

THE ECONOMIC GEOGRAPHY OF EU INCOME: EVOLUTION SINCE THE EIGHTIES*

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Abstract

This paper evaluates the role that geography plays in determining the spatial distribution of EU income. We argue that geography matters for income disparities among EU regions, providing evidence that the geography of access to markets is statistically significant and quantitatively important in explaining cross-regional variation in EU per capita income. However, we also show that its explanatory power in the levels of EU per capita income has been decreasing since the 1980s. Thus, dynamic income regions have also emerged in the periphery, and need not necessarily be close to rich regions.

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1. Introduction

Geography has been much neglected in the past decade of formal econometric studies of cross-country performance. However, it is an important determinant of the spatial variation of per capita income. Examples of early contributions that take into account the role that geography plays in the analysis of the spatial variation of incomes are those of Hanson, (1998, 2000), Hummels (1995), Leamer (1997), Overman et al.(2003), Redding and Venables (2001, 2004). For instance Redding and Venables (2004) have focused mainly on the way that the geographic of access to markets and sources of supply affects per capita income. In a cross-section of data on 101 developed and developing countries they found that market access¹ can explain up to 75% of the spatial variation in income levels. They also carried out robustness tests controlling for other economic, geographical, social, and institutional characteristics to make sure that their findings were well-founded.

Examples of investigation on the effects of social infrastructure on income levels are those of Hall and Jones (1997), Acemoglu et al. (2000) and MacArthur and Sachs (2001).

Our paper focus on the geography of access to markets, i.e., how the distance of regions from large consumer markets in which they sell their output may affect the spatial distribution of EU per capita income. It is a very well-known that there is no natural tendency in Europe towards a spatial balance of the regions, i.e. concentration of population and economic activities is a very well established feature of EU territory. It is perhaps worth reiterating what is frequently cited in the literature, namely that London, Paris Milan, Munich and Hamburg together form a pentagonal area that represents 20% of the total area and contains 40% of EU citizens and 50% of the EU's total GDP. These figures have hardly changed in the last twenty years² although the EU regional policy has made a big effort thorough its different programming periods- the Delors I package (1989-1994), the Delors'II Package (1995-1999) and Agenda 2000 (2000-2006)- to improve infrastructure and levels of human capital and to modernize industry, agriculture and fishery production³ addressing an important amount of resources to less developed regions. Despite this, it seems that delocation of economic activity to these regions (mainly these regions are in the outskirts of EU and far from the pentagonal area defined above) has not taken place. Their geographical disadvantage due to its distance to large consumer markets means that firms can only afford to pay relatively low wages because the higher transport costs and other barriers to trade mean that these regions suffer a *market access* penalty on their sales.

The model outlined in the paper draws on Fujita et al. (1999), and Redding and Venables (2001, 2004)⁴ and captures the role of distance to large consumer markets in determining the maximum level of wages a representative firm in each region can afford to pay. Under the assumption of zero profit condition for firms we will see how the so-called "wage equation" depends on, among other factors, market access, and we will use this to estimate the relationship between per capita income levels and levels predicted by each region's market access. We will carry out our estimation for a

homogeneous sample of EU12 regions in different periods of time, more precisely, 1982, 1985, 1995, 1997, in order to capture the dynamics of this relationship in these fifteen years. Our findings provide evidence of the importance of the geography of access to markets in explaining cross-region variation in EU per capita income. We found that our market access measure could explain at the beginning of the 1980s nearly 60% of the spatial variation in EU income and that by 1997 this figure fell to 44%. Despite the fact that (even now) the figures tell us that geography matters a lot for regional income, it is interesting to remark that throughout these fifteen years we experienced a decay (of around 25%) of *market access* as a determinant of EU regional income.

The idea that market access is important for determining regional income dates back at least to Harris (1954) who approximates a market potential function, which expresses the potential demand for goods produced in a location as the sum of the purchasing power in all other locations, weighted by transport costs. The market-potential function has a long history in urban economics (e.g Clark et al. 1969, Dicken and Lloyd 1977, Keeble et al. 1982) focusing instead on the implication for the location of production. Recent econometric investigation of the role of market access in determining the cross-country distribution of income include Hummels (1995), Leamer (1997), Overman et al. (2001), Redding and Venables (2001, 2004). Our investigation complements the works carried out by Hanson (1998) and Redding and Venables (2001, 2004). It differs from them in geographical focus (European Union regions rather than US counties and World countries) and in the fact that we use an *ad hoc* measure of market access instead of using the theory-based measure.

