n + n_j X_{ji}^n + m_i X_{ii}^m + m_j X_{ji}^m. \tag{13}$$

The firms compete in Cournot fashion. Marginal revenue of a type k firm based in i serving the market of country j is given by $p_j \left(1 + \frac{X_{ij}^k}{X_{jC}} \frac{1}{\eta_j}\right) = p_j(1 - s_{ij}^k)$. Here, $\eta_j = -\frac{p_j}{X_{jC}} \frac{\partial X_{jC}}{\partial p_j}$ is the price elasticity of demand while s_{ij}^k denotes the respective proportional markup of prices over marginal costs. With Cobb-Douglas preferences the price elasticity of demand is one and markups therefore equal the market share of the respective firm.

$$s_{ij}^k = \frac{X_{ij}^k}{X_{jC}} = \frac{p_j X_{ij}^k}{\beta M_j}. \tag{14}$$

Profit maximisation implies that marginal revenue equals marginal cost. Written in complementary slackness form, the pricing equations are given as follows

$$p_i(1-s_{ii}^n) \leq w_i c, \quad (X_{ii}^n \geq 0), \tag{15}$$

$$p_j(1-s_{ij}^n) \leq w_i(c+t), \quad (X_{ij}^n \geq 0), \tag{16}$$

$$p_i(1-s_{ii}^m) \leq w_i c, \quad (X_{ii}^m \geq 0), \tag{17}$$

$$p_j(1-s_{ij}^m) \leq w_j c\,; \ (X_{ij}^m \geq 0). \tag{18}$$

Free entry will drive profits to zero in the long-run equilibrium. The combination of firm types active is therefore determined by four zero-profit conditions. They simply state for each firm type that markup revenues have to be equal to or less than fixed costs. Complementary variables are the respective number of firms active in equilibrium.

$$p_e s_{ee}^n X_{ee}^n + p_a s_{ea}^n X_{ea}^n \leq w_e(G+F), \quad (n_e \geq 0), \tag{19}$$

$$p_a s_{aa}^n X_{aa}^n + p_e s_{ae}^n X_{ae}^n \leq w_a(G+F), \quad (n_a \geq 0), \tag{20}$$

$$p_e s_{ee}^m X_{ee}^m + p_a s_{ea}^m X_{ea}^m \leq w_e(G+F) + w_a G, \quad (m_e \geq 0), \tag{21}$$

$$p_a s_{aa}^m X_{aa}^m + p_e s_{ae}^m X_{ae}^m \leq w_a(G+F) + w_e G, \quad (m_a \geq 0). \tag{22}$$

The general equilibrium of the model is then determined through a system of equalities and inequalities that solve simultaneously for the endogenous variables of the model. Output levels in X sector are associated with pricing inequalities (15) - (18) together with the markup formula in (14). The zero profit conditions (19)-(22) determine the number of each firm type active in equilibrium. Income levels are given by (9) while the price of good X is established through equation (11) in combination with (13). Finally, the wage rate in America and the unemployment rate in Europe are determined by the labour market clearing condition in (8) together with labour demand from the Y sector, equation (2), while the rental rate of R is associated with equation (3).

3 Intuition from Partial Equilibrium Analysis

Before calculating the general equilibrium of the model numerically, I start with deriving results in a partial equilibrium setting. This is meant to provide intuition for the general equilibrium results reported in the following sections.

Equations (2) and (8) show that the American wage rate and the unemployment rate in Europe depend crucially on labour demand originating in the X sector. The latter, in turn, will depend on the type (and number) of firms active in equilibrium as well as the output level of an individual firm. In the flexible wage setting, expanding X production draws labour from the Y sector thereby increasing the R/L ratio in the competitive sector. Wages will increase as a result. With wages fixed at a (binding) minimum wage, labour demand of Y is fixed by equation (2). The units of unemployed labour in Europe are given by total endowment minus labour demands from the Y and X sector.

In the following, the effects of the introduction of a binding (implicit) minimum wage in Europe, i.e. an increase in w_e, are separately analysed for the two crucial determinants of labour demand in the X sector. First, the number of active firms is kept exogenous and the effect of a one-sided wage increase on output levels is studied. I abstract from any general equilibrium effects on income and do not consider feedback effects from the labour market. The influence in a closed economy setting is compared to the effect in an open economy setting with and without multinational enterprises. Second, the effects of a one-sided wage increase on (potential) profits of the four types of firms are considered. This will help to understand what kind of firms are likely to arise in equilibrium and how the location decisions of firms are influenced by the introduction of a minimum wage in Europe.

3.1 Effects of an Increase in the European Wage on Output

Suppose first that the types (and number) of firms active in equilibrium are fixed. For concreteness I will assume that the two countries are identical with respect to the number of active

firms.[7] Since demand functions derived from a Cobb-Douglas utility function are not suitable to study monopoly I further assume that $n_i = n_j = n \geq 2$ (and $m_i = m_j = n \geq 2$ if multinationals are present). Now plug equation (14) into (15)-(18) and rearrange to get inequalities for the output levels

$$X_{ii}^n \geq \beta M_i \left(\frac{p_i - w_i c}{p_i^2} \right), \tag{23}$$

$$X_{ij}^n \geq \beta M_j \left(\frac{p_j - w_i (c+t)}{p_j^2} \right), \tag{24}$$

$$X_{ii}^m \geq \beta M_i \left(\frac{p_i - w_i c}{p_i^2} \right), \tag{25}$$

$$X_{ij}^m \geq \beta M_j \left(\frac{p_j - w_j c}{p_j^2} \right). \tag{26}$$

If the right-hand side is positive, the equations hold with equality, otherwise output is zero. Consider first an equilibrium in which only non-exporting national firms are active. I will refer to this scenario as the closed economy setting. Abstracting from general equilibrium effects, equations (11), (13) and (23) allow to solve for production in terms of the exogenous parameters

$$X_{ii}^n = \frac{\beta M_i (n-1)}{c n^2 w_i}. \tag{27}$$

Since just national firms producing for the domestic market are active, only the production level X_{ii}^n is of interest to country i's labour demand. Now consider the effect of an increase in w_e on domestic production X_{ee}^n. The elasticity of output with respect to wages, denoted ε^c, in a closed economy can easily be calculated to equal -1

$$\varepsilon^c \equiv \frac{\partial X_{ee}}{\partial w_e} \frac{w_e}{X_{ee}} = -\frac{\beta M (n-1)}{c n^2 w_e^2} \frac{w_e c n^2 w_e}{\beta M_e (n-1)} = -1. \tag{28}$$

Next, consider an open economy with positive levels of intra-industry. National firms do export but multinational firms are not present. A national firm based in country i produces for both markets and labour demand depends on X_{ii}^n and X_{ij}^n. Equations (11), (23) and (24) can be

[7] The assumption does not affect the general results of this section but helps to clean up the somewhat messy expressions.

solved simultaneously to find

$$X_{ii}^n = \frac{\beta M_i(2n-1)(nw_j(c+t)-c(n-1)w_i)}{(nw_j(c+t)+cnw_i)^2}, \tag{29}$$

$$X_{ji}^n = \frac{\beta M_i(2n-1)(cnw_i-(n-1)w_j(c+t))}{(nw_j(c+t)+cnw_i)^2}. \tag{30}$$

