The skilled U-shaped Europe:

is it really and on which side does it stand?*

Helena Marques✉

20 March 2004

Abstract

This paper derives from a New Economic Geography model, and estimates, a quadratic sectoral real wage equation for the member countries of the enlarged EU. When significant, the real wages U-shaped curve is increasing and concave with respect to market access, but decreasing and convex with respect to access to skilled labour. Real wages in Chemicals, Wood Products, Leather Products and Textiles do not react to market access, and only those sectors with low degree of scale economies and low-skill intensity are U-shaped with respect to access to skilled labour. At the present GDP levels, EU geography is still in the divergence-inducing side of the U-curve. In addition, EU real wages are significantly determined by country-specific characteristics other than geography that push Northern real wages upward and pull Eastern real wages downward.

Keywords: wage equation, labour demand, human capital, EU enlargement, market potential

JEL: F15, F22, J31, L6

---

* Two related papers have been published as CEUNEUROP (Centre for European Studies) Working Paper 7/2001 (University of Coimbra, Portugal) and Economics Research Paper 03-13 (Loughborough University, UK). I gratefully acknowledge the comments of Elias Soukiazis, Alfredo Marques, and José da Silva Costa on the first paper, and of the participants in the IEFS-UK 2003 Conference (City University, London) on the second paper, which has also benefited from the valuable collaboration of Hugh Metcalf. Any remaining errors in the present paper are my full responsibility.

✉ Department of Economics, Sir Richard Morris Building, Loughborough University, Loughborough, LE11 3TU, UK. Phone: +441509222704. Fax: +441509223910. Email: H.I.Marques@lboro.ac.uk.

1 Introduction

The EU will soon have 25 member countries and will be more heterogeneous than ever. The real wages in the Central and Eastern European Countries (CEECs) that are to join the EU between 2004 and 2007 are on average five times lower than in Greece, Portugal and Spain, and ten times lower than in the wealthiest EU countries. These figures have been fostering fears in some of the current member states that the EU enlargement could accelerate the eastward relocation of Western firms, taking with them production and jobs. As a consequence, many EU workers could risk losing their jobs to cheaper competitors in the CEECs or to be forced to accept lower wages to remain employed. On the other hand, the wage differentials also created anticipation for great flows of East-West migration and restrictions were placed on the movement of Eastern workers. The European Commission (2001) has proposed several alternatives to deal with Eastern migration, ranging from safeguard clauses, flexible systems of transitional arrangements, establishment of fixed quota systems, to general non-application of the Single Market requirement of free movement of labour for a limited period of time. However, after the enlargement such restrictions will progressively come to an end.

Both the relocation of firms and the relocation of workers will influence real wages in the enlarged EU. In turn, the nature of this relationship will ultimately determine the potential for agglomeration of economic activity. This paper tests such agglomeration effects at the sectoral level based on the relationship between sectoral real wages and market size (e.g., Krugman (1991)) for a panel of EU-25 countries during the 1990s. The interplay of supply and demand for labour determines real wages in each country and sector. Whereas the demand for labour depends on the location of firms, the supply of labour is given by initial endowments and also by migrants if migration is allowed for. Thus two possibilities arise. If supply effects are more important, the ratio of real wages varies inversely with country size. In this case, the larger country either loses workers or suffers a real wage loss. The result is convergence. On the contrary, if demand effects are more important, the ratio of real wages varies directly with country size. In this case, the larger country either gains workers or benefits from a real wage gain. The result is divergence.

Empirical applications of New Economic Geography (NEG) models usually test particular relationships derived from complex theoretical models.[1] One of those relationships is a wage equation where wages are a function of market and supplier access and also of access to a pool of skilled workers. In turn these variables are distance-weighted averages of incomes and human capital. This relationship has been tested at an aggregated level for NAFTA by Hanson (1997, 1998) and in a worldwide context by Redding and Venables (2004) and Venables (2001). These studies conclude that nominal wages increase with proximity to markets and suppliers. Venables (2001) finds two separate European wage gradients, one from the EU core to Greece, Portugal and Spain, and another from Western to Eastern Europe. Using regional data for respectively Canada and the UK, Hunt and Mueller (2002) and Monastiriotis (2002) conclude that regions with more human capital tend to have higher average wages. Forslid et al. (2002) have conducted a CGE simulation analysis of the sectoral relationship between industrial concentration and trade costs in the EU. They concluded that industrial concentration in Chemicals, Machinery, Metals, Minerals and Transport Equipment is U-shaped with respect to trade costs, whilst in Leather Products, Food Products, and Textiles it exhibits a linear behaviour.

The present paper derives from a NEG model, and then estimates, a quadratic real wage equation where real wages depend on access to both goods and factor markets, in particular to a pool of skilled workers. However, this study differs from the previous studies cited in several ways. First, the sample used includes the member countries of the enlarged EU. Second, it is a sectoral sample of industrial sectors with different degrees of scale economies and skill-intensity. Third, the concept of market access is extended to both scale and skill. Fourth, the data used is a panel for the transition period (1990-99) with a Feasible GLS estimation structure that allows for country-specific variances and autocorrelation terms, as well as country-pair-specific covariances. Finally, this paper builds an explicit link between theoretical and empirical NEG as the real wage equation to be estimated is derived from a general equilibrium theoretical model with solid micro foundations.

[1] For a thorough survey of empirical work within the NEG framework see, for example, Overman et al. (2003).

The main findings can be summarised as follows. First, several real wage tiers can be distinguished in the enlarged EU: (i) the wealthier "Northern" EU countries; (ii) Italy, Ireland and Spain; (iii) Portugal and Greece; (iv) the Czech Republic, Slovenia, Slovakia, Hungary and Poland; (v) the Baltic States, Bulgaria and Romania. Second, the real wages in some countries are not in accordance to their position in terms of access to goods markets and skilled workers. In particular, some "Northern" countries do not rank particularly high in terms of skill, despite their high real wages, whilst the "Eastern" countries are more highly ranked in skill than in size, but their real wage ranking is the lowest. The explanation may lie in country-specific characteristics other than geography, such as institutional arrangements that make labour markets more rigid or inflationary macroeconomic policies. In fact, the "Northern" countries exhibit significantly positive country-specific factors pushing real wages up, whilst the "Eastern" countries exhibit significantly negative country-specific factors pulling real wages down. Finally, the real wages U-shaped curve is increasing and concave with respect to market access, but decreasing and convex with respect to access to skilled labour. Chemicals, Wood Products, Leather Products and Textiles are not U-shaped with respect to market access. Only those sectors with low degree of scale economies and low-skill intensity are U-shaped with respect to access to skilled labour.

