

# Sectoral impact of free intra-EU migration in the presence of unemployment benefits

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## **Abstract**

This paper builds a multi-sector, three country (centre and two peripheries), New Economic Geography model, where industrial sectors differ in the degree of scale economies and skill-intensity. The model incorporates, for the first time in this class of models, payments to the unemployed in each country. The model is used to evaluate the impact of migration in the enlarged EU under a range of possible migration scenarios involving three types of workers: skilled, unskilled, and unemployed. Full migration is the only scenario in which the central country obtains an increase in both skilled and unskilled wages and employment levels. This obverse is true for the two peripheral countries, they lose firms and real wages decline. As a consequence, the central country has an interest in allowing for full migration but the two peripheral countries have an interest in restricting migration.

**Keywords:** new economic geography, migration, EU enlargement, unemployment, human capital

**JEL:** F15, F16, F22, J61

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## 1 Introduction

The Eastern enlargement of the EU has happened in May 2004. However, the new Eastern member states are not yet full members of the EU's Single Market, as the old member countries have decided to impose discretionary restrictions to East-West migration for up to seven years after the enlargement. A first appraisal will occur two years after the enlargement, and a second appraisal will take place five years from that date. Hence the seven-year scheme is in fact a 2+5+2 scheme. Given these intermediate appraisals, it is of utmost importance to shed some light on what is effectively the optimal migration policy in terms of jobs and wages. That is the objective of this paper.

We use a NEG model with unemployment and simulate the effects of free migration for three types of labour – skilled, unskilled, and unemployed – and combinations thereof. We find that the North has an interest in permitting full migration, if the policy objective is to preserve wages or to preserve jobs. On the contrary, the South and East would lose. The introduction of unemployment does not substantially affect jobs and wages paid by the firms, but it affects the net wages received by the workers after paying the unemployment tax.

The paper is organised as follows: section 2 describes the model and solves it for equilibrium, section 3 presents the simulation results, and section 4 concludes.

## 2 The Model

There are three “countries” in the model, labelled N, S, E. Countries N and S are members of a Single Market that is enlarged to accommodate the poorer third country E. The Single Market comprises free mobility of goods, capital and labour. In this paper we will be dealing only with the latter, as we assume that the previous two freedoms have already been implemented. The inclusion of country E in the Single Market may give rise to a hub effect in the sense of Krugman (1993) if one country has better market access to the other two than the latter have to each other. Let us assume that the richest country N is the hub, that is, the costs of moving between the hub region and each of the spoke regions are lower than those incurred by the two spokes.

The costs of movement within the Single Market have two main distinct components that are useful to disentangle. The first is non-spatial costs ( $t$ ) such as legal barriers to employment (e.g., work permits and

other restrictions) that can be compressed by labour market integration.<sup>1</sup> For simplicity, we assume that these costs are reduced at the same rate (symmetrically) by all current Single Market member countries (N and S) towards the new potential members (E). The second component of costs of movement is purely spatial and depends on distance. Though they can be decreased by, for example, infrastructure improvement, these costs can never be zero. Moreover, spatial costs are country pair-specific. Hence, let them be equal to  $\tau_{ij}d_{ij}$ , with  $d$  the distance between countries  $i$  and  $j$ , and  $\tau_{ij}>0$  a parameter that measures the quality of infrastructures in that country-pair. Thus the total cost of moving goods and factors between countries  $i$  and  $j$  is given by:

$$T_{ij} = t_{ij} + \tau_{ij}d_{ij}. \quad (1)$$

In each country there is a finite number ( $h$ ) of industrial sectors that employ two factors of production, unskilled labour ( $L^U$ ) and skilled labour ( $L^S$ ), in different proportions. Hence some sectors are relatively skill-intensive and others are relatively labour-intensive. The novel feature of the model is the incorporation of unemployment. For simplicity, we assume that each country has a pool of “reserve labour” working in the “reserve sector”, which can be equated to the agricultural sector. The latter only employs reserve labour. The constant returns to scale agricultural sector is perfectly competitive and uses reserve labour to produce a homogeneous commodity  $Y$  that is costlessly tradable and will serve as numeraire. Thus for all countries, the price of the homogeneous good ( $p_Y$ ) and the wage of reserve labour ( $w^R$ ) both equal one. The  $h$  increasing returns to scale industrial sectors ( $X_n$ ) are composed of imperfectly competitive firms that produce both final and intermediate differentiated goods in a Dixit and Stiglitz (1977) manner using both unskilled and skilled labour in different proportions. In the industrial sectors, economies of scale arise from the presence of fixed costs and constant marginal costs, both given in terms of labour. This means that no firm that enters the market will produce an already existing variety. Hence each firm is a monopolist in the production of its own variety.

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<sup>1</sup> With completion of the Single Market for labour non-spatial costs would become zero.

## 2.1 The consumer

The consumer is modelled in the standard way (see Fujita et al. (2000)) as we assume that all countries share a preference structure with a CES functional form. Hence we will use a generic country subscript  $i$ . The utility function for a consumer in country  $i$  can be written as:<sup>2</sup>

$$U_i = \left[ \prod_h (X_{ih})^{\gamma_h} \right]^\rho (Y_i)^{1-\rho}, \quad 0 < \gamma_h < 1, \quad \sum_h \gamma_h = 1, \quad 0 < \rho \leq \frac{1}{3} \quad (2)$$

with each of the increasing returns to scale composite good formed as follows:

$$X_{ih} = \left[ \int_0^{N_h} (x_{ihk})^{\frac{\sigma-1}{\sigma}} dk \right]^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 1$$

where  $x_{ihk}$  is the quantity consumed of each variety  $k$  produced in sector  $h$  in country  $i$ ,  $N_h$  is the number of varieties effectively produced in sector  $h$ ,  $\sigma$  is the elasticity of substitution among varieties of the same good,  $\gamma$  is the share of expenditure on each differentiated good, and  $\rho$  is the share of expenditure on all the differentiated goods. Let  $n_{ih}$  be the total number of varieties of differentiated goods of sector  $h$  effectively produced in country  $i$ ,  $p_i$  the Free-On-Board prices in the producer's location  $i$  and  $i_i$  individual income in country  $i$ . The budget constraint faced by a consumer in country  $i$  can then be written as:

$$p_i Y_i + \sum_{j \in EU} \sum_h \int_0^{n_{jh}} T_{ij} p_{jkh} x_{ihk} dk = i_i. \quad (3)$$

Consumers maximise utility (2) subject to the budget constraint (3). Assume that the price index  $P_i$  of each industry's aggregate good in country  $i$  is the same for inputs as for final products and is expressed as:<sup>3</sup>

$$P_{ih} = \left[ \sum_{j \in EU} \int_0^{n_{jh}} (T_{ij} p_{jkh})^{1-\sigma} dk \right]^{\frac{1}{1-\sigma}}. \quad (4)$$

<sup>2</sup> The assumption of a share of manufactures in consumption not higher than 1/3 ensures that, even if all industry is concentrated in a single country, this country also has some agriculture and thus even with fixed labour force all countries have a pool of reserve labour to draw from.