Now consider the wage elasticity of output of a national firm based in Europe with respect to European wages w_e. First, note that the elasticity can be decomposed as follows

$$\begin{aligned}\frac{\partial(X_{ee}^n+X_{ea}^n)}{\partial w_e}\frac{w_e}{X_{ee}^n+X_{ea}^n} &= \frac{\partial X_{ee}^n}{\partial w_e}\frac{w_e}{X_{ee}^n}\frac{X_{ee}^n}{X_{ee}^n+X_{ea}^n}+\frac{\partial X_{ea}^n}{\partial w_e}\frac{w_e}{X_{ea}^n}\frac{X_{ea}^n}{X_{ee}^n+X_{ea}^n}\\ &= \varepsilon^{oe}s_e+\varepsilon^{oa}s_a,\end{aligned} \tag{31}$$

where ε^{oi} is the wage elasticity of output produced for market i and s_i denotes the share of production for market i in total production. Calculating the two elasticities explicitly yields the following two expressions

$$\varepsilon^{oe} \equiv \frac{\partial X_{ee}^n}{\partial w_e}\frac{w_e}{X_{ee}^n} = \frac{cw_e((n-1)cw_e-(3n-1)w_a(c+t))}{(nw_a(c+t)-c(n-1)w_e)(w_a(c+t)+cw_e)}, \tag{32}$$

$$\varepsilon^{oa} \equiv \frac{\partial X_{ea}^n}{\partial w_e}\frac{w_e}{X_{ea}^n} = \frac{(c+t)w_e((n-1)tw_e+c(w_a-3nw_a+(n-1)w_e))}{(w_e(c+t)+cw_a)(c(nw_a-w_e(n-1))-tw_e(n-1))}. \tag{33}$$

While the expression looks quite messy the following result can be established

Proposition 1. *In an open economy setting with nonnegative intra-industry trade the wage elasticities of production for both markets of a national firm based in Europe, ε^{oe} and ε^{oa}, are smaller than or equal to -1. Hence, the elasticities are smaller than in the closed economy setting. The elasticities are furthermore decreasing in w_e.*

Proof. See Appendix A.1. □

The proposition shows that in an open economy one-sided changes in the wage rate will have more severe effects on production (and, hence, labour demand) than in a closed economy. The wage elasticities are generally smaller the larger the wage level already is. Intuitively, an

increase in European wages only affects firms based in Europe. Therefore, firms will have to reduce output not only because of the increase in marginal costs but also due to the deterioration of their competitiveness relative to their American counterparts. The latter effect is clearly absent in a closed economy setting.

Now consider a market in which multinational firms are active. Pricing equations for multinational firms and national firms serving their local markets are exactly identical because both firms have a factory in the country and, hence, face identical marginal costs. Multinational production relevant for the European labour market is given by X_{ee}^m and X_{ae}^m. The wage elasticity of multinational production will be the same as the wage elasticity of production for the market in Europe of a national firm based in Europe. If a multinational competes only with other multinationals or with national firms based in Europe, the output elasticity will therefore equal -1, i.e. it will be identical to the case of a closed economy. When competing with exporting firms the elasticity will equal ε^{oe}.

However, one crucial difference exists when comparing MNEs to national firms. The multinational has an outside option to produce the output in its oversea facility and then reimport it. It will do so whenever marginal production costs in Europe will exceed those in America, i.e. whenever $w_e c > w_a(c+t)$. Therefore, production in Europe plummets to zero when the minimum wage is set too high. In terms of production, the multinational firm then resembles an exporting firm based in America. Without trading barriers any small positive deviation of w_e from w_a will result in zero production of multinational firms in Europe. Note that in the free-entry equilibrium the case of a multinational with just one factory producing positive output levels will never occur. In fact, the multinational would choose to become a national firm based in the country with lower factor prices.

Increasing the European minimum wage may also affect the level of production and thus labour demand in America. American production will obviously be not affected if the two countries are closed economies without any trade taking place. Increases in the minimum wage only influence marginal costs of producers in Europe and since these firms do not compete with American firms the latter are not affected. On contrary, for the open economy case the following result can be

established

Proposition 2. *In an open economy setting with nonnegative intra-industry trade the output of firms based in America, X_{ae}^n and X_{aa}^n, will be positively affected by increases in the European wage rate, w_e.*

Proof. See Appendix A.2. □

Increases in w_e affect marginal costs of firms based in Europe but not those of firms based in America. Consequently the latter types of firms improve their relative competitiveness and gain ground on expense of the former. In an open economy setting, in which national firms based in both countries compete with each other, increases in the wage rate in Europe will therefore cause firms based in America to expand their production.

Finally, I am interested in the effect of increases in w_e on the production of multinational enterprises for the American market. As long as the increase in w_e does not exceed a certain threshold, multinationals are again equivalent to national firms based in America that produce for the domestic markets only. There will be no effects on their output levels if multinational enterprises only compete with other multinationals or with national firms based in America. When competing with exporters based in Europe their output levels X_{ea}^m and X_{aa}^m will be positively affected as described in proposition 2. Whenever European wages are such that $w_e c > w_a(c+t)$ the multinational will shift all its production to its American factory and therefore will be similar to an American exporter in terms of production patterns.

3.2 Effects of an Increase in the European Wage on Potential Profits

Up to this point, I have taken the number of firms in the market as given. However, changes in the minimum wage will not only alter the behaviour of active firms but also determine which types of firms enter the market. The decision is governed by free entry conditions. In this section, I will briefly look at the effects of an increase in the wage rate of Europe on potential profits of the four types of firms keeping all other endogenous variables constant. Using equations (14) -

(18) in (19) - (22) free entry conditions can be written as

$$\beta\left[M_e\left(\frac{p_e-w_ec}{p_e}\right)^2+M_a\left(\frac{p_a-w_e(c+t)}{p_a}\right)^2\right] \leq w_e(G+F),\ \ (n_e\geq 0), \tag{34}$$

$$\beta\left[M_e\left(\frac{p_e-w_a(c+t)}{p_e}\right)^2+M_a\left(\frac{p_a-w_ac}{p_a}\right)^2\right] \leq w_a(G+F),\ \ (n_a\geq 0), \tag{35}$$

$$\beta\left[M_e\left(\frac{p_e-w_ec}{p_e}\right)^2+M_a\left(\frac{p_a-w_ac}{p_a}\right)^2\right] \leq w_e(G+F)+w_aG,\ \ (m_e\geq 0), \tag{36}$$

$$\beta\left[M_e\left(\frac{p_e-w_ec}{p_e}\right)^2+M_a\left(\frac{p_a-w_ac}{p_a}\right)^2\right] \leq w_a(G+F)+w_eG,\ \ (m_a\geq 0), \tag{37}$$

which are rearranged to obtain

$$\Pi_e^n = \beta\left[M_e\left(\frac{p_e-w_ec}{p_e}\right)^2+M_a\left(\frac{p_a-w_e(c+t)}{p_a}\right)^2\right]-w_e(G+F)\leq 0,\ \ (n_e\geq 0), \tag{38}$$

$$\Pi_a^n = \beta\left[M_e\left(\frac{p_e-w_a(c+t)}{p_e}\right)^2+M_a\left(\frac{p_a-w_ac}{p_a}\right)^2\right]-w_a(G+F)\leq 0,\ \ (n_a\geq 0), \tag{39}$$

$$\Pi_e^m = \beta\left[M_e\left(\frac{p_e-w_ec}{p_e}\right)^2+M_a\left(\frac{p_a-w_ac}{p_a}\right)^2\right]-w_e(G+F)-w_aG\leq 0,\ \ (m_e\geq 0), \tag{40}$$

$$\Pi_a^m = \beta\left[M_e\left(\frac{p_e-w_ec}{p_e}\right)^2+M_a\left(\frac{p_a-w_ac}{p_a}\right)^2\right]-w_a(G+F)-w_eG\leq 0,\ \ (m_a\geq 0). \tag{41}$$

