Investigaciones Regionales

Regional Wage Disparities in Europe: What role for Market Access?

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ABSTRACT: This paper uses a New Economic Geography model to test for wage disparities in the European Union. We derive and estimate an econometric specification relating wages to a distance weighted sum of regional GDP's. The empirical estimations of the model were carried out for a sample of 160 NUTS2 regions in the EU15 for the year 2000 showing that geography of access to markets is statistically significant and quantitatively important in explaining cross-region variation in European wages. We also show that incentives for human capital accumulation and innovation activities arising from market access size are also affecting the shaping of regional wages in the European Union.

JEL classification: F12, F15, R11, R12.

Key words: Economic Development, Economic Geography, Spatial structure, European Union.

Disparidad en los Salarios Regionales en Europa: ¿Qué papel desempeña el *Market Access*?

RESUMEN: En este artículo se usa un modelo de Nueva Geografía Económica para estimar las disparidades en los niveles de salarios en la Unión Europea. Se deriva y estima una especificación econométrica que relaciona los salarios con la suma ponderada por la distancia de los PIB regionales. Las estimaciones empíricas del modelo se llevaron a cabo para una muestra de 160 regiones NUTS2 de la UE15 para el año 2000 demostrando que la geografía de acceso a los mercados es estadísticamente significante y cualitativamente importante en la explicación de la variación regional de los salarios en Europa. Además, se muestra que los incentivos para la acumulación de capital humano y actividades de innovación que se derivan del efecto *acceso al mer-*

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cado afectan también a la estructura espacial de salarios en las regiones de la Unión Europea.

Clasificación JEL: F12, F15, R11, R12.

Palabras clave: Desarrollo Económico, Nueva Geografía Económica, Estructura Espacial, Unión Europea.

1. Introduction

It is a well know fact that regional disparities in the European Union are very large. The available figures for regional wages[1] reflect that in the year 2000 the regions with the highest wages (Compensation per employee in PPS) accounting for 20% of the total employment population in the European Union were 2.4 as rich as the regions with the lowest wages (Compensation per employee in PPS). At the 10% percentile the situation was even worse, the ratio between the regions with the highest wages and those with the lowest wage levels was about 3.5[2]. Table 1 shows some descriptive statistics based on the 2000 figures on compensation per employee.

Table 1 shows that the regions with the highest wages are mainly located in the countries of UK, Brussels, Luxembourg, Germany, Holland and Denmark while the regions with the lowest wages are located in the so called cohesion countries (South Italy, Spain, Portugal and Greece). So, the spatial distribution of regional wage levels show a strong core-periphery wage gradient, i.e. regions with low compensation per employee are predominantly located at the geographical periphery while the richest are at the centre. The persistence of such differences has raised concern on the political and academic arena in light of the successive steps taken by the European Union to even out development levels, being the most important the European Union regional policy[3].

There are a number of reasons which may prevent convergence of income levels such as sluggish technology diffusion, endowment disadvantages[4] and trade costs. At

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[1] We proxy regional wages by building up a variable called «compensation per employee» for a sample of 160 NUTS 2 regions in the EU15. The advantage of this variable is that it avoids an overestimation of the figures that emerge using other variables such us GDP per head. Section 3 contains more details about the definition and the computation of the variable. See the annex for the sample of NUTS 2 regions used in our analysis.

[2] The figures of the 2nd intermediate report on the economic and social cohesion comparing for the year 2000 the 10 and 25% of population with the highest and lowest levels of GDP per head were 2.6 and 2 respectively.

[3] With respect to the effectiveness of the European Union Regional Policy to boost regions whose development is lagging behind the opinions of the scholars are divergent, see Basile *et al.* (2001), Boldrin and Canova (2001), Faiña and López-Rodríguez (2004), Rodríguez-Pose and Fratesi (2004).

[4] Studies examining the link between human capital and growth include Benhabib and Spiegel (1994), Bils and Klenow (2000), Eicher and García-Penalosa (2001), Galor and Mountford (2001), and Mankiw *et al.* (1992).

Table 1. Regional Wage Differences in the EU15 (Year 2000)

Regions	C. p. E.	Regions	C. p. E.	Regions	C. p. E.
Inner London	43.858	Toscana	19.383	Attiki	12.844
Île de France	41.111	Aragón	19.207	Madeira (PT)	10.559
Région de Bruxelles-	40.231	Cornwall and Isles of Scilly	19.068	Algarve	10.283
Stockholm	39.740	Umbria	18.976	Dytiki Makedonia	10.215
Luxembourg	38.274	Cantabria	18.950	Norte	10.054
Dorset and Somerset	34.309	Marche	18.914	Açores (PT)	10.045
Outer London	33.927	Sardegna	18.790	Kentriki Makedonia	9.483
Prov, Vlaams Brabant	33.679	Campania	18.716	Notio Aigaio	9.333
Wien	33.594	Sicilia	18.702	Sterea Ellada	8.865
Prov, Antwerpen	33.257	La Rioja	18.689	Ipeiros	8.825
Denmark	33.047	Principado de Asturias	18.489	Voreio Aigaio	8.799
Sydsverige	32.797	Basilicata	18.475	Anatoliki Makedonia	8.452
Västsverige	32.678	Abruzzo	18.376	Thessalia	7.897
Östra Mellansverige	32.359	Canarias (ES)	18.348	Kriti	7.717
Övre Norrland	31.962	Molise	18.081	Dytiki Ellada	7.653
Berkshire, Bucks and Oxfordshire	31.933	Castilla y León	17.752	Ionia Nisia	7.235
Hamburg	31.818	Com. Valenciana	17.443	Peloponnisos	6.946
Norra Mellansverige	31.759	Calabria	17.260		
Alsace	31.630	Puglia	17.077		
Bremen	31.274	Andalucia	16.588		
Prov, Brabant Wallon	30.939	Castilla-La Mancha	15.860		
Mellersta Norrland	30.915	Región de Murcia	15.841		
Småland med öarna	30.651	Galicia	14.686		
North Eastern Scotland	30.582	Extremadura	14.276		
Average C. p E. 20% of richest employment population	34.013	Average C. p E. 20% of poorest employment population	14.223	Ratio 20% richest employment population against 20% poorest employment population	2.4
Average C. p E. 10% of richest employment population	38.778	Average C. p E. 10% of poorest employment population	10.849	Ratio 10% richest employment population against 10% poorest employment population	3.5

