HUMAN CAPITAL ACCUMULATION AND GEOGRAPHY: EMPIRICAL EVIDENCE IN THE EUROPEAN UNION[*]

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Abstract

This paper evaluates the role that geography plays in determining the spatial distribution of educational attainment levels among European Union regions, based on an extension of the standard two sector (agriculture and manufacturing) FUJITA et al. (1999) economic geography model. We provide evidence that, in the European Union, educational attainment levels are higher in those regions with greater market access. This finding corroborates the theoretical predictions of the model and proves that remoteness is a penalty for the economic development and convergence of the European Union regions.

JEL classification: F12, F14, O10
Keywords: Economic Development, Economic Geography, Spatial structure

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1. Introduction

In January 2003 the release of the 2nd intermediate report on the economic and social cohesion showed that regional disparities in the European Union are still very large and there is little improvement since 1990. The figures given in the report for the year 2000 reflected that at the 10th percentile the ratio between the regions with the highest GDP per head levels and those with the lowest GDP per head levels was about 2.6 (2.8 in 1990). The persistence of such differences is surprising in light of the successive steps taken by the European Union towards higher levels of integration and the number of policies[1] established to level out income differences and to allow the catching-up of the peripheral regions. There are a number of reasons which may prevent convergence of income levels such as slow technology diffusion, endowment disadvantages[2] and remoteness[3].

Recently, the so-called New Economic Geography (NEG) has reached a theoretical consolidation as a theory that explains how remoteness (distance to consumer markets and sources of inputs) may prevent convergence of income levels and therefore provoke the emergence of a heterogeneous economic space. Although the theoretical bases of NEG models are well documented, evidence on their empirical relevance is still scarce. FUJITA el al. 1999 stated "we clearly need much more such [empirical] works, as closely tied to the theoretical models as possible…"(p.347). NEARY 2001, OTTAVIANO 2002 and HEAD and MAYER 2004 also pointed out that empirical research on NEG is lagging behind.

This paper applies the NEG framework in an empirical investigation analyzing the importance of economic geography in explaining the spatial structure of educational attainment levels in the European Union. It is to our knowledge the first paper, at European Union level, to have used the theoretical tools of the New Economic

Geography to analyze the impact of distance from markets in the levels of human capital. Methodologically, it builds on the approach developed by REDDING and SCHOTT 2003 who extend the standard tow-sector (agriculture and manufacturing) FUJITA et. al. 1999 New Economic Geography model, to allow unskilled workers to endogenously choose whether to invest in education. The basic idea is that an increase in remoteness causes higher transport costs to firms in selling their products, which has the same effect as a reduction in the relative price of the manufactured good. Therefore, if manufacturing goods are relatively skill intense, firms have less value added available to remunerate their skilled workers and the incentives to educate decreases They examine the validity of the predictions of their model estimating it for different samples of world countries[4], confirming that countries located far from centres of world economic activity are characterised by relatively low levels of educational attainment.

This paper uses, approximately, the same NEG model in the analysis of the regional educational attainment structure in the European Union. In our application of the model to the European reality two comments are worth making. The first one refers to the model assumption of immobility of human capital. Although the REDDING and SCHOTT 2003 model refers to countries and assumes immobility of human capital their model is the most appropriate for the research topic in question[5]. In general, labour mobility is very low both between and within countries in the European Union. For example BARRO and SALA-i-MARTIN 1995 estimate the impact of income differences on regional migration for several European Countries[6] concluding that on average a 10% increase in local real GDP per capita leads, ceteris paribus, to a yearly population inflow of less than 0.1%. In a similar vein but with a different research agenda CROZET 2004[7] observes very important migration costs reflecting that European workers have a very low degree of geographical mobility, which explain the small scale of inter-regional migration flows. The second comment refers to the market access variable used in the empirical part of the paper. At international level it is possible to compute a theory-based measure of market access. However, at regional level we have to build it in an alternative way due to the lack of regional prices and interregional trade flows. We circumvent this problem computing the market potential function, originally defined by HARRIS 1954 and ISAARD 1954, which is a fairly good approximation of the theory-based measure[8].

This paper contributes, from a methological point of view, to the growing literature that aims at testing formally models of the New Economic Geography and to the still very scarce empirical relevance of the consequences of economic geography for human capital levels, by adapting and estimating the theoretical framework developed by REDDING and SCHOTT 2003 for a different set of data. We estimate the model for a sample of 203 European Union NUTS[9] 2 regions for the year 2000, finding an important role for market access in explaining educational attainment levels in the European Union. Consistent with the predictions of the model regions with higher market access, have higher levels of educational attainment. Our results show that remoteness is an additional penalty for convergence of income levels and development in the European Union by hampering the accumulation of human capital.

From a policy point of view, these results can help to orientate the nature and extent of the EU's efforts to promote growth and development of peripheral regions.

The rest of the paper is structured as follows: Section 2 contains a brief description of the theoretical model that constitutes the theoretical framework of the empirical analysis. Section 3 contains the empirical framework, data and regional system use in our estimations. The results of the regression analysis are presented in section 4. Finally, section 5 contains the final remarks and conclusions.

2. Theoretical Background

The theoretical framework underlying the empirical analysis carried out in this paper is a reduced version of REDDING and SCHOTT 2003 NEG model[10]. Its difference[11] with the standard two sector FUJITA et al. 1999 (agriculture and manufacturing) New Economic Geography model is that it introduces endogenous human capital accumulation. In order to take into consideration this extension we assume a world with R locations where each location is endowed with L_i consumers. Consumers have one unit of labour which is supplied inelastically with zero disutility and consumers choose endogenously whether or not to invest in becoming skilled. The decision of any individual (z) of location $i \in \{1,....,R\}$ to become skilled is given by the wage differential between skilled and unskilled workers and the costs of education.

Mathematically this condition can be expressed in the following way:

$$w_i^s - w_i^u \geq \Omega_i(z) w_i^u \quad (1)$$

Where $\Omega_i(z) = \dfrac{h_i}{a(z)}$ represents the cost of education in terms of units of unskilled labour needed for one unit of it to become skilled. This cost function depends of two components, h_i which can be though of an inverse measure of the extent of public provision education and $a(z)$ which represents the individual ability[12]. From equation (1) the critical value for a (a_i^*) can be obtained such that if $a(z) \geq a_i^*(z^*)$ all individuals choose to become skilled:

$$a_i^* = \frac{h_i}{\left(w_i^S / w_i^U - 1 \right)} \quad (2)$$

The worker with ability (a_i^*) is indifferent between becoming skilled and remaining unskilled, so this equation, in words of REDDING and SCHOTT 2003, can be termed as *skill indifference condition (S).*

Like in standard NEG models, this model assumes homothetic and identical preferences for consumers which are defined over a consumption of a homogenous agricultural good and a variety of differentiated manufacturing goods[13].

Hereinafter, I am going to focus on the supply side, agricultural and manufacturing sector, to characterise the equilibrium relationship between geographical location and endogenous human capital investments.

The agricultural sector produces a homogeneous good under constant returns to scale

$$Y_i = \theta_i^Y (S_i^Y)^{\phi} (L_i^Y)^{1-\phi}, \qquad 0 \prec \phi \prec 1 \qquad (3)$$

Y_i denotes the output in the agricultural sector which is endowed with L_i unskilled workers and with S_i skilled workers. θ_i stands for agricultural productivity.

The manufacturing sector produces a differentiated good according to an increasing returns to scale technology such as the production of each variety requires only primary factors of production (skilled and unskilled labour). The profit function of a representative country i firm is:

$$\Pi_i = \sum_{j=1}^{R} \frac{P_{ij}^M x_{ij}}{T_{ij}^M} - (w_i^S)^{\alpha} (w_i^U)^{1-\alpha} c_i (F + x_i) \qquad (4)$$

Where P_{ij}^M is the price in location j of one unit produced in i, w_i^S is the wage of skilled workers (input share α), w_i^U is the wage of unskilled workers (input share $1-\alpha$), c_i is a constant marginal input requirement, F is a fixed input requirement and $x_i = \sum_{j=1}^{R} x_{ij}$ is the total output of the firm produced for all markets.

Manufactured goods are traded among countries incurring iceberg costs, i.e. a fraction of any good shipped from location i to location j melts away so in order to arrive at location j with one unit of good $T_{ij}^{M} \succ 1$ units must be shipped.

With respect to the producers' equilibrium, in the agricultural sector profit maximization imply that price equals unit costs of production:

$$P_i^Y = 1 = \frac{1}{\theta_i^Y}(w_i^S)^{\phi}(w_i^U)^{1-\phi} \tag{5}$$

where the output of the agricultural good is chosen as the numeraire, and thus $P_i^Y = 1$ for all i.

After solving the first order conditions, profit maximization in the manufacturing sector implies[14]:

$$(w_i^S)^{\alpha}(w_i^U)^{1-\alpha} = \xi c_i^{-1}(MA_i)^{\frac{1}{\sigma}} \tag{6}$$

where $\xi = \frac{\sigma - 1}{\sigma}$ is a constant, c_i is the constant marginal input requirement, $MA_i = \sum_{j=1}^{R}(T_{ij}^{M})^{1-\sigma}E_j G_j^{\sigma-1}$ the market access[15] of region i and σ the elasticity of substitution among manufacturing varieties.