Now consider an increase in the European minimum wage holding all other endogenous variables fixed. It is easy to see that we have the following result

$$d\Pi_e^n < d\Pi_e^m < d\Pi_a^m < d\Pi_a^n = 0. \tag{42}$$

This finding suggests that national firms based in Europe will suffer most from an increase in the (implicit) minimum wage. Not only their marginal production costs but also their fixed costs for headquarters and factories will increase. Multinational firms headquartered in Europe are less affected as they produce their output for the American market in America. Multinationals based in America have the additional advantage that fixed costs for their headquarters do not depend on w_e. Finally, profits of American exporters are not at all affected by the change. Hence, altering the minimum wage in Europe will harm firms based in Europe most and is likely

to give rise to an equilibrium with heavy weight placed on firms based in America.

Importantly, those firms most beneficial for Home in terms of labour demand are affected most severely. Given production levels, a national firm based in Europe will generate more labour demand than a multinational based in Europe, with the latter demanding more labour than a multinational based in America. Finally, national firms based in America, which are not affected by the increase in w_e, do not demand any labour in Europe.

4 Numerical Simulation of the General Equilibrium

Now I compute the general equilibrium of the model described in section 2.[8] As in Markusen and Venables (1998) the benchmark simulation sets trading costs t at 0.15. In order to focus on labour regulations as the only source of heterogeneity, countries have identical endowment levels of $L_a = L_e = 150$ and $R_a = R_e = 50$. The fixed costs of multinational enterprises are 1.45 times the fixed costs of national firms when factor prices are equalised, α equals 2/3, β is 3/8.[9] The European wage rate is set initially so that it equals the free market equilibrium ($w_e = 0.6$). In order to study the effect of a one-sided minimum wage in Europe the level of w_e is then successively increased.

The effects of the full-fledged model are contrasted with those derived from a model without multinational firms and those of a closed-economy setting. For doing so, three different versions of the model are simulated. First, exports and multinationals are suppressed reducing the model essentially to a closed economy setting. Second, firms are allowed to export but multinational firms are still suppressed. As noted by Markusen and Venables (1998), the model then essentially reduces to a two-factor version of Brander and Krugman (1983) and Venables (1985). Third, both exporting firms and multinational firms are allowed to arise endogenously. Note that the different versions of the model do not specify which type of firm will arise endogenously but only restrict the range of possible firm types. There are also no limitations on the location of the headquarters i.e. the respective firm type might not arise in either country, only in one or

[8] The numerical calculations are conducted using the MCP solver of GAMS.

[9] The values of α and β are chosen so that the X sector plays a dominant role in determining labour demand in the two economies.

<table>
<tr><th>w_h</th><th>Nat. Firms</th><th>Exp. Nat. Firms</th><th>Exp. Nat. Firms & MNEs</th></tr>
<tr><td>0.60
0.61
0.62
0.63
0.64</td><td rowspan="16">n_e, n_a</td><td rowspan="9">n_e, n_a</td><td>m_e, m_a</td></tr>
<tr><td>0.65
0.66
0.67
0.68</td><td>m_a</td></tr>
<tr><td>0.69
0.70
0.71
0.72
0.73</td><td>m_a, n_a</td></tr>
<tr><td>0.74</td><td>m_e, m_a, n_a</td></tr>
<tr><td>0.75
0.76
0.77
0.78
0.79
0.80</td><td rowspan="2">m_e, n_a</td></tr>
<tr><td>0.81
0.82
0.83
0.84
0.85</td><td rowspan="2">n_a</td><td>n_a</td></tr>
</table>

Table 1: Type of Firms Active in Equilibrium

in both countries. Furthermore, the term 'closed economy' refers to the X sector only. The numeraire good is freely traded in all three settings.

The numerical simulation serves primarily to establish qualitative results but also to assess the relative magnitudes of the effects across the three settings. Quantitative impacts should be interpreted with some caution given the simplifying features of the model. For instance, in reality implicit minimum wages bind only for a fraction of workers. Hence, the quantitative effect of the wage floor on overall unemployment rates is likely to be overstated. Since the same simplifications are present in all three model versions, relative magnitudes should nevertheless have explanatory power.

Table 1 provides an overview of the firms actually active in equilibrium over the parameter space

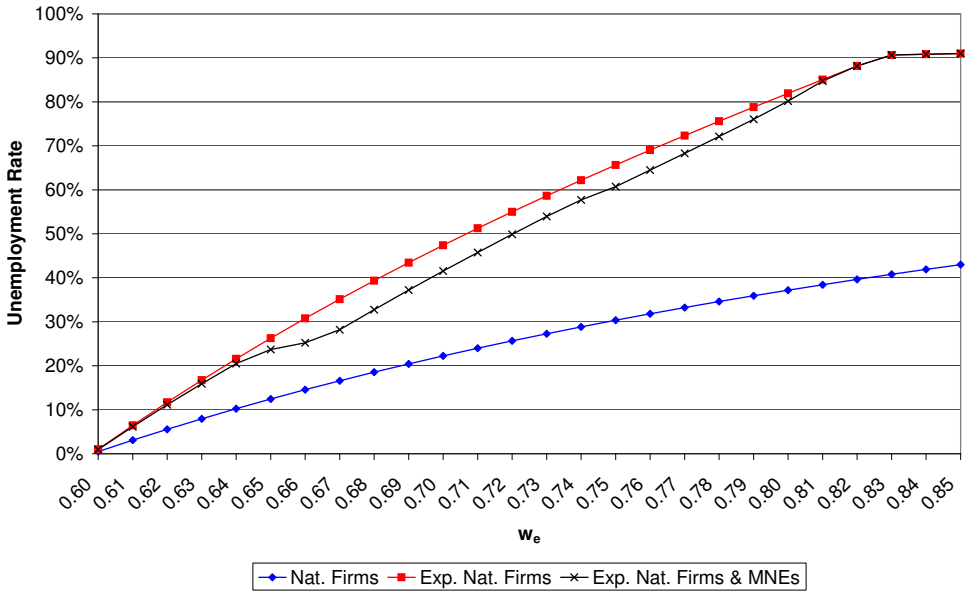

Figure 1: Effect of a European Minimum Wage on Unemployment

w_e and listed separately for the three different model settings. Positive numbers of national and multinational firms headquartered in country $i = a, e$ are indicated by n_i and m_i, respectively.[10] In the closed economy domestic firms do not face foreign competition and will prevail in both countries over the whole parameter space. With exports allowed the firms located in America will constantly gain in terms of relative competitiveness and domestic firms based in Europe will altogether quit the market at a minimum wage of 0.81. Without imposing restrictions on the firm types the initial equilibrium is characterised by coexisting multinational firms. The table shows that a relative small increase in European wages is sufficient for all multinational firms based in Europe to displace their headquarters to American. Further increases in w_e benefit national firms based in America which are the only type of firms whose costs are not affected by European wages. Consequently, for very high levels of w_e multinational firms are no longer profitable and American exporters will be left as the only active type of firm. Interestingly, for $0.74 \leq w_e \leq 0.81$ multinationals relocate from America to Europe, a finding explained later in this section.