In sum, the results show that the evidence of a U-shaped Europe is sectoral and we are still on the diverging side of the U-curve with respect to market access. Only when market access increases further, either through growth or further reduction in the impact of distance, can Europe move to the converging side of the U-curve. These findings support the approach that is being taken by the EU in offering a mix of policy measures encompassing income, education and skills together with infrastructure development. Moreover, EU policies should be more focussed on the particular characteristics of the countries and sectors they seek to influence. The paper is organised as follows. Section 2 derives a sectoral real wage equation from a NEG model with skilled and unskilled labour for the member countries of the enlarged EU. Section 3 presents the empirical wage equation to be estimated and discusses how sectoral real wages correlate with access to the

goods and labour markets across the EU-25 countries. Section 4 provides the estimation results. Section 5 concludes.

2 A Sectoral Wage Equation

The enlarged EU will be composed of a finite number (*i* or alternatively *j*) of hubs and peripheries. According to the definition of Krugman (1993), a country *A* is a hub when the trade costs between *A* and each of the two peripheries *B* and *C* are lower than those incurred by *B* and *C* when trading with each other. This hub effect can persist in the enlarged EU because trade costs have two distinct components. The first, non-spatial trade costs such as tariff and non-tariff trade barriers, can be compressed till zero by integration. These costs are the same for all member countries and will be denoted *t*. However, the second component of trade costs is purely spatial and depends on country pair-specific distance. Though they can be decreased by, e.g., infrastructure improvement, these costs can never equal zero. Spatial trade costs are denoted $\tau_{ij}d_{ij}$, 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 trade between countries *i* and *j* is:

$$T_{ij} = t + \tau_{ij} d_{ij} . \qquad (1)$$

In each country there is a finite number (*h*) of industrial sectors that employ two factors of production, unskilled labour (L^U) and industry-specific skilled labour (L^S), and an agricultural sector that only employs unskilled labour. The constant returns to scale agricultural sector is perfectly competitive and uses unskilled labour with unit marginal product 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 unskilled labour (w^U) both equal one. The *h* increasing returns to scale industrial sectors (X_h) 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. The utility function for a consumer in country *i* can be written as:[2] [3]

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

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

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

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*, σ is the elasticity of substitution among varieties of the same good, γ is the share of expenditure on each differentiated good, and ρ 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:

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

Consumers maximise utility (2) subject to the budget constraint (3).[4] 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:[5]

[2] Though there are many countries in the model, we will use a generic country subscript i as we assume that all countries share a preference structure with a CES functional form.

[3] 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 equilibrium industrial wages equal equilibrium agricultural wages in each country. In this model the equality applies to unskilled labour only since skilled labour is specific to industry. Thus it allows us to treat wage determination as if we still had one single factor of production in the model.

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

Following Venables (1999), we further assume that inter-industry linkages are sufficiently weaker than intra-industry linkages to be ignored. Finally, following Forslid (1999), we assign skilled labour to research (fixed costs) and unskilled labour to production (marginal costs) such that skill-intensive industries have a higher degree of scale economies. The minimum cost function for producing a variety *k* in country *i* will then be:

$$TC_{ihk} = \left(P_{ih} \right)^{\mu} \left[\left(w_{ih}^{S} \right)^{\alpha} + \left(w^{U} \right)^{1-\alpha-\mu} cx_{ihk} \right] \quad (5)$$

with w^S and w^U the wage rates for skilled and unskilled labour, respectively, α the share of skilled labour in total cost, μ the share of intermediates in total cost, *c* the marginal cost, and *x* the equilibrium output. 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:

$$x_{ijhk} = \left[p_{jhk} \right]^{-\sigma} \left[\frac{T_{ij}}{P_{ih}} \right]^{1-\sigma} E_{ih} \quad (6)$$

with E_{ih} the expenditure function given by:

$$E_{ih} = \gamma_h \rho I_i + \mu \int_0^{n_{i1}} TC_{i1k} dk \quad (7)$$

where I_i is the total income in country *i*. The profit maximising price is a mark-up over marginal cost:

$$p_{ihk} = \left(\frac{\sigma}{\sigma - 1} \right) \left(w^{U} \right)^{1-\alpha-\mu} \left(P_{ih} \right)^{\mu} c . \quad (8)$$

[4] Each consumer allocates to good Y a share 1-ρ of individual income. In addition, solving for the first order conditions, we find the demand functions in market i for a variety k of each sector X_h . These are represented by the first term in the total demand equation (6).

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

$$x_{ih} = \frac{(\sigma - 1)\left(w_{ih}^{S}\right)^{\alpha}}{c\left(w^{U}\right)^{1-\alpha-\mu}} \quad . \tag{9}$$

The firm's demand for labour is:

$$w_i^S \lambda_{ih}^S = \sigma\alpha\left(w_{ih}^S\right)^{\alpha}\left(P_{ih}\right)^{\mu} \tag{10}$$

with λ_{ih}^S the share of country *i*'s skilled labour endowment working in manufacturing sector h. According to this condition, the equilibrium wage bill of skilled workers is equal to their share of the equilibrium revenue.[6] In addition, due to the assumption of non-substitutability of labour skills, wages are determined independently: the skilled wage is determined in the differentiated goods sector by (10) and the unskilled wage is determined in the homogeneous goods sector. Unskilled wages are always constant and equal to unity, skilled wages will be denoted simply *w*. In equilibrium, demand as given by equation (6) must equal supply as given by equation (9). After substituting in (5) and (8), solving the integral and rearranging, the following short-run profit equation is obtained:

$$\Pi_{jh} = \sum_{i \in EU} T_{ij}^{1-\sigma} P_{ih}^{\sigma-1} P_{jh}^{\mu(1-\sigma)} E_{ih} n_{jh} - \sigma w_j^{\alpha} P_{jh}^{\mu} n_{jh} . \tag{11}$$

In the long-run, profits must be zero and after rearranging equation (11) with respect to the real wage in industry *h* in country *i*, this is, the ratio of skilled wage (w_{ih}) to the price index (P_{ih}), it becomes:

---

[5] The procedure for the derivation of the CES demand functions and corresponding price index is fully described in Fujita et al. (2000).

[6] In equilibrium the zero profit condition applies and thus the equilibrium total revenue must equal the equilibrium total cost. Hence it is indifferent to think in terms of share in revenue or in costs.

$$\frac{w_{jh}^{\alpha}}{P_{jh}^{\sigma-1}} = \frac{1}{\sigma}\sum_{i\in EU} T_{ij}^{1-\sigma} P_{ih}^{\sigma-1} E_{ih} \qquad (12)$$

Hence real wages of skilled workers in sector *h* of country *i* are a function of an aggregate of variables of all other countries, comprising price index, barriers to trade and expenditure. This aggregate can be empirically approximated by variables built by averaging across the sample countries their GDP or human capital, weighted by the distance between each pair of countries.