The remaining part of the paper is structured as follows. In section 2 we develop the theoretical model and derive the equation that forms the basis of the econometric estimations. Section 3 surveys the main empirical work on market access. Section 4 discusses the empirical implementation of the model. Section 5 presents the results of the estimation. Section 6 presents the main concluding remarks.

2. The model

In New Economic Geography [NEG] models, the interaction of transport costs and increasing returns to scale generates demand linkages and serves as explanation for agglomeration. Agglomeration is caused by a circular relationship in which the spatial concentration of manufacturing both creates and follows market access. In Krugman's (1991) words, *circular causation a la Myrdal* is present because these two effects reinforce each other: "manufactures production will tend to concentrate where there is a large market, but the market will be large where manufactures of production is concentrated" [Krugman 1991, pag. 486]. These forces that are at work in any multiregional economy can be studied within a relatively simple general equilibrium model of monopolistic competition developed by Krugman (1991), which has come to be known as the *core-periphery model*⁵. Krugman's theoretical research on NEG has triggered a plethora of contributions⁶, which have been surveyed by Ottaviano and Puga

(1998). Most recently a synthesis of the existing theoretical research on NEG can be found in Fujita et al. (1999) and Fujita and Thisse (2002).

Our theoretical framework consists of an economic geography model based on Fujita et al. (1999)⁷. The European Union consists of R regions and we focus on the manufacturing sector, composed of firms that operate under increasing returns to scale and produced differentiated products.

On the demand side, each firm's product is differentiated from those of other firms and is used for consumption. We also assume that the elasticity of substitution between any two varieties is constant and takes the value σ , $\sigma \geq 1$. So products enter both utility and manufacturing goods consumption through a constant elasticity of substitution (CES) aggregator with the form:

$$M_j = U_j = \left[\sum_{i=1}^R \int_0^{n_i} m_{i,j}(z)^{\sigma-1/\sigma} dz \right]^{\sigma/\sigma-1} \quad \sigma \geq 1 \quad (1)$$

Making the assumption that in equilibrium, all products produced in country i are demanded by country j in the same quantity, expression (1) can be rewritten as:

$$\left[\sum_i^R n_i m_{i,j}^{\sigma-1/\sigma} \right]^{\sigma/\sigma-1} \quad (2)$$

z stands for manufacturing varieties, n_i is the set of varieties produced in country i , $m_{i,j}(z)$ is country j demand for z th product from this set.

In this expression we dispense with the index z and rewrite the integral as a product.

The Dual to the manufacturing goods consumption index (M_j) is a price index (G_j) defined over the prices of individual varieties produced in i and sold in j (i.e) $P_{i,j}$.

$$G_j = \left[\sum_i^R \int_0^{n_i} P_{i,j}(z)^{1-\sigma} dz \right]^{1/1-\sigma} = \left[\sum_i^R n_i (P_{i,j})^{1-\sigma} \right]^{1/1-\sigma} \quad (3)$$

where the second equation makes use of the symmetry in equilibrium prices.

If we denote by E_j total consumer expenditure on manufacturing goods in country j , a country's demand for each product is (Applying Shephard's lemma on the price index⁸)

$$x_{i,j} = P_{ij}^{-\sigma} E_j G_j^{\sigma-1} \quad (4)$$

The term $E_j G_j^{\sigma-1}$ is a measure of demand in the importing country j termed *market capacity* ($m_j = E_j G_j^{\sigma-1}$) and comprises total expenditure on manufacturing goods in market j (E_j) as well as the number of competing firms and the prices they charge as summarized in the manufacturing price index (G_j).

Turning to supply, a representative country i firm maximizes the following profit function

$$\Pi_i = \sum_{j=1}^R \frac{P_{i,j} X_{i,j}}{T_{i,j}} - w_i^\alpha v_i^{1-\alpha} c_i (F + x_i) \quad (5)$$

where the total output of the firm is $x_i \equiv \sum_j x_{i,j}$. Technology has increasing returns to scale and its represented by a fixed output requirement $c_i F$ and a marginal input requirement c_i , parameters that can vary across regions. For our purpose we suppose that we only need primary factors in the production of manufacturing goods, entering in the production function as a Cobb-Douglas form. Basically, we assume that we need labour (with price w_i and input share α) and other primary factors (with price v_i and input share $1 - \alpha$).