Consider now the effect of an increase in w_e on the level of unemployment in Europe as

[10] As in Markusen (2002) a firm type is ignored when there are less than 0.3 firms in equilibrium.

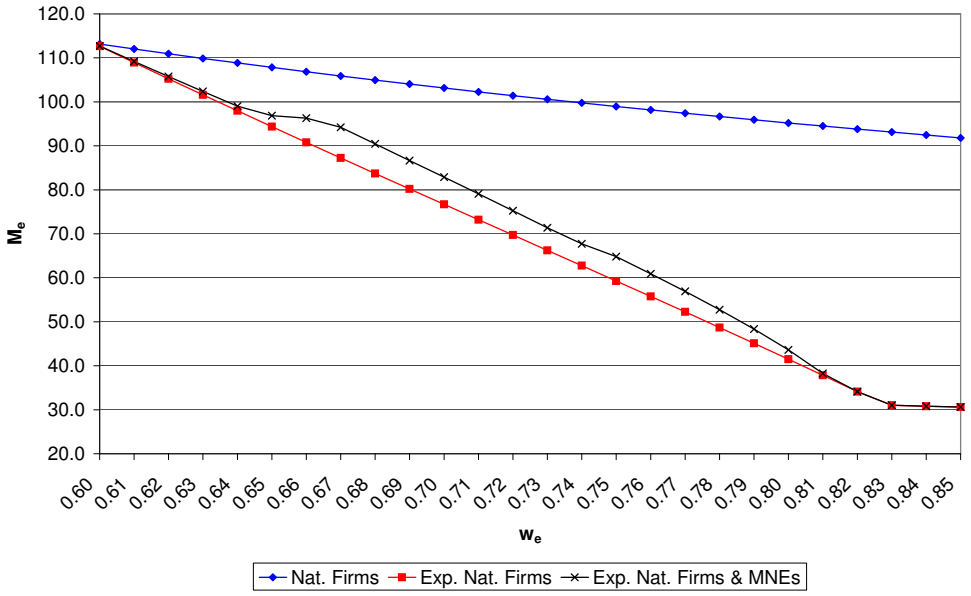

Figure 2: Effect of a European Minimum Wage on the European Income Level

depicted in figure 1. Clearly, unemployment is on the rise for all three simulations. The closed economy setting provides a lower bound to the other specifications. Once firms are allowed to export, the effect of one-sided downward rigidity on the unemployment rate is significantly larger. One can also turn the result upside-down. A move from autarky to an open economy will increase European unemployment. The simulation shows that the calculated unemployment rate is more than twice as high over the complete parameter space. Firms based in America produce ever larger shares of European consumption thereby reducing demand for European labour. In general equilibrium, higher unemployment rates also cause income levels in Europe to fall more rapidly compared to a closed economy setting (see figure 2). Market size and production decline even further.

Interestingly, the existence of multinational enterprises dampens the effect over some range of parameters as they keep larger parts of production in Europe.[11] Multinationals are less affected by changes in w_e than European exporters as parts of their (marginal and fixed) costs depend

[11] Note that the observed dampening effect of multinational enterprises is only evident in a setting, in which trading barriers are low enough for intra-industry trade to occur. If trading barriers are prohibitively high, the open economy setting with exporting firms will effectively reflect a closed economy. Adding multinational firms to such a scenario will raise the actual unemployment rate because multinational firms will relocate their headquarters to the country with lower factor prices.

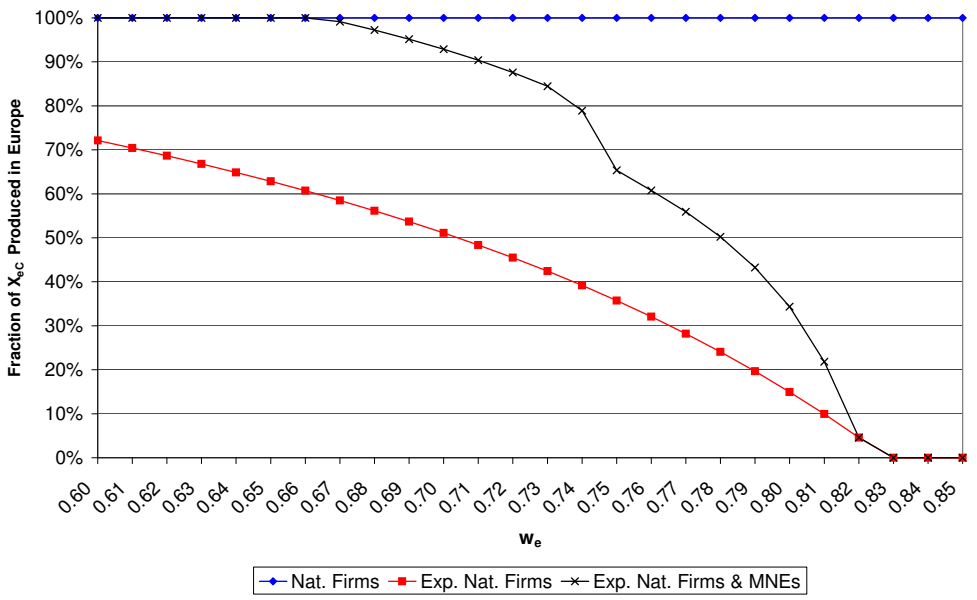

Figure 3: Effect of a European Minimum Wage on the Fraction of European X Consumption Produced Domestically

on American factor prices only. Thus, they are able to compete with American exporters for a wider range of values of the minimum wage. As long as multinationals are present in the market, a fraction of domestic consumption of X is still produced in Europe. This is illustrated in figure 3 that also highlights that the sharp increase in unemployment coincides with the fall in the fraction of X_{eC} produced domestically. With lower unemployment rates purchasing power in Europe initially declines only moderately. Thus, in the presence of MNEs not only a higher fraction of European consumption is met with domestic production. The European market also remains more important in terms of its size relative to the American counterpart.[12]

Once all the production takes place in America, further increases in w_e only affect U_e via the impact on Y production. Consequently, the difference between the open and closed economy setting will diminish for larger values of w_e since in the former setting the domestic production of X is still negatively affected by increases in w_e.

The effects resulting from an introduction of a wage floor in Europe for the American wage level are shown in figure 5. National labour market legislation introduced in Europe has no

[12]Figure 10 in the Appendix depicts the fraction of *worldwide* X consumption produced in Europe thereby also taking into account differences in the relative market sizes across the different model settings.