<sup>3</sup> The procedure for the derivation of the CES demand functions and corresponding price index is fully described in Fujita et al. (2000).

We know that  $i_i$  is individual income in country  $i$ , and that each consumer allocates to good  $Y$  a share  $1-\rho$  of individual income. Thus a consumer's demand for good  $Y$  in country  $i$  is simply:

$$Y_i = (1-\rho)i_i \quad (5)$$

Solving for the first order conditions we find the demand functions in market  $i$  for a variety  $k$  of each sector  $X_1$  and  $X_2$  produced in country  $j$ , with  $i, j = N, S, E$ :

$$x_{ijhk} = \left[ P_{jkh} \right]^{-\sigma} \left[ \frac{T_{ij}}{P_{ih}} \right]^{1-\sigma} \gamma_h \rho i_i \quad (6)$$

Plugging the demand functions (5) and (6) back into the utility function (2) we get the usual indirect utility of the representative consumer in country  $i$ :

$$V_i = \prod_h (P_{ih})^{-\gamma_h \rho} i_i \quad (7)$$

Aggregate income in country  $i$  with total population  $L_i$  is simply the sum of factor's rewards, with  $w_i^S > w_i^U > w_i^R$ . With two factors of production, skilled ( $L^S$ ) and unskilled labour ( $L^U$ ), and some unemployed or reserve labour ( $L^R$ ), equilibrium aggregate income is then given by the sum of individual incomes:<sup>4</sup>

$$I_i = \sum_{L_i} i_i = w_i^S L_i^S + w_i^U L_i^U + w_i^R L_i^R = (1+r) (w_i^S L_i^S + w_i^U L_i^U) \quad (8)$$

where  $r$  is the rate of unemployment benefit, defined as a fraction taxed over the wage of those employed. Although there is no government in the model, we can think of the redistribution being made by firms. They pay each worker  $(1+r)$  times the wage, of which the fraction  $r$  will be redistributed to the unemployed. A balance must be maintained at all times and thus in each country  $i$  the parameter  $r$  is given by:

$$r_i = \frac{w_i^R L_i^R}{w_i^S L_i^S + w_i^U L_i^U} \quad (9)$$

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<sup>4</sup> Rigorously, firms' profits are part of individual income as well. However, we choose to ignore them since we know that in equilibrium they will be zero.

## 2.2 The firm

There are two factors of production, unskilled labour ( $L^U$ ) and skilled labour ( $L^S$ ), used by the manufacturing sector. The constant returns to scale sector uses reserve labour  $L^R$  to produce  $Y$ . The increasing returns to scale sectors use both unskilled and skilled labour, though in different proportions, allowing some sectors to be skill-intensive and others to be labour-intensive. We also assume that skilled and unskilled labour are substitutable in production. We start by assuming that all factors are immobile, though later we allow the different types of labour to move across countries. As in Krugman and Venables (1996), we assume that a firm's unit cost is the product of the unit cost of each input weighted by its respective shares in total cost. Labour and intermediate goods are combined with a Cobb-Douglas technology. Production uses  $f$  units of the input as a fixed cost and  $c$  per unit output thereafter, with the share of intermediate goods, skilled and unskilled labour being the same in fixed and marginal costs. As in Venables (1999), we assume that inter-industry linkages are so small relatively to intra-industry linkages that the former can be ignored and only the latter are kept. Hence the minimum cost function for producing a variety  $k$  in country  $i$  will be:

$$TC_{ikh} = (P_{ih})^\mu \left( (1+r)w_{ih}^S \right)^\alpha \left( (1+r)w_{ih}^U \right)^{1-\alpha-\mu} (f + cx_{ikh}) \quad (10)$$

with  $w^S$  and  $w^U$  the wage rates for skilled and unskilled labour, respectively,  $\alpha$  the share of skilled labour in total cost,  $\mu$  the share of intermediates in total cost,  $c$  the marginal cost,  $x$  the equilibrium output, and  $r$  the "reserve labour subsidy". The total demand from consumers and firms of both sectors faced in market  $i$  by a firm producing variety  $k$  in country  $j$  is given by:

$$x_{ijhk} = [P_{jhk}]^{-\sigma} \left[ \frac{T_{ij}}{P_{ih}} \right]^{1-\sigma} E_{ih} \quad (11)$$

with  $E_{ih}$  the expenditure function given by:

$$E_{ih} = \gamma_h \rho I_i + \mu \int_0^{n_{i1}} TC_{i1k} dk \quad (12)$$

where  $I_i$  is the total income in country  $i$ . Summing up equations (11) among consumer countries  $i$  we get the world demand for each variety produced in each country  $j$ . The profit-maximising price is a mark-up over marginal cost:

$$p_{ihk} = \left( \frac{\sigma}{\sigma-1} \right) (P_{ih})^\mu \left( (1+r)w_{ih}^S \right)^\alpha \left( (1+r)w_{ih}^U \right)^{1-\alpha-\mu} c. \quad (13)$$

From the zero profit condition we can obtain the firm's equilibrium output:

$$x_{ih} = \frac{(\sigma-1)f}{c}. \quad (14)$$

The last relationship to be found is the firm's demand for labour. As only one firm produces each variety and each firm produces only one variety, the number of varieties to be supplied by each sector in each country corresponds to the number of firms in each sector in each country. This number is given implicitly by determining the employment in each sector and country (N, S, E). In manufacturing, employment levels are proportional to the respective number of varieties produced. Let  $\lambda_{ih}$  be the share of country  $i$ 's labour force working in manufacturing sector  $h$ . In each country the total labour endowment can be decomposed as:

$$L_i = L_i^S + L_i^U + L_i^R = \left( \sum_h \lambda_{ih}^S + \lambda_{ih}^U \right) + L_i^R \quad (15)$$

As all firms in the same industry are symmetric, each employs an equal share of workers in the industry. Applying Shephard's lemma to (10) and aggregating over all firms in the industry we obtain the equilibrium wage bill of skilled and unskilled workers:

$$\left( w_{ih}^S \right)^{1-\alpha} \lambda_{ih}^S = \sigma \alpha (1+r)^{1-\mu} (P_{ih})^\mu \left( w_{ih}^U \right)^{1-\alpha-\mu} n_{ih} \quad (16)$$

$$\left( w_{ih}^U \right)^{\alpha+\mu} \lambda_{ih}^U = \sigma (1-\alpha-\mu) (1+r)^{1-\mu} (P_{ih})^\mu \left( w_{ih}^S \right)^\alpha n_{ih} \quad (17)$$

Note that each wage is a function of the other as the two types of labour are substitutable. Firms will adjust the skill-intensity of production to the skill premium. In the short run labour is immobile across countries, but in the long run it is free to move (migrate). Migration happens until differences in real wages are eliminated.<sup>5</sup> Thus, following Puga (1999), for each type of worker, the equality of real wages at equilibrium means the equality of indirect utility in all countries, this is:

$$\prod_h (P_{Nh})^{-\gamma_h \rho} w_{Nh}^S = \prod_h (P_{Sh})^{-\gamma_h \rho} w_{Sh}^S = \prod_h (P_{Eh})^{-\gamma_h \rho} w_{Eh}^S \quad (18)$$