$T_{i,j}$ stands for iceberg transport cost, so when $T_{i,j} = 1$ the trade is costless, while $T_{i,j} - 1$ measures the proportion of output lost in shipping from i to j . The first order conditions for profit maximization yield the standard result that equilibrium prices are a constant mark-up over marginal costs.

$$P_i = \frac{\sigma}{\sigma - 1} w_i^\alpha v_i^{1-\alpha} c_i \quad (6)$$

Substituting this pricing rule into equation (5) we obtain the following expression for the equilibrium profit function,

$$\Pi_i = \left(\frac{P_i}{\sigma} \right) [x_i - (\sigma - 1)F] \quad (7)$$

In order to break even, the firm's output must equal a constant $\bar{X} = \frac{\sigma - 1}{F}$. The price needed to sell this many units satisfies⁹ (using demand function (4)):

$$P_i^\sigma = \frac{1}{x} \sum_{j=1}^R E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma} \quad (8)$$

Combining the expression in equation (8) with the fact that, in equilibrium prices are a constant mark-up over marginal costs we obtain the following zero-profit condition

$$\left[\left(\frac{\sigma}{\sigma-1} \right) w_i^\alpha v_i^{1-\alpha} c_i \right]^\sigma = \sum_{j=1}^R E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma} \quad (9)$$

This is the so-called *nominal wage equation* which is the point of departure of most studies that investigate the existence of a spatial wage structure for different cross sections. According to equation (9), the nominal wage level in region i depends on a weighted sum of purchasing power in all accessible regions j , whereby the weighting scheme is a function declining with increasing distance between locations i and j . This sum we will refer to as the *market access* of country i (MA_i). As Hanson (2000) notes, equation (9) can be thought of as a spatial labour demand function in an economy with perfect labour mobility. Labour demand and wages increase with income of neighbouring regions and decline with rising transport costs to these locations. The nominal wage equation represents one of the main propositions emerging from NEG models mentioned by Head and Mayer (2003): access advantages raise local factor prices. More precisely, production sites with good access to major markets because of relatively low trade costs tend to reward their production factors with higher wage and land rentals. Moreover, the equation resembles the market potential concept introduced by Harris (1954). The market potential concept states that the attractiveness of a region as a production site depends on its access to markets.

The nominal wage equation can be rewritten as:

$$\left(w_i^\alpha v_i^{1-\alpha} c_i \right)^\sigma = A \sum_{j=1}^R E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma} = AMA_i \quad (10)$$

The left hand side contains the wage, w_i , prices of others factors of production, v_i and a measure of technology differences, c_i . The constant A on the right-hand side combines constants from the equation (9). The meaning of the equation is that high market access locations have relatively high wages.

The full general equilibrium of the model can be seen in Fujita et al. (1999), but for our purposes the relationship we were looking for was equation (9). What we analyze here are the wages that manufacturing firms can afford to pay in each location.

3. Empirical Framework, Data and Regional System

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

$$\ln w_{it} = \alpha + \beta \ln MA_{it} + u_{it} \quad (11)$$

Equation (11) allows us to check if there is a spatial wage structure in the EU, i.e. whether there is a positive correlation between manufacturing wages and distance from large consumer markets, i.e. if high market access locations have relatively higher levels of manufacturing wages. In our estimations we use GDP per capita as a proxy for manufacturing wages. This variable is in Purchasing Power Standards (PPP) at constant 1985 prices for all of the years we run the estimations. Data was taken from the Eurostat Regio databank.

The right-hand side of the equation contains the market access variable, a constant and the random disturbance. With respect to the market access measure (MA_i), we built an *ad hoc* measure, that is the so-called *population potential*.

Definition and Methodology used to compute Population Potentials

The concept of *population potential* must be understood as the force or attraction which the population centre i would exert on one inhabitant located at location j in geographical space and conditioned according to the distance between them, T_{ij} . Therefore, this measure shows the influence each place exerts on all other places and in this sense it measures the proximity of a place to other places. There is a natural link with Lösch's (1954) concept of demand cones and the market potential concept proposed by Harris (1954). *Population potentials* at a given location represent an index of the aggregate market potential from the whole structure of population weighing the number of inhabitants by their distance to this location.

