SERC DISCUSSION PAPER 10

Urban Growth Drivers in a Europe of Sticky People and Implicit Boundaries

Paul Cheshire (SERC, London School of Economics)
Stefano Magrini (University of Venice)

November 2008

This work was part of the research programme of the independent UK Spatial Economics Research Centre funded by the Economic and Social Research Council (ESRC), Department for Business, Enterprise and Regulatory Reform (BERR), the Department for Communities and Local Government (CLG), and the Welsh Assembly Government. The support of the funders is acknowledged. The views expressed are those of the authors and do not represent the views of the funders.

Urban Growth Drivers in a Europe of Sticky People and Implicit Boundaries

Paul Cheshire* and Stefano Magrini**

November 2008

* SERC, Department of Geography & Environment, London School of Economics
** Department of Economics, University of Venice

Acknowledgements
We have benefited from many discussions with colleagues but retain responsibility for any remaining deficiencies or errors. This paper draws on work undertaken for a project within the ESRC's Cities Initiative under Award L 130251015 whose support is gratefully acknowledged.

Abstract
We investigate urban GDP pc growth across the EU12 using data for functionally defined cities - rather than administrative regions. We test hypotheses on the role of human capital, EU integration and fragmentation of urban government and explore spatial dependence and mechanisms of spatial interaction. Results are acceptable on standard econometric tests without measures of spatial interaction but there is spatial dependence. If variables reflecting spatial adjustment are included, they are statistically significant and eliminate spatial dependence. Not only do the results now provide consistent estimates of parameters, they also support relevant theoretical insights and show national borders are still significant barriers to economic adjustment. People in Europe are sticky so it is unreasonable to assume spatial disparities will disappear. Our findings also imply that cities in Europe form national rather than a single continental system.

Keywords: growth; cities, local public goods, spatial adjustment, local economic growth
JEL Classifications: H41, H73, O18, R11, R50

1. Introduction

This paper is about the fundamental drivers of urban growth: in particular in a European institutional and geographic context. There is a powerful and rigorous US tradition analysing regional or urban growth in a neo-classical framework assuming full spatial equilibrium. A good exemplar is Glaeser *et al* (1995). They build on the compensating differentials model of Roback (1982). Full spatial equilibrium implies that people cannot improve their welfare by moving from one location to another whether that is between neighbourhoods in one city or from one city to another. Differences in prices, for quality constant houses, or wages, for productivity constant workers, signal differences in the value of environmental amenities across space. People equalise real welfare, not even just real wages, across space, so they accept higher house prices and/or lower wages to live and/or work in more desirable locations. So Glaeser *et al* (1995) conclude that since people vote with their feet, the best measure of changing patterns of spatial welfare is differential rates of population growth as a result of net migration: not differential rates of productivity growth, manifesting itself in different rates of output or GDP per capita growth.

Empirically the most important of these environmental factors leading to quality of life differences between regions seems to be climate (see Graves, 1976; 1980 and 1983; or 2003a & b; Rappaport, 2007) but there is a more elaborate literature analysing spatial differences in the 'quality of life' building on full spatial equilibrium as an underlying assumption. Gyourko and Tracy (1991), for example, include in their estimates the implied value of differences in local public goods. Several recent articles by Glaeser and associates (for example Glaeser and Gottlieb, 2006) implicitly use the assumption of full spatial equilibrium as support for an analysis of the causes of 'urban resurgence' and the rediscovery of the 'consumer city'. They observe real wages have been falling in cities relative to non-urban areas because urban productivity and wages have not risen as fast as urban house prices. Since city population(s) have been stabilising, however, they conclude that urban resurgence is more because of the rising attractiveness of cities as places to live (significantly because of falling urban crime rates) than because of increasing agglomeration economies driving factor productivity growth in cities compared to non-urban areas.

Europe is a continent of nation states with only recent and partial steps towards integration. It is, moreover, a continent of geographically very sticky people. The reasons for Europeans' low responsiveness to differences in opportunities across space seem complex. The costs of movement are high compared to the US, because of transactions costs and housing policies (social housing is a much larger fraction of the stock in most EU countries and place-specific and rent controlled housing ties people to their existing locations). Probably more important, however, are differences in culture,

.

language and institutions. For whatever reason, in an earlier paper (Cheshire and Magrini, 2006) we showed that while population movement across the EU of 12 between 1980 and 2000 did significantly respond to generalised differences in economic advantage (as reflected, for example, in the systematic spatial effects of European integration or regional inheritances of old resource-based industries), and also responded to climatic differences, the evidence was inconsistent with full spatial equilibrium. The response of population movement to economic factors was sluggish; net migration rates between comparably sized regions in the USA are fifteen times greater than in Europe (Cheshire and Magrini, 2006). Perhaps more telling, population movement responded strongly to climatic differences but only to climatic differences *within* countries. There was no significant migration response to climatic differences measured across Europe as a whole. Moreover population growth interactions between regions were strongly impeded by national borders.

