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Sub-regional disparities in Britain: convergence, asymmetries and spatial dependence

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Sub-Regional Disparities in Britain: convergence, asymmetries and spatial dependence

Vassilis Monastiriotis[#]

Abstract

Regional outcomes in Britain have exhibited strong signs of divergence and asymmetries on the basis of a North-South divide for over twenty years. This paper examines the nature of these evolutions within a spatial econometrics framework, integrating the analysis of neoclassical β-convergence with that of spatial dependence. The analysis illuminates the dynamic interdependencies that connect the local economies of Britain and provides useful insights for the conduct of regional policy in the country and the goal of regional equalisation of growth potentials.

JEL codes: J31, R12, R15, R58

Keywords: Britain, convergence, spatial dependence, North-South divide

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Sub-Regional Disparities in Britain: convergence, asymmetries and spatial dependence

1. Introduction

Since the seminal works of Baumol (1986) and Barro and Sala-i-Martin (1991; Barro, 1991) a significant body of empirical literature has developed examining the convergence implications of the neoclassical growth model, initially for countries and later for regions (Barro and Sala-i-Martin, 1992; Bernard and Durlauf, 1995; Carlino and Mills, 1996; Siriopoulos and Asteriou, 1998; Kangasharju, 1998; De La Fuente, 2000; and many others). Following, and partly as a result of the identified limitations of this empirical literature, a number of theoretical and empirical contributions offered new insights on the issue of regional growth and provided new tools for its examination.[1] These included the examination of 'transition probabilities' or temporal changes in the distribution of growth performance indicators (Quah, 1993 and 1996), the utilisation of the Markov chain properties (Magrini, 1999), panel data approaches (Knight et al., 1996; Evans and Karras, 1996; Soukiazis and Castro, 2004) and the application of measures of concordance and stratification (Webber and White, 2003). Probably the most significant contribution to the issue, however, has been the introduction quite recently of spatial econometrics in the examination of patterns of regional convergence (Rey and Montouri, 1999). Modelling and exploring patterns of spatial interaction and dependence is of paramount importance, as it relaxes the unrealistic assumption that economies grow in isolation and highlights the importance

[1] Among the identified limitations, the annoyingly invariable convergence rate of 2% pa probably stands out, although more substantive issues include the case of overshooting (β-convergence with σ–divergence), the presence of clusters and convergence clubs and the existence of divergent steady states.

of economic linkages and spillovers for the growth performance of interconnected economies. This is an insight which has long been realised in the areas of economic geography and regional science (Myrdal, 1957; Cheshire and Carbonaro, 1996), but which economics has been slow in adopting.

The introduction of a spatial interactions perspective into the issue of convergence is not only important empirically, as it corrects for a possible source of statistical bias, but moreover at the level of theory. Taking into account such interactions brings together –and allows to examine simultaneously– two distinct approaches to the issue of regional growth, as represented by the neoclassical growth model and the theory of cumulative causation.[2] This paper contributes to this developing literature by formally examining the convergence hypothesis for the case of Britain with a focus on addressing the role of spatial interactions in the process of economic convergence.

The issues of growth performance and of regional imbalances in productivity and living standards across the British regions have attracted significant attention in the literature and more recently have become a focal point of regional and competition policy for the UK government (DTI, 2003; ODPM, 2003). Under the Public Service Agreement of the 2002 Spending Review (HMT, 2002), the three governmental bodies mainly responsible for regional policy adopted a shared target to "make sustainable improvements in the economic performance of all English regions and over the long term reduce the persistent gap in growth rates between the regions,

[2] Recent developments in the fields of trade theory and (new) economic geography have produced a further bridging of the two theoretical approaches, by re-introducing cumulative causation (related however to dynamic agglomeration economies and not to Keynesian-type linkages) on a set of micro-economic foundations of neoclassical flair (Krugman, 1991; Fujita et al., 1999). The theoretical contribution of this literature, in relation to the issue examined here, is in its establishment of a framework where mechanisms of divergence and convergence can co-exist, so that movements in observed disparities simply reflect the relative importance of the two sets of mechanisms (Cheshire and Malecki, 2004).

defining measures to improve performance…". This signalled a significant shift of UK policy, which until the mid-1990s put little emphasis on regional disparities. Interestingly, the emphasis of policy is not on reducing regional disparities per se (i.e., in levels), but on achieving 'growth convergence'. Although quite controversial, this policy seems consistent with the government's emphasis on productivity, competitiveness and (industrial-regional) clusters. Moreover, it reflects the underlying policy view that real convergence is hindered by the presence of strong agglomeration forces and that 'growth convergence' can be a first step towards diffusing growth potentials across the country.

Clearly, the issue of regional and sub-regional disparities in Britain is particularly important, not least because of the significant evidence pointing to an economically hazardous and politically embarrassing North-South divide (Blackaby and Murphy, 1995; Machin, 1996; Dewhurst, 1998). Significant disparities exist among, as well as within, the British regions in terms of wages, productivity, per capita incomes, and even unemployment and employment participation rates (Martin, 1997). Although recent trends suggest that regional inequalities have stabilised, especially in real terms, the existing disparities are large and difficult to bridge. Moreover, a number of contributions in the literature suggest that, while aggregate disparities were widening (in the 1980s and 1990s), regional reward structures have been converging (Monastiriotis, 2002; Duranton and Monastiriotis, 2002) with the implication that spatial disparities in Britain are increasingly the outcome of differences in human capital characteristics and thus in labour productivities. From a new economic geography perspective this suggests a pattern of cumulative causation

and increasing spatial heterogeneity (core-periphery), where low-wage regions lose out in skills and thus diverge further from the most dynamic regions of the country.[3]

Quite paradoxically, there is very little research addressing specifically the convergence hypothesis for the British regions. Only a handful of studies exist that explicitly test for β-convergence in the country (amongst them, one can note those by Dewhurst, 1998, and Evans and Pentecost, 1998) and even fewer use data at sub-regional level (Chatterji and Dewhurst, 1996; Dunford, 1997; Gripaios et al., 2000; Roberts, 2004); and still, only cover the period up to the early 1990s. Thus, despite the significant disparities and policy interest, there is no study in Britain that examines regional and sub-regional disparities within a β-convergence framework post-1993. This is a significant omission in the literature and has also important implications for regional policy in the country. The analysis performed here is an attempt to fill this significant gap, by examining the growth performance and evolution of disparities across the British counties over the period 1981-2002. The analysis employs the β-convergence framework but integrates together the analysis of spatial interactions and thus provides a valuable inquiry into the dynamics that link the sub-regional economies of Britain and an original opportunity for testing the extent and relative importance of equalisation and cumulative causation mechanisms in the country.