In order to compute de *population potentials* for the European Union we have to say that it is not possible to consider all the possible points within a given space (i.e, there are infinite points in a given space). This is why the practical computation of the population potentials is carried out by using a dot or grid "net". This net, which is placed over the European space, defines a finite and manageable set of nodes for the calculations. The potential indices are calculated by going through each node on the net and assigning to it a corresponding "potential" value, that is, the value of its own population plus the population of each and every other node divided by the distance separating them to the original node.

Mathematically, the expression we use to compute the market potential values for each node is the following one:

$$MP_i = Po_i + \frac{Po_1}{D_{i,1}} + \dots + \frac{Po_n}{D_{i,n}} = Po_i + \sum_{j \neq i, j=1}^n \frac{Po_j}{D_{i,j}} \quad (12)$$

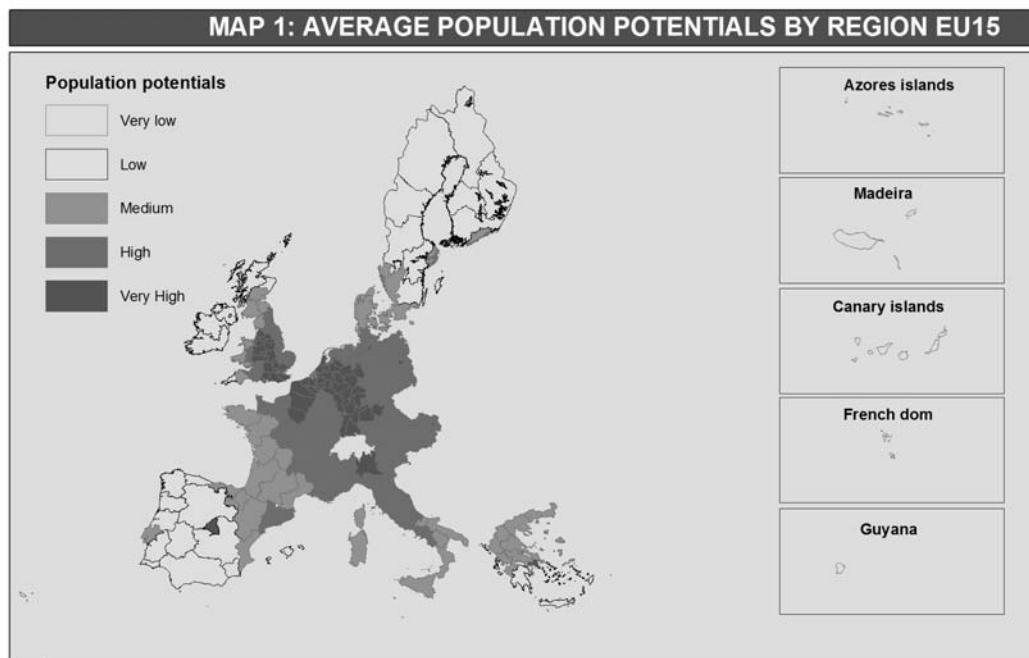
Were MP_i represents the market potential at the 'i' node, Po_i represents the population of the 'i' node and $D_{i,j}$ measures the distance between 'i' node and 'j' node.

To carry out the computations, we use a Geographic Information System (Arc/Info software from ESRI) that allows us to design an algorithm which goes through the whole nodes of the net (i) and compile the values.

The population data take in all the urban centers with twenty thousand or more inhabitants. These data have been obtained from the statistics information service of the European Commission (Eurostat) and the cartographic data from Gisco.

The next step in our computations was to assign a *market potential* value to each of the NUTS2 regions of the European Union -we compute market potential values for each node of the net without taking into account to which NUTS2 European region they belong to- in order to have a comparable relationship between levels of development-regional GDP per capita- and these *market potentials* based on the same geographical coverage. The *market potential* value assigned to each of the NUTS2 regions in the European Union is the average value of the nodes' market potential that form each region.

The results of our computations can be seen in the following map (map 1). Map 1 displays a classification in five levels of our market potential values within the EU15. It has been plot by using Arc Map 8.2 from ESRI.



The value of the market access measure (*population potential*) is reflected in the relative shade of the colour used. The darker the shade, the higher the market access (*population potential*) and vice versa. The map reflects a concentric distribution of the market access measure, which has its centre in an area in which the values are the highest, an area that is commonly known as the Golden Triangle (Greater Manchester-London-Paris and the Ruhr Valley). This area is surrounded by successive envelopes of decreasing market access values, which eventually reach the Atlantic periphery where the values are lowest.