The empirical specification of this sectoral real wage equation for the EU-25 is based on the relationship between real wages and goods and factors market potentials. In a NEG setting, real wages change as a result of three conflicting effects. First, the home market effect: wages are higher in the larger markets. This is an agglomeration force. Second, the competition effect: there is less competition in goods and factor markets in the less industrialized markets, thus wages can be fixed at a higher level. This is a dispersion force. Third, the price index effect: scale economies and lower trade costs decrease the price index of the larger markets, increasing their real wages. This is an agglomeration force. From the interaction of these three effects two possibilities arise. If real wages change inversely with market access, when the latter increases there will be an outflow of workers and thus of firms. This is an equilibrating mechanism that reduces wage disparities, allowing for convergence. On the contrary, if real wages change proportionately to market access, when the latter increases there will be an inflow of workers and of firms and agglomeration follows.

3 Data Features and Empirical Specification

The explanatory variables resulting from equation (12) are weighted averages of the sample countries' GDPs or human capital endowments. These variables were constructed using distance between countries as weights. This formulation goes back to Harris (1954), who defined the distance-weighted average of incomes as a market potential function, this is, the potential demand for goods produced in a certain location is the sum of the purchasing power in all other locations

weighted by transport costs (and these are a function of distance). Redding and Venables (2004) and Venables (2001) propose the use of two concepts, market access and supplier access, that use distance coefficients taken out of respectively export and import gravity equations. Accordingly, countries have access to a market where to place their goods while exporters and a market where to draw inputs from while importers. This formulation is a convenient way of testing empirically the presence of backward and forward linkages and in this paper the concept is extended to human capital.[7] For a country *i* with neighbour country *j* in year *t* the variables can be formalised as follows:

$$MA_{it} = \sum_{j} \frac{GDP_j}{d_{ij}} \qquad (13) \qquad\qquad HKA_{it} = \sum_{j} \frac{HK_j}{d_{ij}} \qquad (14)$$

where MA stands for access to the goods markets, proxied by the gross domestic product (GDP), HKA represents access to the human capital (HK) markets, and d is distance between each of the enlarged EU country pairs.

It should be noted that there are substantial differences among EU countries regarding not just wages, but also access to markets and human capital. The sample countries were ranked with respect to each variable (Appendix C). On the whole, it is possible to distinguish three groups of countries in the enlarged EU: the "North", formed by the wealthier EU countries, with higher real wages, market and human capital access; the "South", formed by the "Cohesion Four" (and Italy, for some sectors), in an intermediate position; the "East", grouping all the new members, with lower real wages, market and human capital access. The South and East both seem to be two-tier groups. Within the Southern group, real wages in Portugal and Greece lag behind those of Spain, Ireland or Italy. Within the Eastern group, there is a gap between the Czech Republic, Slovenia, Slovakia, Hungary and Poland, on one hand, and the Baltic States, Bulgaria and Romania, on the other hand. The latter five pay the lowest real wages in the EU.

[7] In this paper there is no empirical distinction between forward and backward linkages as estimated distance coefficients from a gravity model are not used. This was done in Marques and Metcalf (2003).

Naturally the market and human capital access rankings are not as clear-cut as those of real wages. First, Spain has lower real wages than what its position in terms of size and skill would seem to indicate. Second, the Eastern member countries are more highly ranked in skill than in size, but their real wage ranking is the lowest. In particular, Poland has the highest market access position in the "East", even higher than Ireland, Portugal and Greece. Third, some "North" countries do not rank particularly high in terms of skill, despite their high real wages.

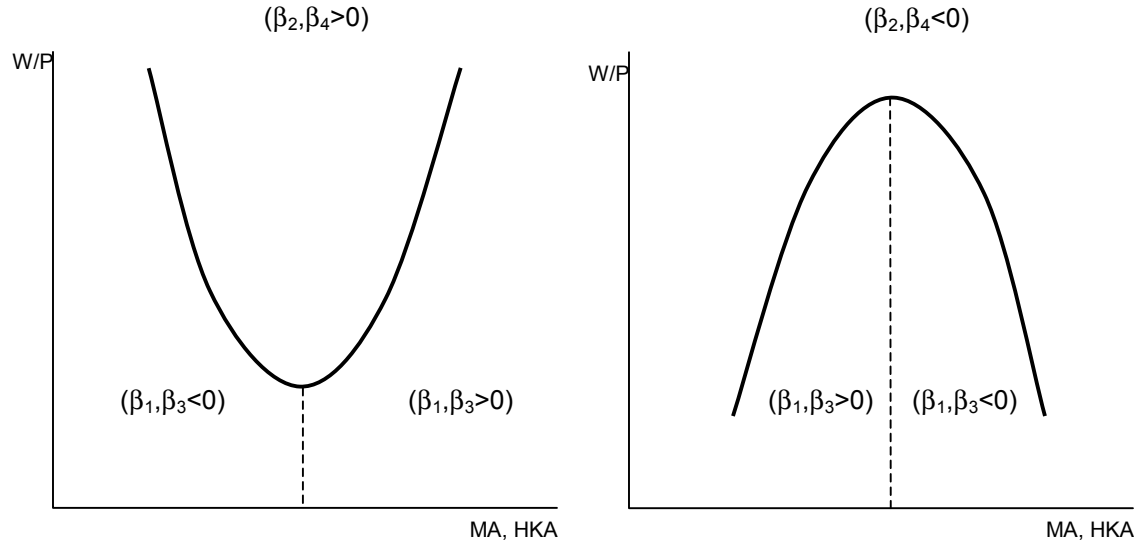
The variables represented in equations (13) and (14) were separately plotted against sectoral real wages for each of the enlarged EU member countries in the period 1990-99 (Appendix B). On the whole, real wages tend to react more to scale than to skill. The scatter plots indicate a positive relationship between real wages and access to goods and factors markets. Although the magnitude of this relationship differs across the sample sectors and countries, there seems to be a reason for the agglomeration of industrial sectors in countries with higher access to markets and skilled workers. However, a statement on the significance of these relationships for the sample sectors and countries requires some econometric analysis.