Equations (4) and (5) combined together give the equilibrium wages for skilled and unskilled workers. Taking logs and differentiating equations (4) and (5) and combining them with the skill indifference condition-equation (2)- the equilibrium relationship between geographical location and endogenous human capital investments, is obtained.

$$0 = \phi\frac{dw_i^S}{w_i^S} + (1-\phi)\frac{dw_i^U}{w_i^U} \tag{7}$$

$$\alpha\frac{dw_i^S}{w_i^S} + (1-\alpha)\frac{dw_i^U}{w_i^U} = \frac{1}{\sigma}\frac{dMA_i}{MA_i} \tag{8}$$

Taking into account equations (7) and (8) it can be shown that if the equilibrium market access (MA_i) decreases and if the manufacturing sector is skill-intensive relative to the agricultural sector, the new equilibrium must be characterised by a lower relative wage of skilled workers, therefore, by using the skill indifference condition this new equilibrium implies a higher critical level of ability (a_i^*) above which individuals become skilled[16] and a reduced supply of skilled workers[17].

This intuitive explanation is based on that the decrease in the market access modifies the initial equilibrium conditions in the manufacturing sector, which experiences a decrease in size. This reduction in size releases more skilled labour than is demanded initially in the agricultural sector. To go back to the equilibrium point, the nominal skilled wage has to be lower and the nominal unskilled wage higher and therefore the relative wage of skilled workers is lower, which reduces the incentives to invest in education.

3. Empirical framework, data and regional system

3.1 Econometric specification

The results that are obtained from the theoretical model can be tested by using the following regression equation:

$$Ln(E\mathrm{A}_\mathrm{i}) = \alpha_0 + \alpha_1 \ln(MA_i) + \varepsilon_i \qquad (9)$$

$E\mathrm{A}_\mathrm{i}$ stands for levels of educational attainment, MA_i for regions market access and ε_i is the disturbance term. Equation (9) allows us to check if there is a spatial educational attainment structure in the EU, i.e. whether there is a positive correlation between medium and high levels of educational attainment and distance from large consumer markets, i.e. if high market access locations have relatively high levels of education. In this specification the error term captures differences in technology across regions, c_i. To begin with, we consign these to the error term and examine how much of the variation in cross regional wages can be explained when only including information on market access. This provides the basis for our baseline estimation where we assume that the error term is uncorrelated with the explanatory variables. Considering that this assumption can be violated and therefore the coefficient estimates be biased and inconsistent, we also present estimates using instrumental variables regression.

In order to control for the effects of outlying observations, we also estimate this alternative specification:

$$Ln(EA_{\mathrm{i}}) = \alpha_0 + \alpha_1 \ln MA_i + \sum_{n=1}^{N} \gamma_n X_{i,n} + \varepsilon_i \tag{10}$$

Where X_{in} is a control variable and γ_{in} is the correspondent coefficient.

To complement the estimations of different equations for different educational attainment levels, we also report the results of two alternative estimations based on transformations in the definition of the dependent variable. The first transformation of the dependent variable consists of ranking EU regions given the values 1 if low educational attainment is the highest share educational attainment, 2 if it is medium and 3 if it is high and then estimate and ordered probit model. The second transformation consists of estimating a single equation where the dependent variable is regional average years of schooling instead of educational attainments.

3.2. Data and Regional System

The dependent variable in the regression analysis is the *log educational attainment* defined as the % of persons age 25-64 with low, medium or high levels of education.

Data on educational attainment come from the European Union Labour Force Survey (LFS). The classification is based on the highest level of education attained (educational attainment) as well as on recent or current participation of the population in education and training. Data on education collected through the LFS includes three levels of educational attainment[18], Low level: at best lower secondary education level (ISCED[19]97= Levels 0-2), Medium level: upper secondary education level (ISCED97 = levels 3-4) and High level: higher education qualification (ISCED97 = levels 5-6).

In our analysis data on regional educational attainment refers to the year 2000 for a sample of 203 NUTS 2 EU15 regions.

The variables in the right-hand side of the equation are the following ones:

Market access (MA), which is a proxy for access to sources of expenditure. In this study the theory-based measure of market access can not be computed since at regional level in Europe there is no data on regional prices and interregional trade flows. We compute market access as a distance weighted sum of regional GDPs. Technically, the expression we use to compute market access is:

$$MA_i = \sum_{j=1}^{n} \frac{M_j}{T_{i,j}}$$

Mj is a measure of the volume of economic activity of region j, Tij is a measure of the distance between i and j and n is the number of regions considered. For the market access computations, taking into account that we are measuring access to sources of expenditure and to avoid underestimation of market access of more peripheral EU regions, we build up our measure for all EU27 NUTS2 regions with the exceptions of French Dominions (Guadeloupe, Martinique, Reunion and Guyane), Portuguese Islands (Azores and Madeira) and Spanish Island of Canarias. A total of 259 EU27 NUTS2 regions were included. As a measure of economic activity (Mj), we took Regional Gross Domestic Product and with respect to distance between regions (Tij), they are great circle distances in Km between the main cities of the regions. These distances are derived from the latitude and longitude coordinates of each region's main city. Distance from a region i to itself, T_{ii} is modeled as proportional to the square root of the region's area. The expression we use to compute it is $0.66\sqrt{\frac{Area}{\pi}}$ in which "Area" is the size of region i in km2. This formula gives the average distance between two points in a circular location, (see HEAD and MAYER 2000 and CROZET 2004 for a discussion of this measure for internal distance). Market access computations were carried out using a geographic information system (arc info and arc map 8.2 softwares) and the graphic results can be seen in the following map[20].

(INSERT FIGURE 1 AROUND HERE)

Figure 1 shows the results of regional market access computations for the year 2000. The value of the market access measure is reflected in the relative shade of the colour used[21], that is, the darker the shade, the higher the value of market access and visa versa. The spatial pattern of the market potential resembles accessibility measures and peripherality indices calculated by KEEBLE et al. 1982 or SCHURMANN and TALAAT 2000. Regions marked by low market potentials are located in the geographic periphery, comprising in particular Finland, the northern part of the United Kingdom, Portugal, the western and the southern parts of Spain and south-Eastern part of Greece. In contrast, high accessibility and market potentials are estimated for the regions in the North-East of Europe, covering the area commonly known as the Golden triangle Greater Manchester-London-Paris and the Rhur Valley.

4. Economic Geography and Educational Attainment Levels: Empirical results

The educational attainment of the European population varies greatly. Table 1 shows the share of labour force with low, medium and high educational levels. As it can be seen from the table, a large percentage of the labour force in the South European Union countries and Ireland (the so-called cohesion countries)– Portugal (78%), Spain (60%), Italy (52%), Ireland (49%) and Greece (45%)- have an education at the lower secondary level, well above the EU15 average (35%). However, in the North and most central European Union countries –Germany (83%), Denmark (82%), United Kingdom (82%) Sweden (80)- more than 80% of the labour force population has schooling to at least a higher secondary level, well above the EU15 average (65%).

(INSERT TABLE 1 AROUND HERE)

Table 2 shows the figures on educational attainment at regional level for the 62 regions with the highest upper secondary and tertiary education and the 62 regions with the highest primary and lower secondary education. Among the regions with the highest levels of educational attainment are those located in the so-called *blue banana* (Greater Manchester, Inner London, Outer London, Köln). The lowest educational attainment levels are in those regions located in the EU periphery.

(INSERT TABLE 2 AROUND HERE)

Therefore the figures on the spatial distribution of educational attainment at European Union Level show a core-periphery gradient, a pattern that is commonly observed when we refer to the spatial distribution of EU income (poor regions predominantly found in the European periphery). Figure 2 illustrates this fact by plotting high educational levels in 2000 against distance from Luxembourg, the approximate geography centre of the European Union.

(INSERT FIGURE 2 AROUND HERE)

This core-periphery pattern of European Union educational attainment levels can also be analysed by testing econometrically expression (9), which specifically tests for the correlation between human capital investments and market access[22]. Consistent with the model, we provide evidence that educational attainment is higher in those regions that have greater market access.

Figures 3, 4 and 5 plot low, medium and high educational attainment levels against market access for year 2000. It is clear from these figures that the relationship between regional levels of educational attainments and regional market access are in line with the predictions of the model. The relationship is robust and is not due to the influence of a few individual regions.

(INSERT FIGURE 3 AROUND HERE)

(INSERT FIGURE 4 AROUND HERE)

(INSERT FIGURE 5 AROUND HERE)

Columns 1, 3, 6 and 9 of table 3 present the results of our econometric estimations for a sample of 203 EU NUTS2 regions. Column 1 shows the results of regressing the percentage of population with primary education (labelled as “low” educational level in the table) against market access. The results indicate that an increase in regional market access is negatively correlated with the percentage of population who has primary education. Considering that we are dealing only with figures of educated people (population who has attained primary, secondary or tertiary education) and therefore the share of population with primary education is one minus the share of population with secondary and tertiary education, this result constitutes an indirect way of checking the theoretical predictions of the model. Columns 3, 6 and 9 report the results of regressing the share of population with medium, high and medium+high educational levels[23] against market access using OLS and as such it is a direct way of testing the predictions of the model. The coefficients on market access are significant and the signs correspond with theoretical expectations. Doubling market access would increase medium educational levels by 27% and high educational levels by 26%. These results show that between 16-19% of the variation in regional levels of secondary and tertiary education is explained by market access.

(INSERT TABLE 3 AROUND)

The estimation of three different equations for the different levels of educational attainment (medium, high and medium+high) is based on the fact that the coefficient estimates are significantly different for the three equations. In order to check this fact we run this alternative regression:

$$Ln(E\mathrm{A}_{\mathrm{i,j}}) = \alpha_0 + \alpha_1 \ln(MA_{i,j}) + \alpha_2 D_{i,j} + \varepsilon_{i,j}$$

Where $i = 1,2,.....203$ represents the 203 NUTS 2 EU15 regions of our sample, $j = \{0,1\}$ stands for the level of educational attainment, being 0 secondary education and 1 tertiary education, so $EA_{1,0}$ is the proportion of population in region 1 who has secondary education and $EA_{1,1}$ is the proportion of population in region 1 who has tertiary education. $MA_{i,j} = MA_i$ for all $j = \{0,1\}$ is the market access of region $i = 1,2,.....203$ and $D_{i,j} = \{0,1\}$ is a variable that takes the value 0 if $j = \{1\}$ and 1 if $j = \{0\}$, $\varepsilon_{i,j}$ stands for the error term.