4. Empirical Evidence concerning Market Access

Generally speaking, the empirical investigation of the significance of market access for regional development can be divided into two blocks. The first one comprises studies that use the market potential concept to analyse spatial integration effects. To this block belongs the works carried out by Clark et al. (1969) and Keeble et al. (1982) who investigate effects of European integration by analysing changes in regional accessibility and market potential induced by a reduction of tariff barriers. In their analysis, the market potential measure used is the one proposed by Harris (1954). The analysis assumes that accessibility is important for investment decisions and, therefore,

regional growth. The higher the value of market potential for a region is, the higher its locational advantage. According to this, the most densely populated areas and central locations in Europe should realise the highest integration benefits.

Keeble et al. (1982), showed that the geographical periphery, composed of regions whose level of accessibility is very low, is characterized by low levels of market potential. However, high levels of accessibility and market potential are estimated for regions that are located in the north-east of Europe -Paris, Cologne, Düsseldorf, Rhur Valley- i.e key parts of the Netherlands, Belgium and WestGermany. The results also showed a widening of regional disparities in accessibility and market potential: enlargement, as well as faster growth of more accessible regions, tended to favour the central areas in Europe in the 1960s and 1970s. As Keeble et al. point out, the basic pattern of the market potential reflects historic processes, e.g. industrialization and urbanization. The effects of the integration induce only slight changes in the market potential of European regions.

More recently Faina et al. (2001) and Lopez-Rodriguez (2002) have carried out analyses of the spatial structure of Europe using the market potential concept *a la* Harris(1954), but instead of using values of GDP they use values of population. In their analysis of the market potential for the EU15 the results are in line with those obtained by Keeble et al. (1982). The potential maps they draw clearly illustrate the nature of the spatial structure of the European Union and its large central agglomeration area: Greater Manchester-London-Paris-Cologne-Ruhr Valley. Moreover, their computations for an extended area (Europe as a whole) allowed them to highlight some policy guidelines for the European Spatial Development Perspective and for the future of the European Regional Policy, taking into account the scenario of EU enlargement. Although the enlargement of the European Union to the Central and Eastern European Countries is a complex question, they do a first attempt through the comparison of market potentials for EU15 and Europe, so they could analyze its impact among the different European Union areas. They conclude that the enlargement of the European Union will imply a movement of the Europe's center of gravity towards the East. For instance enlargement would increase the market potential of Vienna and Berlin around 22% and 16% while London, Paris, Lisbon and Madrid would see their market potentials increased less than 6.5%. This displacement effect would have an important impact in Western peripheral areas. The main case is the Atlantic periphery. Special attention and new policy measures must be addressed to reinforce the position of this Atlantic space (and particularly its most peripheral areas) to face the displacement effect that will be caused by the enlargement. Other peripheral areas like the Northern periphery and low density areas in Sweden and Finland will also deserve special attention but the enlargement will be more beneficial for these areas due to their Eastern location. However these analyses are not based on a well-defined theoretical approach.

The development of NEG means that the theoretical pitfalls concerning market access have been remedied. This second block of studies investigating the empirical significance of market potential focuses on tests of corresponding theoretical models. Hanson (1998, 2000) conducted the first analysis of this kind for US counties. He estimated the structural parameters of Krugman's (1991) economic geography model,

and also a reduced form of it which approximates the Harris' (1954) market-potential function. His findings indicate how far demand linkages extend across space and how shocks to income in one location affect wages and employment in other locations. The regression analysis points to strong and growing over time demand linkages between regions, but they are highly localized. Regional wages decline with increasing distance to consumer markets. The results suggest a 10% fall in regional income for a region the size of Illinois reduces employment by 6-6.4% in countries that are 100 Km in distance, with effects declining to zero for countries more than 800 Km in distance. Brakman et al. (2000) estimate the market potential function for German districts finding a strong confirmation of the significance of a spatial wage structure in Germany. Regional wages are affected by economic activity and demand in neighbouring regions. Again, the effects of the demand are highly localized, i.e., distance matters a lot for interregional demand linkages.