C.p. E: Compensation per Employee
Source: Own elaboration based on Eurostat data

this point New Economic Geography (NEG) has reached a theoretical consolidation as a theory that explains the emergence of a heterogeneous economic space on the bases of increasing returns to scale and transport costs, (see Krugman, (1991, 1992)). Although NEG has experienced rapid theoretical advances[5], authors such as Head and Mayer (2004), Neary (2001), and Ottaviano (2002) pointed out that empirical research on NEG is lagging behind[6]. One of the most successful ways to test the validity of the forces put at work in NEG models has been the analysis of the effects of distance from consumer markets on income levels. These studies can be divided into two strands according to the assumptions made, basically the one referring to the mobility of labour. One strand analyses the effects of economic geography (proximity to consumer markets) on income levels at national level where labour is assumed to be perfectly mobile and real wages are equalised. To this strand belongs the works of Brakman *et al*. (2004) and Roos (2001) for Germany, Hanson (2005) for US, Mion (2004) for Italy and Tirado *et al*. (2003) for Spain. The other strand focuses on the effects of economic geography on income levels at international level being represented by the work of Redding and Venables (2004) where real wage levels are influenced by intermediate factors of production. In both types of studies, national level and international level, the authors find a significant impact of the geography of access to markets in shaping income levels.

This paper uses the theoretical framework of the New Economic Geography to analyse the causes of regional wage differentials in the European Union for the year 2000 and quantifies the importance of spatial proximity. NEG is a suitable framework to explain wage differences across regions but within the field of regional and urban economics there are other possibilities to explain spatial inequality. For instance, models involving technological spillovers and human capital externalities yield to wage equations that link regional wages to the density of local economic activity. As an example, Ciccone (2002) shows how wages in the European Union are positively associated with the population density of the region[7].

We derive and estimate a New Economic Geography model that captures the role of market access in determining the maximum level of wages a representative firm in each region can afford to pay. The basic idea is that firms in remote locations (low market access) pay greater transport costs on both exports and intermediate inputs, reducing the amount of value added left to remunerate domestic factors of production, so they can only afford to pay relatively low wages in comparison with central regions (high market access). Therefore, we emphasize the role of remoteness (market access) in avoiding regional wage differences to be bid away and so in acting as a penalty for economic convergence of income levels.

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[5] See Fujita *et al*. (1999), Fujita and Thisse (2002) for theoretical texts on New Economic Geography. For texts combining theory and empirics see Brakman *et al*. (2001, 2005)

[6] See Combes and Overman (2004), Head and Mayer (2004) and Overman, Redding and Venables (2003) for comprehensive surveys of the existing empirical literature.

[7] Other papers dealing with the determinants of wage differences in Europe from a spatial approach are Brakman *et al*. (2004), Combes et. al. (2004), Head and Mayer (2006) and Larsen (2003). For the Japanese regions see Dekle and Eaton (1999).

Our findings contribute to the empirical literature on New Economic Geography (NEG) providing evidence of the importance of the geography of access to markets in explaining cross-region variation in EU wages. Using regional data on 160 European Union NUTS[8] 2 regions we find that a significant fraction of wage differences can be explained by this variable. We check the robustness of our results including control variables that capture the potential indirect effects of economic geography being able to isolate the direct influence due to market access disadvantages for peripheral regions. The findings of the effects of market access on regional wages proved to be robust to the inclusion of control variables. Our final contribution was to disentangle the main channels through which market access can be affecting regional wages. We have found that the main benefits of market access in shaping the regional wage gradient in the European Union seem to come from increased incentives for innovation activities and human capital accumulation.

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 discusses the empirical implementation of the model. Section 4 presents the results of the estimations. Finally, section 5 concludes.

2. Theoretical Background

Our theoretical framework is a reduced form of a standard New Economic Geography model based on Redding and Venables (2004). We consider a world with regions and we focus on the manufacturing sector, composed of firms that operate under increasing returns to scale and produce differentiated products.

On the demand side, the final demand in location j can be obtained by the Utility maximization of the following CES function:

$$\max_{x_{i,j}} U_j = \left[\sum_{i=1}^R n_i x_{i,j}^{\frac{\sigma-1}{\sigma}} \right]^{\sigma/\sigma-1} s.t. \left[\sum_{i=1}^R n_i x_{i,j} p_{i,j} = Y_j \right]$$

where n_i is the number of firms in location i, $x_{i,j}$ is the country j demand for a variety produced in i, σ is the elasticity of substitution between any two varieties, $P_{i,j}$ ($P_{i,j} = P_i T_{i,j}$, $T_{i,j}$ stands for iceberg transport cost, so $T_{i,j} = 1$ the trade is costless, while $T_{i,j} - 1$ measures the proportion of output lost in shipping from i to j) is the price of varieties produced in i and sold in j and Y_j is the total income in location j.