In this alternative specification our main parameter of interest is α_2 such that if α_2 is statistically different from cero, we can reject that the estimated coefficient α_1 is equal for the different equations estimated and thus it confirms our approach to the problem. The results reported in column 12 of table 3 show that α_2 is significantly different from cero, thus justifying the estimation of three different equations for the different levels of educational attainments.

A potential shortcoming of the previous analysis, as in almost all papers in this literature is the one referring to the endogeneity of the market access measure, i.e., good market access can be correlated with other determinants of the level of educational attainment of the region. This endogeneity problem can cause inconsistent and biased estimates. To avoid problems of endogeneity between human capital levels and regional market access, the paper presents instrumental variables estimates.

Determining a causal effect of market access on educational attainment levels depends on the availability of instruments. These need to be variables that are determinants of market access but exogenous with respect to human capital levels. Furthermore, they should also be variables that are not driven by an unobservable third variable the authors suspect might be jointly affecting market access and human capital levels.

Geographic variables seem to be the most adequate candidates for such an instrumental variables estimation. Similar to REDDING and VENABLES 2004 and BREINLICH

2005, I instrument market access with distance from Luxembourg and with the size of a region's home country. The first instrument captures market access advantages of regions close to the geographic centre of EU. The second instrument captures the advantage of large national markets in the composition of domestic market access.

Columns 4, 7 and 10 present the results for the corresponding instrumental variables estimation. Both instruments are highly statistically significant and have the expected signs in the first stage. Distance to Luxembourg and size of a region's home country explains about 57% of regional market access. Since the instruments represent quite a distinct source of information and are uncorrelated, we can trust them to be reliable instruments.

In the second-stage estimation we again find positive and highly statistically significant effects of market access. The effects of market access on educational attainment levels are even reinforced. The market access coefficient changes from the interval 0.26-0.27 to 0.28-0.35.

For comparison purposes, columns 2, 5, 8, and 11 of table 3 report results of regressing educational attainment levels against distances from the geographic centre of Europe (approximately Luxembourg) in place of market access. The results provide evidence of the negative correlation between regional medium and high educational attainment levels and regions' distance from Luxembourg and a positive correlation with low educational attainment levels.

However, the models given in table 3 are marked by outlying observations. The outlying regions do not correspond with the spatial educational attainment structure determined by the majority of the observations. Outliers will seriously affect the coefficient estimates, if they are influential leverage points, i.e. outlying observations with regard to our measure of market access. In order to control for effects of outlying observations, dummy variables for the outliers are introduced. The most significant outliers[24] are the austrian regions of Wien (AT13), Kärnten (AT21) and Steiermark (AT22), the belgium region of Brussels (BE10) and the british regions of Inner London (UKI1) and Outer London (UKI2).

Columns 1, 3 and 5 of table 4 report the results including dummies for outlying regions. The results show that the effects of market access on educational attainment levels is reinforced; doubling market access would increase medium educational levels by 47% and high educational levels by 30%. Moreover, the fit of the regressions improves considerably (by 56-57%). The models in table 4 explain between 25-30% of the spatial variation in the educational attainment levels in the European Union. Columns 2, 4 and 6 investigate the potential endogeneity problem of market access. Our instruments are again distance to Luxembourg and size of a region's home country. In the second stage we again find positive and statistically significant effects with the IV estimate. Again, the effect of market access on educational attainment levels is reinforced when IV estimation is carried out.

(INSERT TABLE 4 AROUND HERE)

To complement the estimations of different equations for different educational attainment levels, Columns 7 and 8 of table 4 report the results of two alternative estimations based on transformations in the definition of the dependent variable. In column 7 we transform regional educational attainment levels into average years of schooling and then we estimate a single equation using average years of schooling as our dependent variable[25]. To do the transformation of educational levels into average years of education we use the regional information on the proportion of work force with primary, secondary and tertiary education from the Labour Force Survey and we make the following assumptions: primary education (low educational attainment) consists, on average, of 8 years of education, students generally begin primary education between the age of 5 and 7 years and end at 13 to 15 years; secondary education (medium educational attainment) consists on average in 4 years of education, students generally begin secondary education between 13 and 15 years of age and finish between 17 and 18 years of age and tertiary education (high educational attainment) consists of 4 years of education[26]. The coefficient on market access is positive and statistically significant at the usual critical values, showing that an increase in a region's market access increases the average years of education of its population.

Column 8 reports the estimates of an ordered probit model where the dependent variable was transformed given to it the values 1, 2 or 3 according to the relative importance of the proportion of population who has low, medium or high educational levels. Therefore a region that has the highest proportion of population with primary education is ranked 1, if the highest proportion is secondary education is ranked 2 and if the highest proportion is tertiary is ranked 3. In ordered probit models, the sign of the coefficient shows the direction of the change in the probability of falling in the endpoint rankings, in our case (Educational attainment level 1-primary education or Educational attainment level 3-tertiary education) when market access changes. Probability of Educational Attainment level 1 changes in the opposite direction of the sign of the estimated coefficient and probability of educational attainment level 3 changes in the same direction. The coefficient reported in column 8 of table 4 is positive showing that the probability of having higher educational levels is higher in regions with high market access. Moreover the sign of the coefficient informs that the probability of having low educational attainment decreases with increases in a region's market access. The estimated coefficient is statistically significant at the conventional critical values[27].

Therefore the results reported in columns 7 and 8 of table 4 can be taken as additional proofs that geographic location matters for determining educational levels across EU regions.

Our results are in line with those obtained by REDDING and SCHOTT 2003 for a world sample of countries. In their estimations market access itself explained 23% of the variation in educational attainment levels (105 countries) and excluding from the sample OECD countries, US, Japan and Belgium (66 countries) the explanatory power of the regression raised to 26%.

These results shed new light to the pioneering work initiated by REDDING and SCHOTT 2003, showing that at the EU level, geographical location matters for incentives to invest in human capital, i.e., there is a positive correlation between higher educational attainment levels and market access. Fruitful avenues for future research can be exploited through the analysis of the relationship between changes in educational attainment levels and changes in market access for the EU regions and looking for a similar relationship across regions within countries.

6. Final Remarks and Conclusions

In this paper, we analyse the relationship between market access and the levels of educational attainment in the European Union regions for the year 2000. Consistent with the predictions of the theoretical model, we provide empirical evidence of a spatial educational attainment structure in the EU, i.e., a positive correlation between regional medium and high levels of educational attainment and market access. The inclusion of dummy variables alters the coefficient of market access considerably, changing it from values 0.26-0.27 to values of the interval 0.30-0.47. Moreover the fits of the regressions also increase substantially and the augmented models explain around 30% of the spatial variation in the educational attainment levels in the European Union regions.

Alternative estimations using single equations for the dependent variable, years of schooling and an ordered probit model, corroborate the results previously found. There is a positive correlation between market access and years of schooling and there is also a positive correlation between the probability of having higher educational levels a region's market access.

Taking into account that human capital accumulation is a key factor for regional development and to promote convergence among EU regions and that the results of this analysis show that in the EU there is a penalty of remoteness for human capital accumulation, one obvious policy implication is that the outlying regions in the EU should make bigger efforts to improve the quality of their infrastructures trying to reduce distance to the main centres of economic activity. An important role in this sense has been played by the European Union Regional Policy since its institutionalization (1989), devoting an important part of its resources to objective 1 regions (most of them in the outskirts of the EU and so facing the penalty of the remoteness) throughout its three programming periods (Delors I and II packages and Agenda 2000). The majority of resources where channelled to improvements in infrastructure, human capital and aids to production sectors.

One potential shortcoming of this analysis could be the clarification of whether the spatial educational structure observed in Europe (high educational levels in the geographical centre of Europe) is a result of skilled workers' incentives to migrate to such regions and therefore our empirical evidence would also be consistent with quite a different new economic geography model, where skilled workers migrate within each country[28]. Then the question that emerges is if migration to high market access regions within each country, based on the fact that industries agglomerate within a country in regions with good market access, generates an incentive for skilled workers to migrate to such regions. This aspect was studied by CROZET 2004 for a sample of five European Union Countries[29] using data on internal annual migration flows. Crozet concludes that interregional migration flows are very weak because centripetal forces are very limited in geographic scope and barriers to migration are high enough to balance the centripetal forces. He observes very important migration costs reflecting that European workers have a very low degree of geographical mobility which explain the small extent of inter-regional migration flows. In CROZET words "…..*it seems very unlikely that a catastrophic core-periphery pattern will emerge within European Countries, or a fortiori on a greater scale*" (CROZET 2004, page 457). Taking into consideration Crozet's findings we can admit that migration has little influence on the configuration of the spatial educational attainment structure in the EU.

7. References

BARRO R.J. and SALA-i-MARTIN X. (1995) Economic Growth, New York, McGraw-Hill.

BASILE R., DE NARDIS S. and GIRARDI, A. (2001) Regional Inequalities and Cohesion Policies in the European Union, Istituto di Studi e Analisi Economica (ISAE) 1-40.

BENHABIB J. and SPIEGEL M (1994) The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-country Data, *Journal of Monetary Economics* **34**, 143-73.

BILS M. and KLENOW P. (2000) Does Schooling Cause Growth?, *American Economic Review* **90**, 1160-83.