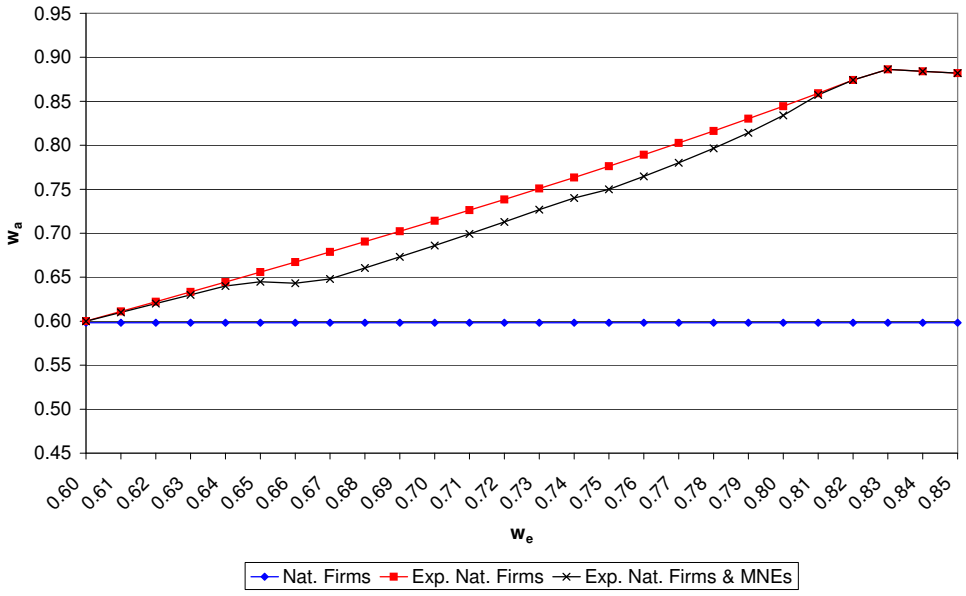

Figure 4: Effect of a European Minimum Wage on American Wages

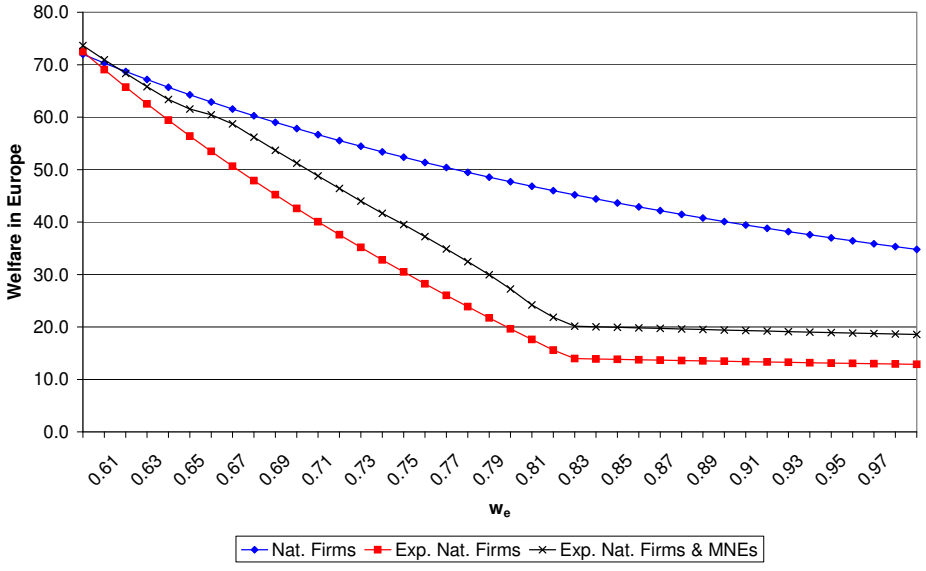

Figure 5: Effect of a European Minimum Wage on European Welfare

effect on the American labour market in a closed economy. However, wage rigidity in Europe props up wages in America when product markets are global. American firms gain a relative cost advantage vis-a-vis their competitors and will therefore produce larger amounts of X. This raises labour demand and wages in America. As long as multinationals are profitable, the effect is somewhat less pronounced in the unrestricted setting since a lower fraction of the production for the American market is transferred to America. After reaching a peak the wage level in America is decreasing in w_e. This is so because further increases of wages in Europe generate further unemployment and income losses in Europe. Demand for good X in Europe falls and so does production and labour demand in America.

There is yet another interesting aspect evident from figure 5. For a certain parameter range the wage level is actually higher in America than in Europe despite of the (binding) minimum wage in the latter. Why can such an equilibrium be sustainable? The reason is a sort of home market effect. While income levels in America are soaring,[13] unemployment in Europe depresses local income and demand for X production. Therefore, national firms based in America serve a far larger domestic market than their counterparts in Europe. And since national markets are somewhat shielded by trading barriers, American national firms do have a competitive advantage despite of higher domestic equilibrium wages.

In the presence of multinational enterprises wages in America are higher than in Europe for an implicit minimum wage of between 0.75 and 0.81. Note that in this case there is a sudden shift backwards to multinationals headquartered in Europe, since MNEs based in different countries clearly do not have a home market advantage in comparison to each other. Hence, multinationals will always locate their headquarters in the country with lower factor prices.

Finally, a note on the welfare consequences of the introduction of an implicit minimum wage. After the preceding analysis it is hardly surprising that introducing downward wage rigidity depresses consumption and, hence, welfare levels in Europe. For a given wage rigidity moving from a closed to an open economy setting actually lowers welfare. This is an interesting result in itself since it shows that there might be a case for protectionism in the presence of one-sided wage rigidities. The adverse welfare effects are somewhat dampened when multinational firms

[13] The effect of wages on income levels in America is depicted in figure 11 in the Appendix.

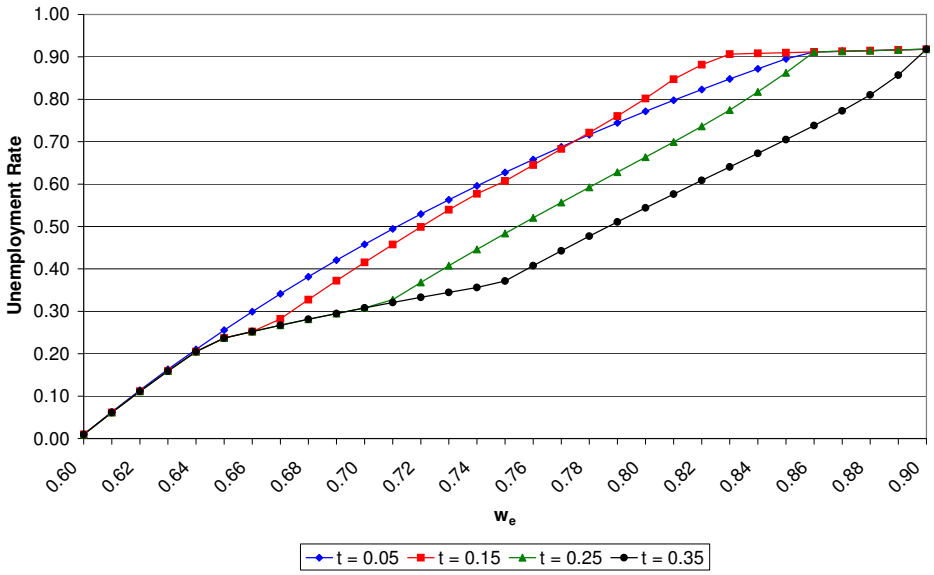

Figure 6: Effect of a European Minimum Wage on Unemployment for Different Trading Costs

are allowed to enter.