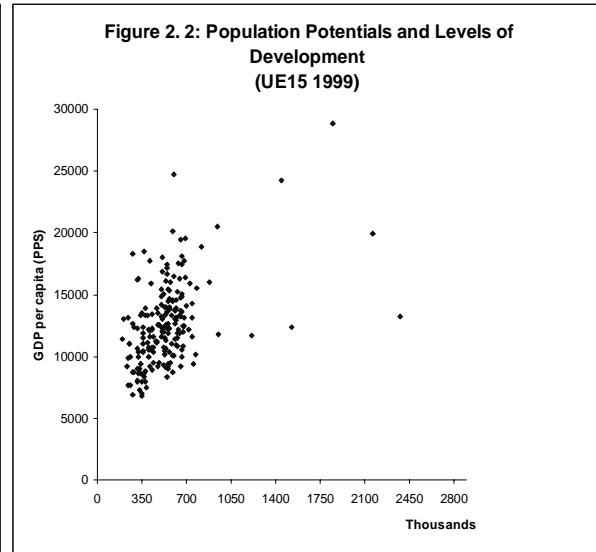
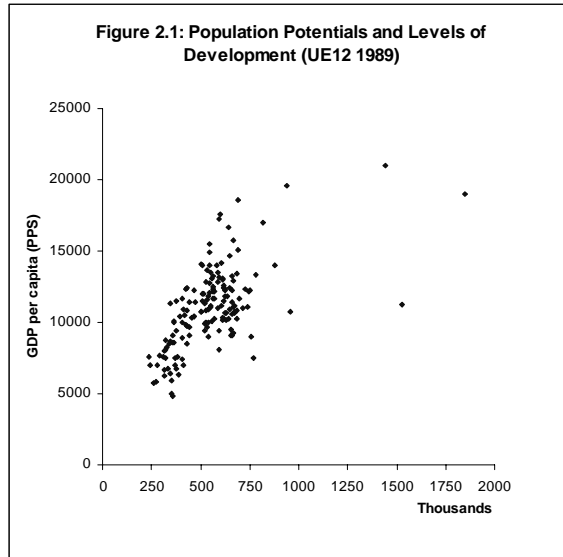
Roos (2001) corroborates the work of Hanson (2000) and Brakman et al. (2000). A positive relationship between regional wage and purchasing power in neighbouring locations marks the analysed cross section of West German NUTS3 regions. Mion (2003) also -analysing Italian NUTS3 regions- found his results consistent with the NEG hypothesis that demand linkages affect the spatial structure of economic activities. Studies with broader geographical scope were carried out by Redding and Venables (2001, 2004) who estimated an structural model of economic geography using world cross-country data on per capita income, bilateral trade and price of manufacturing goods. They found that over 70% of the spatial variation in per capita income could be explained by the geography of access to markets and sources of supply of intermediate inputs.

To sum up, the findings of current empirical investigations are in line with specific implications of NEG models.

5. Economic Geography and Levels of Development: Empirical results

In this section we test expression (11) econometrically for different periods of time. This allows us to evaluate whether the explanatory power of the market access measure is constant over time or whether, on the contrary, it has been decreasing as we move forward, testing it for the latest data from 1997.

Figures 1 and 2 plot log GDP per capita against log market access for years 1989 (EU12-figure 1) and 1999 (EU15-figure 2). It is clear from these figures that the relationship between regional GDP per capita and regional market access is very robust and is not due to the influence of a few individual regions. A visual inspection on the scatter plots shows a higher dispersion in 1999 than in 1989 indicating that this relationship is vanishing all over the time.



Tables 1-4 summarize the results of our econometric estimations based on a homogeneous sample of EU 12 regions. We regress log GDP per capita on log ad hoc measure of market access using OLS. The coefficients are significant and the signs correspond with theoretical expectations. Market access explains 58% of the cross-region variation in GDP per capita in 1982 and since then its explanatory power have continuously been decreasing, where in 1997 the R^2 of the regression falls by around a quarter to 44%.