The structure of the paper is as follows. Section 2 makes some theoretical considerations, revisiting the issue of convergence in the neoclassical growth model and introducing the notions of spatial association that are to be used in the empirical analysis. Section 3 briefly discusses some data issues and presents an exploratory analysis of county-level disparities in Britain. The formal analysis on β-convergence is reported in Section 4, where the issues of spatial dependence and spatial

[3] Duranton and Monastiriotis (2002) have identified a pattern of 'disaggregate convergence' within the aggregate patterns of divergence, with similar individuals commanding increasingly similar wages across regions.

heterogeneity are also considered and the dynamics that connect the growth performance of British counties are further explored through a number of simulations. The final section concludes with some thoughts for policy.

2. Theoretical considerations

The simple notion of convergence derives from the neoclassical growth model (Solow, 1956; Swan, 1956) and is effectively based on the assumptions of constant returns to scale in the production function and decreasing returns individually for each factor of production. With diminishing individual returns and as long as all countries share (or have access to) similar technologies, each economy is deemed to reach a common steady-state rate of growth, with deviations being only short-run phenomena, deriving from exogenous population and technology shocks (innovations). Under this mechanism poorer countries (or regions) tend to grow faster and thus catch-up with the more developed economies where returns to capital are lower.

Casual empirical observation suggests that such a process is operative only in special cases. Differences in endowments, fixed characteristics (e.g., location, history), institutions and the like, create structural differences in the organisation of production resulting in permanent differences in long-run rates of growth (steady-states). This observation leads to the concept of conditional convergence, where long-run growth rates are conditioned on the initial endowments of each economy. Where groups of countries/regions share similar initial conditions and fundamentals, club convergence is observed in the sense that each club tends to move towards a distinct steady-state so that disparities decline over time within each club while they tend to stabilise across clubs.

A similar mechanism of conditional-only convergence is derived from the endogenous growth literature that builds on the standard neoclassical model (e.g., Mankiw et al., 1992). By endogenising the process of technological progress it introduces increasing returns to scale in the production function (with or without diminishing returns to individual factors). Increasing returns allow for heterogeneous steady states (club convergence) but can further generate a process of divergence in a cumulative fashion (i.e., more advanced economies tend to grow faster) due to continuous benefits accruing from agglomeration and scale economies.

It is important to note that these processes of convergence and divergence (based on the neoclassical and endogenous growth models) do not require any interaction between economies (even within clubs). The equalisation of growth rates is purely an outcome of congestion that comes about with economic development and is predicted to occur even if all economies are closed/isolated. Endogenous or exogenous innovations can lead to short- or long-run deviations from the convergence path but movements along this path are integrated into the mechanics of the production function and are not related to any system of economic interdependencies. This rather restrictive perspective of the 'convergence hypothesis' has been also adopted in the empirical literature on β-convergence, which rarely examines dynamics related to physical proximity and economic interactions.

Nevertheless, the analysis of mechanisms of convergence and divergence operating through economic interaction has a long history in economics. In the traditional trade theory (e.g., Stolper-Samuelson theorem) openness to trade leads to factor and market price equalisation with complete specialisation of production. Thus, even in the presence of heterogeneous endowments, rapid convergence can be achieved through economic interactions (trade or factor movements) across

economies. A similar process of factor price equalisation is predicted in the more Keynesian mechanisms of the Harris-Todaro model, where regional differences in rewards (wages) and costs (market prices) are diminished through migration. On the other hand, new trade theory and new economic geography, by emphasising the role of agglomeration and scale economies in influencing the location decisions of firms and individuals, allow for processes of sustained divergence across countries and regions (Fujita et al., 1999). Such processes tend to differ from the traditional process of cumulative causation generated through Keynesian-type forward and backward linkages (Myrdal, 1957), but have a clear observational equivalence in the sense that they both produce patterns of increased and persistent regional inequalities, as well as patterns of clustering and core-periphery dependencies.

Traditionally in the empirical literature, such patterns of interaction and dependence have been captured through the examination of input-output tables. The recent boom in the field of spatial econometrics, however, has offered a very dynamic alternative route for the empirical investigation of such mechanisms. More importantly, it has advanced the theoretical understanding of the mechanics governing spatial interactions and forward and backward linkages. Through the development of the field, a number of econometric concepts have diffused and expanded in such a way that today they represent distinctive concepts in the theoretical understanding of economic interactions.

Exploring the different dimensions of spatial association in econometrics has produced two distinctive types of association, those of spatial dependence and spatial heterogeneity. Spatial heterogeneity implies that behavioural economic characteristics and relations are not constant across space. In other words, whereas economic outcomes might be more or less similar across locations (e.g., groups of regions), the

structure of economic relationships can differ. In empirical terms, the concept of spatial heterogeneity is equivalent to the time-series concepts of structural breaks and time-varying coefficients. Technically, the examination of spatial heterogeneity is performed through a spatial version of threshold regression, conventionally labelled as 'spatial regimes'. The second type of spatial association (spatial dependence or autocorrelation) refers directly to processes that transmit economic conditions and outcomes through space. Positive spatial dependence suggests a process of clustering or contamination, where similar characteristics and outcomes tend to concentrate geographically in order to exploit specific scale and agglomeration advantages (clustering), or where the presence of a characteristic in a specific location (probably above a critical mass) triggers its diffusion across neighbouring locations (contamination). Negative spatial dependence, in contrast, is related to notions of competition and absorption, reflecting conditions of restricted availabilities (e.g., competition for hiring a fixed supply of skilled labour) or of centripetal dynamics (e.g., concentration of skilled labour in locations with a competitive advantage even in conditions of slack labour demand), respectively.

Empirically, the concept of spatial dependence can be further analysed into three distinct processes: spatial error dependence refers to the transmission of random (unexpected) shocks across space; spatial lag autocorrelation refers to the conditionality of local outcomes to those of neighbouring locations; finally, cross-regressive spatial dependence describes a process where local outcomes are partly shaped by neighbouring locations' initial conditions. In the context of the analysis of β-convergence, these three distinct types can be described as follows: long-run growth in a given location depends on (i) random shocks occurring in neighbouring locations,

(ii) the long-run growth rates of neighbouring locations, and (iii) the initial level of development of the neighbouring locations.