The econometric model coming out of equation (12) turns out to be an extended version of those in, among others, Hanson (1997,1998), Venables (2001), Redding and Venables (2004). In addition to its quadratic structure, the wage equation is applied to a new panel data sample, the EU-25 in the 1990s, at a sectoral level. This is the more important in a highly heterogeneous group of 25 countries that have very different real wages and from which can be expected a differentiated behaviour of industrial sectors with different characteristics. The equation to estimate for country *i*, and sector *h*, in year *t* is given by:

$$\ln\left(\frac{W_{iht}}{P_{iht}}\right) = \beta_0 + \beta_1 \ln(MA_{it}) + \beta_2 \left(\ln(MA_{it})\right)^2 + \beta_3 \ln(HKA_{it}) + \beta_4 \left(\ln(HKA_{it})\right)^2 + \alpha_i + \mu_{iht} \qquad (15)$$

with W the wage, P the price index, MA the goods market access, HKA the human capital market access, and α country dummies.[8] The MA and HKA variables derive directly from NEG theory and as such may influence wages in a non-linear way. Econometrically this is approximated by the squared term in equation (15). If these variables influence real wages positively ($\beta_1>0$, $\beta_3>0$), divergence may be expected. Otherwise ($\beta_1<0$, $\beta_3<0$), convergence may occur. The possible cases are represented in Fig. 1 below. The actual position of each EU member country with respect to the maximum ($\beta_2<0$, $\beta_4<0$) or minimum ($\beta_2>0$, $\beta_4>0$) ultimately determines on which side of the EU curve they are and what are the future possibilities. If statistically $\beta_2=0$, $\beta_4=0$, there is no curvature, this is, the relationship between real wages and access to goods and factor markets is a straight line and the convergence or divergence outcome does not depend on the actual value for each country. The results of the estimation of equation (15) are presented next.

Fig. 1: Relationship between real wages and access to goods and factor markets



[8] There are no sectoral dummies as the regressions are run for each sector separately.

4 Estimation Results

The real wage rates of the enlarged EU member countries were regressed for four groups of sectors distinguished by degree of economies of scale as in Pratten (1988) and skill-intensity as in Baldwin et al. (2000). These four groups are as follows: Chemicals, Machinery and Transport Equipment are high scale economies and high skill-intensive, Metals are high scale economies and low skill-intensive, Leather & Footwear, Minerals and Textiles & Clothing are low scale economies and low skill-intensive, and Wood Products are low scale economies and high skill-intensive. A full description of the data sources and codes is provided in Appendix A. Estimation was carried out through Feasible GLS with country-specific AR term and contemporaneously correlated panels (country-specific variance and country pair-specific covariance). The full estimation results are provided in Appendix D.

The country dummies indicate country-specific characteristics that drive real wages below or above those of Germany. These can be institutional arrangements that make labour markets more rigid or inflationary macroeconomic policies. The countries that consistently exhibit significantly positive country-specific factors driving real wages up are Austria, Belgium, Denmark, Finland, Ireland, the Netherlands, Sweden, and the UK. These countries are at the top of the real wage ranking and Ireland has high real wages for a relatively low market and human capital access. The two exceptions in the top real wage band are France and Italy, who show a sectorally differentiated behaviour. Whilst there was only one real wage observation for Italy and thus this country had to be dropped from the regression sample, France shows significantly positive country-specific effects in the Chemical Products sector and significantly negative country-specific effects in the Wood Products sector. There are also countries that exhibit significantly negative country-specific factors pulling real wages down and all are Eastern countries: Bulgaria, Latvia, Lithuania, Poland, Romania. The rest of the sample presents sectoral effects: negative effects for Estonia in Machinery, Metals, Wood Products, Leather & Footwear, Textiles & Clothing; positive effects in Chemical Products and Transport Equipment for Greece, Portugal, Spain, the Czech Republic, Hungary, Slovakia, and Slovenia; positive effects in Metals for Greece, Portugal, Spain and

Slovakia; negative effects in Leather & Footwear for Portugal, the Czech Republic, Hungary, Slovakia and Slovenia; positive effects in Mineral Products for Portugal, Spain and Slovakia; positive effects in Textiles & Footwear for Greece, Portugal and Spain.

The remaining variables relate to NEG theory and measure a country's own size and that of its neighbours. According to theory, if the home market and the price index effects prevail, real wages will increase in the larger markets. But if the competition effect in the goods and labour markets is more important, real wages will increase in the smaller markets. Setting aside the country-specific effects described above, the results indicate whether there would be a U-shaped real wage curve for the sample sectors with respect to market and human capital access. Surprisingly, only low scale economies, low skill-intensity sectors exhibit a U-shaped curve with respect to human capital access. This U-curve is convex and the EU is on its decreasing side, this is, as access to human capital increases real wages in such sectors decrease, although after a certain threshold they tend to start increasing again. In the sample period, the EU had not yet achieved such threshold. The real wage U-curve with respect to market access takes exactly the opposite form: it is concave and the EU is in its increasing side. Moreover, this U-curve is significant only for Machinery, Transport Equipment, Metals, and Minerals.

Several previous studies estimated a wage equation where wages are a function of market and supplier access and also of access to a pool of skilled workers. In turn these variables are distance-weighted averages of incomes and human capital using distance coefficients taken from a gravity model. Examples at an aggregate level are Hanson (1997,1998) on NAFTA and Venables (2001), Redding and Venables (2004) in a worldwide context. These studies conclude that wages increase with proximity to markets and suppliers. Hanson (1997,1998) finds that in Mexico nominal wages decrease with the distance from industrial centres but were not influenced by NAFTA trade liberalisation. Venables (2001) finds two European wage gradients, one from the EU core to Greece, Portugal and Spain, and another from Western to Eastern Europe. These are however aggregate wages and do not distinguish sectoral effects. Using regional data for respectively

Canada and the UK, Hunt and Mueller (2002) and Monastiriotis (2002) conclude that regions with more human capital tend to have higher average wages. Forslid et al. (2002) have conducted a CGE simulation analysis of the sectoral relationship between industrial concentration and trade costs in the EU. They concluded that Chemicals, Machinery, Metals, Minerals and Transport Equipment are U-shaped, whilst Leather Products, Food Products, and Textiles are linear.

The results presented here are not directly comparable with these previous studies. On one hand, the scope in terms of countries and sectors differs as an exclusively European sample is used and industrial sectors are disaggregated. By doing this, it is found that the behaviour of specific sectors greatly differs from what might be suggested by aggregate data. The Forslid et al. (2002) results are confirmed, except for Chemicals, which in this paper is linear and not U-shaped. However, because the analysis is extended to human capital, the U-shapedness with respect to skill is very much put in question. Finally, whether Europe is or not U-shaped, other sort of country-specific characteristics are at least as important as geography in explaining the wide disparities in real wages.

5 Conclusions

In this paper a quadratic sectoral real wage equation has been estimated for the member countries of the enlarged EU. It has been shown that the reaction of real wages to scale and skill differs across industrial sectors. When significant, the real wages U-shaped curve is increasing and concave with respect to scale, but decreasing and convex with respect to skill. However, real wages in Chemicals, Wood Products, Leather Products and Textiles do not react to scale, and only those sectors with low degree of scale economies and low-skill intensity are U-shaped with respect to skill. At the present GDP levels, EU geography is still in the divergence-inducing side of the U-curve. The impact of demand for labour on real wages is stronger than that of supply of labour and thus real wages vary directly with country size. The result is divergence. In addition, EU real wages are significantly determined by country-specific characteristics other than geography that push Northern real wages upward and pull Eastern real wages downward.