BOLDRIN M. and CANOVA F. (2001) Inequality and Convergence: Reconsidering European Regional Policies, *Economic Policy* **32**, 207-53.

BRAKMAN S., GARRETSEN H. and SCHRAMM M. (2004) The Spatial Distribution of Wages: Estimating the Helman-Hanson Model for Germany, *Journal of Regional Science* **44**, 437-66

BREINLICH H. (2005) The Spatial Income Structure in the European Union - What Role for Economic Geography?, mimeo, LSE.

CROZET M. (2004) Do migrants follow market potentials? An estimation of a new economic geography model, *Journal of Economic Geography* **4**, 439-58.

DE LA FUENTE A. and DOMENECH R. (2001) Schooling Data, Technological Diffusion, and the Neoclassical Model, *American Economic Review* **91**, 323-27.

DE LA FUENTE A. and DOMENECH R. (2002) Educational Attainment in the OECD, 1960-1995, CEPR D.P. 3390.

DIXIT A.K. and STIGLITZ J.E. (1977) Monopolistic Competition and Optimum Product Diversity, *American Economic Review* **67**, 297-308.

EICHER T. and GARCIA-PENALOSA C. (2001) Inequality and Growth: The Dual Role of Human C apital in Deve lopment, *Journal of Development Economics* **66,** 173-97.

FAIÑA A., LANDEIRA F., FERNÁNDEZ-MUNIN J. and LOPEZ-RODRIGUEZ J. (2001) La Técnica de los Potenciales de Población y la Estructura Espacial de la Union Europea, *Investigación Operacional* **3**,163-72.

FAIÑA A. and LOPEZ-RODRIGUEZ J. (2001) The Regional Policy of the European Union and the Enlargement Process to Central and Eastern European Countries, Discussion papers in Economics *01/07*, Department of Economics, Exeter University. pp. 1-23.

FAIÑA A. and LOPEZ-RODRIGUEZ J. (2004) European Regional Policy and Backward Regions: Implications towards EU enlargement, *European Journal of Law and Economics* **18**, 5-32.

FUJITA M., KRUGMAN P. and VENABLES A. (1999) The Spatial Economy: Cities, Regions and International Trade, MIT Press: Cambridge MA.

GALLUP J., SACHS J. and MELLINGER A. (1998) Geography and Economic Development. Proceedings of the World Bank Annual Conference on Development Economics. World Bank, Washington.

GALLUP J., MELLINGER A. and SACHS J. (2000) Climate, Coastal Proximity and Development, Chapter 9. In: Clark, G., Gertler, M., Feldman, M. (Eds), *The Oxford Handbook of Economic Geography*. Oxford Univ. Press, Oxford, pp. 169-194.

GALOR O. and MOUNTFORD A. (2002) Why are One third of People Indian and Chinese: Trade, Industrialization and Demography, Brown University Working Paper , 38-01.

HANSON G. (2005) Market potential, increasing returns and geographic concentration, *Journal of International Economics* **67**, 1-24

HARRIS C. (1954) The market as a factor in the localization of industry in the United States, *Annals of the Association of American Geographers,* **64** 315–48.

HEAD K. and MAYER T. (2000) Non-Europe : The Magnitude and Causes of Market Fragmentation in the EU, *Weltwirtschaftliches Archiv* **136**, 285-314.

HEAD K. and MAYER T. (2004) The Empirics of Agglomeration and Trade, in: Henderson J.V. and Thisse J.F. (eds.), Handbook of Regional and Urban Economics 4, forthcoming.

HUMMELS D. (1999) Towards a Geography of Trade Costs. Mimeograph, Purdue University

ISAARD W. (1954) Location Theory and Trade Theory: Short-Run Analysis, *Quarterly Journal of Economics* **48,** 305-20.

KEEBLE D., OWENS P.L. and THOMPSON D C. (1982) Regional Accessibility and Economic Potential in the European Community, *Regional Studies* **16**, 419-32.

KRUEGER A.D. and LINDAHL M. (1999) Education for Growth in Sweden and the World, *Swedish Economic Policy Review* **6**, 289-339.

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

KRUGMAN P. (1992) A Dynamic Spatial Model, NBER Working Paper No. 4219, Cambridge, Massachusetts.

KRUGMAN, P. and . VENABLES A. (1995) Globalization and the Inequality of Nations, *Quarterly Journal of Economics*, 857-80.

LEAMER E. (1997) Access to Western Markets and Eastern Effort. In: Zecchini, S. (Ed.), Lessons from the Economic Transition, Central and Eastern Europe in the 1990s. Kluwer Academic Publishers, Dordrecht, pp. 503-526.

LOPEZ-RODRIGUEZ J. and FAIÑA A. (2004) The Economic Geography of EU Income: Evolution since the Eighties, Research Papers in Environmental and Spatial Analysis, ISBN: 0 7530 1826 8, London School of Economics.

LOPEZ-RODRIGUEZ J., FAIÑA J.A. and LOPEZ RODRIGUEZ J. (2005) Human Capital Accumulation and Geography: Empirical Evidence in the European Union, DT Funcas, DT Numero 222/2005.

MANKIW G. ROMER D. and WEIL D. (1992) A Contribution to the Empirics of Economic Growth, *Quarterly Journal of Economics* **107**, 407-37.

MION G. (2003) Spatial Externalities and Empirical Analysis: The Case of Italy", ZEW Discussion Paper No.03-38, Mannheim.

NEARY P. (2001) Of Hype and Hyperbolas: Introducing the New Economic Geography, *Journal of Economic Literature* **39**, 536-61.

NIEBUHR A. (2004) Market Access and Regional Disparities: New Economic Geography in Europe HWWA Discussion Paper N. 269, Hamburg, Germany.

OTTAVIANO G. (2002) National Borders and International Trade: Evidence from the European Union, *Canadian Journal of Economics* **22**, 1091-105

OTTAVIANO G. and PUGA D. (1998) Agglomeration in the Global Economy: A Survey on the New Economic Geography, *World Economy* **21**, 707-31

OVERMAN H.G., REDDING S. and VENABLES A.J. 2003 The Economic Geography of Trade Production and Income: A Survey of Empirics, in Kwan-Choi and J. Harrigan (Eds.) Handbook of International Trade, Oxford: Basil Blackwell.

RADELET S. and SACHS J. (1998) Shipping Costs, Manufactured Exports, and Economic Growth. Paper presented at the American Economic Association Meetings, Harvard University, mimeo.

REDDING S. and SCHOTT P. (2003) Distance, Skill Deepening and Development: Will Peripheral Countries Ever Get Rich?, *Journal of Development Economics* **72,** 515-41

REDDING S. and VENABLES A. (2004) Economic geography and international inequality, *Journal of International Economics* **62,** 53-82.

RODRIGUEZ-POSE A. and FRATESI U. (2004) Unbalanced Development Strategies and The Lack of Regional Convergence in the European Union, *Regional Studies* **38**, 97-113.

ROOS M. (2001) Wages and Market Potential in Germany, *Jahrbuch fur Regionalwissen-schaft* **21**, 171-95.

SHURMANN, C. and TALAAT A. (2000) Towards a European Peripherality Index: Final Report, Berichte aus dem Institut fur Raumplanung, N0.53, Dormund.

TEMPLE J. (1999) A positive effect of Human Capital in Growth, *Economic Letters* **65**, 131-34

VENABLES A. (1996) Equilibrium Locations of Vertically Linked Industries, *International Economic Review* **37**, 341-59.

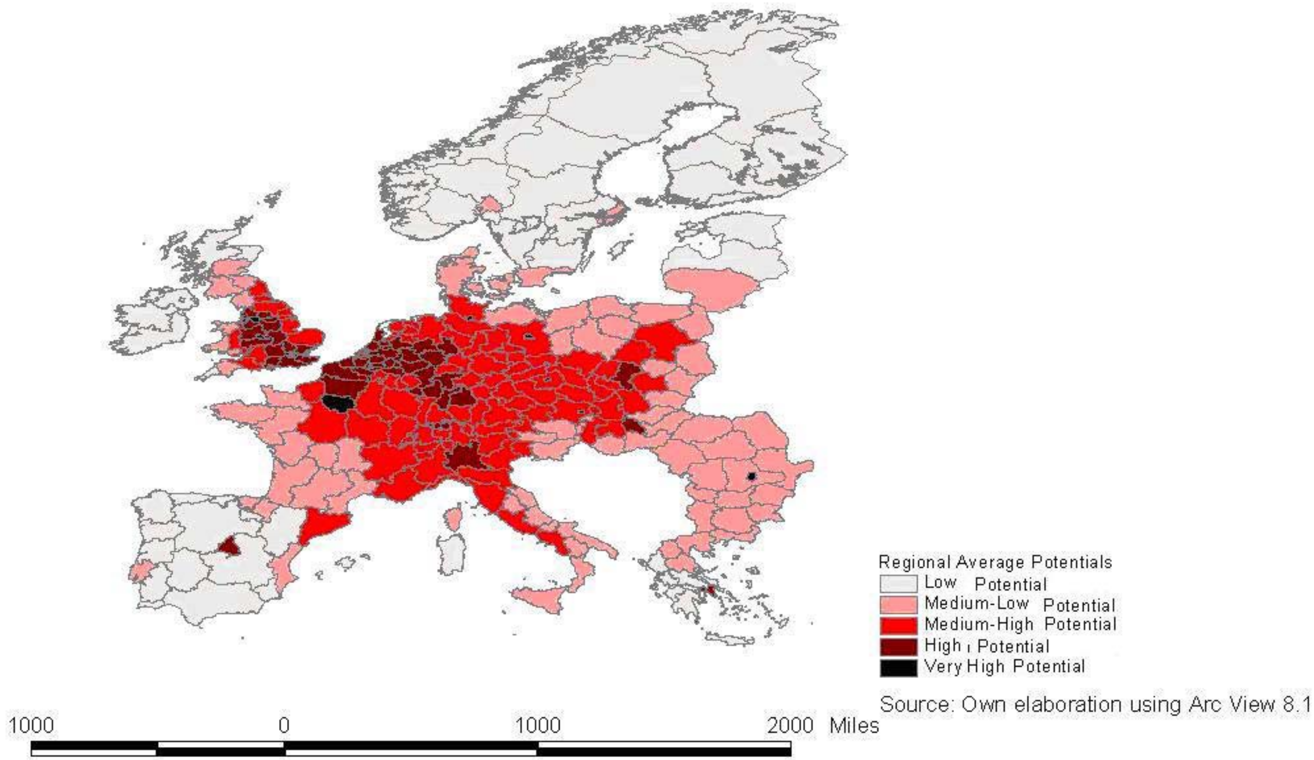

Figure 1:Estimated Market Potential by Region (EU27)