The final demand in i from location j is given by the expression [1]:

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[8] 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.

$$x_{i,j} = p_{ij}^{-\sigma} \left[\sum\nolimits_{n=1}^{R} n_n p_{nj}^{1-\sigma} \right]^{-1} Y_j \qquad [1]$$

If we define a price index for manufacturing goods as $G_j = \left[\sum\nolimits_{n=1}^{R} n_n p_{nj}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$ and

rewrite the expenditure on consumption as $E_j = Y_j$ the final demand in location *j* can be given by $x_{ij}^{cons} = p_{ij}^{-\sigma} P_{ij}^{-\sigma} Ej$. However, in order for x_{ij}^{cons} units to arrive, $T_{ij} x_{ij}^{cons}$ units must be shipped. Thus effective demand facing a firm in i from j is given by expression [2]

$$x_{ij} = T_{ij} p_{ij}^{-\sigma} G_j^{\sigma-1} E_j = p_i^{-\sigma} T_{ij}^{1-\sigma} G_j^{\sigma-1} E_j \qquad [2]$$

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

$$\Pi_i = \sum_{n=1}^{R} p_i x_{in} - w_i^{\alpha} \upsilon_i^{1-\alpha} c_i (F + x_i)$$

where the total output of the firm is $x_i = \sum_j x_{i,j}$. 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 $1 - \alpha$).

The first order conditions for profit maximization yield the standard result that equilibrium prices are $P_i = \left(\dfrac{\sigma}{\sigma - 1} \right) w_i^{\alpha} v_i^{1-\alpha} c_i$. Substituting this pricing rule into the profit function we obtain the following expression for the equilibrium profit function, $\Pi i = \left(\dfrac{P_i}{\sigma} \right) [x_i - (\sigma - 1) F]$. Free entry assures that long-run profits will be zero implying that $x_i = \overline{x} = \dfrac{\sigma - 1}{F}$ The price needed to sell this many units satisfies $P_i^{\sigma} = \dfrac{1}{\overline{x}} \sum_{j=1}^{R} E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma}$. Combining this expression with the fact that in equilibrium

prices are a constant mark-up over marginal costs we obtain the following zero-profit condition

$$\left[\left(\frac{\sigma}{\sigma - 1} \right) w_i^{\alpha} \upsilon_i^{1-\alpha} c_i \right]^{\sigma} = \sum_{j=1}^{R} E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma} \qquad [3]$$

This is the so-called nominal *wage equation* which is point of departure of our investigation. According to equation [3], 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).

The nominal wage equation can be rewritten as:

$$w_i = A(MA_i)^{\frac{1}{\alpha\sigma}} \upsilon_i^{\frac{-\beta}{\alpha}} c_i^{\frac{-1}{\alpha}} \tag{4}$$

Where $A = \left(\dfrac{\sigma}{\sigma-1}\right)^{\frac{-1}{\alpha}}$ combines constants from the equation [3] and

$MA_i = \sum^{R} E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma}$ is the «*market access*» of country i.

The meaning of this equation is that 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 wages.

3.   Econometric specification and Regional System

3.1.   Econometric specification

The nominal wage equation [3] cannot be estimated directly since data on regional price indices are not available. The strategy followed to eliminate G_j and arrived at an estimable specification was to consider that the price index is equal in all regions ($G_j = G$). Taking into account this assumption the theoretical predictions of the model can be tested by using the following specification (taking logs in equation [4]):

$$\ln w_i = \alpha_0 + \alpha_1 \ln MA_i + u_i \tag{5}$$

Where the error term captures both the price of other factors of production, v_i, as well as 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[9]. Considering that this assumption can be violated and therefore the coefficient estimates be biased and inconsistent we also presents estimates using instrumental variables regression.

However, equation [5] is a restricted specification for analysing the effects of market access on wages. We cannot tell if the relationship founded in the bivariate re-

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[9]   Factor mobility should equalize v_i across locations and hence it will be captured by the term α_0 of the regression. However this is not the case for the parameter c_i and the variables affecting it. These variables can be correlated with market access generating endogeneity problems.

gression is causality or it might simple capture correlations with omitted variables like access to technological innovation, educational levels and so. In order to deal with these issues and to control for the potential existence of other shocks to the dependent variable that are correlated with measures of economic geography, we also estimate this alternative specification that explicitly allows for these possibilities:

$$\text{Ln } w_i = \alpha_0 + \alpha_1 \ln MA_i + \sum_{n=1}^{N} \gamma_n X_{in} + \varepsilon_i \qquad [6]$$

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

3.2. Data and Regional System

The dependent variable in the regression analysis is the log compensation per employee defined as the total remuneration in wages and salaries payable by an employer to an employee in return for work done by the latter during the accounting period. Eurostat does not have this variable as such, instead it has data on the total amount of wages and salaries pay at regional level, labelled «compensation of employees» (Eurostat table code e2rem95). To get the compensation of employees *per capita*, we use the regional employment figures from the European Union Labour Force Survey (Eurostat table code lf2emp) and we labell this new variable in our analysis as «compensation per employee». The advantages of this variable as a proxy for regional wages against *per capita* GDP is that using the latter what we are doing is to divide the GDP produced by production units in region X by the resident population of the same region X. This leads to an overestimation of the figures in regions where you have a net inward commuting, circumstance common to several EU regions (London, Paris, etc.). On the other hand, if you divide compensation of employees by the number of employees, then you get the compensation «per employee» of all the production units in region X. Therefore compensation per employee is a better indicator for regional wages.

The dependent variable is given for 160 NUTS2 regions[10] for the year 2000.

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. We compute market access as a distance weighted sum of regional GDPs[11]. Technically speaking the expression we use to compute market access is:

$$MA_i = \sum_{j=1}^{R} E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma}$$

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[10] See appendix for the list of NUTS2 regions.