When the relationship between real wages and market access is significantly U-shaped, after a certain threshold the divergence mechanism turns into a convergence mechanism. In this case, the impact of supply of labour on real wages would be higher than that of demand for labour. Real wages would vary inversely to market access and convergence would result. Whereas the demand for labour depends on the location of firms, the supply of labour is given by initial endowments and also by migrants if migration is allowed for. The fact that in the EU the demand side is stronger can be explained by a greater mobility of capital with respect to labour. Hence the enhancement of labour mobility is an important factor in promoting convergence of real wages. The growth of GDP and the decrease of trade costs, including the improvement of infrastructures, can also promote convergence of real wages by moving the EU to the other side of the U-curve. The opposite applies to the human capital U-curve: the EU is on its converging side and an increase in human capital would create real wage divergence. In practice, because the Eastern countries have a high human capital level but the lowest real wages, the relationship appears negative overall.

The results of the paper come as a support of recent developments in the EU's Agenda 2000, which has been a first step in the right direction by emphasising different roles for the EU's Regional Policy. The latter should in fact be a mix of policies, focussing on both income and education/skills, together with infrastructure development. The support of Regional Policy may be particularly important to compensate those country-specific factors that tend to increase real wages where they are already higher. In addition, the EU's Regional Policy should be increasingly sector-specific as the behaviour of sectoral wages differs from the aggregate. What has been said in the European context may be extrapolated at the worldwide level. Developing countries that suffer from poor market access, low human capital endowments and low productivity are failing to converge. Institutions such as the World Bank may have a role, adopting a balanced mix of policies, fostering both income and education/skill levels, together with infrastructure improvement. The policy mix should be less general and pay more attention to the particular characteristics of countries and sectors that it seeks to influence.

References

Baldwin, R., Forslid, R., Haaland, J. and Midelfart-Knarvik, K. (2000), EU Integration and Outsiders: A Simulation Study of Industrial Location, *Norwegian School of Economics and Business Administration Discussion Paper*, 02/2000.

Commission, E. (2001), *The Free Movement of Workers in the Context of Enlargement,* DG-V, Brussels.

Dixit, A. and Stiglitz, J. (1977), Monopolistic Competition and Optimum Product Diversity, *American Economic Review,* 67, 297-308.

Forslid, R. (1999), Agglomeration with Human and Physical Capital: An Analytically Solvable Case, *CEPR DP 2102*.

Forslid, R., Haaland, J. and Midelfart-Knarvik, K. (2002), A U-Shaped Europe? A Simulation Study of Industrial Location, *Journal of International Economics,* 57, 273-97.

Fujita, M., Krugman, P. and A.Venables (2000), *The Spatial Economy: Cities, Regions and International Trade,* MIT Press, Cambridge, MA.

Hanson, G. (1997), Increasing Returns, Trade and the Regional Structure of Wages, *Economic Journal,* 107, 113-133.

Hanson, G. (1998), Market Potential, Increasing Returns and Geographic Concentration, *NBER WP 6429*.

Harris, C. (1954), The Market as a Factor in the Localisation of Industry in the United States, *Annals of the Association of American Geographers,* 64, 315-48.

Hunt, G. and Mueller, R. (2002), A Methodology for Estimating Returns to Skills for Canadian Provinces and US States, *Journal of Regional Science,* 42, 127-43.

Krugman, P. (1991), Increasing Returns and Economic Geography, *Journal of Political Economy,* 99, 483-499.

Krugman, P. (1993), The Hub Effect, or Threeness in Interregional Trade, In *Theory, Policy and Dynamics in International Trade*(Ed, Neary, J. P.) CUP, Cambridge (UK), pp. 29-37.

Marques, H. and Metcalf, H. (2003), Wage Gradients in an Enlarged EU, *Loughborough University Economics Research Paper 03-13*.

Monastiriotis, V. (2002), Human Capital and Wages: Evidence for External Effects from the UK Regions, *Applied Economics Letters,* 9, 843-46.

Overman, H., Redding, S. and Venables, A. (2003), The Economic Geography of Trade, Production and Income: A Survey of Empirics, In *Handbook of International Trade*(Ed, Harrigan, J.) Blackwell, Oxford.

Pratten, C. (1988), A Survey of Economies of Scale, In *Research on the Cost of Non-Europe*, Vol. 2 (Ed, CEC) CEC, Luxembourg.

Redding, S. and Venables, A. (2004), Economic Geography and International Inequality, *Journal of International Economics,* 62, 53-82.

Venables, A. (1999), The International Division of Industries: Clustering and Comparative Advantage in a Multi-Industry Model, *Scandinavian Journal of Economics,* 101, 495-513.

Venables, A. (2001), Geography and International Inequalities: The Impact of New Technologies, *CEP DP 507*.

Appendix A

Data Sources and Codes

Data is taken for the transition period (1990-99), for the following industrial aggregates: ISIC Rev. 2: chemicals (35), leather products (323, 324), machinery (382, 383), metals (37, 381), minerals (36), textiles and clothing (321, 322), transport equipment (384), and wood products (33); ISIC Rev. 3: chemicals (24), leather products (19), machinery (29, 30, 31), metals (27, 28), minerals (26), textiles and clothing (17, 18), transport equipment (34, 35), and wood products (20, 36). The country codes used in the paper are as follows: Austria (aus), Belgium (bel), Bulgaria (bul), Czech Republic (cze), Denmark (dk), Estonia (est), Finland (fin), France (fra), Germany (ger), Greece (gre), Hungary (hun), Ireland (ire), Italy (ita), Latvia (lat), Lithuania (lit), Netherlands (ned), Poland (pol), Portugal (por), Romania (rom), Slovakia (slk), Slovenia (slo), Spain (spa), Sweden (swe), United Kingdom (uk). The sector codes used in the paper are as follows: Chemicals (chem), Leather & Footwear (leat), Machinery (mach), Metals (meta), Minerals (mine), Textiles & Clothing (text), Transport Equipment (trans) and Wood Products (wood). These sectors can be further classified according to the degree of economies of scale (Pratten (1988)) and skill-intensity (Baldwin et al. (2000)): high scale economies and high skill-intensity – chem, mach, tran; high scale economies and low skill-intensity – meta; low scale economies and high skill-intensity – wood; low scale economies and low skill-intensity – leat,mine,text. Data on wages and prices was provided by the International Labour Organisation's Yearbook of Labour Statistics. Data for distances and borders was taken from the CEPII website (www.cepii.fr). Distance data is measured in km between the sample countries' economic centres. These correspond to the capital city except for Germany (Hamburg is the city used). Data for GDP (given in billions USD at 1995 prices and exchange rates) was taken from the IMF's International Financial Statistics. Human capital is proxied by a schooling variable given by the number of people with tertiary education studies. This number was obtained from the Barro-Lee dataset for 1990 and then added of the yearly number of enrolments. The enrolment data was taken from the OECD Education Statistics and UNESCO Statistics of Educational Attainment and Literacy.