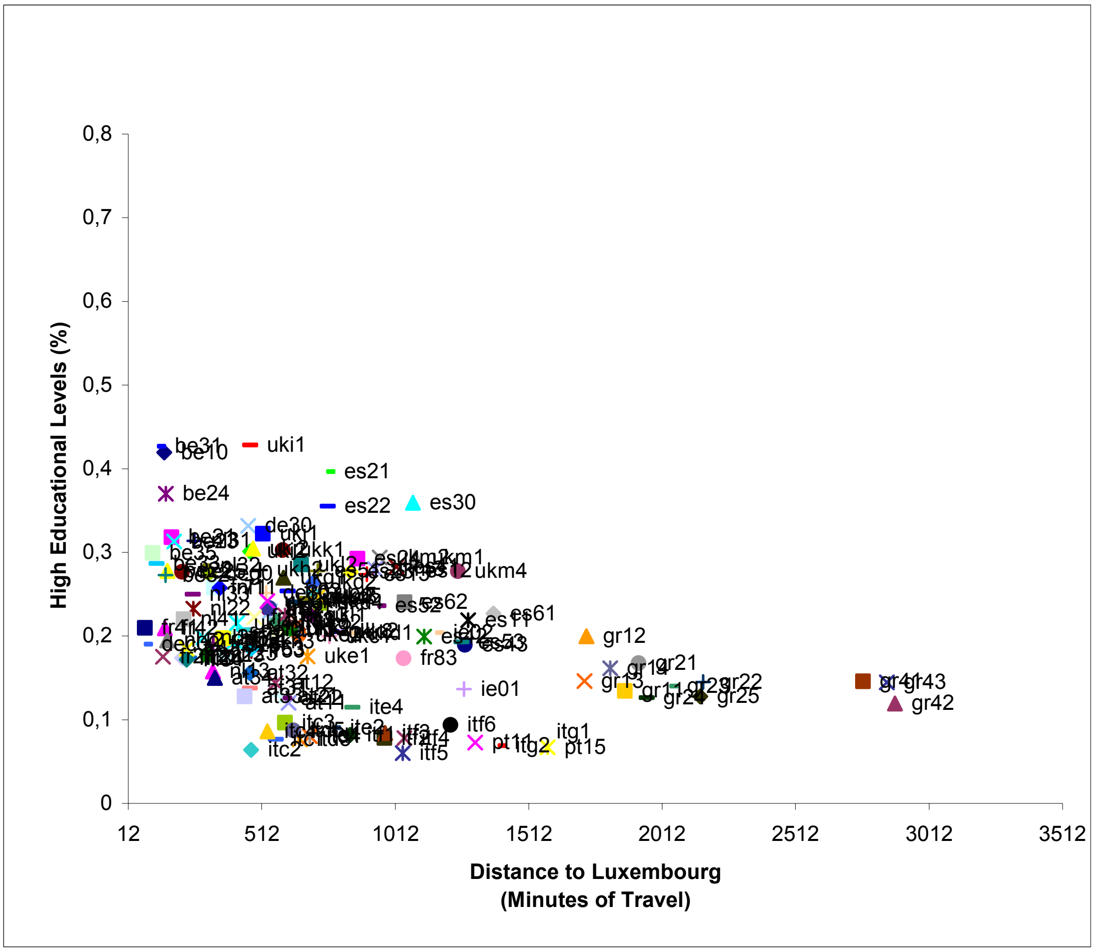

Figure 2: High Educational Levels and Distance from Luxembourg, EU15, Year 2000

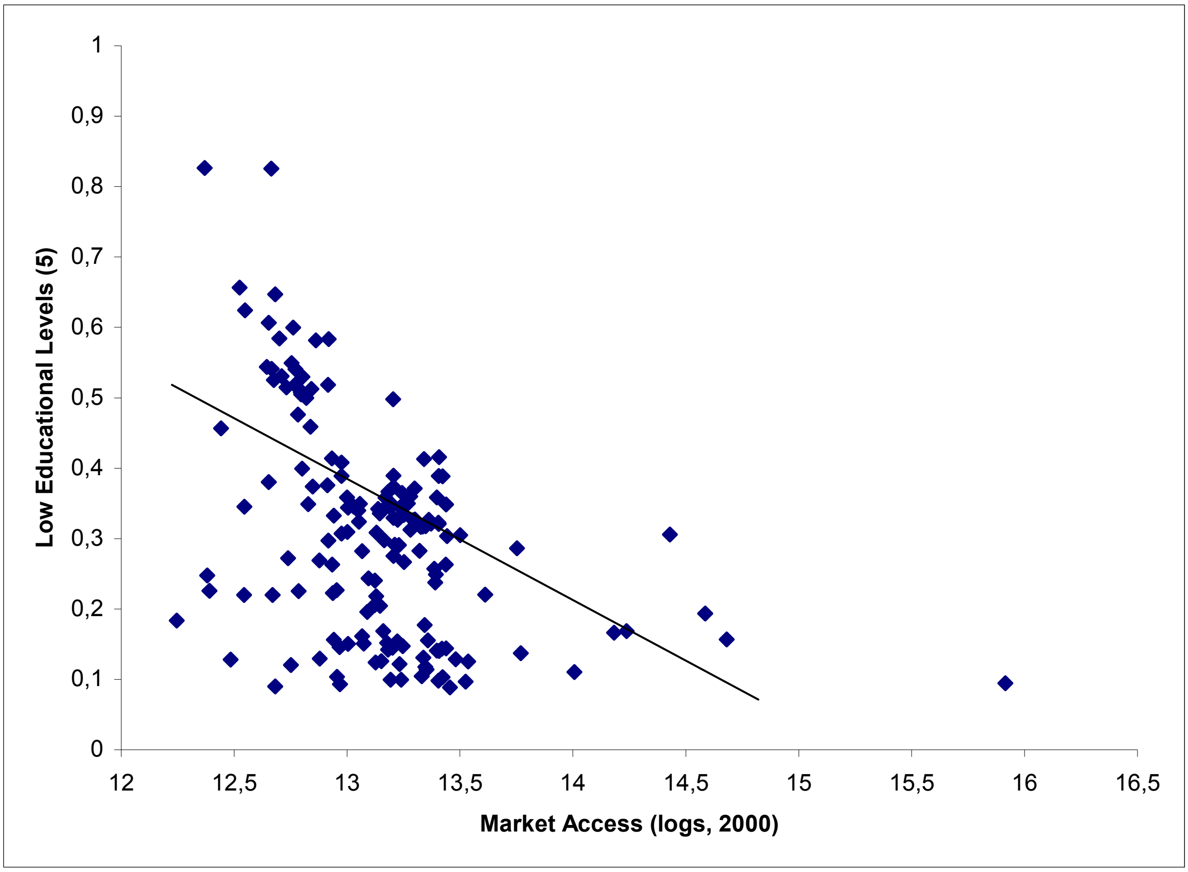

Figure 3: Low Educational Levels and Market Access, EU15, Year 2000

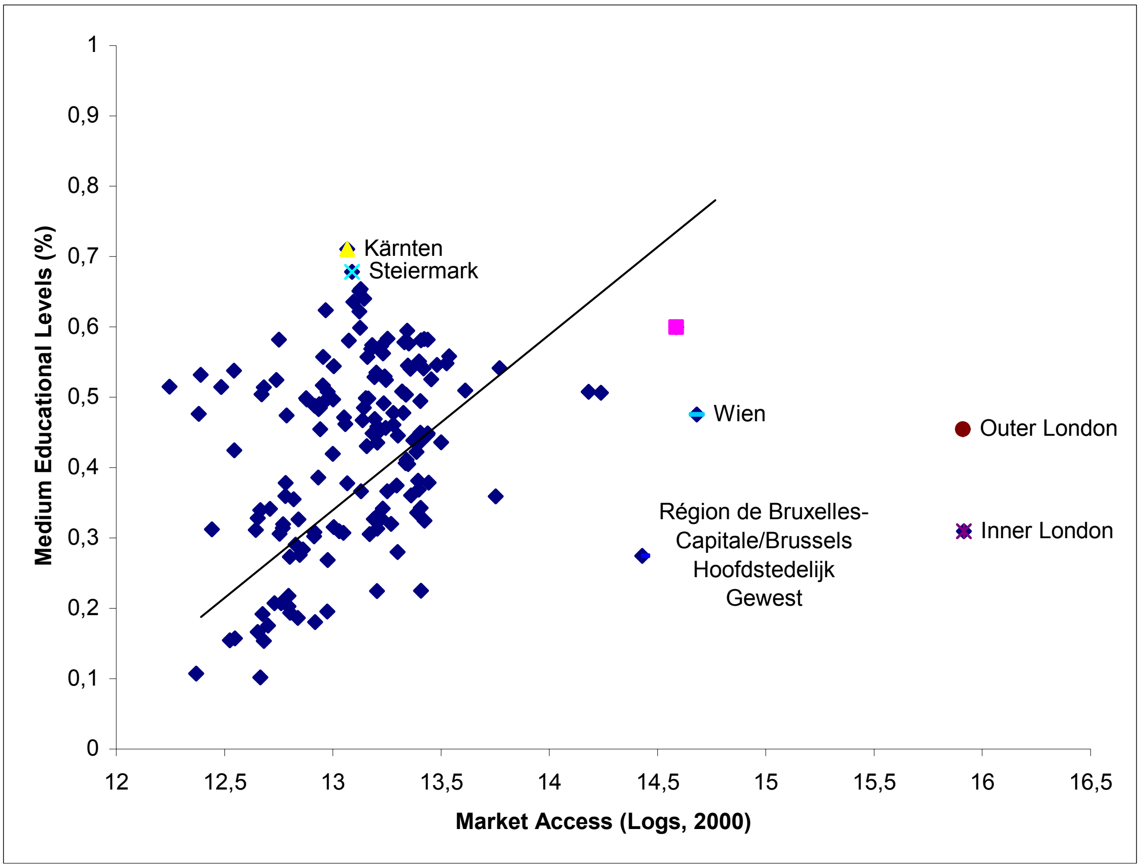

Figure 4: Medium Educational Levels and Market Access, EU15, Year 2000

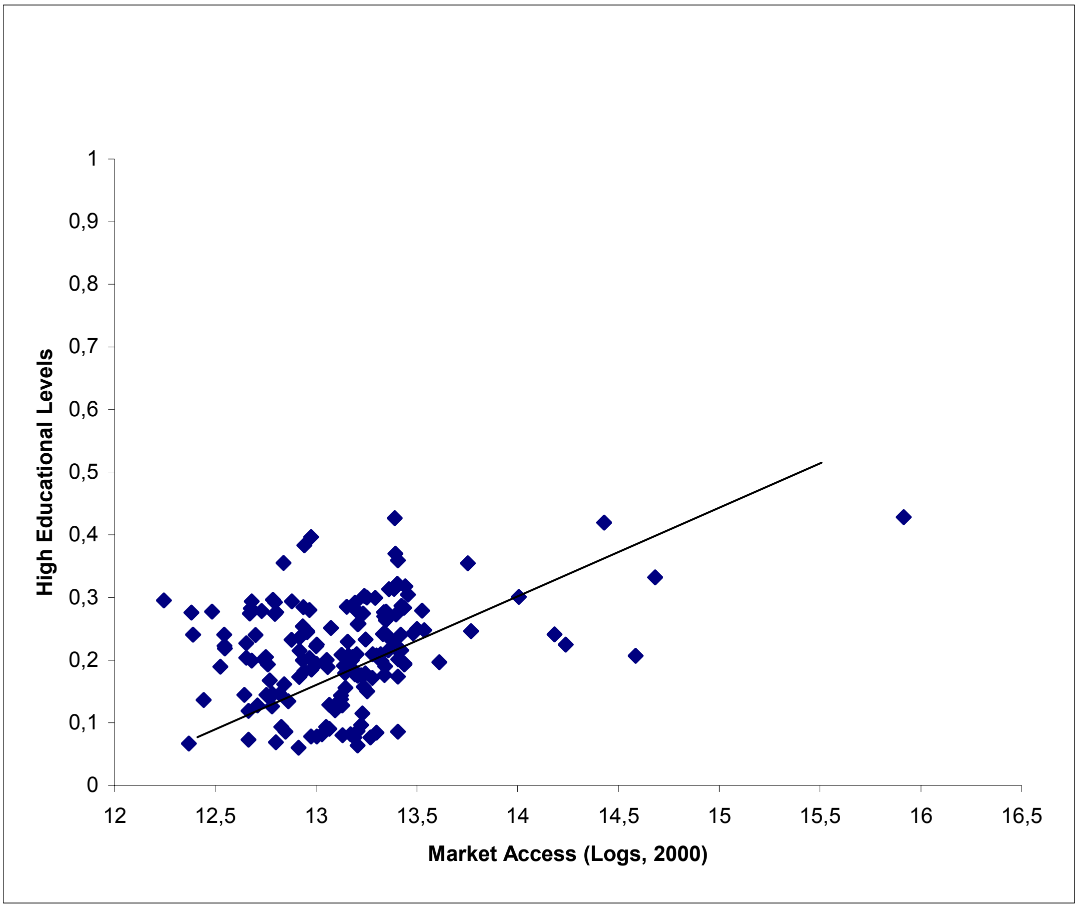

Figure 5: High Educational Levels and Market Access, EU15, Year 2000

Table 1: Percentage of population age 25-64 with low, medium and high educational levels (Year 2000).

EU/Countries	Low	Medium	High
EU15	35	43	22
Belgium	39	32	29
Denmark	19	55	27
Germany	17	58	25
Greece	45	37	18
Spain	60	17	23
France	36	42	23
Ireland	49	28	23
Italy	52	38	10
Luxembourg	37	44	19
Nederland	33	42	25
Austria	22	63	15
Portugal	78	12	10
Finland	24	42	34
Sweden	21	49	31
United Kingdom	19	53	29

Source: Own elaboration based on Labour Force Survey 2000

Table 2: Regional disparities in Educational Attainment Level Across EU15 Regions. Year 2000

EU regions with the highest higher secondary and Tertiary education (% values)				EU regions with the highest primary and lower secondary education (% values)			
Chemnitz	96	Hannover	83	Açores	86	Ellada	57
Dresden	94	Kassel	82	Madeira	84	Cataluña	56
Halle	94	East Wales	82	Norte	82	Makedonia	56
Brandenburg	94	Oberbayern	82	Algarve	82	Thessalia	56
Leipzig	94	Wien	82	Centro	80	Basilicata	55
Magdeburg	92	Hamburg	82	Alentejo	77	Kriti	54
Thüringen	91	High.& Islands	82	Lisboa	71	Veneto	54
Dessau	91	Kärnten	82	C. la Mancha	70	Navarra	54
Meck.Vorpommern	89	Heref. Worc.& Warks	82	Extremadura	69	Calabria	54
Berk. Bucks & Oxfordshire	89	Darmstadt	82	Galicia	67	Peloponnisos	53
Surrey, East & West Sussex	89	East Anglia	81	Andalucía	67	Valle d'Aosta	53
Bed., Hertfordshire	89	Danmark	81	Islas Baleares	64	V. Aigaio	53
G.,Wilt. & N. Somerset	87	Weser-Ems	81	C.Valenciana	63	Toscana	52
Cumbria	87	Inner London	81	Canarias	63	Piemonte	52
NE Scotland	86	E. Scotland	81	Murcia	62	Marche	52