<sup>5</sup> Note that real wages are the ratio of nominal wages over the price ratio and in turn the price ratio depends on the costs of moving (T).

$$\prod_h (P_{Nh})^{-\gamma_h \rho} \mathcal{W}_{Nh}^U = \prod_h (P_{Sh})^{-\gamma_h \rho} \mathcal{W}_{Sh}^U = \prod_h (P_{Eh})^{-\gamma_h \rho} \mathcal{W}_{Eh}^U \quad (19)$$

$$\prod_h (P_{Nh})^{-\gamma_h \rho} \mathcal{W}_{Nh}^R = \prod_h (P_{Sh})^{-\gamma_h \rho} \mathcal{W}_{Sh}^R = \prod_h (P_{Eh})^{-\gamma_h \rho} \mathcal{W}_{Eh}^R \quad (20)$$

### 2.3 General equilibrium

The previous subsections provided the building blocks of the model. The next step is to solve for equilibrium following Puga and Venables (1997) and Puga (1999). We choose units such that  $c = \frac{\sigma-1}{\sigma}$ . The assumption of absence of inter-industry linkages allows us to solve a separable problem for each industry. The system to be analysed consists of three fundamental equations on the price index, profit and expenditure that aggregate all the others.<sup>6</sup> The price index equation is obtained once we substitute the pricing equation (13) into the price index expression (4). The profit equation comes from the short run demand-supply relationship given by the difference between (11) and (14) substituting in (8), (10) and (13). When migration is allowed (18)-(20) are used as well. After substituting and rearranging we can summarise the general equilibrium behaviour of each country in the following three equations:

$$P_{ih}^{1-\sigma} = \sum_{j \in EU} T_{ij}^{1-\sigma} P_{jh}^{\mu(1-\sigma)} \left( (1+r)w_{jh}^S \right)^{\alpha(1-\sigma)} \left( (1+r)w_{jh}^U \right)^{(1-\alpha-\mu)(1-\sigma)} n_{jh} \quad (21)$$

$$\begin{aligned} \Pi_{jh} = & \sum_{i \in EU} T_{ij}^{1-\sigma} P_{ih}^{\sigma-1} P_{jh}^{\mu(1-\sigma)} P_{ih}^{1-\sigma} \left( (1+r)w_{jh}^S \right)^{\alpha(1-\sigma)} \left( (1+r)w_{jh}^U \right)^{(1-\alpha-\mu)(1-\sigma)} E_{ih} n_{jh} - \\ & - \sigma P_{jh}^{\mu} \left( (1+r)w_{jh}^S \right)^{\alpha} \left( (1+r)w_{jh}^U \right)^{1-\alpha-\mu} n_{jh} \end{aligned} \quad (22)$$

$$E_{ih} = \gamma_h \rho (1+r) \left( w_{ih}^S L_{ih}^S + w_{ih}^U L_{ih}^U \right) + \sigma \mu P_{ih}^{\mu} \left( (1+r)w_{ih}^S \right)^{\alpha} \left( (1+r)w_{ih}^U \right)^{1-\alpha-\mu} n_{ih} \quad (23)$$

These equations jointly determine the equilibrium values of price indexes, profits and expenditures in the producing country  $j$  and the market country  $i$ , given the allocation of labour across industries  $h$  defined by (16)-(17). The price index equation implies that the competition effect is stronger than the economies of scale effect as the price index decreases with the number of firms. The profit equation gives the short run profits obtained by firms in each country and sector. As demand and supply adjust, profits approach zero and the equation then defines the skilled and unskilled wages at which firms in each country and sector break even,

<sup>6</sup> The expenditure equation is written for simplicity of representation. Actually this expression can be substituted back into the profit equation, eliminating expenditure from the system.

given the expenditure levels, quality levels and price indices in all countries, and trade costs with these countries.

There are four locational forces that together determine the equilibrium distribution of firms across locations: forward and backward linkages, and product and labour markets competition. When forward and backward linkages are strong enough they can overturn product and labour market competition thereby making dispersed outcomes unstable and triggering industrial agglomeration. Forward and backward linkages tend to increase the profitability of locations with a larger number of firms. Forward linkages come from the assumption that firms use the output of other firms in the same industry as input (intra-industry linkages). A larger number of locally produced varieties, other things being equal, implies a lower price index of industrial goods, and therefore lower costs of production, as shown in (10). Backward linkages arise as an increase in the mass of local firms and/or number of workers raises local expenditure on final and/or intermediate industrial goods, as shown in (11), and firms benefit from a shift in expenditure from their foreign market to their local market.

Product and labour markets competition tend to make firms located in markets with a relatively high number of firms less profitable, thereby encouraging the geographical dispersion of industry. Product market competition is stronger where a higher number of varieties is produced locally in the sense that the price index of industrial goods is lower, as shown in (4), so that, for given price and expenditure levels, local demand for each industrial good is smaller, as shown in (11). Labour market competition appears in (16) for skilled labour and in (17) for unskilled labour: a larger number of firms producing in the same location increases local demand for both types of labour, leading to higher wage costs, thus increasing firms' costs. Since skilled and unskilled labour are substitutable to some extent, the demand for the two types are interlinked: a higher skilled wage increases demand for unskilled labour and vice-versa. The "reserve labour subsidy" also increases demand for labour, as unemployment becomes relatively more expensive and more workers are necessary to keep balance. However, this effect is weighted by the share of inputs such that the existence of unemployment provides firms with an incentive to replace labour with capital.

A long-run equilibrium is defined as a stationary state in which the number of firms in each country no longer changes in response to short-run profits. The stationary state requires zero profits wherever there is a positive number of firms and negative profits (at least for potential firms) wherever the number of firms is zero. In this case, employment levels are assumed to adjust instantly to equalise real wages. An alternative

approach would be to consider the number of workers as state variables, so that migration proceeds gradually while the number of firms adjusts instantly. The two specifications are equivalent in terms of long-run equilibria and stability properties as long as the ratio of real wages when profits are zero is equal to the ratio of profits when wages are equal (Puga (1999)). Selecting the number of firms as state variables has the advantage that the same dynamics can be used with or without inter-regional migration.