Appendix B

Fig. B1: Scatter plots of sectoral real wages against market access (logs)

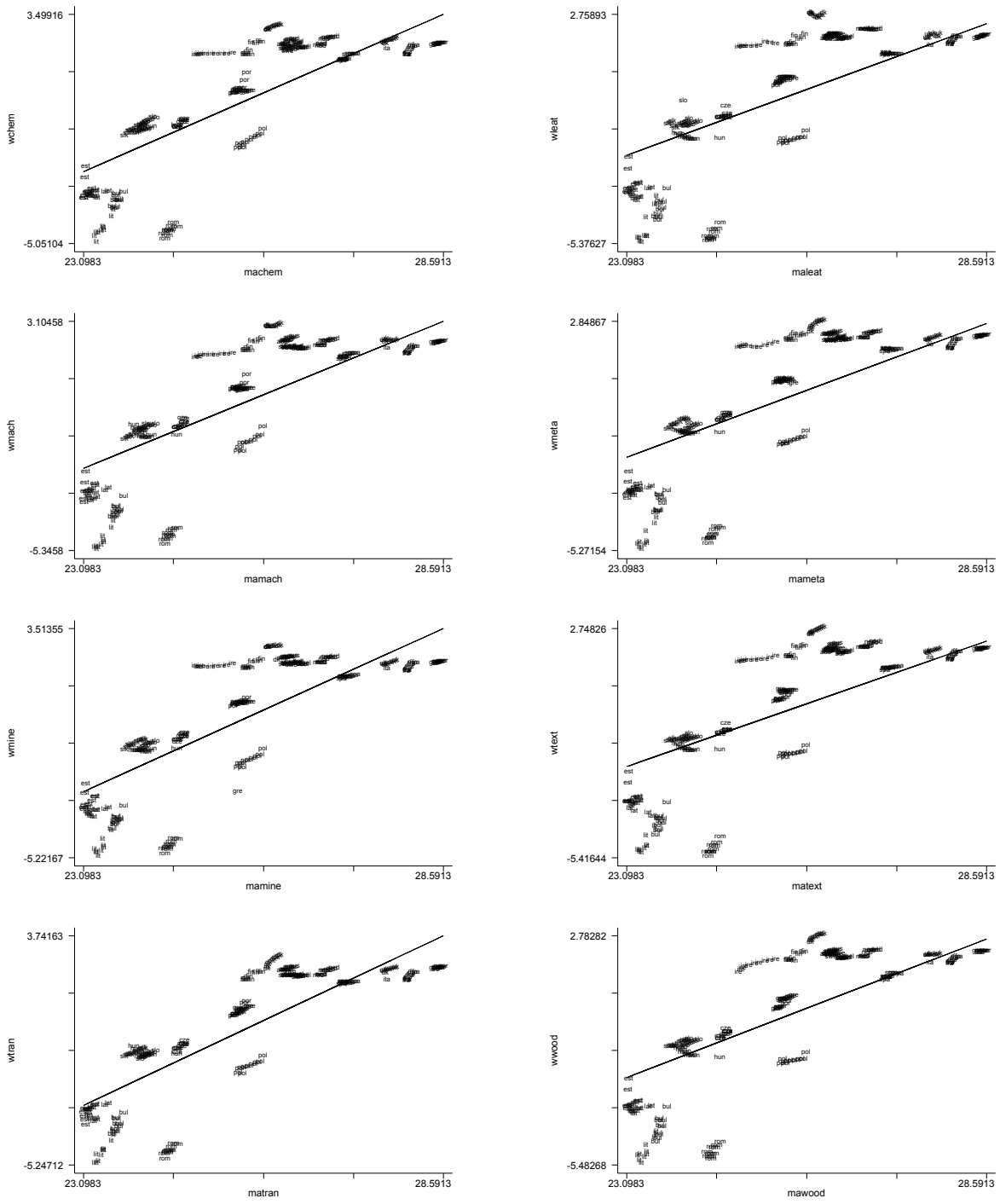
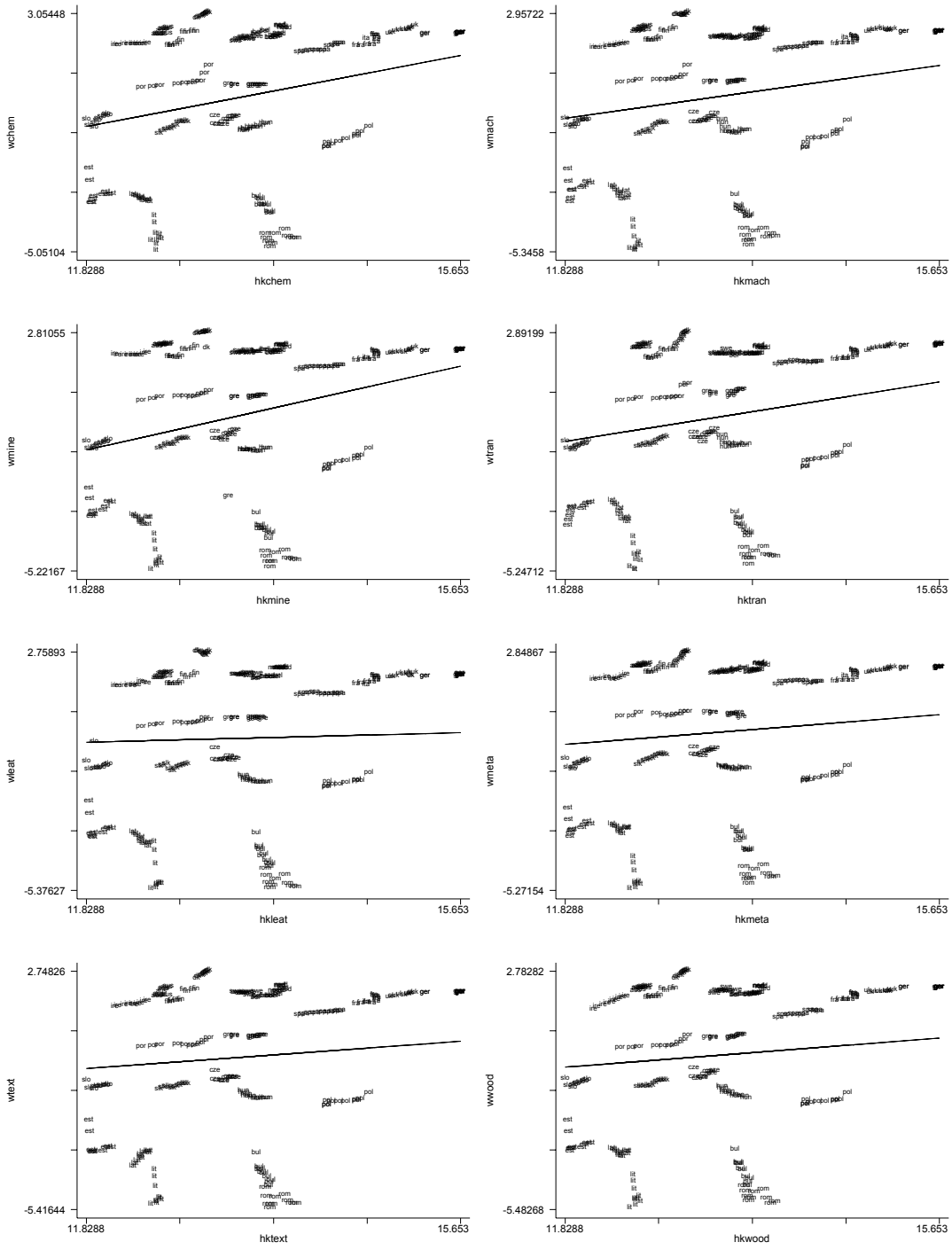