Hamp.& I. Wight	86	Münster	81	Notio Aigaio	61	S. and E.	52
North Yorkshire	86	Essex	81	Corse	61	Molise	51
Devon	86	Detmold	81	Asturias	60	Liguria	50
Dorset & Somerset	85	Gießen	81	La Rioja	60	Friuli-V. G.	50
Kent	85	Lincolnshire	81	Sardegna	59	Abruzzo	50
Stockholm	84	W. Yorkshire	81	A. Makedonia	59	Lombardia	50
Övre Norrland	84	Trier	80	Puglia	59	Madrid	49
Braunschweig	84	Saarland	80	Aragón	59	Pais Vasco	49
Berlin	84	Salzburg	80	C. y León	59	E. Romagna	49
Schleswig-Holstein	83	Arnsberg	80	Ceuta y Melilla	59	K.Makedonia	47
Lüneburg	83	Leic., Rutland & Northants	80	Sterea Ellada	58	B.,M., and Western	46
Cheshire	83	Karlsruhe	80	Sicilia	58	Liège	46
Cornwall & Isles of Scilly	83	Köln	80	Ipeiros	58	Hainaut	46
Schwaben	83	Oberfranken	80	Ionia Nisia	58	Picardie	46
Outer London	83	Derb.& Nottingh.	80	Cantabria	57	Nord - Pas-de-Calais	45
Lancashire	83	G.Manchester	80	Campania	57	Umbria	44

Source: Own elaboration based on Labour Force Survey 2000

Table 3: Market Access and Educational Levels: Baseline estimation (EU15 2000)

Dep. Variable	Low	Low	Medium	Medium	Medium	High	High	High	Medium and High	Medium and High	Medium and High	$EA_{i,j}$
Regressors												
Constant	5.5**	-2.55**	-4.45**	-4.62**	0.30	-5.05**	-6.23**	-0.72**	-3.9**	-4.41**	0.59**	-5,74**
	(1.23)	(0.27)	(0.80)	(1.23)	(0.20)	(0.76)	(1.03)	(0.19)	(0.81)	(0.85)	(0.15)	(0.88)
Market Access	-0,54**		0,27**	0.28**		0,26**	0.35**		0.26**	0.30**		0.31**
	(0,00)		(0.06)	(0.09)		(0,05)	(0.07)		(0.06)	(0.06)		(0.06)
Ln (Distance to Luxembourg)		0.18**			-0.18**			-0.14**			-0.16**	
		(0.04)			(0.03)			(0.03)			(0.02)	
$D_{i,j}$												0.75**
												(0.04)
Estimation	OLS	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS
R2	0,18	0.08	0,19	0,18	0.14	0,16	0,15	0.07	0,19	0,18	0.17	0.50
Prob(F-statistic)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jarque-Bera	4.23		0.79			3.75			1.73			
Prob (J-B)	0.12		0.67			0.15			0.42			
Number Observations	203	203	203	203	203	203	203	203	203	203	203	406