These four types of spatial association (error, lag, cross-regressive, and heterogeneity) can be represented for the unconditional β-convergence model in mathematical form as follows:

Error dependence $$\Delta y_i = a + \beta y_{0i} + (\eta_i + \lambda W \xi_i) \quad (1)$$

Lag dependence $$\Delta y_i = a + \beta y_{0i} + \rho W \Delta y_i + \varepsilon_i \quad (2)$$

Cross-regressive $$\Delta y_i = a + \beta y_{0i} + \gamma W y_{0i} + \varepsilon_i \quad (3)$$

Spatial regimes $$\Delta y_i = a + \beta_k y_{0i} + \varepsilon_i \quad (4)$$

where Δy is the average annual growth rate (e.g., of GDP per capita) for region i over a period of years, y_{0i} is the initial value of GDP per capita (at time t=0) for the same region, k indexes groups of regions (spatial regimes), ε and η are iid residuals, ξ is a vector of region-specific shocks, W is a matrix of spatial weights,[4] and α, β, λ, ρ, and γ are coefficients to be estimated.

The next section describes the data used in the empirical analysis and provides an exploratory investigation of regional disparities and spatial autocorrelation (clustering) across the counties of Britain over the period 1981-2002. Following, section 4 presents the formal examination of the issue of β-convergence in the presence of spatial interactions, based on the models of unconditional β-convergence presented above. The analysis focuses on unconditional β-convergence for two main reasons. First, for simplicity and clarity of presentation it is preferable to examine the simple form of convergence, to avoid complications in the specification and

[4] The elements of the spatial weights matrix are coefficients that discount proximity or contiguity according to various criteria. Proximity is discounted through a distance decay function (each observation in the sample is weighted by a measure of its standardised distance from the location of interest). Contiguity is accounted for by taking an un-weighted average of the locations directly neighbouring the location of interest. For more details about the nature and construction of spatial weights see any textbook on spatial econometrics (e.g., Anselin, 1988).

estimation of the empirical models and thus focus on the spatial processes that are of interest. Second, the concept of conditional convergence implies structural differences across the sample economies, an assumption which is less relevant at such a spatially disaggregate level of analysis. Despite their differences, the British counties belong to the same national economic and institutional system and are completely open to factor movements and free of any financial, linguistic, institutional or other restrictions. It follows that, in the absence of systematic spatial processes, which the paper seeks to explore, equilibrating mechanisms of the type of Stolper-Samuelson or Harris-Todaro should operate immediately thus wiping out any structural differences across regions and leaving only the scale effect to determine the speed of convergence.

3. Regional disparities and supra-regional clusters

a. The measurement of the growth variable

The specification of the growth variable is an important issue for a number of technical and theoretical reasons. The theoretical model of long-run growth deriving from the standard neoclassical model refers to labour productivity (GVA or GDP per employee). Due to data problems, many cross-country studies have used GDP per capita instead, but at this level this choice in not particularly problematic, as employment participation differences across countries are rather small and relatively constant over time. The use of GDP per capita, however, becomes increasingly problematic as one moves to finer spatial disaggregations, as the volume of commuting increases (creating problems relating to workplace- versus residence-based measures of GDP) and the quality of the data declines (problems relating to the measurement of GDP and GVA) (Douglas, 2001). Further, county-level data on

GDP/GVA in Britain are only available for selected years and not later than the mid-1990s, while they are subject to frequent revisions and measurement problems.[5] On the other hand, at least at the sub-regional level, the equilibrating mechanisms described by trade and migration theory refer to the equalisation of both factor prices (wages) and productivities. Wage data of good quality exist for very fine disaggregations in Britain for long time-periods. Research for the country has shown that regional returns to human capital characteristics have been converging, implying that regional wage differentials increasingly reflect differences in labour and residual productivities, even after accounting for regional price differentials (Duranton and Monastiriotis, 2002). Thus, at the county level where the measurement-related problems for GDP/GVA are significantly accentuated, wages appear to be the most appropriate relevant measure for the analysis of convergence. Following these considerations, the present analysis uses data on wages for male full-time employees obtained from the annual publications of the New Earnings Survey.

b. Temporal patterns of regional disparities

Nominal wages in Britain have grown fast over the last two decades (at over 6% per annum). As is well reported, this growth has not been spatially even and subsequently geographical wage disparities have worsened over the period. Table 1 presents some summary wage statistics for the counties of Britain.

As can be seen, cross-county wage disparities rose significantly according to all measures. The standard deviation of county wages increased by 7.5 times, partly reflecting the influence of inflation and the strong wage growth during the period. However, even on the basis of the coefficient of variation, which controls for such

[5] Significant problems with the measurement of incomes at the regional and sub-regional levels in the UK have recently been reported by Cameron and Muellbauer (2000) and Bishop and Gripaios (2004). Both sources point to the superiority of the NES wage data in terms of accuracy and consistency.

influences, regional disparities appear to have doubled over the period, implying an average rate of σ-divergence of just below 4% per year. The relative range of the cross-county wage distribution (maximum-to-minimum ratio) produces a similar albeit somewhat smaller result (around 2% pa). Thus all statistics suggest a widening over time of the cross-county wage distribution. As depicted in columns 5 and 6 this widening coincided with an increase in both skewness and kurtosis, suggesting the development over time of a more compressed cross-county wage distribution, with fewer outliers to the left (low-wage counties) but more extreme outliers to the right (high-wage counties; this interpretation is consistent with the identified differences in the evolution of the coefficient of variation and the max-min ratio noted above). The implication is that over time high-wage counties have become increasingly uncharacteristic of the median.