[11] Keeble *et al*. (1986) have referred to this coefficient as the «peripherality index» because this measure relates negatively to the peripherality of a region (see also CE 1988). Other authors that have built very similar indexes are Biehl (1988) and Niebuhr (2006). For a more comprehensive analysis of peripherality indicators see Shurmann and Talaat (2000).

Mj is a measure of the volume of economic activity of region *j*, T_{ij} 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 Canary Islands. A total of 259 EU27 NUTS2 regions were included. As a measure of economic activity *(M_j)*, we took Regional Gross Domestic Product and with respect to distance between regions *(T_{ij})*, they are great circle distances in Km between the main cities of the regions. The 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 $0{,}66\sqrt{\dfrac{Area}{\pi}}$ in which «Area» is the size of region i in km^2.

This formula gives the average distance between two points in a circular location (see Head and Mayer, 2000; Nitsch, 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).

Our baseline regression was the bivariate regression *log compensation per employee-log market access* represented by equation [5]. However we carried out a number of alternative specifications (equation [6]) to check for the robustness of market access in explaining the wage estructure in the European Union. We introduce variables thought to be important in explaining average regional wages and whose influence may be picked up by the market access measure such as educational levels and patents per capita as a measure of innovation activity. The corresponding data for all these variables were taken from Eurostat.

4. Empirical results

In this section we test econometric specifications [5] and [6] for the year 2000. Our main goal is testing for a spatial wage structure in the European Union according to the predictions of the model in section II.

Figure 1 plots log compensation per employee against log market access for the year 2000 illustrating the key relationship we want to test. This preliminary approach shows a positive effect of market access shaping regional wages.

The columns of table 2 summarize the results of our econometric estimations for the year 2000 for the sample of 160 NUTS2 regions. First column is our baseline estimation. We regress log compensation per employee on log of market access using OLS. The estimated equation, $\ln w_i = 3{,}54 + 0{,}50 \ln MA_i$, shows that the coefficients on market access are significant and the signs correspond with theoretical expectations. On average, a 10% increase in market access will increase wages by 5%. Market access explains around 29% of the spatial variation in cross-regional wages for the year 2000. In the light of these results the geography of access to markets is an important factor in explaining the spatial wage structure in the European Union.

Figure 1. Wages and Market Access
(EU15 2000)
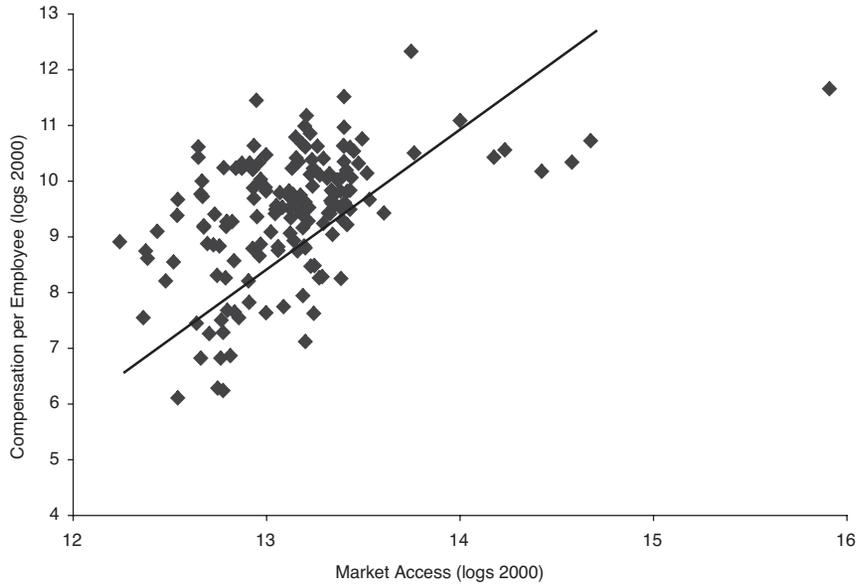
Table 2. Market Access and Compensation per Employee (2000).
Baseline estimation

	Dependent Variable: Log (Compensation per employee) Coefficients	
Regressors	(1)	(2)
Constant	3.54**	2.45*
	(0.89)	(1.30)
Market Access	0.50**	0.57**
	(0.06)	(0.09)
Estimation	OLS	IV
Inst. variables		(a)
First stage R2		0.57
R2	0.29	0.30
J-Statistic		0.66
Prob (F-statistic)	0.000	0.000
Number observations	160	160

(a) Distance to Luxembourg and size region's home country.
Notes: Table displays coefficients and Huber-White heterocedasticity robust standard errors in parenthesis.
** indicates coefficient significant at 0.01 level * significant 0.05 level.
«First stage» R2 is the R2 from regressing market access on the instruments set.

It is very interesting to compare the influence of remoteness in wage levels with its influence on GDP per head levels. Poorest and peripheral regions will have difficulties to converge in wages with the richest and central ones. The role of peripherality affecting poorest regions seems to have a greater impact on wage levels than in per capita income levels. This point is in line with the commonly accepted view that the long term income convergence must be accompanied by a convergence in real wages (see Emerson *et al.,* 1992). The evidence obtained in this paper gives support to such idea. Comparing the results of the regressions carried out on the influence of market access on *per capita* income levels (López-Rodríguez and Faiña, 2006) and the above results on its impact on wage levels, the effect of peripherality is greater on wages than on income levels. The coefficient of the market access in the double logarithmic regressions represents the elasticity of the dependent variable with respect to the market access. The results obtained for a similar period and with the same framework showed an elasticity of income levels to market access of 0.32 (st. error 0,036), which is significantly much lower than the one corresponding to wages (0,50, st. error 0,06).

However, the use of market access as the only regressor brings the problem of reverse causality in the sense that in its computation we include GDP which in turn is increasing in per capita income as captured by the dependent variable, compensation per employee. This endogeneity problem can cause inconsistent and biased estimates.