Table 1: Market Access and Regional Income EU12-1982

Dependent Variable: Lnw_{it}

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$LnMA_{it}$	0.708395	0.052933	13.38296	0.0000
R-squared	0.581310	Mean dependent var		9.161970
Adjusted R-squared	0.578064	S.D. dependent var		0.301394
S.E. of regression	0.195775	Akaike info criterion		-0.408551
Sum squared resid	4.944296	Schwarz criterion		-0.364655
Log likelihood	28.76011	F-statistic		179.1037
		Prob(F-statistic)		0.000000

Table 2: Market Access and Regional Income EU12-1989

Dependent Variable: Lnw_{it}

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$LnMAit$	0.556469	0.046651	11.92837	0.0000
R-squared	0.472262	Mean dependent var		9.270123
Adjusted R-squared	0.468943	S.D. dependent var		0.261802
S.E. of regression	0.190785	Akaike info criterion		-0.463000
Sum squared resid	5.787397	Schwarz criterion		-0.424722
Log likelihood	39.27149	F-statistic		142.2860
		Prob(F-statistic)		0.000000

Table 3: Market Access and Regional Income EU12-1994

Dependent Variable: Lnw_{it}

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$LnMAit$	0.449592	0.038998	11.52861	0.0000
R-squared	0.443164	Mean dependent var		9.288080
Adjusted R-squared	0.439830	S.D. dependent var		0.264769
S.E. of regression	0.198165	Akaike info criterion		-0.387672
Sum squared resid	6.557967	Schwarz criterion		-0.350632
Log likelihood	34.75831	F-statistic		132.9089
		Prob(F-statistic)		0.000000

Table 4: Market Access and Regional Income EU12- 1997

Dependent Variable: Lnw_{it}

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$LnMAit$	0.444498	0.038424	11.56837	0.0000
R-squared	0.444864	Mean dependent var		9.358730
Adjusted R-squared	0.441540	S.D. dependent var		0.261268
S.E. of regression	0.195246	Akaike info criterion		-0.417345
Sum squared resid	6.366234	Schwarz criterion		-0.380305
Log likelihood	37.26565	F-statistic		133.8271
		Prob(F-statistic)		0.000000

The models given in tables 1-4 are marked by outlying observations. These outlying regions do not correspond to the spatial wage 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 the effects of outlying observations, dummy variables for the outliers are introduced. The most significant outliers are the regions of Athens (gr3) and several UK regions such as Greater Manchester (ukd3), Merseyside (ukd5) and the West Midlands (ukg3). To control for the latter observations, regional dummies were included.

According to the results (see Tables 5-8), market access has a positive effect on the levels of development of European Union regions. This effect is reinforced when dummy variables are included in the regressions. Moreover Dummy variables improve the fit of the regressions considerably. The models presented in tables 5-8 explain over 50% of the spatial variation in the per capita GDP levels across European Union regions. Again, tables 5-8 show a decreasing tendency in the explanatory power of market access on the levels of GDP per capita over time.

Table 5: Market Access, Regional Dummies and Regional Income
EU12- 1982

Dependent Variable: Lnw_{it}

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.399697	0.672429	-0.594407	0.5533
$LnMAit$	0.728841	0.051227	14.22765	0.0000
DGR3	-0.648984	0.190194	-3.412215	0.0009
R-squared	0.616219	Mean dependent var	9.161970	
Adjusted R-squared	0.610223	S.D. dependent var	0.301394	
S.E. of regression	0.188167	Akaike info criterion	-0.480345	
Sum squared resid	4.532049	Schwarz criterion	-0.414500	
Log likelihood	34.46257	F-statistic	102.7620	
		Prob(F-statistic)	0.000000	

Table 6: Market Access, Regional Dummies and Regional Income
EU12- 1989

Dependent Variable: Lnw_{it}

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.922777	0.600763	1.536009	0.1266
$LnMAit$	0.635012	0.045674	13.90318	0.0000
DGR3	-0.613860	0.177713	-3.454213	0.0007
DUKD5	-0.413150	0.177621	-2.326016	0.0213
DUKG3	-0.639013	0.183601	-3.480444	0.0007
DUKD3	-0.387176	0.178990	-2.163114	0.0321
R-squared	0.561298	Mean dependent var	9.270123	
Adjusted R-squared	0.547146	S.D. dependent var	0.261802	
S.E. of regression	0.176178	Akaike info criterion	-0.598088	
Sum squared resid	4.810999	Schwarz criterion	-0.483253	
Log likelihood	54.14612	F-statistic	39.66293	
		Prob(F-statistic)	0.000000	