Note: Table displays coefficients and Huber-White heterocedasticity robust standard errors in parenthesis.
** indicates coefficient significant at 0.01 level * significant 0.05 level

Table 4: **Market Access, Regional Dummies and Educational Levels, (EU15 2000)**

Dep. Variable Log (Ed. Attainment Levels)	Medium	Medium	High	High	Medium and High	Medium and High	Educational Level	Average Years of Education
Regressors								
Constant	-7.00**	-6.9**	-4.79**	-6.5**	-5.36**	-5.87**		1.62**
	(1.35)	(1.29)	(1.04)	(1.36)	(1.02)	(1.05)		(0.25)
Market Access	0,47**	0.46**	0,30**	0.37**	0.37**	0.41**	1.19**	0.060**
	(0.10)	(0.09)	(0,07)	(0.10)	(0.07)	(0.07)	(0.25)	(0.01)
Dummy Wien	-0.33**	-0.30**	-0.34**	-0.48**	-0.30**	-0.35**		
	(0.14)	(0.13)	(0.10)	(0.14)	(0.10)	(0.11)		
Dummy Karnten	0.55**	0.55**	-0.41**	-0.40**	0.30**	0.30**		
	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.01)		
Dummy Steiemark	0.50**	0.49**	-0.44**	-0.42**	0.25**	0.25**		
	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)		
Dummy Brussels	-1.03**	-1.02**	0.43**	0.27**	-0.39**	-0.44**		
	(0.12)	(0.12)	(0.10)	(0.12)	(0.09)	(0.09)		
Dummy inner London	-1.62**	-1.60**	0.09**	-0.25**	-0.88**	-0.99**		
	(0.17)	(0.26)	(0.2)	(0.27)	(0.20)	(0.21)		
Dummy Outer London	-0.33**	-0.32**	0.20**	0.10**	-0.14**	-0.18**		
	(0.08)	(0.08)	(0.06)	(0.08)	(0.06)	(0.06)		
Estimation	OLS	IV	OLS	IV	OLS	IV	Ordered Probit	OLS
R2	0.30	0.31	0.25	0.26	0.28	0.29	0.10	0.10
Prob(F-statistic)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jarque-Bera	0.70		3.65		1.60		1.59	
Prob (J-B)	0.69		0.16		0.45		0.45	
Number Observations	203	203	203	203	203	203	203	203

Note: Table displays coefficients and Huber-White heterocedasticity robust standard errors in parenthesis.
** indicates coefficient significant at 0.01 level * significant 0.05 level

Appendix A:

From the zero profit condition (ZPC) in the agricultural sector (Eq. 5) we can express the derivative of unskilled wages in the following way:

$$\frac{dw_i^U}{w_i^U} = -\frac{\phi}{(1-\phi)}\frac{dw_i^S}{w_i^S}$$

Now substituting this expression into ZPC of manufacturing sector we get this expression. (note that I renamed $(1-\alpha)=\beta$)

$$(\alpha - \frac{\beta\phi}{1-\phi})\frac{dw_i^S}{w_i^S} = -\left[\frac{1}{\sigma}\right]\gamma$$

Taking into account that $(\alpha - \frac{\beta\phi}{1-\phi}) \succ 0 \iff \frac{\alpha}{\beta} \succ \frac{\phi}{1-\phi}$

Therefore

$$\frac{dw_i^U}{w_i^U} \succ 0 \qquad \frac{dw_i^S}{w_i^S} \prec 0 \qquad \frac{d(w_i^S/w_i^U)}{w_i^S/w_i^U} \prec 0$$

Appendix B:

List of regions

A. Codes and names of the EU 203 NUTS 2 regions included in the analysis

(BE) Belgique (11 regions)

(BE1) Reg. Bruxelles-Cap. / Brussels Hfdst. Gew., (BE21) Antwerpen, (BE22) Limburg, (BE23) Oost-Vlaanderen, (BE24) Vlaams Brabant, (BE25) West-Vlaanderen, (BE3) Région Wallonne, (BE31) Brabant Wallon, (BE32) Hainaut, (BE33) Liège, (BE34) Luxembourg, (BE35)Namur.

(DK)Danmark (1 region)

(DK) Danmark

(DE) Germany (40 regions)

(DE11)Stuttgart, (DE12) Karlsruhe, (DE13) Freiburg, (DE14)Tübingen, (DE21) Oberbayern, (DE22) Niederbayern, (DE23) Oberpfalz, (DE24) Oberfranken, (DE25) Mittelfranken, (DE26) Unterfranken, (DE27) Schwaben, (DE3) Berlin, (DE4) Brandenburg, (DE5) Bremen, (DE6) Hamburg, (DE71) Darmstadt, (DE72)Gießen, (DE73) Kassel, (DE8) Mecklenburg-Vorpommern, (DE91) Braunschweig, (DE92) Hannover, (DE93) Lüneburg, (DE94)Weser-Ems, (DEA1) Dusseldorf, (DEA2)Köln, (DEA3)Münster, (DEA4) Detmold, (DEA5) Arnsberg, (DEB1)Koblenz, (DEB2)Trier, (DEB3) Rheinhessen-Pfalz, (DEC) Saarland, Chemnitz, (DED2) Dresden, (DED3)Leipzig, (DEE1) Dessau, (DEE2)Halle, (DEE3)Magdeburg, (DEF) Schleswig-Holstein, (DEG) Thüringen

(GR) Greece (13 regions)

(GR11)Anatoliki Makedonia, (GR12) Kentriki Makedonia, (GR13)Dytiki Makedonia, (GR14)Thessalia, (GR21)Ipeiros, (GR22)Ionia Nisia, (GR23) Dytiki Ellada, (GR24)Sterea Ellada, (GR25)Peloponnisos, (GR3)Attiki, (GR41)Voreio Aigaio, (GR42)Notio Aigaio, (GR43) Kriti

(ES) Spain (17 regions)

(ES11) Galicia, (ES12) Principado de Asturias, (ES13) Cantabria, (ES21) Pais Vasco, (ES22)Comunidad Foral de Navarra, (ES23) La Rioja, (ES24) Aragón, (ES3) Comunidad de Madrid, (ES41)Castilla y León, (ES42) Castilla-la Mancha, (ES43)Extremadura, (ES51) Cataluña, (ES52) Comunidad Valenciana, (ES53)Islas Baleares, (ES61) Andalucía, (ES62)Región de Murcia, (ES63) Ceuta y Melilla

(FR) France (22 regions)

(FR1)Île de France, (FR21) Champagne-Ardenne, (FR22)Picardie, (FR23)Haute-Normandie, (FR24)Centre, (FR25)Basse-Normandie, (FR26) Bourgogne, (FR3)Nord -

Pas-de-Calais, (FR41) Lorraine, (FR42)Alsace, (FR43)Franche-Comté, (FR51) Pays de la Loire, (FR52)Bretagne, (FR53) Poitou-Charentes, (FR61)Aquitaine, (FR62) Midi-Pyrénées, (FR63) Limousin, (FR71)Rhône-Alpes, (FR72) Auvergne, (FR81) Languedoc-Roussillon, (FR82)Provence-Alpes-Côte d'Azur, (FR83)Corse

(IE) Ireland (2 regions)

(IE01) Border, Midland and Western, (IE02) Southern and Eastern

(IT) Italy (20 regions)

(IT11) Piemonte, (IT12)Valle d'Aosta, (IT13)Liguria, (IT2)Lombardia, (IT31) Trentino-Alto Adige, (IT32)Veneto, (IT33) Friuli-Venezia Giulia, (IT4) Emilia-Romagna, (IT51)Toscana, (IT52) Umbria, (IT53) Marche, (IT6) Lazio, (IT71) Abruzzo, (IT72)Molise, (IT8) Campania, (IT91)Puglia, (IT92)Basilicata, (IT93) Calabria, (ITA)Sicilia, (ITB)Sardegna

(LU) Luxembourg (1 region)

(LU)Luxembourg (Grand-Duché)

(NL) Netherlands (11 regions)

(NL11) Groningen, (NL12) Friesland, (NL13) Drenthe, (NL21)Overijssel, (NL22) Gelderland, (NL23)Flevoland, (NL31) Utrecht, (NL32) Noord-Holland, (NL33)Zuid-Holland, (NL34) Zeeland, (NL41)Noord-Brabant

(AT) Austria (9 regions)

(AT11) Burgenland, (AT12)Niederösterreich, (AT13) Wien, (AT21) Kärnten, (AT22) Steiermark, (AT31)Oberösterreich, (AT32)Salzburg, (AT33) Tirol, (AT34)Vorarlberg

(PT) Portugal (5 regions)

(PT11)Norte, (PT12)Centro, (PT13) Lisboa e Vale do Tejo, (PT14) Alentejo, (PT15) Algarve,

(FI) Finland (6 regions)

(FI13) Itä-Suomi, (FI14)Väli-Suomi, (FI15)Pohjois-Suomi, (FI16) Uusimaa (Suuralue), (FI17) Etelä-Suomi, (FI2)Åland

(SE) Sweden (8 regions)

(SE01) Stockholm, (SE02)Östra Mellansverige, (SE04)Sydsverige, (SE06)Norra Mellansverige, (SE07) Mellersta Norrland, (SE08) Övre Norrland, (SE09) Småland med Öarna, (SE0A)Västsverige

(UK) United Kingdon (37 regions)

(UKC1) Tees Valley & Durham, (UKC2) Northumberland and Tyne & Wear, (UKD1) Cumbria, (UKD2)Cheshire, (UKD3) Greater Manchester, (UKD4) Lancashire, (UKD5) Merseyside, (UKE1) East Riding & North Lincolnshire, (UKE2) North Yorkshire, (UKE3) South Yorkshire, (UKE4) West Yorkshire, (UKF1) Derbyshire & Nottinghamshire, (UKF2) Leicestershire, Rutland & Northants, (UKF3) Lincolnshire, (UKG1) Herefordshire, Worcestershire & Warks, (UKG2) Shropshire & Staffordshire, (UKG3)West Midlands, (UKH1) East Anglia, (UKH2) Bedfordshire, Hertfordshire, (UKH3) Essex, (UKI1) Inner London, (UKI2) Outer London, (UKJ1)Berkshire, Bucks & Oxfordshire, (UKJ2)Surrey, East & West Sussex, (UKJ3)Hampshire & Isle of Wight, (UKJ4)Kent, (UKK1)Gloucestershire, Wiltshire & North Somerset

(UKK2) Dorset & Somerset, (UKK3) Cornwall & Isles of Scilly, (UKK4) Devon, (UKL1) West Wales & the Valleys, (UKL2) East Wales, (UKM1) North Eastern Scotland, (UKM2) Eastern Scotland, (UKM3) South Western Scotland, (UKM4) Highlands & Islands, (UKN) Northern Ireland.