In order to address this issue, we use instrumental variables to estimate the effect of market access on wage levels.

The instruments

Determining a causal effect of market access on wage levels depends on the availability of instruments. These need to be variables that are determinants of market access but exogenous with respect to wage 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 wages. Taking into account these premises and following other studies carried out on spatial economic issues quite linked to the nature of this research [see Breinlich (2006), López-Rodríguez *et al.* (2007) and Redding and Venables (2004)] the paper uses as instruments geographical variables which are the most suitable candidates for such estimation and are exogenous determinants of market access. Therefore, we instrument market access with distance from Luxembourg and with the size of a region's home country. The first instrument captures the market access advantages of locations close to the geographic centre of EU, while the second instrument captures the advantage of large national markets in the composition of domestic market access.

In the second column of table 1, the effect of market access in wage levels is estimated using cross-sectional data on market access, compensation per employee and the set of instruments.

The instruments are highly statistically significant and have the expected signs. The p-value for an F-test of the null hypothesis that the coefficients on the excluded instruments are equal to zero is 0.00. Distance to Luxeboug and size of a region's home country explains about 57% of regional market access. Since the instruments

represent quite distinct source of information and are uncorrelated, we can trust them to be reliable instruments. However, we examine the validity of the instruments using a Hansen J test of the model overidentifying restrictions. For our market access measure we are unable to reject the validity of the instruments.

In the second-stage compensation per employee equation we again find positive and highly statistically significant effects of market access. The instrumental variables estimation, $\ln w_i = 2,45 + 0,57 \ln MA$, even increases slightly the effects of market access on compensation per employee changing its coefficient from 0.50 to 0.57.

The bivariate regression, Log Compensation per employee-log market access in table 1 does not allow us to know whether the positive correlation found is indeed a causality or might simply capture correlations with omitted variables. In order to deal with this issue and hence to test for the robustness of market access and for possible changes in its coefficient, control variables were added to our baseline specification.

Although there are a large number of alternative determinants of regional wage levels[12] we choose as control variables those whose influence might potentially be picked up by market access measures. Thus, we include the number of patents per capita as a proxy for innovative activities[13] and the share of economically active population with medium and high educational levels.

Indeed, stocks of medium and high educational levels and the number of patents per capita are highly correlated with market access. The theoretical foundations for the relationship between market access and educational levels have been put forward by Redding and Schott (2003). They proved that high market access provides long-run incentives for human capital accumulation by increasing the premium of skilled labour. Empirical works carried out at international and European level have confirmed this relationship [see Faina and López-Rodríguez (2005) and Redding and Schott (2003)]. Innovative activity is also affected by spatial proximity and geography. Moreover, at European level the regional dimension is very relevant due to the presence of border effects. The interaction of high market access in dense and central European regions (see figure 2 for the relationship between market access and centrality), which makes them large and profitable markets for innovation, together with increasing returns to innovation and localization of the knowledge spillovers, seem to explain the pattern of high concentration[14] of innovative activities in the centre of Europe.

The regression results relating medium and high educational levels and patents per one hundred thousand population against market access are reported in table 3. Although testing for the determinants of educational levels and patents in Europe is beyond the scope of this paper, these findings support a potential impact of market access in shaping the distribution of human capital and patents across European Union regions.

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[12] Porter (2003) provides a comprehensive analysis of US regions performance analysing in detail determinants of wage levels.

[13] Patenting is the best available and comparable measure of innovative activity across regions even though it does not capture all innovative activity. For more details about the relative merits of using patents as a proxy of innovative activity see Dosi *et al.* (1990), Griliches (1984, 1990) and Jaffe (1986).

[14] For comprehensive analysis of innovation activity in Europe see Bilbao-Osorio and Rodriguez-Pose (2004), Bottazzi and Peri (1999, 2003), Moreno *et al.* (2005) and Rodriguez-Pose (1999, 2001).

Figure 2. Market Access and Distance from Luxembourg
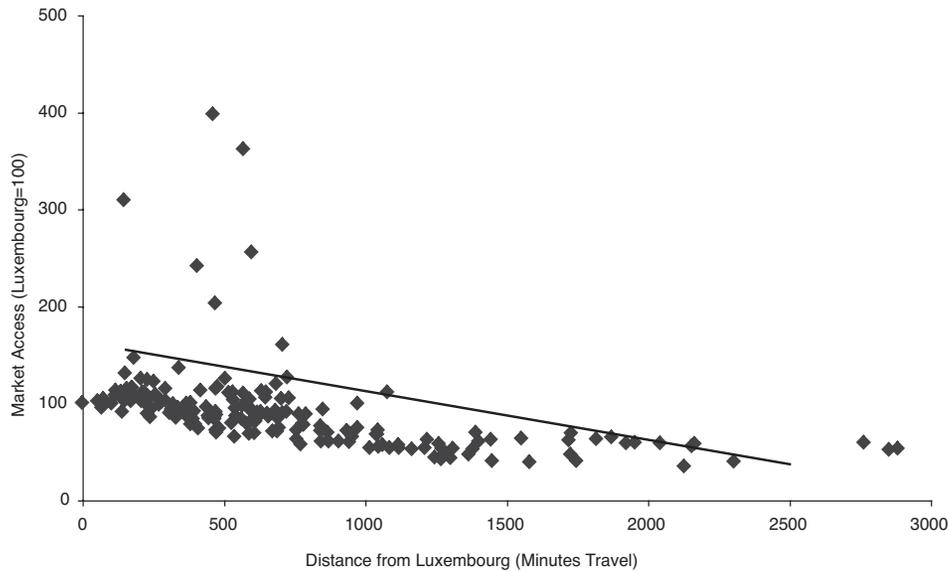
Table 3. Market Access, Educational Levels and Patents, (EU15 2000)