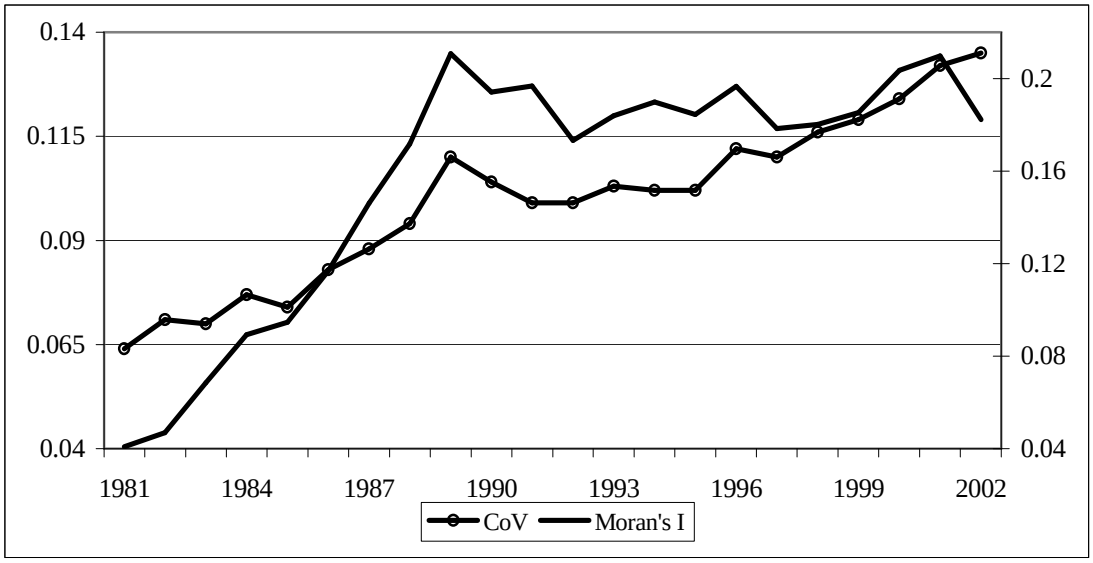
Table 1. Summary statistics for county-level nominal wages

Year	*Mean (£s)*	*Std dev.*	*CoV*	*Max/Min*	*Skewness*	*Kurtosis*	*Min*	*Max*
1981	134.6	8.55	0.064	1.387	0.62	4.23	Cornwall	London
1982	147.7	10.51	0.071	1.447	0.73	4.26	Cornwall	London
1983	160.2	11.24	0.070	1.434	1.08	5.15	Powys	London
1984	170.2	13.08	0.077	1.440	1.01	4.66	Powys	London
1985	183.0	13.54	0.074	1.459	1.20	5.37	Cornwall	London
1986	196.3	16.24	0.083	1.506	1.14	5.19	Cornwall	London
1987	210.7	18.46	0.088	1.552	1.19	5.42	Cornwall	London
1988	230.2	21.59	0.094	1.637	1.18	5.46	Cornwall	London
1989	253.5	27.78	0.110	1.690	1.47	5.70	Powys	London
1990	276.3	28.85	0.104	1.735	1.27	5.18	Powys	London
1991	298.6	29.70	0.099	1.659	1.34	5.38	Cornwall	London
1992	318.6	31.58	0.099	1.652	1.23	5.18	Powys	London
1993	330.1	33.93	0.103	1.681	1.44	5.83	Powys	London
1994	339.5	34.71	0.102	1.622	1.40	5.51	Powys	London
1995	349.0	35.44	0.102	1.788	1.57	7.06	Powys	London
1996	363.9	40.65	0.112	1.717	1.39	5.68	Powys	London
1997	380.3	41.95	0.110	1.717	1.43	5.91	Cornwall	London
1998	396.0	45.98	0.116	1.772	1.44	5.60	Cornwall	London
1999	411.1	48.82	0.119	1.833	1.42	5.97	Cornwall	London
2000	428.2	53.10	0.124	1.881	1.62	6.39	Cornwall	London
2001	450.0	59.46	0.132	1.833	1.51	5.74	Cornwall	London
2002	471.1	63.74	0.135	1.943	1.54	6.05	Cornwall	London

Source: NES (various years) and own calculations. Data are for full-time male employees in Britain.

In addition to the observed widening of disparities, the cross-country wage distribution in Britain is characterised by very strong inequality persistence. That Greater London has been by far the region with the highest wages throughout the period is not surprising. Less expected is the observation that Cornwall (in the South West) and Powys (in Wales) have been consistently the two counties with the lowest wages for over twenty years. Persistence has been remarkably high across the distribution (with a rank correlation coefficient for 1981-2002 of 0.76) and has further increased in the 1990s (at 0.90 between 1992 and 2002).

Figure 1. Spatial disparities and spatial dependence



The high persistence of the wage distribution and the intensification of disparities leave open the possibility that significant structural interdependences (spatial autocorrelation) connect wage determination across the counties of Britain. Figure 1 presents a standard measure of global spatial autocorrelation (Moran's I), which depicts the path of spatial dependence followed by the British counties over the

period.[6] As can be seen, spatial dependence rose sharply during the 1980s and remained relatively stable (at high levels) through to 2002. The marked increase in cross-county dependence in terms of wages implies a strengthening of clustering initially and a stabilisation thereafter.

What is more important is the observation that spatial autocorrelation (Moran's I) and spatial disparities (coefficient of variation) follow a rather similar path. This could be reflecting a structural characteristic of the nature of cross-county disparities in the country, for example, widening disparities in the presence of club convergence (intensification of clusters) or cluster formation (increase in the number of clusters). The next sub-section explores further these dynamics.

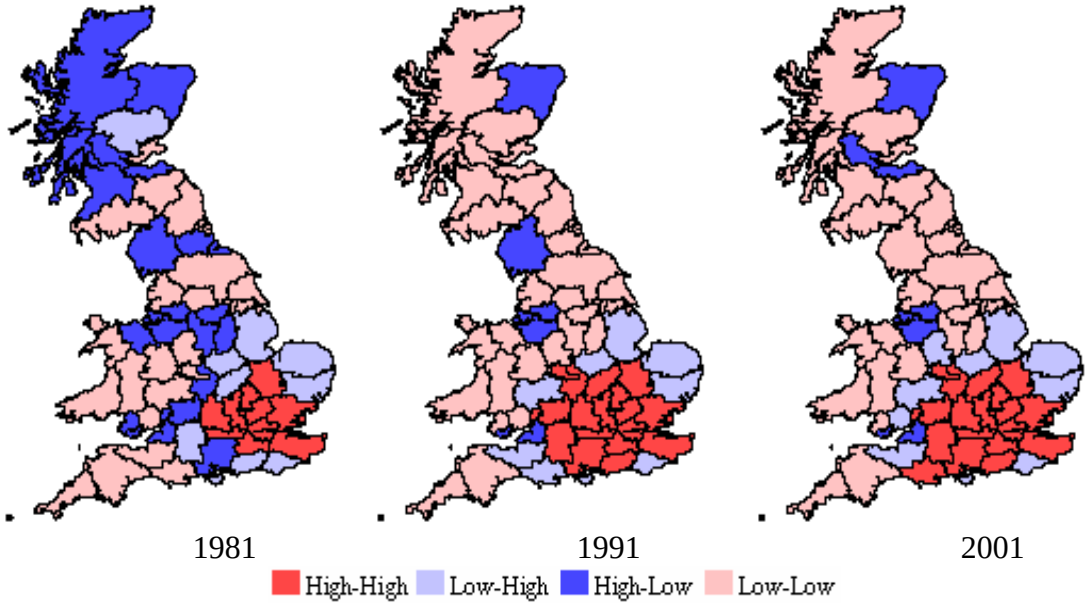
c. Geographical patterns of spatial association