Following Puga and Venables (1997), Puga (1999), we rewrite the equilibrium conditions in vector form. Let  $\mathbf{n}$ ,  $\mathbf{P}$ ,  $\mathbf{w}^S$ ,  $\mathbf{w}^U$ ,  $\mathbf{L}^S$ ,  $\mathbf{L}^U$ ,  $\boldsymbol{\lambda}^S$ ,  $\boldsymbol{\lambda}^U$ ,  $\mathbf{R}$  denote 3-column vectors with representative elements  $n_{ih}$ ,  $P_{ih}$ ,  $W_{ih}^S$ ,  $W_{ih}^U$ ,  $L_{ih}^S$ ,  $L_{ih}^U$ ,  $\lambda_{ih}^S$ ,  $\lambda_{ih}^U$ ,  $1+r_{ih}$  respectively. Superscript  $\wedge$  denotes a diagonal matrix with the  $i$ th element of the corresponding vector in position  $(i,i)$  and zeros off the diagonal. We further define the matrix  $\Theta$  as a 3x3 symmetric matrix with representative element  $T_{ij}^{1-\sigma}$ ,  $i \neq j$ , off the diagonal and ones in the diagonal. Hence we can write (21), (22), (16) and (17) as:<sup>7</sup>

$$Q(n, P, \Theta, R, w^S, w^U) \equiv \Theta \hat{P}^{\mu(1-\sigma)} \hat{R}^{(1-\mu)(1-\sigma)} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} n - P^{1-\sigma} = 0 \quad (24)$$

$$\begin{aligned} \Pi(n, P, \Theta, R, w^S, w^U) &\equiv \Theta \hat{P}^{(1-\mu)(\sigma-1)} \hat{R}^{(1-\mu)(1-\sigma)} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} \\ &\left[ \gamma_h \rho \hat{R} (\hat{w}^S L^S + \hat{w}^U L^U) + \sigma \mu \hat{P}^{\mu} \hat{R}^{(1-\mu)} (\hat{w}^S)^{\alpha} (\hat{w}^U)^{(1-\alpha-\mu)} n \right] - \sigma \hat{P}^{\mu} \hat{R}^{(1-\mu)} (\hat{w}^S)^{\alpha} (\hat{w}^U)^{(1-\alpha-\mu)} n = 0 \end{aligned} \quad (25)$$

$$\Lambda^S(n, P, w^S, w^U, \lambda^S) \equiv \sigma \alpha \hat{P}^{\mu} \hat{R}^{(1-\mu)} (\hat{w}^U)^{(1-\alpha-\mu)} n - (\hat{w}^S)^{(1-\alpha)} \lambda^S = 0 \quad (26)$$

$$\Lambda^U(n, P, w^S, w^U, \lambda^U) \equiv \sigma(1-\alpha-\mu) \hat{P}^{\mu} \hat{R}^{(1-\mu)} (\hat{w}^S)^{\alpha} n - (\hat{w}^U)^{(\alpha+\mu)} \lambda^U = 0 \quad (27)$$

Equilibrium values of the number of firms, of the price index of industrial goods and of the skilled and unskilled wages in each country are a simultaneous solution to the system (24)-(27). If migration is allowed, it will occur until differences in real wages are eliminated. Thus, following Puga (1999), with migration we have three more equilibrium conditions that result from writing equation (18) in matrix form and considering that, for each labour type, the equality of real wages at equilibrium means the equality of indirect utility in all countries:

$$V^S(P, w^S) \equiv \hat{P}^{-\gamma_h \rho} w^S = 0 \quad (28)$$

<sup>7</sup> Writing equations (21) and (16) as equations (24) and (26), respectively, is simply a convenient way to carry out the analysis of location and welfare effects in sections 3 and 4. This is because to carry out this analysis the system (24)-(26) is transformed into a system of differential equations in the three variables determined by (24)-(26) and the differentials of formulations (24) and (26) can be

$$V^U(P, w^U) \equiv \hat{P}^{-\gamma_h \rho} w^U = 0 \quad (29)$$

$$V^R(P, w^R) \equiv \hat{P}^{-\gamma_h \rho} w^R = 0 \quad (30)$$

We will conduct a number of policy experiments through a matrix  $d\Theta$  representing symmetric changes in the policy matrix  $\Theta$ . Let us first define the integration matrix  $d\Theta$ . Suppose that N is EU-North, S is EU-South and E is EU-East. Then the eastward enlargement of the Single Market can be described as a decrease in transaction costs between N and E and between S and E such that:

$$d\Theta = \begin{bmatrix} 0 & 0 & d\Theta_{NE} \\ 0 & 0 & d\Theta_{SE} \\ d\Theta_{NE} & d\Theta_{SE} & 0 \end{bmatrix} \quad (31)$$

where  $d\Theta_{iE} = (1 - \sigma)T^{-\sigma}dT_{iE} > 0$ ,  $i = N, S$ . We incorporate asymmetry by assuming that the decrease in costs is not the same for country pairs NE and SE, since, as stated before, the existence of both spatial and non-spatial costs leads to a different evolution across country pairs. These experiments will allow the comparison of the firm location and real income effects that result from free migration of skilled, unskilled, “reserve” labour, and combinations thereof, that leads to real wage equalisation as described in (18)-(20). By totally differentiating the system (24)-(27), together with (28)-(30), we obtain:

$$Q_P dP + Q_n dn + Q_\Theta d\Theta + Q_R dR + Q_{w^S} dw^S + Q_{w^U} dw^U = 0 \quad (32)$$

$$\pi_P dP + \pi_n dn + \pi_\Theta d\Theta + \pi_R dR + \pi_{w^S} dw^S + \pi_{w^U} dw^U = 0 \quad (33)$$

$$\Lambda_P^S dP + \Lambda_n^S dn + \Lambda_\Theta^S d\Theta + \Lambda_{w^S}^S dw^S + \Lambda_{w^U}^S dw^U + \Lambda_{\lambda^S}^S d\lambda^S = 0 \quad (34)$$

$$\Lambda_P^U dP + \Lambda_n^U dn + \Lambda_\Theta^U d\Theta + \Lambda_{w^S}^U dw^S + \Lambda_{w^U}^U dw^U + \Lambda_{\lambda^U}^U d\lambda^U = 0 \quad (35)$$

$$V_P^S dP + V_{w^S}^S dw^S = 0 \quad (36)$$

$$V_P^U dP + V_{w^U}^U dw^U = 0 \quad (37)$$

$$V_P^R dP + V_{w^R}^R dw^R = 0 \quad (38)$$

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conveniently expressed in a standard form which yields, together with the total differential of (25), explicit expressions for the differentials of the three variables determined in (24)-(26). Hence the fictitious functions Q and  $\Lambda$ .

where  $Q_P, Q_n, Q_\Theta, Q_R, Q_{w^S}, Q_{w^U}, \pi_P, \pi_n, \pi_\Theta, \pi_R, \pi_{w^S}, \pi_{w^U}, \Lambda_P^S, \Lambda_n^S, \Lambda_\Theta^S, \Lambda_{w^S}^S, \Lambda_{w^U}^S, \Lambda_{\lambda^S}^S, \Lambda_P^U, \Lambda_n^U, \Lambda_\Theta^U, \Lambda_{w^S}^U, \Lambda_{w^U}^U, \Lambda_{\lambda^U}^U, V_P^S, V_{w^S}^S, V_P^U, V_{w^U}^U, V_P^R, V_{w^R}^R$  are partial derivatives whose explicit forms are given in Appendix A. By substituting those explicit forms into (32)-(38) and solving for  $d\mathbf{n}$ ,  $d\mathbf{P}$ ,  $d\mathbf{w}^S$ ,  $d\mathbf{w}^U$ ,  $d\lambda^S$ ,  $d\lambda^U$ , and  $d\mathbf{R}$  as functions of  $d\Theta$ , we can obtain some preliminary conclusions about the responsiveness of the number of firms and real wages of skilled, unskilled and unemployed to policy changes.