Dep. Variable:	Log (L. Ed. Level)	Log (M. Ed. Level)	Log (H. Ed. Level)	Log (Patents)
Regressors				
Market Access	-0,32**	0,99**	0,90**	1,35**
	(0,05)	(0.14)	(0,14)	(0,36)
Estimation	OLS	OLS	OLS	OLS
R2	0,18	0,19	0,16	0,19
N. observations	160	160	160	160

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

In order to disentangle the above mentioned possible channels through which market access may influence wage levels, a straightforward way of checking it is by including educational levels and patens as additional regressors in the baseline specification estimated in table 1. The results including these variables are reported in columns 2, 4 and 6 of table 4:

$Lnw_i = 6,33 + 0,23 \ln MA_i + 0,17 \, Pat.pc$ for patents *per capita* (column #2).

$Lnw_i = 5,72 + 0,35 \ln MA_i + 0,58 \, MedHigh.Ed$ for Medium and High educational levels (column #4).

$Lnw_i = 6,39 + 0,32 \ln MA_i + 0,33 \, HighEd$ for High educational levels (column #6).

They show that the direct influence of market access on wages is smaller than indicated by the baseline regression. In these alternative estimations market access retains a positive relationship with regional wages, at the usual critical levels, however coefficients on market access drop from values of 0.50 to values between 0.23-0.35 while the R2 of the regression rises to values between 38-61%. Still these estimations show that doubling a region market access increases compensation per employee between 23 to 35%.

In columns 3, 5 and 7 of table 4 we investigate the potential existence of other shocks to the dependent variable that may be correlated with our control variables by means of instrumental variable estimations. The results are the following ones:

$Lnw_i = 6,39 + 0,23 \ln MA_i + 0,18$ *Pat.pc* for patents *per capita* (column #3).

$Lnw_i = 4,65 + 0,43 \ln MA_i + 0,54$ *MedHigh.Ed* for Medium and High educational levels (column #5).

$Lnw_i = 5,31 + 0,39 \ln MA_i + 0,30$ *MedHigh.Ed* for High educational levels (column #7).

Our instruments are again distance to Luxembourg and size of region's home country. In the second stage we again find positive and statistically significant effects with the IV estimation. Again, the effect of market access on regional wages is reinforced when IV estimation is carried out.

Table 4. Market access and Compensation per employee (2000).
Analysing channels of influence

Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	3,54** (0,89)	6,33** (0,92)	6,39** (0,92)	5,72** (0,8)	4,65** (1,18)	6,39** (0,89)	5,31** (1,15)
Market Access	0,50** (0,06)	0,23** (0.07)	0,23** (0.07)	0,35** (0,06)	0,43** (0,08)	0,32** (0,06)	0,39** (0,08)
Patents pc		0,17** (0,02)	0,18** (0,02)				
Med-High. Ed. Level				0,58** (0,07)	0,54** (0,07)		
High Ed. Level						0,33** (0,04)	0,30** (0,04)
Estimation	OLS	OLS	IV	OLS	IV	OLS	IV
Inst. variables			(a)		(a)		(a)
First Stage R2			0,57		0,57		0,57
R2	0,29	0,61	0,63	0,46	0,47	0,38	0,39
Prob (F-statistic)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Number observations	160	160	160	160	160	160	160

Dependent Variable — Log (Compensation per employee) — Coefficients

(a) Distance to Luxembourg and size region's home country.
Notes: Table displays coefficients and Huber-White heterocedasticity robust standard errors in parenthesis.
** indicates coefficient significant at 0.01 level * significant 0.05 level
«First stage» R2 is the R2 from regressing market access on the instruments set.

The results reported in tables 2 and 3 also allow us to shed new light about the way in which market access might be affecting the shape of regional wages in Europe. Possible channels of influence are in the form of increased incentives for human capital accumulation and innovation activities.

5.   Conclusions

In this paper we test for a spatial wage structure in the European Union estimating a New Economic Geography model for a sample of 160 European Regions in the year 2000. The results suggest the importance of the geography of access to markets in determining the spatial distribution of wages across European Union regions. 29% of cross-regional variation in wages is explained by region's distance to consumer markets.

Regional wage levels are quite sensitive to market access. Actually our results show an elasticity of 0.50 (st. error 0.06) between these variables, which is greater than the previously obtained in a similar framework for income levels dependency on market access (0.32, st. error 0.036, López-Rodríguez and Faiña, 2006). This evidence is in line with the commonly accepted long term view that convergence in income levels must be accompanied by a convergence in real wages (see Emerson *et al*. 1992).

Alternative estimations to our baseline specification adding control variables whose influence may be picked up by market access measures show that two important channels through which market access might affect wage levels are educational levels and the size of the innovation activities.

Our results emphasises the role of remoteness in avoiding regional wage differences to be bid away and so in acting as a penalty for economic convergence of income levels. In addition, peripherality may humper the human capital accumulation and the size of innovation activities. Taking into account that human capital accumulation and the size of innovation activities are key factors for regional development and to promote convergence among EU regions, 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. We think that 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.

Our results relates to the works carried out by other researchers such us Brakman *et al*. (2004), Breinlich (2006), Hanson (2005), Mion (2004), Redding and Venables (2004), Roos (2001) and Tirado *et al*. (2003). These authors try to analyse the effects of economic geography on income levels either at national level (for different countries like Spain, Italy and Germany) or at international level (for a sample of world countries). Our results carried out for a different geographic unit of analysis (the re-

gions of the European Union) confirm the results obtained by the mentioned authors for their respective geographic units of reference, i.e., economic geography (market access measures) matters when we analyze the spatial variation of European Union income levels.