To explore further the patterns of spatial autocorrelation and inequality across the British counties, a more detailed statistic has to be employed. The local Moran is the most widely used such statistic (Anselin, 1995), measuring the degree of spatial association at any given location. With the use of such a local indicator of spatial association (LISA) one can arrive at a classification of locations based on the type of spatial interactions that characterise them. Following convention, four groups are identified: 'HH' locations, which exhibit high values (i.e., high wages) and are neighbouring similar locations (high-wage clusters); 'LH' locations, of low wages, neighbouring high-wage locations; 'LL' locations, where both local and neighbouring outcomes are low (low-wage clusters); and finally 'HL' locations of superior performance relative to their neighbours. Based on such a classification, the presence of clusters and the extent of positive or negative spatial autocorrelation can be visually

[6] Moran's I is the spatial equivalent of the correlation coefficient and measures the correlation between local and neighbouring values across the sample. For details about this and similar measures see Anselin (1988).

explored with the use of maps. Figure 2 presents three such maps (Local Moran Maps) for the initial, median, and final years of the sample.

Figure 2. Wage clustering (local Moran maps)



These maps confirm the conclusions from the earlier analysis. Significant geographical clustering (positive spatial autocorrelation) is observed throughout the period. In the early 1980s a number of clusters can be identified, broadly speaking located around Greater London, the corridors across Warwick-Bristol, Leeds-Merseyside, Cumbria-Cleveland and Edinburgh-Glasgow, and northern Scotland (possibly due to the North Sea oil activities). High wages are largely concentrated in Greater London, whereas the remaining clusters appear predominantly as high-wage enclaves along low-wage hinterlands.

By 1991 this picture is significantly altered. In line with the global Moran results (Figure 1), spatial concentration around Greater London has been increasing, while the other clusters have significantly subsided, a pattern that persists through the end of the period. Thus, as cross-county disparities widened and spatial dependence intensified, a pattern of club-convergence emerged, with a strong and quite diffused

cluster of high wages in the south and a relatively low-wage cluster in the rest of the country (the 'North').

Table 2. Global Moran tests for wage growth across the British counties

	Flat discount factor			*Steep discount factor*		
Wage growth	**Short**	**Medium**	**Long**	**Short**	**Medium**	**Long**
1981-2002						
Moran's I	0.2102	0.1767	0.1701	0.3739	0.3617	0.3600
p-value	0.000	0.000	0.000	0.000	0.000	0.000
1981-1991						
Moran's I	0.2425	0.1998	0.1897	0.4084	0.3922	0.3898
p-value	0.000	0.000	0.000	0.000	0.000	0.000
1992-2002						
Moran's I	0.0742	0.0584	0.0560	0.1242	0.1196	0.1192
p-value	0.000	0.000	0.000	0.003	0.002	0.002

Notes: See footnotes 5 and 7.

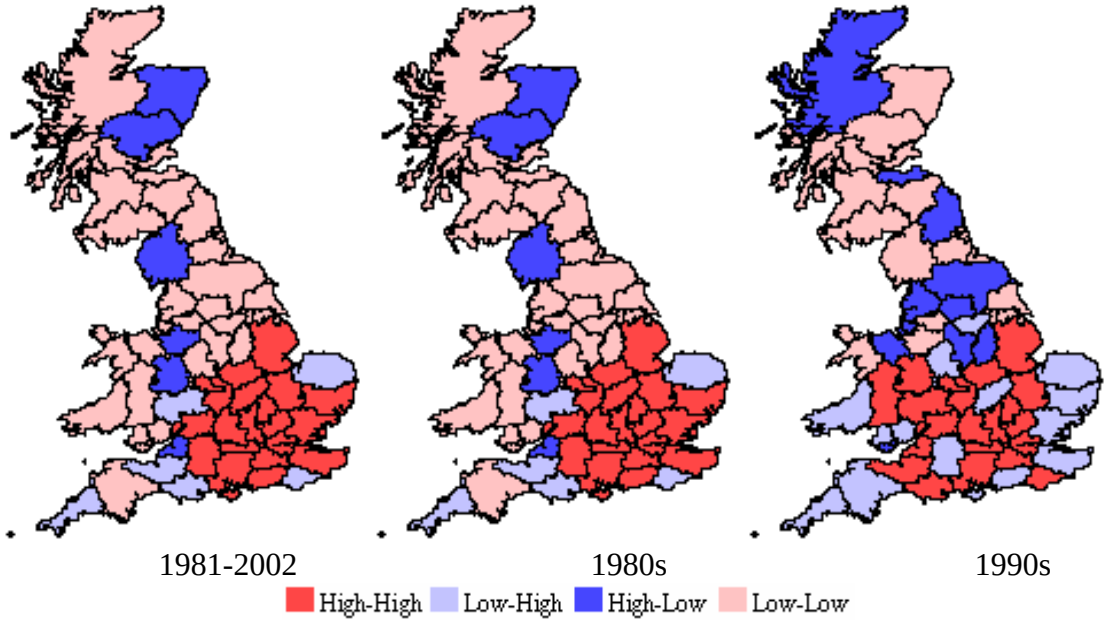
A similar analysis can be performed for wage growth in order to identify the geographical incidence of dynamic clusters. As was the case for wage levels, strong positive spatial autocorrelation characterises the wage-growth performance of the British counties. Table 2 presents a series of tests on global spatial autocorrelation based on a number of alternative spatial weights matrices.[7] Spatial tests are performed for two types of distance decay functions (flat and steep, penalising distance to a lesser and greater extent, respectively) and for three distance cut-off points (short, medium, long).[8] As can be seen, the measures of global spatial autocorrelation are always positive and always significant for all distance discount factors and for different sub-periods. Spatial dependence (growth clustering) appears more significant in the 1980s and is stronger for steep distance decay factors, implying significant but

[7] The same set of matrices has been used in all previous and following tests of spatial autocorrelation but full results are only presented here for economy of space. All relevant tests and calculations are available upon request.