Fig. B2: Scatter plots of sectoral real wages against human capital access (logs)



Appendix C
Country Rankings (1990-99 average)

High scale economies and high skill-intensity						*High scale economies and low skill-intensity*		*Low scale economies and high skill-intensity*		*Low scale economies and low skill-intensity*									
wchem		wmach		wtran		wmeta		wwood		wleat		wmine		wtext		ma		hk	
dk	2.96	dk	2.87	dk	2.69	dk	2.68	dk	2.67	dk	2.68	dk	2.72	dk	2.61	ger	28.52	ger	15.57
uk	2.46	aus	2.38	ger	2.44	aus	2.37	ger	2.18	ned	2.17	aus	2.37	ned	2.11	fra	28.08	uk	15.07
ned	2.45	uk	2.34	aus	2.40	ned	2.32	aus	2.16	swe	1.95	ned	2.27	aus	1.99	uk	27.76	fra	14.74
aus	2.40	ger	2.29	uk	2.35	ger	2.29	ned	2.10	uk	1.94	ger	2.18	ger	1.99	ita	27.72	ita	14.64
ger	2.35	ned	2.28	ned	2.26	fin	2.22	swe	2.06	aus	1.94	uk	2.14	swe	1.96	spa	27.11	pol	14.46
bel	2.27	fin	2.13	swe	2.15	uk	2.20	uk	2.05	ger	1.93	bel	2.12	uk	1.90	ned	26.79	spa	14.23
swe	2.16	swe	2.10	bel	2.10	bel	2.19	fin	1.95	bel	1.85	swe	2.11	bel	1.84	bel	26.41	ned	13.81
ita	2.15	ita	2.07	fin	2.10	swe	2.13	bel	1.93	fra	1.77	fin	2.06	fin	1.83	swe	26.24	rom	13.78
fin	2.13	bel	2.05	fra	2.08	fra	1.98	fra	1.84	fin	1.74	ire	2.02	fra	1.72	aus	26.22	bel	13.67
fra	2.09	fra	1.98	ita	1.96	ita	1.98	ita	1.75	ire	1.60	fra	1.99	ita	1.65	dk	25.99	bul	13.64
ire	1.96	ire	1.80			ire	1.92	ire	1.68	ita	1.60	ita	1.91	ire	1.58	fin	25.66	hun	13.54
spa	1.83	spa	1.78	spa	1.85	spa	1.80	spa	1.28	spa	1.31	spa	1.62	spa	1.30	pol	25.63	gre	13.50
por	0.71	por	0.67	gre	0.82	gre	0.71	gre	0.48	gre	0.46	por	0.64	gre	0.48	gre	25.54	swe	13.44
gre	0.59	gre	0.56	por	0.70	por	0.70	por	0.22	por	0.31	gre	0.30	por	0.21	por	25.46	cze	13.25
slo	-0.60	cze	-0.74	cze	-0.64	cze	-0.58	cze	-0.82	cze	-0.89	cze	-0.68	cze	-0.95	ire	25.04	dk	13.02
cze	-0.61	slo	-0.87	slk	-0.89	slk	-0.81	slo	-1.12	slo	-1.10	slk	-0.93	slo	-1.22	cze	24.59	por	12.81
slk	-0.83	slk	-1.06	hun	-0.93	slo	-0.98	slk	-1.16	slk	-1.18	slo	-0.99	slk	-1.24	rom	24.41	fin	12.79
hun	-0.86	hun	-1.11	slo	-0.99	hun	-1.14	hun	-1.49	hun	-1.66	hun	-1.19	hun	-1.58	slo	24.06	slk	12.72
pol	-1.25	pol	-1.38	pol	-1.42	pol	-1.41	pol	-1.75	pol	-1.72	pol	-1.55	pol	-1.74	hun	24.05	aus	12.61
est	-3.07	est	-3.12	est	-3.23	est	-3.10	est	-3.22	est	-3.27	est	-3.09	est	-3.25	slk	23.88	lit	12.54
lat	-3.28	lat	-3.35	lat	-3.28	lat	-3.20	lat	-3.54	lat	-3.69	lat	-3.54	lat	-3.65	bul	23.61	lat	12.39
bul	-3.49	bul	-3.92	bul	-3.74	bul	-3.63	bul	-4.16	bul	-4.18	bul	-3.83	bul	-4.20	lit	23.38	ire	12.30
lit	-4.56	rom	-4.83	rom	-4.73	rom	-4.77	lit	-5.04	lit	-4.90	lit	-4.79	lit	-4.93	lat	23.27	slo	11.95
rom	-4.62	lit	-5.03	lit	-4.81	lit	-4.90	rom	-5.04	rom	-5.10	rom	-4.82	rom	-5.14	est	23.17	est	11.94

Note: The "w" variables are logs of sectoral real wages, "ma" is a measure of market access built as the distance-weighted average of log GDPs, "hk" is a measure of access to skilled labour given by the distance-weighted average of log HK stock.