5 The Role of Trading Barriers

The previous section has illustrated how the effects of a one-sided minimum wage in an open economy with multinationals differ from those in a closed economy or an open economy without multinational firms. It has been shown that the effects of national labour market institutions might be much more pronounced in a world in which product markets are linked globally. Trading barriers are of great importance to the results as they determine the degree of openness of an economy and the type of firms active in equilibrium. With very high trading barriers horizontal multinational enterprises are more likely to arise while exporting is relatively costly. In this section, the unrestricted full-fledged model is simulated for different levels of trading barriers $t = \{0.05, 0.15, 0.25, 0.35\}$ to assess their influence on the model's main results.

Figure 6 provides an overview of the effect of a one-sided minimum wage in Europe on the unemployment rate. Consider first the cases in which $t = \{0.15, 0.25, 0.35\}$. The three curves coincide for a range of parameters at the lower and the upper bound of w_e. For low and high levels of the minimum wage the active types of firms are the same irrespective of the level of trading

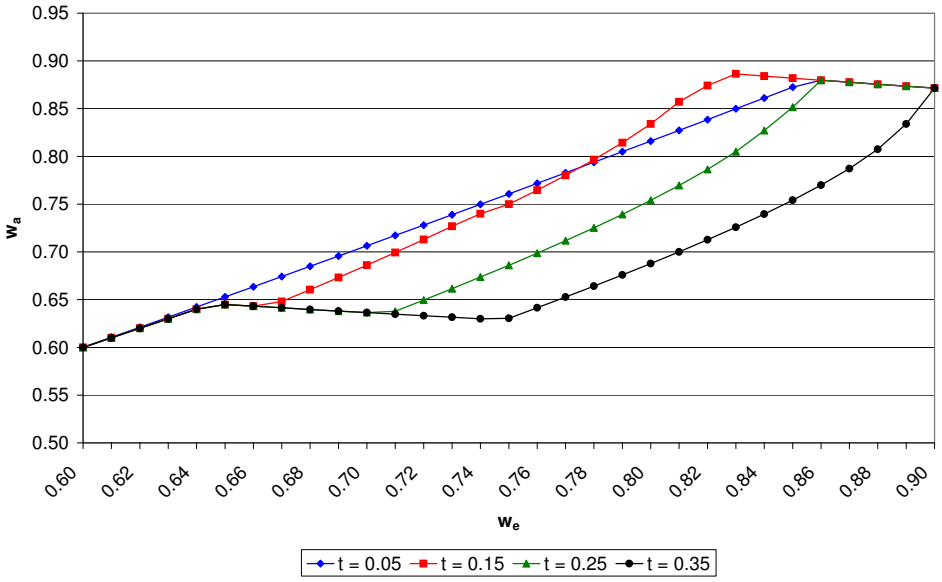

Figure 7: Effect of European Minimum Wage on American Wages for Different Trading Costs

barriers. Introducing only a moderate minimum wage will prevent multinational enterprises from leaving the market while at very high levels only national firms based in America can prevail.[14]

The effect of the level of trading barriers is evident from the intermediate parameter range. With relative low barriers exporters will enter the market already at relatively small values of w_e. Labour demand for the production of the X good is transferred abroad and the unemployment rate rises abruptly above the one calculated in simulations with higher trading barriers. A comparably moderate minimum wage is sufficient to generate high unemployment. With higher levels of trading costs the entry barriers for exporting national firms are higher. Therefore, the 'turning point', at which the fraction of X consumption produced abroad increases sharply, lies at higher values of w_e. The range of parameters w_e consistent with multinational production is enlarged while exporting firms arise only at higher values of w_e. Hence, higher trading barriers reduce the adverse effects on unemployment in Europe for intermediate values of w_e.

Figure 7 provides the mirror image for the American labour market. Again, the curves coincide for low and high levels of w_e. American wages are increasing initially as multinational enterprises

[14] A detailed table showing the types of firms active for any combination of w_e and t is provided in the Appendix.

are relocating their headquarters to America. A marked increase in w_a can be observed once American exporters start to produce higher fraction for the market in Europe. The lower the level of trading barriers is the lower is the level of w_e sufficient for the appearance of American-based exporting firms. Consequently, the positive effect of implicit European minimum wages on wages in America is higher with lower trading barriers for some intermediate parameter range of w_e.

The two figures also show that there is an interesting twist for $t = 0.05$. Note first that for trading barriers of such small magnitude multinational enterprises will never arise since exporting is almost costless. Moving from $t = 0.15$ to $t = 0.05$ can then actually *decrease* unemployment in Europe in the case of a very high wage floor. Intuitively, the very high unemployment rate in Europe depresses income and market size. Worldwide consumption of X is then strongly dominated by American demand. Very low trading barriers enables exporters from Europe to access the American market and European labour benefits since a fraction of American demand is met with European production.

6 National Labour Supplies, Global Consequences

In this section I study the effect of national factor supplies on the two labour markets.[15] In line with Davis (1998) the fixed European minimum wage insulates America from any effects caused by factor accumulation in Europe. Figure 8 shows how American wages and European unemployment vary with European labour endowment. As long as the minimum wage binds labour supply has no effect on factor prices in America and additional labour endowment will add to the European unemployment stock. Hence, the unemployment rate is steeply increasing in L_e. On contrary, the relative cost competitiveness of American firms and American labour demand are not affected by factor accumulation in Europe. Therefore, the American wage rate is independent from European factor supplies.

The effects of an increase in American labour supply, depicted in figure 9, are more subtle. Initially, there is a parameter range, in which American wages do not respond to domestic labour

[15] For the simulations the European wage rate is fixed at 0.65.

Figure 8: Labour Market Consequences of an Increase in European Labour Supply

supply and equal the (fixed) wage in Europe. This result resembles the one of Davis (1998) who finds that differences in the accumulation of labour can not explain divergent wage trends. The parameter space corresponds to a regime of multinational firms based in both countries. Increases in the American labour supply put downward pressure on American wages. More and more multinationals move their headquarters from Europe to America increasing labour demand in America and decreasing it in Europe. This allows America to sustain its wage level while European unemployment soars.

Once all multinationals have relocated to America further factor accumulation leads to a decline in American wages. The number of multinationals based in America increases only slightly and no additional labour demand is generated from relocation of headquarters. In this parameter space unemployment in Europe is hardly affected by American factor accumulation. It even falls somewhat as the (slightly) increasing number of multinationals based in America is accompanied by a (slight) increase of production in Europe.