[8] All distances refer to Euclidian straight-lines between each county's centroid as calculated by ArcView. The cut-off points refer to distance bands beyond which spatial interactions are assumed to cease to exist and have been defined on the basis of the lower, median, and upper quartiles of the cross-country distribution of distances.

rather concentrated wage-growth clusters. The visual presentation of these results is offered in Figure 3.

Figure 3. Growth clustering (local Moran maps)



The picture obtained in Figure 3 has some similarities with the patterns of clustering in wage levels but exhibits also some marked differences. The cluster around Greater London is still present but is now much larger, while clusters similar to the 'high-wage enclaves' of Figure 2 are hardly identifiable. The aggregate picture is strongly influenced by developments in the 1980s. During the 1990s the Greater London cluster appears to have been weakened and further diffused towards the west, while strong wage-growth enclaves have been emerging in some of the earlier identified corridors (most notably across Yorkshire-Merseyside). Overall, the evidence gathered in Figure 3 seems to be consistent with the notion that significant cumulative causation or dynamic agglomeration forces are in operation in terms of wage formation across the British counties, at least in the 1980s. In the 1990s, the weakening of spatial concentration and the emergence of growth enclaves seems to

suggest some absorption effects acting towards regional convergence. The formal investigation of the presence of such convergence dynamics in presented next.

4. Spatial dynamics and β-convergence

a. Convergence and spatial dependence

Following the extensive exploration of geographical patterns of wage inequality and interdependencies, this section examines in detail the process of β-convergence across the British counties explicitly incorporating in the analysis the influences of the identified patterns of spatial dependence and heterogeneity. As stated earlier, the empirical investigation is based on a simple model of (unconditional) convergence, which makes the growth rate of wages, over a long-run period, a function of the initial level of wages in each county. The analysis is performed for the full sample (growth period of 1981-2002) and repeated for two sub-samples (1981-1991 and 1992-2002) in order to identify structural differences in the evolution and spatial dynamics of cross-county wage inequalities in the country.

Table 3 presents the results of the standard β-convergence analysis for the three sub-periods (left panel). The performance of the regressions is in general satisfactory, although the fit of the regressions is rather low and evidence of heteroskedasticity is present, pointing to possible mis-specification. In line with the earlier discussion the convergence coefficient is always significantly positive (slightly less so in the 1980s), confirming that the last two decades have been periods of significant regional divergence in the country. The speed of divergence can be calculated at 2.4% per year for the full period, similar to the findings of σ-divergence around Table 1.

Table 3. Testing for β-convergence: standard analysis

Wage growth regressions				*Tests for spatial dependence*			
	Full	**1980s**	**1990s**		**Full**	**1980s**	**1990s**
Estimates				**Flat distance discount**			
Constant	-0.090	-0.047	-0.108	Moran I (error)	0.000	0.000	0.271
p-value	0.02	0.376	0.001	LM (error)	0.000	0.000	0.770
Initial	0.031	0.026	0.026	Robust LM (error)	0.098	0.002	0.174
p-value	0.000	0.020	0.000	LM (lag)	0.000	0.000	0.304
Diagnostics				Robust LM (lag)	0.002	0.000	0.093
R^2-adjusted	0.20	0.07	0.24	LM (SARMA)	0.000	0.000	0.233
AIC	-515.16	-472.59	-502.24	**Steep distance discount**			
F-test	16.53	5.74	20.65	Moran I (error)	0.000	0.000	0.497
Normality				LM (error)	0.000	0.000	0.845
Jarque-Bera	0.978	0.971	0.390	Robust LM (error)	0.216	0.002	0.260
Heteroskedasticity				LM (lag)	0.000	0.000	0.427
Breusch-Pagan	0.001	0.026	0.073	Robust LM (lag)	0.003	0.000	0.173
White	0.004	0.091	0.084	LM (SARMA)	0.000	0.000	0.387

Notes: All regressions have been estimated with OLS. AIC is the Akaike Information Criterion. Tests for spatial dependence are performed in SpaceStat and include Moran's I statistic and various Lagrange Multiplier (LM) tests. SARMA is a joint test for error and lag dependence.

More important, however, for the present analysis are the results from the tests for spatial autocorrelation (right panel). Six tests are reported for each of the three regressions and for each of two different distance decay functions. For the full period and for the 1980s the tests almost uniformly suggest that significant spatial dependence, both in terms of lag- and error-autocorrelation, is present, with spatial lag autocorrelation being marginally stronger. In contrast, for the 1990s the evidence of spatial autocorrelation is either weak (spatial-lag with flat distances) or non-existent. With the possible exception of the 1990s regression, these findings suggest that the convergence regressions are mis-specified and thus the inferences drawn regarding the process of convergence across the counties of Britain are not valid. To further explore the presence and influence of spatial dependence in the convergence regressions, a number of alternative specifications are examined, corresponding to models (1) – (3) as presented in section 2.

Table 4. Testing for β-convergence: spatial dependence

		Full period	*1980s*	*1990s*
Spatial Error	beta (β)	0.0246	0.0140	0.0251
	p-value	0.000	0.128	0.000
	lambda (λ)	0.8320	0.8570	0.1029
	p-value	0.000	0.000	0.802
	AIC	-530.00	-490.16	-502.30
	LM-lag	0.000	0.001	0.125
Spatial Lag	beta (β)	0.0265	0.0185	0.0240
	p-value	0.000	0.035	0.000
	rho (ρ)	0.8462	0.8608	0.2531
	p-value	0.000	0.000	0.440
	AIC	-531.24	-490.19	-500.92
	LM-error	0.192	0.098	0.156
Cross-Regressive	beta (β)	0.0242	0.0140	0.0194
	p-value	0.001	0.137	0.005
	gamma (γ)	0.1548	0.2660	0.0366
	p-value	0.000	0.000	0.099
	AIC	-527.96	-494.07	-503.13
	Moran (error)	0.000	0.000	0.685

Notes: The spatial error and spatial lag models have been estimated with the Maximum Likelihood procedure; the cross-regressive model has been estimated with OLS. All regressions have been carried out in SpaceStat.