Table 7: Market Access, Regional Dummies and Regional Income
EU12- 1994

Dependent Variable: Lnw_{it}

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.837544	0.510344	5.560059	0.0000
$LnMAit$	0.490339	0.038760	12.65058	0.0000
DGR3	-0.439924	0.191188	-2.301001	0.0227
DUKD5	-0.418781	0.191128	-2.191103	0.0299
DUKD3	-0.333483	0.192025	-1.736666	0.0843
DUKG3	-0.503596	0.195093	-2.581309	0.0107
R-squared	0.500380	Mean dependent var	9.288080	
Adjusted R-squared	0.485054	S.D. dependent var	0.264769	
S.E. of regression	0.189997	Akaike info criterion	-0.448758	
Sum squared resid	5.884125	Schwarz criterion	-0.337637	
Log likelihood	43.92002	F-statistic	32.64959	
		Prob(F-statistic)	0.000000	

Table 8: Market Access, Regional Dummies and Regional Income
EU12- 1997

Dependent Variable: Lnw_{it}

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.995336	0.504576	5.936347	0.0000
$LnMA_{it}$	0.483686	0.038322	12.62160	0.0000
DGR3	-0.408432	0.189027	-2.160710	0.0322
DUKD5	-0.401410	0.188968	-2.124226	0.0352
DUKG3	-0.505632	0.192888	-2.621378	0.0096
DUKD3	-0.292790	0.189854	-1.542186	0.1250
R-squared	0.498438	Mean dependent var	9.358730	
Adjusted R-squared	0.483052	S.D. dependent var	0.261268	
S.E. of regression	0.187850	Akaike info criterion	-0.471493	
Sum squared resid	5.751854	Schwarz criterion	-0.360373	
Log likelihood	45.84119	F-statistic	32.39692	
		Prob(F-statistic)	0.000000	

These results suggest the following interpretation. One spatial factor that determines regional income is the closeness to large consumer markets as emphasized in demand-oriented models of regional growth (Kaldor 1970) and by the agglomeration effects of the NEG models. On the assumption that our ad hoc market access measure can capture this proximity to large market areas, we have found that closeness to large consumer markets was an important explanatory variable for regional income in the early 1980s and that it has decreased its significance in determining regions income in the 1990s. Thus, dynamic income regions have also emerged in the periphery, and need not necessarily be close to rich regions.

Our results are in line with those obtained by Redding and Venables (2004) for a world sample of countries. In their estimations, in 1997, market access itself explains between 55% and 73% of the spatial variation of world income¹⁰. Our results shed new light on the pioneering work initiated by Redding and Venables (2001, 2004), showing that at the EU level there is a positive (but decreasing) correlation between regional per capita income and market access.

6. Conclusions

In the paper, we analyse the relationship between an *ad hoc* measure of market access (population potential) and levels of development in the European Union for different periods of time. Running regressions for different periods of time, we check if this relationship was stable. The results suggest the importance of geography in determining the spatial distribution of EU cross-region income. However, our results also show that within the European Union space, the geography of access to markets is vanishing over time, i.e. we found that the penalty of distance is less important in the nineties than at

the beginning of the 1980s. Thus, dynamic income regions have also emerged in the periphery, and need not necessarily be close to rich regions. This fact suggests that we think about the possible effects that the “new” European Union regional policy has exerted since the mid-1980s. The results presented here could support the hypothesis that the regional policy of the European Union has had an important effect in terms of boosting the growth of peripheral regions and therefore their income levels.

7. References

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¹ By market access we refer to a measure of how well-placed a location is with respect to markets

² An extensive analysis of the spatial distribution of population and GDP in the EU space is in Chapter 2 of Lopez-Rodriguez, J. PhD Dissertation (2002).

³ A detailed analysis of European Union Regional Policy and its effects on Objective 1 regions can be seen in Faiña and Lopez-Rodriguez (2001) and Faiña and Lopez-Rodriguez (2004).

⁴ See also Krugman and Venables (1995), Redding and Schott (2003).

⁵ An earlier analysis that anticipated several aspects of Krugman's work was developed by Faini (1984). Ideas close to economic geography had already appeared in Krugman (1979) but were not fully worked out.

⁶ See Krugman and Venables (1995), Venables (1996), Redding and Venables (2004) among others.

⁷ See also Krugman and Venables (1995), Redding and Schott (2003) and Redding and Venables (2001, 2004).

⁸ See also Dixit and Stiglitz (1977).

⁹ The transport cost term ($T_{i,j}$) enters with the exponent $(1 - \sigma)$ and not σ because total shipments to market j are $T_{i,j}$ times quantities consumed.

¹⁰ The reasons for the different explanatory power in Redding and Venables (2004) relate to the different definitions they use in computing domestic market access.