B. Codes and names of Central and Eastern European countries NUTS 2 regions included in the Market Access Computations (note: Market Access computations also include the regions listed in part A of this appendix)

(CH) Chipre (1 region)

(CZ) Check Republic (8 regions)

(CZ01)Praha, (CZ02) Strední Cechy, (CZ03) Jihozápad, (CZ04) Severozápad, (CZ05) Severovýchod, (CZ06) Jihovýchod, (CZ07) Strední Morava (CZ08)Moravskoslezsko

(HU) Hungury (7 regions)

(HU01) Közép-Magyarország, (HU02) Közép-Dunántúl, (HU03)Nyugat-Dunántúl, (HU04)Dél-Dunántúl, (HU05)Észak-Magyarország,(HU06) Észak-Alföld, (HU07) Dél-Alföld

(HUN)Eesti (1 region)

(LT) Lietuva (1 region)

(LV) Latvija (1 region)

(PL) Poland (16 regions)

(PL01) Dolnoslaskie, (PL02)Kujawsko-Pomorskie, (PL03)Lubelskie, (PL04)Lubuskie, (PL05) Lódzkie, (PL06) Malopolskie,(PL07) Mazowieckie, (PL08)Opolskie, (PL09) Podkarpackie, (PL0A) Podlaskie, (PL0B)Pomorskie, (PL0C)Slaskie, (PL0D)Swietokrzyskie, (PL0E) Warminsko-Mazurskie, (PL0F)Wielkopolskie, (PL0G)Zachodniopomorskie

(SK) Slovakia (4 regions)

(SK01)Bratislavský, (SK02)Západné Slovensko, (SK03)Stredné Slovensko, (SK04) Východné Slovensko

(SL) Slovenija (1 region)

Malta (1 region)

(BG) Bulgary (6 regions)

(BG01) Severozapaden, (BG02) Severen Tsentralen, (BG03) Severoiztochen, (BG04) Yugozapaden, (BG05) Yuzhen Tsentralen, (BG06) Yugoiztochen

(RO) Romania (8 regions)

(RO01) Nord-Est, (RO02)Sud-Est, (RO03) Sud, (RO04) Sud-Vest, (RO05) Vest, (RO06)Nord-Vest, (RO07) Centru, (RO08) Bucuresti

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[1]One of the most important policies to foster growth in backward regions is the European Union Regional Policy. With respect to its effectiveness the opinions of the scholars are divergent (see BASILE et al. 2001, BOLDRIN and CANOVA 2001, FAIÑA and LOPEZ-RODRIGUEZ 2001, 2004, RODRIGUEZ-POSE and FRATESI 2004).

[2]Studies examining the link between human capital and growth include BENHABIB and SPIEGEL (1994), BILS and KLENOW 2000, EICHER and GARCIA-PENALOSA 2001 GALOR and MOUNTFORD 2001, and MANKIW et al. 1992.

[3] See BRAKMAN et al. 2004, BREINLICH, 2005, LOPEZ-RODRIGUEZ and FAIÑA 2004, HANSON (2005), LOPEZ-RODRIGUEZ et al. 2005, MION 2003, NIEBUHR 2004, REDDING and VENABLES 2004, ROSS 2001 for recent empirical contributions. See OVERMAN et al 2003 and HEAD and MAYER 2004 for two recent empirical surveys in Geography and Trade. For early contributions of geography and income see GALLUP et al. 1998, 2000, HUMMELS 1995, LEAMER 1997 and RADELET and SACHS 1998.

[4]REDDING and SHOTT 2003 use three samples of world countries depending on the availability of data for the regressions they carry out, the largest contains 105 countries, the intermediate 66 and the smallest 49. In all cases the theoretical predictions of the model are confirmed.

[5]BREINLICH 2005 also applies a NEG model based on the assumption of immobile labour for the analysis of the spatial wage structure in the European Union regions.

[6]The countries they consider in their analysis are Germany, Italy, France, Spain and the United Kingdom and the period of observation is 1950-1990.

[7]CROZET's 2004 paper deals with the analyses of the effects of market potential on migration flows within five European Union Countries (Germany, Italy, Spain, Netherlands and United Kingdom).

[8]The results are not distorted by this adaptation. Works carried out at international level using both the theory-based measure and the alternative market potential function reach very similar results (REDDING and VENABLES 2004). For other studies dealing with regional analysis that have used measures of market access similar to ours see NIEBUHR 2004 and HANSON 2005.

[9]Nomenclature of Territorial Units for Statistics (NUTS) is a Eurostat's classification in order to provide a single uniform breakdown of territorial units for the production of regional statistics for the European Union. The present NUTS nomenclature valid from 11 July 2003 onwards and extended to EU-25 on 1 May 2004 subdivides the economic territory of the European Union (EU25) into 89 regions at NUTS 1 level, 254 regions at NUTS 2 level and 1214 regions at NUTS 3 level. See appendix for the list of NUTS2 regions included in this analysis.

[10]See also KRUGMAN 1991, 1992, KRUGMAN and VENABLES 1995 and VENABLES 1996

[11]The difference with REDDING and SCHOTT 2003 model is that in our model manufacturing production does not use intermediate goods in the production of final output.

[12]Individual ability is determined by human biology. The probability of finding individuals with a particular level of ability can be assumed to be the same across all locations.

[13]We skip the analysis of the demand side of the model (consumer side) which is similar to standard New Economic Geography models. See for more details BREINLICH 2005, FUJITA el al. 1999, REDDING and SCHOTT 2003, REDDING and VENABLES 2004.

[14]This is another version of the so-called nominal wage equation. For full details about the derivation see LOPEZ-RODRIGUEZ and FAIÑA 2004, REDDING and SCHOTT 2003, REDDING and VENABLES 2004, BREINLICH 2005.

[15] E_j stands for total expenditure on manufacturing goods in region j and G_j is the price index for them.

[16]It is a natural assumption that as we consider higher and higher levels of ability there will be fewer individuals more able than this level.

[17]See proof in appendix A.

[18]The three levels of educational attainment defined here as low, medium and high can also be alternatively defined as primary, secondary and tertiary education. Primary education would correspond to ISCED levels 1 and 2. Students generally begin primary education between the age of 5 and 7 years and end at 13 to 15 years. Secondary education consists of ISCED levels 3 (designated "upper secondary education") and 4 (designated "post-secondary non-tertiary education"), and students generally begin between 13 and 15 years of age and finish between 17 and 18 years of age. Tertiary education corresponds to ISCED levels 5 and 6.

[19]International Standard Classification of Education is an instrument used for assembling, compiling and presenting statistics of education. Eurostat provides data based on the 1976 and 1997 versions of ISCED. For further details about ISCED see UNESCO: *International Standard Classification of Education/ISCED 1997(*Paris,1998); website: http://uis.unesco.org. The document can be downloaded at: http://portal.unesco.org/uis/TEMPLATE/pdf/isced/ISCED_A.pdf.

[20]For a comprehensive analysis of the Spatial Structure of Europe see FAIÑA et al. 2001

[21]Representation of regional market access computations in figure 1 is based on a five-interval classification of market access values depicted in a graduated red colour. The lowest interval (first interval represented with the lightest colour) comprises all regions whose market access value is lower or equal to 200000, the second interval comprises regions with market access values lower or equal to 600000 but higher than 200000, the third interval comprises regions with market access values lower or equal to 800000 but higher than 600000, the fourth interval comprises regions with market access values lower or equal to 1200000 but higher than 800000 and the fifth interval (highest interval represented with the darkest colour) comprises regions with market access higher than 1200000.

[22]Market Access is negatively correlated with distance to Luxembourg

[23]Redding and Schott 2003 define in their paper "higher education" as those who has surpassed primary education. However they also mention that the results are robust for different definitions of higher education (e.g. only considering secondary education attainment).

[24]We identify outliers as those observations for which Cook's distance is greater than 1.

[25]This synthetic indicator for human capital levels has been used in many empirical studies, see BENHABID and SPIEGEL 1994, TEMPLE 1999, KRUEGER and LINDAHL 1999 and DE LA FUENTE and DOMENECH 2001.

[26]With respect to tertiary education it is difficult to give a standard figure in terms of number of years of education since University systems varies across countries. For a comprehensive analyses see DE LA FUENTE and DOMENÉCH 2002.

[27]The statistic reported in ordered probit models to check the significance of the estimated coefficient is z-statistic instead of t-statistic from OLS.

[28]We want to thank an anonymous referee for pointing out this possible shortcoming of our analysis.

[29]The countries included in the analysis are Germany, Italy, Spain, Netherlands and Great Britain.