As is illustrated in Table 4, controlling for various processes of spatial dependence reduces the estimated rate of divergence for all sub-periods. The impact is stronger in the 1980s regression, where controlling for two forms of spatial dependence (error and cross-regressive) returns a convergence coefficient not statistically different from zero. Taken literally, this result indicates that the whole process of divergence in the 1980s can be solely attributed to cross-county interdependences in terms of observed and unobserved determinants of growth.[9] Nevertheless, the specification tests suggest that the best performing model is the spatial lag specification (model (3)). Based on the Akaike Information Criterion (AIC) there is little to separate the models. On the other hand, the Lagrange Multiplier tests reported in Table 4 suggest that controlling for spatial interactions in long-run growth

[9] There is a series of factors that can be explored in relation to these determinants. Among them, the geography and evolution of industrial clustering is an important candidate (see for example Duranton and Overman, 2002, and Roberts, 2004), but the examination of its relation to the aggregate spatial patterns observed here is beyond the scope of this paper.

renders the influence of spatial error and cross-regressive autocorrelation insignificant.[10]

b. Convergence with spatial regimes

The β-convergence analysis so far provides results in line with the exploratory analysis of the previous section. Significant divergence of over 2% per year has characterised wages across the British counties for the last two decades. Although spatial dependence in wage levels has been higher in the 1990s, signalling the intensification of clustering, for wage growth spatial interactions have diminished as the wage-growth cluster around Greater London became more diffused. The models examined thus far, though, do not allow a formal investigation of the different spatial regimes that seem to characterise the country, in line with the wider literature of a North-South divide in Britain and the clusters that were identified in the previous section. To investigate the process of β-convergence under the operation of different spatial clusters, we turn to the spatial regimes model presented earlier (model (4)). The model splits the British counties into separate spatial regimes, along the lines of the North-South divide and in accordance with groupings used elsewhere in the literature (Rowthorn, 1999; Roberts, 2004).[11] Two models are estimated. The first is the spatial regimes version of the simple convergence equation. The second takes into account the findings of the spatial dependence analysis and fits a spatial regimes model that further includes the spatial lag of the growth variable to control for the

[10] In the case of the 1990s regression, however, as was the case before, no significant spatial influences are detected in any form.

[11] The counties are allocated to regimes based on the regions on which they belong. The 'North' includes the regions of Scotland and the counties of Wales, North West, North, Yorkshire, and West Midlands. The remaining regions (East Midlands, East Anglia, South East, South West and Greater London) are classified as the 'South'. Alternative definitions of 'North' and 'South' produced qualitatively very similar results.

most prominent form of spatial dependence observed. For the 1990s regression the first specification appears more appropriate.

Table 5. Testing for β-convergence: spatial regimes

Statistics	Spatially Static Models			Spatial Lag Models		
	1981-2002	1981-1991	1992-2002	1981-2002	1981-1991	1992-2002
			Estimates			
South	0.0531	0.0423	0.0380	0.0494	0.0369	0.0381
p-value	0.000	0.000	0.000	0.000	0.001	0.000
North	-0.0043	-0.0113	-0.0006	-0.0019	-0.0083	-0.0008
p-value	0.608	0.354	0.950	0.815	0.475	0.937
			Spatial Stability (spatial regimes)			
Chow test	25.00	22.06	4.93	27.00	19.48	10.23
p-value	0.000	0.000	0.011	0.000	0.000	0.006
			Diagnostics			
R^2-adjusted	0.56	0.45	0.33	0.60	0.50	0.36
AIC	-549.70	-503.66	-507.97	-550.05	-503.92	-505.97
			Normality			
Jarque-Bera	0.704	0.174	0.532	-	-	-
			Heteroskedasticity			
Breusch-Pagan	0.925	0.781	0.851	0.787	0.969	0.839
			Spatial Dependence (Euclidian distance)			
Moran (error)	0.127	0.125	0.988	-	-	-
LM (error)	0.208	0.193	0.163	0.584	0.557	0.162
LM (lag)	0.037	0.037	0.235	0.125	0.133	0.941
LM (SARMA)	0.110	0.108	0.377	-	-	-

Notes: The spatially static models have been estimated with OLS; the spatial lag models have been estimated with the Maximum Likelihood procedure. All regressions are in SpaceStat.

As expected, the performance of the spatial regimes regressions is significantly improved, with the adjusted R^2 more than doubling in the full-period regression compared to the simple regressions of Table 3. The stability of the convergence coefficients (Chow test) is rejected for all models at any conventional level of significance (although this is much weaker in the 1990s regressions), confirming the approach taken to split the sample into two separate groups. The spatial regimes specification removes any sign of heteroskedasticity and of spatial dependence when the spatial-lag autocorrelation is controlled for (spatial lag models). The results concerning the convergence coefficients are particularly illuminating. In

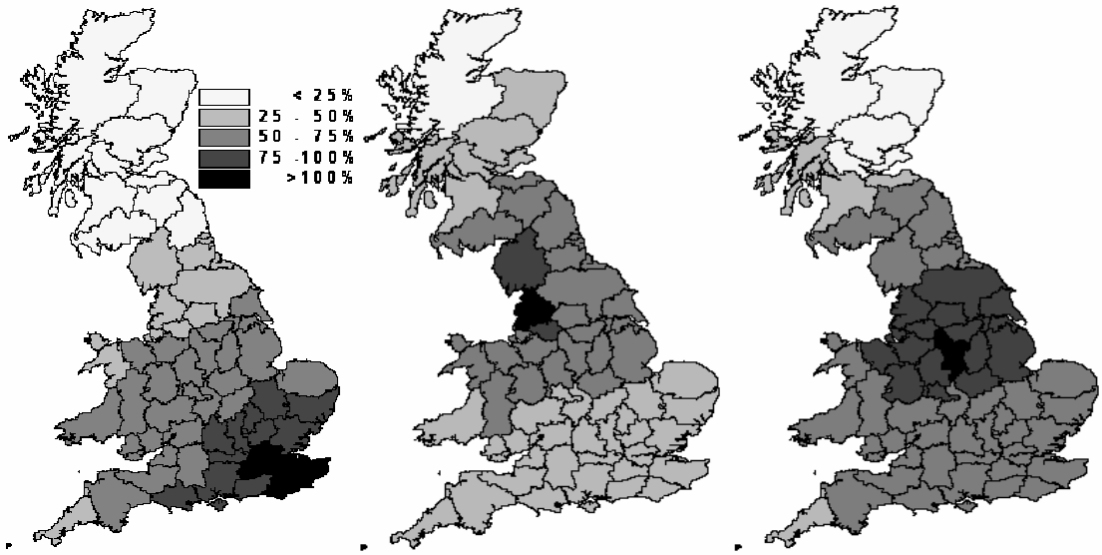
all regressions the evidence of cross-county divergence is highly significant in the South, with speeds of divergence almost twice as large as the ones estimated before, while the evidence of divergence for the North disappears completely, as the coefficients become negative and highly insignificant. This finding suggests that, outside the South, regional evolutions have been particularly unfavourable: although in relative terms county wages across the North became more similar, this apparently happened through a process of 'convergence to the bottom', with the high-wage enclaves of the 1980s disappearing fast. Spatial dependence in the sense of clustering of wage growth is observed, but this has mainly translated into a negative cumulative causation mechanism and the geographical expansion of the low-wage cluster. In contrast, the South has been characterised by a continuous process of both cross-county (within the South) and national (between the South and the North) divergence, with high-wage counties experiencing faster wage growth, presumably at the expense of neighbouring counties with lower initial values.