### 3 Simulation results

Given the complexity of the analytical expressions after solving (32)-(38) we will proceed by simulation with the objective of evaluating different migration policies given the policy matrix (31). The values that will be presented in section 3 are simply the percentage changes in the number of firms, the real skilled wage, the real unskilled wage, and the level of unemployment benefit following a one percent change in the ‘cost of migration’  $T$ . Following Baldwin et al. (2000), industrial sectors were assigned factor value-added shares and ordered in descending order of the ratio of skilled to unskilled labour employed in the sector (see appendix B for details). Parameter values are those used in Puga and Venables (1997), Puga (1999), that is,  $\gamma=0.5$ ,  $\rho=0.3$ ,  $\sigma=6$ . The cases simulated are eight: (1) migration of skilled, unskilled and “reserve” labour; (2) migration of skilled and unskilled labour ( $d\mathbf{R} = 0$ ); (3) migration of skilled and “reserve” labour ( $d\lambda^U = 0$ ); (4) migration of unskilled and “reserve” labour ( $d\lambda^S = 0$ ); (5) migration of skilled labour ( $d\lambda^U = d\mathbf{R} = 0$ ); (6) migration of unskilled labour ( $d\lambda^S = d\mathbf{R} = 0$ ); (7) migration of “reserve” labour ( $d\lambda^S = d\lambda^U = 0$ ); (8) absence of migration ( $d\lambda^S = d\lambda^U = d\mathbf{R} = 0$ ).

The results of experiments (2), (5), (6), and (8) will be first analysed sectorally in section 3.1, abstracting from the issue of unemployment.<sup>8</sup> Then, in section 3.2, we look at the impact of unemployment in terms of unemployment bill under experiments (1), (3), (4), and (7).

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<sup>8</sup> The results with and without unemployment are very similar in terms of number of firms and wages. The difference is in the unemployment tax and so the latter will be analysed separately.

### **3.1 Sectoral analysis**

The percentage change in the number of firms, skilled and unskilled wages, and skill premium induced by a 1% reduction in  $T$  is shown in Tables 1-4 for each migration experiment. The real wage of skilled and unskilled workers is affected by the interplay of four forces: (1) an induced demand for labour from the goods market which will also have an impact on the price levels in the economy; (2) where the 'reserve' labour force is permitted to migrate there will be a change in the cost of labour via a change in the unemployment tax levied on firms; (3) migration will provide a change in the supply of labour that is available to each sector; (4) and finally allowing firms to adjust the ratio of skilled to unskilled workers will induce firms to restructure their workforce.

In the no migration scenario, there is a net loss of firms in nearly all sectors in each of the country groups, this is the result of a restructuring of the sectors which generates an increase in the real wage for both the skilled and the unskilled workers in almost all cases. In addition the skill premium increases in almost all sectors in the North and South, though generally more in the least skilled sectors. The status quo scenario therefore generates an increase in welfare in all regions although the skilled workers gain a greater share of the benefits.

If migration is restricted to skilled workers only, there is a growth of firms in all regions with the exception of the two least skilled sectors in the North. However, this increase in the supply of labour reduces the welfare of the economies, with the unskilled suffering most. In effect what is occurring is that the skilled wage remains almost unchanged but a restructuring of the sectors reduces the demand for unskilled labour and therefore the real wage, this in turn reduces firms costs but not enough to offset the reduction in demand in the economy.

Migration of unskilled labour is generally beneficial. There is almost no change to the unskilled real wage, but the wages paid to skilled workers increase. This increase in firms costs is passed through to consumers with almost no impact on the number of firms in the economies.

Finally, allowing both skilled and unskilled migration is beneficial for the North, it generates more jobs and increases real wages in both sectors. Under this scenario there is no restructuring and therefore the skill

premium remains the same. The South and East have a reduction in firms but the welfare of workers remains unaltered.

Overall, the best policy in terms of jobs (Table 1) is skilled migration only. Alternatively, the North would gain jobs with skilled and unskilled migration only, whereas the South and East would lose jobs with skilled and unskilled migration. In terms of unskilled (Table 2) and skilled wages (Table 3), the first best policy for all the EU is unskilled migration only. However, most sectors in all regions would also gain from no migration. The skill premium (Table 4) always decreases in the North. In the South and East, the skill premium increases in the sectors with the highest levels of absolute employment. In the North the largest level of skill premium increase is when migration is restricted to skilled workers, whereas in the South and East the largest levels are generated when unskilled workers migrate. Hence, from the point of view of the skill premium, the best policy would be unskilled migration for all the EU.

However, even when a policy is beneficial overall, some sectors may lose out. For example, the no migration policy is bad for jobs overall, but Transport Equipment and Wood Products would gain in the North, and Chemicals, Machinery, Minerals and Textiles & Clothing would gain in the East. The skilled migration policy benefits wages in the North, but not in the low skill-intensity sectors (Leather & Footwear and Textiles & Clothing). However, these sectors account for only 19% of the manufacturing workforce in the North (Appendix C).

	(1)	(2)	(3)	(4)
<b>North</b>				
<i>ma</i>	-0.35	0.73	-0.06	0.11
<i>ch</i>	-0.38	1.11	-0.06	0.11
<i>tr</i>	0.11	1.06	-0.04	0.10
<i>wo</i>	0.13	2.22	-0.005	0.12
<i>me</i>	-0.21	4.30	-0.04	0.13
<i>te</i>	-0.24	-1.86	-0.05	0.17
<i>le</i>	-0.23	-1.75	-0.05	0.17
<b>Weighted total</b>	-0.13	1.05	-0.05	0.11
<b>South</b>				
<i>ma</i>	-1.04	0.10	0.00	-1.02
<i>ch</i>	-1.03	0.14	0.00	-1.03
<i>tr</i>	-1.47	0.15	0.00	-1.47
<i>wo</i>	-1.22	0.15	0.00	-1.25
<i>me</i>	-0.55	0.14	0.00	-1.22
<i>te</i>	-0.38	0.16	0.00	-1.05
<i>le</i>	-0.40	0.16	0.00	-1.12
<b>Weighted total</b>	-1.01	0.14	0.00	-1.18
<b>East</b>				
<i>ma</i>	0.45	0.06	0.01	-0.78
<i>ch</i>	0.11	0.07	0.03	-0.77
<i>tr</i>	-0.99	0.08	0.01	-0.99
<i>wo</i>	-0.92	0.09	0.01	-0.92
<i>me</i>	-2.04	0.10	0.01	-1.06
<i>te</i>	0.51	0.60	0.01	-0.63
<i>le</i>	-1.35	0.28	0.02	-2.20
<b>Weighted total</b>	-0.72	0.09	0.01	-0.93

Note: (1) no migration; (2) skilled migration only; (3) unskilled migration only; (4) skilled and unskilled migration. The weighted total is the average of sectoral changes weighted by sectoral employment shares (Appendix C).