Further decreases in the American wage rate increase the competitiveness of national American firms relative to their multinational competitors. As soon as national firms enter the market, production of the X good starts being relocated from Europe to America. This causes a surge

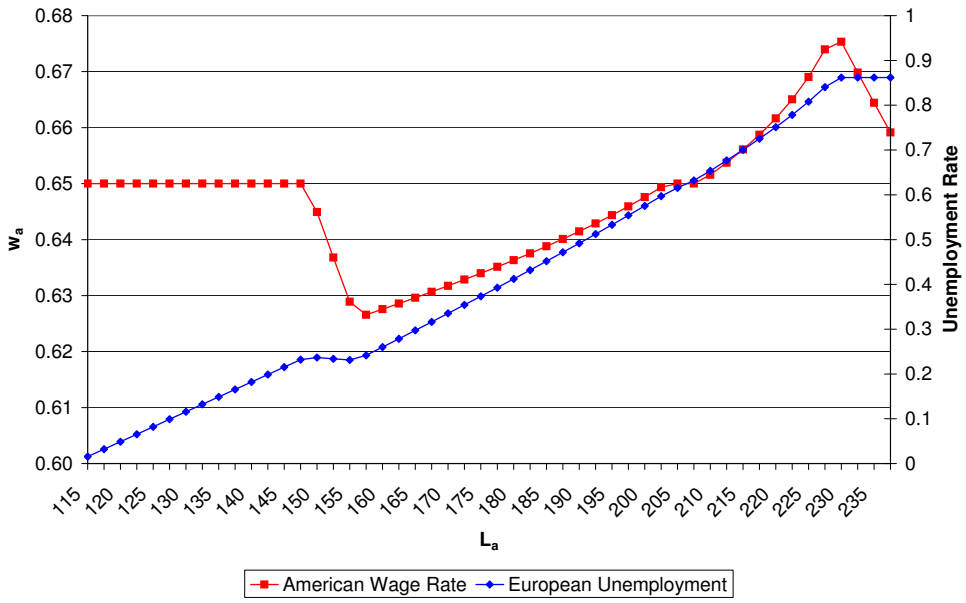

Figure 9: Labour Market Consequences of an Increase in American Labour Supply

in American labour demand and depresses labour demand in Europe. Hence, American wages and unemployment in Europe start to increase hand in hand. These developments also change the relative size of the two markets and favour the establishment of national firms based in America. Further factor accumulation will lead to higher and higher American wages while unemployment keeps on rising in Europe. The development comes to an end at the point at which all production of the X good takes place in America and only national firms are left in the market. Further increases in American labour supply will then again depress American wages. The unemployment rate in Europe is left unchanged since the X sector does not generate labour demand any more. Thus, lower American wages do not influence relative costs of European firms as the latter do simply not exist.

7 Concluding Remarks

This paper has studied the effects of introducing a one-sided minimum wage in a model of intra-industry trade and multinational firms. Even though factor prices do not equalise across countries, the overarching message of Davis (1998) is confirmed. National labour market regulations profoundly interact and can not be analysed in isolation when goods markets are global.

The result illustrates why rigid institutions might have contributed significantly to the European unemployment problem even though they were already in place long before the problem actually occurred. Moving towards a global world economy dramatically alters the outcome of labour market rigidity.

The paper has shown that the adverse employment effects of an asymmetric minimum wage are much more pronounced in an open economy setting with positive intra-industry trade compared to a framework without exporters. Perhaps surprisingly, multinational firms do not worsen but potentially mitigate the effects somewhat. While there is no one-to-one relation between the European minimum wage and the wage rate in America (as in Davis, 1998), a (binding) wage floor in one country will prop up wages in the other. The magnitude of the effects and the differences between the results derived in open and closed economy settings depend crucially on the level of trading barriers.

In particular, (asymmetric) wage rigidities are likely to affect employment prospects more severely in economies with a high degree of openness than in economies that are shielded from foreign competition by relatively high trading barriers. Consequently, wage flexibility appears to be of specific importance for the labour market performance in open economies. This finding suggests that labour market reforms should indeed be directed towards a higher degree of (wage) flexibility in the face of global competition. Alternatively, one may argue for more coordination of labour market policies among countries. If institutions that cause wage rigidity are - for whatever reason - perceived to play a beneficial role, adverse effects can be reduced by simultaneously introducing them in more than just one country. Since moving from a closed to an open economy setting depresses welfare in the rigid-wage country, there might even be a case for protectionism in the presence of one-sided wage rigidities.

The interaction of national labour market institutions is also illustrated with respect to the effects of local factor accumulation on global labour market outcomes. Factor accumulation in Europe has no effect on American wage rates which are protected by the binding European minimum wage. Unemployment rates in Europe rise hand and hand with national labour endowment. On contrary, the effects of an increase in the American labour supply are more subtle.

The direction generally depends on the level of the minimum wage and the resulting types of firms active in equilibrium. In fact, factor accumulation in America can even *increase* American wages.

The model lends itself to a number of extensions. The present study has, for instance, abstracted from key elements that characterise the recent wave of economic integration. A central and novel feature that has attracted a lot of academic and public attention has been the fragmentation of production across national borders. Furthermore, trade with developing countries such as China or India has soared. Adding elements of these features to the model may generate further important insights into the interaction of national labour market regulations in a globalised world.

References

[1] Brander, James and Paul Krugman (1983). A 'reciprocal dumping' model of international trade. *Journal of International Economics*, 15(3-4):313–321.

[2] BMWi (2006), Wissenschaftlicher Beirat. *Der deutsche Arbeitsmarkt in Zeiten globalisierter Maerkte.* Berlin.

[3] Davidson, Carl and Steven J. Matusz (2004). *International trade and labor markets: theory, evidence, and policy implications.* W.E. Upjohn Institute for Employment Research, Kalamazoo, Michigan.

[4] Davis, Donald R. (1998). Does European unemployment prop up American wages? National labor markets and global trade. *American Economic Review*, 88(3):478–94.

[5] Kok, Wim (2004). *Facing the challenge. The Lisbon Strategy for Growth and Employment,.* Report from the High Level Group chaired by Wim Kok submitted to the European Council.

[6] Kreickemeier, Udo and Douglas Nelson (2006). Fair wages, unemployment and technological change in a global economy. *Journal of International Economics*, 70(2):451–469.

[7] Markusen, James R. (2002). *Multinational firms and the theory of international trade.* The MIT Press.

[8] Markusen, James R. and Anthony J. Venables (1998). Multinational firms and the new trade theory. *Journal of International Economics*, 46(2):183–203.

[9] Navaretti, Giorgio B. and Anthony J. Venables (2004). *Multinational Firms in the World Economy.* Princeton University Press.

[10] Oslington, Paul (2002). Factor market linkages in a global economy. *Economics Letters*, 76(1):85–93.

[11] Scheve, Kenneth F. and Matthew J. Slaughter (2001). *Globalization and the Perception of American Workers.* Institute for International Economics, Washington, DC.

[12] Venables, Anthony J. (1985). Trade and trade policy with imperfect competition: The case of identical products and free entry. *Journal of International Economics*, 19(1-2):1–19.

A Proofs

A.1 Proof of Proposition 1

Proof. I start with differentiating equations (32) and (33) with respect to w_e to find

$$\frac{\varepsilon^{oe}}{\partial w_e} = cw_a(c+t)\left(\frac{-n(n-1)}{(nw_a(c+t)-c(n-1)w_e)^2} - \frac{2}{(w_a(c+t)+cw_e)^2}\right) < 0, \tag{43}$$

$$\frac{\varepsilon^{oa}}{\partial w_a} = cw_a(c+t)\left(\frac{-(n-1)n}{(cnw_a-(n-1)(c+t)w_e)^2} - \frac{2}{(cw_a+(c+t)w_e)^2}\right) < 0. \tag{44}$$