Appendix D
Regression Results

	High scale economies and high skill-intensity			*High scale economies and low skill-intensity*	*Low scale economies and high skill-intensity*	*Low scale economies and low skill-intensity*		
	chem	***mach***	***tran***	***meta***	***wood***	***leat***	***mine***	***text***
MA	0.88 (1.48)	5.28*** (1.53)	3.71*** (1.17)	3.08*** (1.01)	2.15* (1.17)	1.94 (1.37)	6.06*** (1.58)	0.39 (1.08)
(MA)²	0.00 (0.03)	-0.09*** (0.03)	-0.05** (0.02)	-0.04** (0.02)	-0.03 (0.02)	-0.03 (0.03)	-0.10*** (0.03)	0.01 (0.02)
HKA	-0.05 (0.91)	-0.75 (0.69)	-0.70 (0.68)	-0.30 (0.49)	0.18 (0.53)	-1.74*** (0.64)	-1.71** (0.88)	-1.74*** (0.60)
(HKA)²	0.01 (0.03)	0.03 (0.02)	0.02 (0.02)	0.01 (0.02)	-0.01 (0.02)	0.06*** (0.02)	0.07** (0.03)	0.06*** (0.02)
aus	2.68*** (0.24)	1.44*** (0.26)	2.02*** (0.22)	1.66*** (0.16)	1.35*** (0.21)	0.76*** (0.21)	1.99*** (0.29)	1.48*** (0.20)
bel	2.17*** (0.25)	1.00*** (0.24)	1.58*** (0.20)	1.35*** (0.15)	1.05*** (0.20)	0.80*** (0.19)	1.42*** (0.28)	1.45*** (0.17)
bul	-1.10*** (0.37)	-2.21*** (0.42)	-0.94*** (0.38)	-1.92*** (0.31)	-2.61*** (0.34)	-3.55*** (0.39)	-2.14*** (0.44)	-2.29*** (0.31)
cze	1.01*** (0.31)	-0.14 (0.34)	0.89*** (0.29)	0.16 (0.22)	-0.22 (0.27)	-0.98*** (0.28)	0.09 (0.38)	0.07 (0.23)
dk	3.36*** (0.25)	2.15*** (0.27)	2.58*** (0.22)	2.16*** (0.17)	2.07*** (0.22)	1.75*** (0.21)	2.42*** (0.31)	2.41*** (0.19)
est	0.06 (0.37)	-0.94** (0.42)	-0.03 (0.34)	-0.98*** (0.30)	-1.39*** (0.31)	-2.74*** (0.39)	-0.60 (0.42)	-1.49*** (0.30)
fin	2.85*** (0.28)	1.65*** (0.29)	2.34*** (0.24)	1.97*** (0.18)	1.60*** (0.23)	0.92*** (0.24)	2.03*** (0.32)	1.83*** (0.21)
fra	0.31** (0.13)	-0.07 (0.13)	0.03 (0.08)	-0.02 (0.10)	-0.15** (0.07)	0.03 (0.08)	-14.34 (9.82)	0.07 (0.07)
gre	1.32*** (0.28)	0.22 (0.30)	1.26*** (0.24)	0.94*** (0.21)	0.30 (0.24)	-0.15 (0.24)	0.22 (0.44)	0.79*** (0.20)
hun	1.16*** (0.34)	0.06 (0.42)	1.26*** (0.39)	0.06 (0.32)	-0.47 (0.48)	-1.38*** (0.43)	-0.06 (1.41)	-0.08 (0.31)
ire	7.37*** (1.08)	2.77*** (0.46)		2.20*** (0.23)	1.77*** (0.25)	1.23*** (0.38)	2.53*** (0.37)	1.90*** (0.28)

lat	-0.39 (0.34)	-1.28*** (0.41)	-0.19 (0.40)	-1.19*** (0.29)	-1.82*** (0.29)	-3.14*** (0.36)	-1.23*** (0.41)	-1.90*** (0.30)
lit	-1.72*** (0.35)	-3.04*** (0.41)	-1.78*** (0.35)	-2.94*** (0.31)	-3.35*** (0.31)	-4.30*** (0.41)	-2.57*** (0.43)	-3.10*** (0.31)
ned	2.00*** (0.21)	0.96*** (0.21)	1.38*** (0.17)	1.20*** (0.13)	0.94*** (0.18)	0.95*** (0.20)	1.33*** (0.24)	1.43*** (0.15)
pol	-0.80*** (0.30)	-1.78*** (0.33)	-1.06*** (0.26)	-1.60*** (0.20)	-1.92*** (0.25)	-2.27*** (0.26)	-2.01*** (0.36)	-1.34*** (0.21)
por	1.34*** (0.31)	0.49 (1.07)	1.20*** (0.27)	0.62*** (0.19)	0.09 (0.66)	-0.42* (0.25)	0.75** (0.33)	0.39* (0.24)
rom	-2.95*** (0.33)	-4.03*** (0.37)	-2.95*** (0.31)	-3.85*** (0.25)	-4.24*** (0.29)	-4.98*** (0.31)	-4.01*** (0.40)	-3.84*** (0.26)
slk	1.50*** (0.32)	0.28 (0.37)	1.48*** (0.31)	0.58** (0.25)	0.02 (0.27)	-0.95*** (0.31)	0.65* (0.39)	0.19 (0.25)
slo	1.71*** (0.31)	0.20 (0.36)	1.06*** (0.29)	0.20 (0.24)	-0.16 (0.26)	-1.22*** (0.30)	0.45 (0.38)	-0.22 (0.23)
spa	1.01*** (0.18)	0.26 (0.18)	0.64*** (0.16)	0.43*** (0.11)	-0.08 (0.15)	-0.03 (0.15)	0.39* (0.22)	0.40*** (0.13)
swe	2.25*** (0.24)	1.18*** (0.25)	1.82*** (0.21)	1.43*** (0.15)	1.30*** (0.21)	0.96*** (0.20)	1.57*** (0.29)	1.67*** (0.18)
uk	0.89*** (0.12)	0.41*** (0.12)	0.57*** (0.09)	0.40*** (0.07)	0.33*** (0.10)	0.35*** (0.10)	0.37*** (0.14)	0.56*** (0.08)
constant	-24.18 (17.70)	-73.27*** (18.42)	-56.96*** (12.94)	-47.99*** (12.14)	-38.36*** (13.77)	-18.46 (17.18)	-76.89*** (18.13)	-2.46 (12.06)
No. obs.	230	230	220	230	230	230	230	230
Log-likelihood	309.10	322.39	299.70	340.67	354.55	308.00	276.14	338.45
Wald Chi^2	82361.85***	69121.88***	128713.94***	128025.19***	137006.23***	82223.47***	83359.99***	154450.34***

Note: The regression method used is the FGLS with panel-specific AR(1) and contemporaneous panel correlation. Standard errors are shown in parenthesis. *, ** and *** represent significance at 10, 5 and 1%, respectively. The omitted country is Germany as it has the highest market and human capital access. Italy was dropped due to an insufficient number of observations in the real wage series. In the FGLS the R^2 is not reported as when the GLS parameters are estimated the total sum of squares cannot be broken down as in an OLS regression, making the R^2 less useful as a diagnostic tool for GLS regressions. Specifically, an R^2 computed from GLS sums of squares need not be bounded between zero and one and does not represent the percentage of total variation in the dependent variable that is accounted for by the model. Additionally, eliminating or adding variables in a model does not always increase or decrease the computed R^2 value.