We believe that there is substantial scope for further work. Future studies should consider other hypothesis that could provide alternative explanations for the spatial income structures observed in the European Union and elsewhere.

Moreover, additional work is also needed to identify alternative channels, we have discovered only two, human capital and the size of innovation activities. Perhaps a good direction is to take into account the accumulation of physical capital.

Acknowledgements

6.   References

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.

Biehl, D. (1988): «Las infraestructuras y el desarrollo regional», *Papeles de Economía Española*, 35:293-310.

Bilbao-Osorio B. and Rodriguez-Pose A. (2004): From R&D to Innovation and Economic Growth in the EU», *Growth and Change*, 35:434-455.

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.

Bottazzi, L. and Peri, G. (1999): «Innovation, Demand and Knowledge Spillovers: Theory and Evidence From European Regions» *CEPR Discussion Papers* 2279.

Bottazzi, L. and Peri, G. (2003): «Innovation and spillovers in regions: Evidence from European patent data». *European Economic Review*, 47:687-710.

Brakman, S., Garretsen, H., Gorter J., van der Horst, A. and Schramm, M. (2005): «New Economic Geography, Empirics, and Regional Policy». *CPB Occasional Paper*, Koninklijke De Swart-Publishers, Den Haag.

Brakman, S., Garretsen H. and Schramm M. (2004): «The spatial distribution of wages and Employment: Estimating the Helpman-Hanson model for Germany» Journal of Regional Science, 44:437-466.

Brakman, S., Garretsen, H. and van Marrewijk C. (2001): An Introduction to Geographical Economics, Cambridge University Press.

Breinlich, H. (2006): «The Spatial Income Structure in the European Union - What Role for Economic Geography?», *Journal of Economic Geography, 6,* 593–617

Ciccone, A. 2002, «Agglomeration effects in Europe», *European Economic Review*, 46:213-237.

Combes, P.-P, Duranton, G. and Gobillon, L. (2004): «Spatial wage disparities: sorting matters!», *CEPR Discussion Paper*, vol. 4240.

Combes, P.-P. and Overman, H.G. (2004): «The Spatial distribution of Economic Activities in the European Union»in Henderson, J.V. and J.F.Thisse (eds.), *Handbook of Urban and Regional Economics,* Volume 4.

Crozet M. (2004): «Do Migrants Follow Market Potentials? An Estimation of a New Economic Geography Model». *Journal of Economic Geography*, 4:439-458.

Dekled, R. and Eaton, J. (1999): «Agglomeration and land rents: evidence from the prefectures». *Journal of Urban Economics*, 46:200-214

Dosi, G., Pavitt,K. and Soete, L. (1990): The Economics of Technical Change and International Trade. New York University Press

Eicher, T. and García-Penalosa C. (2001): «Inequality and Growth: The Dual Role of Human Capital in Development», *Journal of Development Economics* 66**:**173-97.

Emerson, M., Gros, D., Italianer, A., Pisani-Ferry, J. and Reichenbach, H. (1992): One Market, one Money. Oxford University Press, Oxford.

Faiña, A. and López-Rodríguez, J. (2004): «European Regional Policy and Backward Regions: Implications towards EU enlargement», *European Journal of Law and Economics* 18:5-32.

Faiña, A. and López-Rodríguez, J. (2005): «Market Access and Human Capital Accumulation: The European Union case», *Applied Economics Letters*, 13(9):563-567

Fujita, M., Krugman, P. and Venables, A. (1999): «The Spatial Economy: Cities, Regions and International Trade», MIT Press: Cambridge MA.

Fujita, M. and Thisse, J.-F. (2002): Economics of Agglomeration: Cities, Industrial Location and Regional Growth, Cambridge: Cambridge University Press.

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.

Griliches Z. (1984): R&D, Patents and Productivity, University of Chicago Press, Chicago, IL.

Griliches, Z. (1990): «Patent statistics as economic indicators: a survey», *Journal of Economic Literature*, 92:630-653

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

Head, K. and Mayer, T. (2000): «Non-Europe: The Magnitude and Causes of Market fragmentation in Europe», *Weltwirtschaftliches Archiv,* 136(2):285-314.

Head, K. and Mayer, T. (2004): «The Empirics of Agglomeration and Trade», Handbook of Urban and Regional Economics. Vol. 4, Chapter 59 edited by V. Henderson and J.F. Thisse.

Head, K. and Mayer, T. (2006): «Regional Wage and employment responses to Market Potential in the EU», *Regional Science and Urban Economics*, 36, 573-594.

Jaffe, A.B. (1986): «Technological Opportunity and Spillovers of R&D: Evidence from firm's patents, profits, and market value», *American Economic Review*, 76(5):984-1001.

Keeble, D., Offord, J. and Walker, S. (1986): « Peripheral Regions in a Community of Twelve Member States» (Luxembourg: Commission of the European Communities).

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

Krugman, P. (1992): «A Dynamic Spatial Model», *NBER Working Paper* No. 4219, Cambridge, Massachusetts.

Krugman, P. and Venables, A. J. (1995): «Globalization and the Inequality of Nations». *Quarterly Journal of Economics*, 857-880.

Larsen Marrot, M. (2003): «Regional wage differentials-does distance matter?» *European Regional Science Association-ERSA* (conference paper).

López-Rodríguez, J., Faiña J. A. and López Rodríguez, J. (2007): «Human Capital Accumulation and Geography: Empirical Evidence from the European Union», *Regional Studies,* 42:217-234.

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. (2004): «Spatial Externalities and Empirical Analysis: The Case of Italy», *Journal of Urban Economics*, 56:97-118.