	(1)	(2)	(3)	(4)
<b>North</b>				
<i>ma</i>	0.57	-0.10	0.31	0.02
<i>ch</i>	-0.62	-0.11	0.34	0.01
<i>tr</i>	0.02	-0.21	0.37	0.02
<i>wo</i>	0.02	-0.33	0.40	0.02
<i>me</i>	0.61	-0.75	0.43	0.02
<i>te</i>	0.74	0.24	0.58	0.02
<i>le</i>	0.74	0.24	0.58	0.02
<b>Weighted total</b>	0.15	-0.17	0.38	0.02
<b>South</b>				
<i>ma</i>	2.18	-0.00	0.50	-0.00
<i>ch</i>	2.19	-0.00	0.56	-0.00
<i>tr</i>	-0.01	-0.00	0.58	-0.00
<i>wo</i>	-0.01	-0.00	0.64	-0.00
<i>me</i>	1.31	-0.00	0.67	-0.00
<i>te</i>	1.38	-0.01	0.90	-0.00
<i>le</i>	1.37	-0.01	0.90	-0.00
<b>Weighted total</b>	0.77	-0.01	0.60	-0.00
<b>East</b>				
<i>ma</i>	-0.86	-0.00	0.48	-0.00
<i>ch</i>	-0.08	-0.00	0.37	-0.00
<i>tr</i>	0.01	-0.00	0.58	-0.00
<i>wo</i>	0.01	-0.00	0.62	-0.00
<i>me</i>	4.52	-0.00	0.67	-0.00
<i>te</i>	-2.11	-0.00	0.82	-0.00
<i>le</i>	1.98	-0.01	0.92	-0.00
<b>Weighted total</b>	0.52	-0.00	0.56	-0.00

Note: (1) no migration; (2) skilled migration only; (3) unskilled migration only; (4) skilled and unskilled migration. The weighted total is the average of sectoral changes weighted by sectoral employment shares (Appendix C).

	(1)	(2)	(3)	(4)
<b>North</b>				
<i>ma</i>	0.37	-1.44	0.00	0.02
<i>ch</i>	0.39	-1.94	0.00	0.01
<i>tr</i>	0.02	-2.90	0.00	0.02
<i>wo</i>	0.02	-4.92	0.00	0.02
<i>me</i>	0.25	-10.26	0.00	0.02
<i>te</i>	0.21	3.47	0.00	0.02
<i>le</i>	0.21	3.42	0.00	0.02
<b>Weighted total</b>	0.18	-2.49	0.00	0.02
<b>South</b>				
<i>ma</i>	1.42	-0.36	-0.00	-0.00
<i>ch</i>	1.39	-0.41	-0.00	-0.00
<i>tr</i>	-0.01	-0.04	-0.00	-0.00
<i>wo</i>	-0.01	-0.43	-0.00	-0.00
<i>me</i>	0.53	-0.44	-0.00	-0.00
<i>te</i>	0.41	-0.53	-0.00	-0.00
<i>le</i>	0.40	-0.53	-0.00	-0.00
<b>Weighted total</b>	0.40	-0.29	-0.00	-0.00
<b>East</b>				
<i>ma</i>	-0.56	-0.18	0.00	-0.00
<i>ch</i>	-0.05	-0.04	-0.00	-0.00
<i>tr</i>	0.01	-0.25	-0.00	-0.00
<i>wo</i>	0.01	-0.21	-0.00	-0.00
<i>me</i>	1.88	-0.27	-0.00	-0.00
<i>te</i>	-0.61	-0.16	-0.00	-0.00
<i>le</i>	0.06	-0.37	-0.00	-0.00
<b>Weighted total</b>	0.20	-0.20	-0.00	-0.00

Note: (1) no migration; (2) skilled migration only; (3) unskilled migration only; (4) skilled and unskilled migration. The weighted total is the average of sectoral changes weighted by sectoral employment shares (Appendix C).

	(1)	(2)	(3)	(4)
<b>North</b>				
<i>ma</i>	0.20	1.34	0.30	0.00
<i>ch</i>	-1.01	1.83	0.34	0.00
<i>tr</i>	0.00	2.69	0.36	-0.00
<i>wo</i>	-0.00	4.59	0.40	-0.00
<i>me</i>	0.36	9.50	0.42	0.00
<i>te</i>	0.52	-3.23	0.57	-0.00
<i>le</i>	0.53	-3.17	0.58	-0.00
<b>Weighted total</b>	-0.03	2.32	0.38	-0.00
<b>South</b>				
<i>ma</i>	0.75	0.35	0.50	-0.00
<i>ch</i>	0.80	0.40	0.56	0.00
<i>tr</i>	-0.00	0.03	0.59	0.00
<i>wo</i>	0.00	0.42	0.64	0.00
<i>me</i>	0.77	0.43	0.67	-0.00
<i>te</i>	0.98	0.51	0.90	0.00
<i>le</i>	0.98	0.51	0.90	0.00
<b>Weighted total</b>	0.38	0.28	0.60	0.00
<b>East</b>				
<i>ma</i>	-0.30	0.18	0.48	0.00
<i>ch</i>	-0.03	0.04	0.37	0.00
<i>tr</i>	-0.00	0.24	0.58	-0.00
<i>wo</i>	-0.00	0.20	0.62	0.00
<i>me</i>	2.64	0.26	0.67	0.00
<i>te</i>	-1.49	0.15	0.83	0.00
<i>le</i>	1.39	0.35	0.92	-0.00
<b>Weighted total</b>	0.31	0.19	0.56	0.00

Note: (1) no migration; (2) skilled migration only; (3) unskilled migration only; (4) skilled and unskilled migration. The weighted total is the average of sectoral changes weighted by sectoral employment shares (Appendix C).

### 3.2 The issue of unemployment

Migrants place a burden on the welfare system when they remain unemployed and claim benefits, however they are also consumers who generate demand for goods in the economy. Additionally, the entry of migrant workers exerts pressure on the labour market to absorb the new workers, inducing restructuring thereby altering the balance of skilled and unskilled workers in employment. Under all of the scenarios that are considered the burden on the welfare system always increases in the North, except with skilled and reserve only migration (Table 6). In the South and East, migration always decreases the unemployment tax, except where only the reserve workforce is permitted to migrate. The impact of migration operates through the workers' wages, which are deducted of a contribution towards the unemployment benefit that is paid to the reserve workforce. As a consequence of migration of unemployed workers, the net wage received by workers will increase in the North and reduce in the South and East.