Hence, the elasticities are decreasing in w_e. Next, one can calculate the wage rate, at which the two elasticities exactly equal -1. For ε^{oe} this is true for $w_e = \frac{nw_a(c+t)}{c(3n-2)}$, while for ε^{oa} one finds that $w_e = \frac{cnw_a}{(c+t)(3n-2)}$ delivers an elasticity of -1. Hence, the following conditions have to be fulfilled for the proposition to hold

$$w_e \geq \frac{nw_a(c+t)}{c(3n-2)}, \tag{45}$$

$$w_e \geq \frac{cnw_a}{(c+t)(3n-2)}. \tag{46}$$

Consider first condition (45) referring to the wage elasticity of production for market e. From equation (30) one can infer that for nonnegative levels of exports into the European market, w_e has to be equal to or larger than $\frac{(n-1)w_a(c+t)}{cn}$. Plugging this lower bound into equation (45) leaves us with $\frac{n-1}{n} \geq \frac{n}{3n-2}$, which is always fulfilled for the assumption $n \geq 2$. Similarly, for the American market one can derive a lower bound for w_h from equation (29) assuming $X_{aa}^n > 0$.[16] Substituting into condition (46) yields again $\frac{n-1}{n} \geq \frac{n}{3n-2}$. □

A.2 Proof of Proposition 2

Proof. Taking the first derivative of exports from America to Europe with respect to w_e yields

$$\frac{\partial X_{ae}^n}{\partial w_e} = \frac{\beta M_e c(2n-1)((3n-2)w_a(c+t)-cnw_e)}{n^2(w_a(c+t)+cw_e)^3}. \tag{47}$$

[16] The assumption follows directly from assuming nonnegative intra-industry trade. A national firm will always produce for the domestic market provided that it is an exporter.

This expression is nonnegative as long as $w_e \leq \frac{(3n-2)w_a(c+t)}{cn}$. By plugging in the upper bound for w_e as derived from equation (29), $w_e \leq \frac{nw_a(c+t)}{c(n-1)}$, one obtains $\frac{n}{n-1} \leq \frac{3n-2}{n}$. The assumption $n \geq 2$ guarantees that the condition is satisfied.

The derivative of production of a firm based in America for its domestic market with respect to European wages is given by

$$\frac{\partial X_{aa}^n}{\partial w_e} = \frac{\beta M_a(2n-1)(c+t)(cw_a(3n-2) - nw_e(c+t))}{n^2((c+t)w_e + cw_a)^3} \tag{48}$$

The expression will be nonnegative for $w_e \leq \frac{cw_a(3n-2)}{n(c+t)}$ which can again be verified by plugging in the upper bound of w_e. □

B Additional Tables and Figures

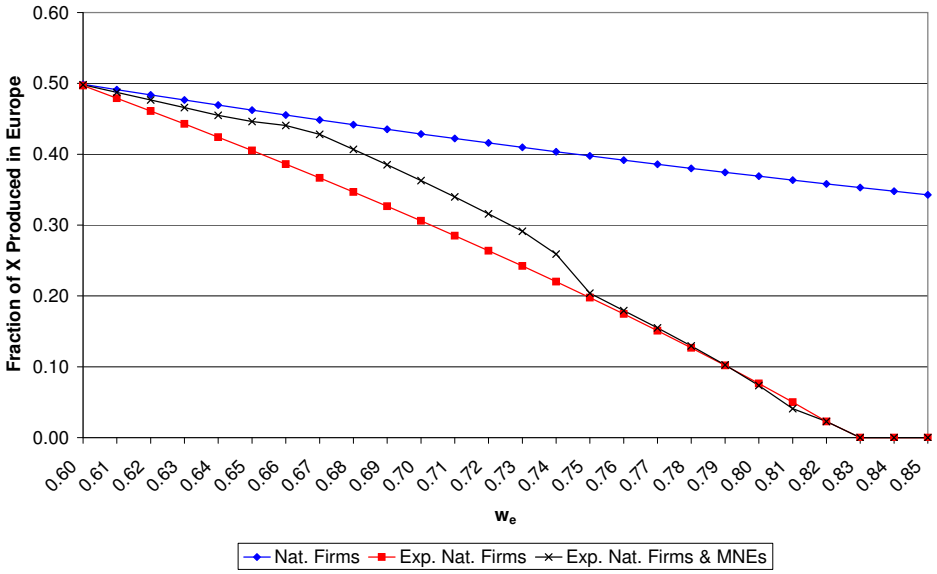

Figure 10: Effect of a European Minimum Wage on the Fraction of Worldwide X Consumption Produced in Europe

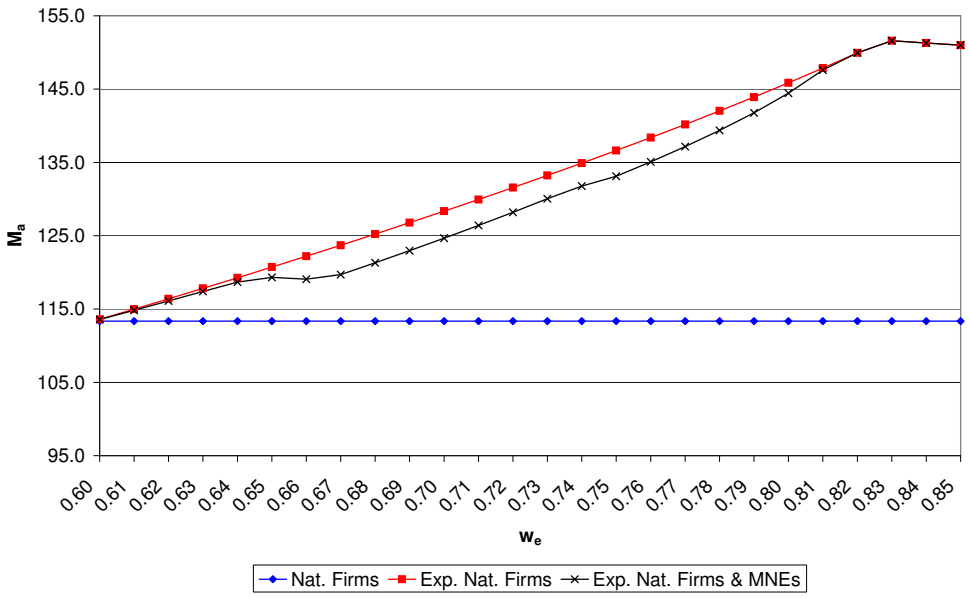

Figure 11: Effect of a European Minimum Wage on the American Income Level

<table>
<tr><th>w_h</th><th>t = 0.05</th><th>t = 0.15</th><th>t = 0.25</th><th>t = 0.35</th></tr>
<tr><td>0.60
0.61
0.62
0.63
0.64</td><td rowspan="19">n_e, n_a</td><td>m_e, m_a</td><td>m_e, m_a</td><td>m_e, m_a</td></tr>
<tr><td>0.65
0.66
0.67
0.68</td><td>m_a</td><td rowspan="4">m_a</td><td rowspan="6">m_a</td></tr>
<tr><td>0.69
0.70
0.71
0.72</td><td>m_a, n_a</td></tr>
<tr><td>0.73
0.74</td><td>m_e, m_a, n_a</td></tr>
<tr><td>0.75
0.76
0.77
0.78
0.79
0.80
0.81</td><td>m_e, n_a</td><td rowspan="5">m_a, n_a</td></tr>
<tr><td>0.82
0.83</td><td rowspan="7">n_a</td><td rowspan="6">m_a, n_a</td></tr>
<tr><td>0.84
0.85</td><td rowspan="6">n_a</td><td>m_e, n_a</td></tr>
<tr><td>0.86
0.87
0.88
0.89
0.90</td><td rowspan="5">n_a</td></tr>
</table>

Table 2: Type of Firms Active in Equilibrium for Different t Values