Moreno, R., Paci, R. and Usai, S., 2005 «Spatial spillovers and innovation activity in European regions» *Environment and Planning A*, 37(10):1793-1812.

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

Niebuhr, A. (2006): «Market Access and Regional Disparities. New Economic Geography in Europe». *Annals of Regional Science*, 40:313-334.

Nitsch, V., 2000, «National borders and international trade: Evidence from the European Union». *Canadian Journal of Economics*, 22, 1091-1105.

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

Overman, H. G., Redding, S. and Venables, A. J. (2003): «The economic geography of trade, production and income: a survey of empiric» In: E. Kwan-Choi and J. Harrigan, Editors, *Handbook of International Trade*, Basil Blackwell, Oxford (2003), pp. 353-387.

Porter, M. (2003): «The economic Performance of Regions». *Regional Studies,* 37:549-578.

Redding, S. and Schott, P. (2003): «Distance, Skill Deepening and Development: Will Peripheral Countries Ever Get Rich?». *Journal of Development Economics*, 72(2):515-41.

Redding, S. y Venables, A. J. (2004): «Economic geography and international inequality», *Journal of International Economics*, 62, (1):53-82.

Rodriguez-Pose, A. (1999): «Innovation prone and innovation averse societies. Economic Performance in Europe», *Growth and Change,* 30:75-105.

Rodriguez-Pose, A. (2001): «Is R&D investment in lagging areas of Europe worthwhile? Theory and Empirical evidence», *Papers in Regional Science,* 80:275-295.

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,* 21:171-195.

Schürman, C. and Talaat, A. (2000): «*Towards a European Peripherality Index*». Report for DGXVI Regional Policy of the European Commission, University of Dortmund.

Tirado, D., Paluzie, E. and Pons, J. (2003): «Industrial agglomerations and wage gradients: the Spanish economy in the interwar period». Document du Travail 01/03, CERAS (ENPC).

Appendix

List of NUTS2 regions included in the analysis.

Belgium (10): Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest, Prov. Antwerpen, Prov. Limburg (B), Prov. Oost-Vlaanderen, Prov. Vlaams Brabant, Prov. West-Vlaanderen, Prov. Brabant Wallon, Prov. Hainaut, Prov. Liège, Prov. Luxembourg (B), Prov. Namur.

Denmark (1): Denmark.

Germany (7): Berlin, Bremen, Hamburg, Mecklenburg-Vorpommern, Saarland, Schleswig-Holstein, Thüringen.

Greece (13): Sterea Ellada, Peloponnisos, Thessalia, Dytiki Makedonia, KentrikiMakedonia, Anatoliki Makedonia, Ipeiros, Kriti, Attiki, Dytiki Ellada, Voreio Aigaio, Notio Aigaio, Peloponnisos.

Spain (17): Galicia, Principado de Asturias, Cantabria, Pais Vasco, La Rioja, Comunidad Foral de Nava-rra, Castilla y León, Comunidad de Madrid, Castilla-La Mancha, Extremadura, Aragón, Cataluña, Is-las Baleares, Comunidad Valenciana, Región, de Murcia, Andalucía, Canarias.

Finland (2): Itä-Suomi, Aland.

France (26): Rhône-Alpes, Picardie, Auvergne, Provence-Alpes-Côte d'Azur, Champagne-Ardenne, Midi-Pyrénées, Languedoc-Roussillon, Basse-Normandie, Poitou-Charentes, Centre, Limousin, Bourgogne, Bretagne, Aquitaine, Franche-Comté, Haute-Normandie, Pays de la Loire, Lorraine, Nord - Pas-de-Calais, Alsace, Île de France, Corse Ireland (2): Border, Midland and Western, Sout-hern and Eastern, Guadaloupe, Martinique, Reunion, Guyane.

Ireland (2): Border, Midlands and Western, Southern and Eastern.

Italy (19): Valle d'Aosta, Piemonte, Liguria, Lombardia, Emilia-Romagna, Veneto, Friuli-Venezia Giulia, Toscana, Marche, Umbria, Lazio, Abruzzo, Molise, Puglia, Campania, Basilicata, Calabria, Sicilia, Sardegna.

Luxembourg (1).

Netherlands (12): Groningen, Friesland, Drenthe, Overijssel, Gelderland, Flevoland, Utrecht, Noord-Ho-lland, Zuid-Holland, Zeeland, Noord-Brabant, Limburg.

Switzerland (9): Burgenland, Niederösterreich, Wien, Kärnten, Steiermark, Oberösterreich, Salzburg, Tirol, Vorarlberg.

Portugal (4): Norte, Algarve, Azores, Madeira.

Sweden (8): Stockholm, Östra Mellansverige, Sydsverige, Norra Mellansverige, Mellersta Norrland, Övre Norrland, Småland med öarna, Västsverige.

United Kingdom (36): Tees Valley and Durham, Cumbria, Northumberland and Tyne and Wear, East Ri-ding and North Lincolnshire, North Yorkshire, South Yorkshire,West Yorkshire, Derbyshire and Not-tinghamshire, Leicestershire, Rutland and Northamptonshire, Lincolnshire, East Anglia, Bedfords-hire and Herefordshire, Berkshire, Buckinghamshire and Oxfordshire, Surrey, East and West Sussex, Essex, Inner London, Outer London, Hampshire and Isle of Wight, Kent, Gloucestershire, Wiltshire, and North Somerset, Cornwall and Isles of Scilly, Devon, Dorset and Somerset, Herefordshire, Wor-cestershire and Warwickshire, Shropshire and Staffordshire, West Midlands, Cheshire, Greater Man-chester, Lancashire, Merseyside, East Wales, West Wales and The Valleys, Eastern Scotland, South Western Scotland, North Eastern Scotland, Highlands and Islands.