	(1)	(2)	(3)	(4)
<b>North</b>	0.0026	-0.01	0.0008	0.003
<b>South</b>	0.0044	-0.001	-0.000009	-0.0006
<b>East</b>	0.0059	-0.001	-0.0001	-0.000007

*Note: (1) reserve migration only; (2) skilled and reserve migration; (3) unskilled and reserve migration; (4) full migration.*

	(1)	(2)	(3)	(4)
<b>North</b>	-0.3826	0.8529	-0.0643	0.0869
<b>South</b>	-1.0039	0.1057	0.0008	-0.9518
<b>East</b>	-1.3880	0.0920	0.0084	-0.7815

*Note: (1) reserve migration only; (2) skilled and reserve migration; (3) unskilled and reserve migration; (4) full migration.*

Permitting the reserve workforce to migrate has as consequence a cost borne by the North and cost savings generated in the South and East. However, the net effect of this policy can ultimately be judged by the impact that migration has on the real wage and on employment creation. The impact on employment is shown in Table 7. The strongest effect occurs where only the reserve workforce migrates. In this situation jobs are lost in each country group, with the largest impact in the East. Migration is not altering the balance of the workforce as there is a pool of unemployed in each economy, however the unemployed are reducing the demand for goods in the country they leave and increasing the cost base in the country to which they migrate. Full migration also has a large and negative impact in the South and East and a smaller but positive impact in the North. This scenario allows the workforce to rebalance and the agglomeration forces in the North appear to dominate the cost advantages in the South and East. Interestingly, skilled and reserve migration generates employment in all countries. Under this scenario, there is pressure on both the skilled and the unskilled wage from migrants and this allows firms to reduce their cost base and generate employment.

	(1)	(2)	(3)	(4)
<b>North</b>	0.3669	-1.4217	0.0052	0.0187
<b>South</b>	1.3594	-0.3651	-0.00006	-0.0037
<b>East</b>	1.9233	-0.3373	-0.0007	-0.00005

*Note: (1) reserve migration only; (2) skilled and reserve migration; (3) unskilled and reserve migration; (4) full migration.*

	(1)	(2)	(3)	(4)
<b>North</b>	0.5637	-0.0702	0.3096	0.0187
<b>South</b>	2.0795	-0.0087	0.5014	-0.0037
<b>East</b>	2.9414	-0.0076	0.5222	-0.00005

*Note: (1) reserve migration only; (2) skilled and reserve migration; (3) unskilled and reserve migration; (4) full migration.*

The impact of migration on real wages is shown in Tables 8 and 9. The highest increase of real wages in all countries occurs when only the reserve workforce migrates. This is a function of the additional cost of unemployment benefit, which in equilibrium is passed through to those in employment. Its nominal value outweighs the general price level increase. Permitting the skilled and reserve workforce to migrate causes a general reduction in welfare, particularly for the unskilled in the North, for the reasons discussed above. Full migration is beneficial for workers in the North. Workers in the South and East suffer a small diminution in their real pay. Overall it can be seen that the only scenario that increases the real wage of all workers is migration of only reserve, or unemployed workers. Interestingly, the Northern fears of an erosion in wages when full migration occurs are unfounded. On the contrary, the erosion does occur, albeit to a relatively small extent, in the South and East.

#### **4 Conclusions**

The fears within the EU of the negative impact of permitting full migration are found to be largely unfounded. The effects that are found are generally very small, particularly so in the East. However in overall terms the worst scenario is to permit only skilled and reserve workforce to migrate, as it is the only situation in which the welfare of all workers is made worse. It so happens that this scenario is close to what is the present situation. Interestingly, permitting migration does generate restructuring of individual sectors and there are relatively large increases in the skill premiums that are paid particularly in the least skilled sectors of the economy. Surprisingly, the scenario that generates the highest level of benefit to all workers is to permit unskilled migration only, and further permitting skilled migration is bad for unskilled workers in all regions of the EU. In political economy terms, it results from the paper's analysis that the North has an interest in allowing for full migration but the South and East have an interest in restricting migration.

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## Appendix A

### Partial derivatives

$$\begin{aligned}
 \pi_n &= \frac{\gamma_h \rho}{\sigma} \Theta \hat{P}^{(\mu-1)(1-\sigma)} \hat{R}^{\mu(\sigma-1)-\sigma} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} (\hat{w}^S L^S + \hat{w}^U L^U) \\
 &+ 2\mu \Theta \hat{P}^{(\mu-1)(1-\sigma)+\mu} \hat{R}^{(1-\mu)(2-\sigma)} (\hat{w}^S)^{\alpha(2-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(2-\sigma)} n \\
 &- \hat{P}^\mu \hat{R}^{(1-\mu)} (\hat{w}^S)^\alpha (\hat{w}^U)^{(1-\alpha-\mu)} \\
 \pi_p &= \frac{\gamma_h \rho (\mu-1)(1-\sigma)}{\sigma} \Theta \hat{P}^{(\mu-1)(1-\sigma)-1} \hat{R}^{\mu(\sigma-1)-\sigma} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} (\hat{w}^S \hat{L}^S + \hat{w}^U \hat{L}^U) n \\
 &+ \mu [(\mu-1)(1-\sigma) + \mu] \Theta \hat{P}^{(\mu-1)(2-\sigma)} \hat{R}^{(1-\mu)(2-\sigma)} (\hat{w}^S)^{\alpha(2-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(2-\sigma)} n^2 \\
 &- \mu \hat{P}^{(\mu-1)} \hat{R}^{(1-\mu)} (\hat{w}^S)^\alpha (\hat{w}^U)^{(1-\alpha-\mu)} n \\
 \pi_\Theta &= \frac{\gamma_h \rho}{\sigma} \hat{P}^{(\mu-1)(1-\sigma)} \hat{R}^{\mu(\sigma-1)-\sigma} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} (\hat{w}^S \hat{L}^S + \hat{w}^U \hat{L}^U) n \\
 &+ \mu \hat{P}^{(\mu-1)(1-\sigma)+\mu} \hat{R}^{(1-\mu)(2-\sigma)} (\hat{w}^S)^{\alpha(2-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(2-\sigma)} n^2 \\
 \pi_{w^S} &= \frac{\gamma_h \rho}{\sigma} \Theta \hat{P}^{(\mu-1)(1-\sigma)} \hat{R}^{\mu(\sigma-1)-\sigma} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} \left[ (\alpha(1-\sigma)+1) \hat{L}^S + \alpha(1-\sigma) (\hat{w}^S)^{-1} (\hat{w}^U) \hat{L}^U \right] n \\
 &+ \mu \alpha (2-\sigma) \Theta \hat{P}^{(\mu-1)(1-\sigma)+\mu} \hat{R}^{(1-\mu)(2-\sigma)} (\hat{w}^S)^{\alpha(2-\sigma)-1} (\hat{w}^U)^{(1-\alpha-\mu)(2-\sigma)} n^2 \\
 &- \alpha \hat{P}^\mu \hat{R}^{(1-\mu)} (\hat{w}^S)^{\alpha-1} (\hat{w}^U)^{(1-\alpha-\mu)} n \\
 \pi_{w^U} &= \frac{\gamma_h \rho}{\sigma} \Theta \hat{P}^{(\mu-1)(1-\sigma)} \hat{R}^{\mu(\sigma-1)-\sigma} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} \left[ ((1-\alpha-\mu)(1-\sigma)+1) \hat{L}^U + (1-\alpha-\mu)(1-\sigma) (\hat{w}^U)^{-1} (\hat{w}^S) \hat{L}^S \right] n \\
 &+ \mu \alpha (1-\alpha-\mu)(2-\sigma) \Theta \hat{P}^{(\mu-1)(1-\sigma)+\mu} \hat{R}^{(1-\mu)(2-\sigma)} (\hat{w}^S)^{\alpha(2-\sigma)-1} (\hat{w}^U)^{(1-\alpha-\mu)(2-\sigma)-1} n^2 \\
 &- (1-\alpha-\mu) \hat{P}^\mu \hat{R}^{(1-\mu)} (\hat{w}^S)^\alpha (\hat{w}^U)^{-(\alpha-\mu)} n
 \end{aligned}$$