c. Spatial transmissions of growth innovations

The implications of the identified patterns of weak geographical interdependencies in the North and significantly strong agglomeration forces in the South can be further explored with a simulation exercise. Based on the spatial-lag / spatial-regimes model estimated for the full period (Table 5, column 4), it is possible to explore the geographical patterns of the spatial transmission mechanisms related to a random growth shock affecting a particular location. The maps of Figure 4 graphically present these geographical patterns for a random shock, equal to two standard deviations of the estimated stochastic growth, which is introduced in three different counties of Britain (Greater London, Lancashire and Derbyshire). Due to the

spatial interactions mechanism of the model, the localised shock is transmitted across counties in a cumulative fashion. The results presented in Figure 4 are based on a series of ten iterations (loops), after which the size of the spatially transmitted effect is significantly minimised.

Figure 4. Simulation results for a random shock on wage growth



Greater London Lancashire Derbyshire

The introduction of the growth shock in London produces a significant spillover effect mainly across the South East and East Anglia, but the effect fails to reach Scotland. Due to the strong interdependencies in the region, the overall effect is significantly magnified but rather concentrated. Introducing an identical shock elsewhere in the country produces markedly different results, which are however in line with expectations based on the economic geography of the country. Lancashire is probably an extreme case, where the multiplier effect of the shock affects strongly only two neighbouring counties and, while spillover effects of over one standard deviation (>50%) are rather diffused, the shock only modestly affects the south. In Derbyshire the spillover effects appear stronger and are more evenly distributed

across space, with the whole of England and Wales benefiting from at least one-standard-deviation stochastic growth (although again there is a stronger north-ward bias). This simulation exercise helps illustrate the different spatial dynamics operating in various parts of the country. Further analysis of localised interdependencies and spillover dynamics can provide valuable information for the patterns and potentials of (wage) growth across the British counties but such a detailed investigation is outside the scope of this paper.

6. Conclusion

Presented in this paper is an extensive analysis of the temporal and geographical patterns of wage growth, cross-county wage dispersions, and spatial associations for the case of Britain over the last two decades. The analysis produced a number of interesting results, some of which confirm previous findings in the literature and some of which are completely new, offering fresh insights on the nature and dynamics of wage growth in Britain. Nominal wages exhibited strong signs of both sigma- and beta-divergence throughout the period. Cross-county divergence persists even after controlling for various patterns of spatial association. The observed patterns of spatial association point to rather strong clustering of both wages and wage growth, mainly around the wider Greater London area. The presence of spatial-error dependence suggests a contamination mechanism (where random shocks are transmitted across neighbouring counties), but in all cases the evidence of spatial-lag dependence is stronger. This implies a degree of co-determination of wage outcomes, which is consistent with the notions of convergence clubs and spatial heterogeneity and the extensive literature on the British North-South divide.

Geographically, the observed cross-county divergence is probably entirely due to evolutions in the south of Britain and specifically to the presence of a strong cluster around Greater London, which is diverging both within itself (in the 1990s) and from the rest of the country. The rest of the British counties have exhibited, if anything, weak signs of β-convergence, at least in the 1980s. It needs to be stressed, however, that this resulted partly in the disappearance in the 1990s of a number of small high-performing clusters (enclaves) in the north and is thus not necessarily a positive evolution. The distinct evolutions in the two parts of the country are connected to a form of structural heterogeneity (along the lines of the North-South divide) that appears stronger than any other form of spatial association operating in the country (especially as clustering occurs in specific locations and not randomly across Britain). This observation implies that the British economy, at least at the sub-regional level examined here, is characterised by structural imbalances and asymmetries that exert strong influences on the patterns of regional, and thus also of national, growth.

Dealing with such imbalances is a crucial responsibility of economic policy-making and the recent resurgence of interest from various departments of the UK government on regional disparities, with the objective of achieving convergence in regional and sub-regional growth performances, is in this sense more than welcome. Important policy implications in relation to the new targets of the UK regional policy stem from the empirical findings obtained here. Regional and sub-regional disparities in Britain are structural, in the sense that spatial mechanisms are in operation (at least at the county level) that reinforce the existing regional advantages and perpetuate the geographical concentration of positive and adverse outcomes. These cumulative causation mechanisms are based on wider spatial divisions (i.e., the North-South divide) and less so on genuine patterns of localised clustering that could be related to

pure dynamic agglomeration effects (although the latter can be identified within the South). To achieve a reversal of the trends of the last two decades and facilitate real regional and sub-regional convergence (in the sense of reductions in the coefficient of variation of local outcomes) policy must tackle directly the structural asymmetries that characterise the two parts of the country.

Although this is all but a straightforward task, all is not lost. Lack of evidence of negative spatial autocorrelation implies that there is little direct (localised) territorial competition across local economies in Britain –at least as far as wage outcomes are concerned– and thus that positive growth outcomes can rather easily spread across local economies. Although the structural imbalances between the north and the south suggest that the policy objective of harmonising the growth performance of the British regions is not going to be an easy task, the implications of the geographical dynamics revealed in this paper suggest that UK regional policy does well to focus on 'growth convergence' and the strengthening of clusters around the country. Especially in light of findings elsewhere in the literature, that suggest that spatial wage evolutions are mainly attributable to differences in human capital characteristics (Duranton and Monastiriotis, 2002), it appears that assisting the emergence of growth enclaves in various parts of the country is a viable strategy that can uphold the human capital endowments of the lagging regions and trigger cumulative growth through the positive spillover effects that already characterise inter-regional dynamics in Britain. Providing such pre-conditions for equalisation of growth rates across the British regions will assist towards the narrowing of the existing regional and sub-regional disparities (in levels), which of course should be the ultimate goal of regional and national economic policy.

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