$$\pi_R = \frac{\gamma_h \rho [\mu(\sigma-1) - \sigma]}{\sigma} \Theta \hat{P}^{\mu(1-\sigma)} \hat{R}^{\mu(\sigma-1)-\sigma-1} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} (\hat{w}^S \hat{L}^S + \hat{w}^U \hat{L}^U) n$$

$$+ \mu(1-\mu)(2-\sigma) \Theta \hat{P}^{\mu(1-\sigma)+\mu} \hat{R}^{(1-\sigma)+\mu(\sigma-2)} (\hat{w}^S)^{\alpha(2-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(2-\sigma)} n^2$$

$$-(1-\mu) \hat{P}^\mu \hat{R}^{-\mu} (\hat{w}^S)^\alpha (\hat{w}^U)^{(1-\alpha-\mu)} n$$

$$Q_n = \Theta \hat{P}^{\mu(1-\sigma)} \hat{R}^{(1-\mu)(1-\sigma)} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)}$$

$$Q_P = \mu(1-\sigma) \Theta \hat{P}^{\mu(1-\sigma)-1} \hat{R}^{(1-\mu)(1-\sigma)} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} n - (1-\sigma) P^{-\sigma}$$

$$Q_\Theta = \hat{P}^{\mu(1-\sigma)} \hat{R}^{(1-\mu)(1-\sigma)} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} n$$

$$Q_{w^S} = \alpha(1-\sigma) \Theta \hat{P}^{\mu(1-\sigma)} \hat{R}^{(1-\mu)(1-\sigma)} (\hat{w}^S)^{\alpha(1-\sigma)-1} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} n$$

$$Q_{w^U} = (1-\alpha-\mu)(1-\sigma) \Theta \hat{P}^{\mu(1-\sigma)} \hat{R}^{(1-\mu)(1-\sigma)} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)-1} n$$

$$Q_R = (1-\mu)(1-\sigma) \Theta \hat{P}^{\mu(1-\sigma)} \hat{R}^{\mu(\sigma-1)-\sigma} (\hat{w}^S)^{\alpha(1-\sigma)} (\hat{w}^U)^{(1-\alpha-\mu)(1-\sigma)} n$$

$$\Lambda_P^S = \sigma \alpha \mu \hat{P}^{\mu-1} \hat{R}^{(1-\mu)} (\hat{w}^U)^{(1-\alpha-\mu)} n$$

$$\Lambda_n^S = \sigma \alpha \hat{P}^\mu \hat{R}^{(1-\mu)} (\hat{w}^U)^{(1-\alpha-\mu)}$$

$$\Lambda_{w^S}^S = (1-\alpha) (\hat{w}^S)^{-\alpha} \lambda^S$$

$$\Lambda_{w^U}^S = \sigma \alpha (1-\alpha-\mu) \hat{P}^\mu \hat{R}^{(1-\mu)} (\hat{w}^U)^{(-\alpha-\mu)} n$$

$$\Lambda_P^U = \sigma \mu (1-\alpha-\mu) \hat{P}^{\mu-1} \hat{R}^{(1-\mu)} (\hat{w}^S)^\alpha n$$

$$\Lambda_n^U = \sigma (1-\alpha-\mu) \hat{P}^\mu \hat{R}^{(1-\mu)} (\hat{w}^S)^\alpha$$

$$\Lambda_{w^S}^U = \sigma \alpha (1-\alpha-\mu) \hat{P}^\mu \hat{R}^{(1-\mu)} (\hat{w}^S)^{(\alpha-1)} n$$

$$\Lambda_{w^U}^U = (-\alpha-\mu) (\hat{w}^U)^{\alpha+\mu-1} \lambda^U$$

$$\Lambda_{\lambda^S}^S = -(\hat{w}^S)^{1-\alpha}$$

$$\Lambda_{\lambda^U}^U = -(\hat{w}^U)^{\alpha+\mu}$$

$$V_P^S = -\gamma_h \rho \hat{P}^{(-\gamma_h \rho-1)} w^S$$

$$V_P^U = -\gamma_h \rho \hat{P}^{(-\gamma_h \rho-1)} w^U$$

$$V_P^R = -\gamma_h \rho \hat{P}^{(-\gamma_h \rho-1)} w^R$$

$$V_{w^S}^S = V_{w^U}^U = V_{w^R}^R = P^{-\gamma_h \rho}$$

## Appendix B

European averages of factor value added shares Baldwin et al. (2000)

Sector	Unskilled labour ( $1-\alpha-\mu$ )	Skilled labour ( $\alpha$ )	Capital ( $\mu$ )
Machinery	0.478	0.313	0.210
Chemicals	0.438	0.278	0.285
Transport equipment	0.540	0.268	0.198
Wood products	0.530	0.245	0.228
Other manufacturing	0.553	0.240	0.205
Metals	0.565	0.233	0.203
Minerals	0.455	0.195	0.353
Food products	0.450	0.185	0.365
Textiles	0.595	0.175	0.235
Leather products	0.603	0.175	0.225

## Appendix C

Employment shares (1990-99 average)

	Sectoral shares			Country shares		
	North	South	East	North	South	East
ch	0.15	0.11	0.10	0.78	0.11	0.11
le	0.01	0.06	0.03	0.33	0.44	0.25
ma	0.26	0.18	0.22	0.78	0.08	0.14
me	0.22	0.17	0.18	0.75	0.12	0.13
mi	0.11	0.18	0.17	0.60	0.20	0.20
te	0.07	0.21	0.18	0.48	0.27	0.26
tr	0.12	0.09	0.06	0.80	0.11	0.09
wo	0.06	0.06	0.06	0.71	0.14	0.15

## Appendix D

Unemployment rates (1990-99 average)

aus	6.50	gre	9.63	bul	12.24
bel	12.31	por	5.59	cze	4.95
dk	9.55	spa	19.87	est	8.67
fin	12.79			hun	9.49
fra	11.14			lat	6.71
ger	11.28			lit	5.39
ire	12.88			pol	12.64
ita	11.09			rom	8.70
ned	5.52			slk	12.80
swe	6.27			slo	8.30
uk	7.42				
North	9.7	South	11.7	East	9.0