This finding provides additional interest to trying to understand better the drivers of urban economic growth – the main focus of this paper. It implies that Europe is not typified by full spatial equilibrium and even if migration flows did reduce spatial disparities, real differences in welfare between regions may be strongly persistent. Differences in levels of real per capita GDP or in its growth, are unlikely to be fully offset by counterbalancing differences in environmental quality or amenities. This investigation of the drivers of economic growth differences across the city-regions of the EU has implications for wider themes, therefore. It carries strong implications for whether it is reasonable to think of a single European 'urban system'; it sheds light on the mechanisms producing spatial economic adjustment and how national borders still impede this while dense urbanisation and good transport links facilitate it; it reveals an important limitation of the Tiebout hypothesis[1]; and it implies that concern for spatial disparities in GDP per capita or growth, may be reasonable in Europe, if policy aims to reduce spatial welfare differences for similar individuals.

In addressing questions of differential spatial growth the question immediately arises: what are the most appropriate spatial units to look at? US urban scholars automatically use data for core-based metropolitan regions (or CBSAs)[2]. These were originally known as Standard Metropolitan Areas (SMAs) but precise criteria for defining them and the names applied have evolved over time. US textbooks such as Mills and Hamilton (1994) or DiPasquale and Wheaton (1996) hardly discuss the

---

[1] Tiebout (1956) is one of the most highly cited papers in local public finance and in applied urban economics. This analyses a world in which people can vote with their feet for the package of local public goods and services which best suits their incomes and preferences and shows that under the assumption of full spatial equilibrium and no local public policy spillovers competition between local jurisdictions can produce optimal sets of local public goods. The issue here is that in the context of European systems of local government we need to consider a world in which people are not perfectly mobile and there may be important classes of local public goods which have spatial spillovers associated with their consumption and/or their production.

[2] Now known as Core-Based Statistical Areas – or CBSAs. The responsibility for this system of urban definitions rests with the Office of Management and Budget (2000).

reasons for using data for this standard urban concept or even alternative definitions of urban areas, except to mention the existence of administrative 'cities'. A good review of US and European concepts and definitions of urban areas and how US definitions have evolved over time is provided in Freeman (2005).

Data for core-based city-regions have a number of critical advantages: criteria used to define them are uniform across the whole US, so while political boundaries compared to actual settlement patterns are highly variable, the data for CBSAs relate to comparable concepts of 'city'; because CBSAs include both employment and the residents who hold the jobs, they are in economic terms as self-contained as spatial subdivisions of national economies are likely to be; they cover the whole urban area, so they abstract from patterns of residential segregation – they include all citizens, both rich and poor, and all ethnic groups. The data for these US core-based city-regions are also available as time series – for population going back to 1790 – for both constant definitional boundaries and boundaries which evolve as settlements evolved and commuting systems expanded.

Some European countries have data for consistent definitions of urban areas for long periods – the French data for a particular definition of the built-up area of cities - the *agglomération* - are available back to 1831 (Guérin-Pace, 1995); others have data for core-based functional definitions of 'city' (for example Germany); but unfortunately definitions vary greatly across countries and some county's definitions do not usefully translate to others. For example, in France, until recently the concept of the *agglomération* corresponded quite closely to that of a city-region since land use planning in France permitted continuous expansion of built-up areas and did not attempt to impose growth boundaries (unlike the British or Dutch systems) and urban centres in France are mainly some distance apart. Applying the French *agglomération* concept to the very different legal and geographical setting of Belgium, however, ends up having just one continuous Belgian city – stretching from Antwerp to Liége. As a result it is not surprising that even some European urban scholars wanting to understand more about how cities work have turned to US data (one of many examples would be Duranton and Puga, 2005). There is a large enough number of consistently defined city-regions in the US for statistical analysis and the data are comparable and freely available.

The analysis in this paper employs data for a specific definition of core-based city regions - Functional Urban Regions (FURs – see section 2) – in the EU of 12. More detail is given in Section 3 but the FUR dataset was first constructed as the foundation for a research project funded by the European Commission during the 1980s (and that drew on earlier work by Hall and Hay, 1980). The results of this, together with details of how the FURs were defined and some of the data, were set out in Cheshire and Hay, 1989. This FUR dataset has been continuously updated and expanded and the analysis reported here uses the most recent version. In Appendix 2 we provide an illustrative map of these FURs and more detailed maps for two countries showing how their boundaries relate to those of the official administrative regions.

2. Issues and approach

In a world characterised by full spatial equilibrium and a constant distribution of environmental amenities the drivers of spatial population growth would be the direct complement of the drivers of economic growth. Both processes are worth investigating but understanding one illuminates the other. The finding reported in Cheshire and Magrini (2006) that full spatial equilibrium is not a reasonable assumption in the context of European spatial development therefore focuses additional interest in understanding better what factors drive urban economic growth differentials – the subject of this paper.

The 'new economic geography', initiated by Krugman (1991), has re-awakened interest amongst mainstream economists in agglomeration economies; as a result, interest in cities and their contribution to economic productivity has risen up the agenda. At the same time, internationalisation of the world's economy and European integration have created an interest in and focused more policy efforts on, local economic development. Against this background we hope this paper makes a particular contribution: to understanding the fundamental drivers of urban growth and the welfare impacts differences in growth may generate; how such growth should be measured and the implications of alternative measures; and how these forces play out in the particular European context of geographically sticky people, continuing national barriers to adjustment but dense urbanisation. At the same time we apply the tools of spatial econometrics to help understand and interpret spatial economic processes rather than as simply diagnostic tools or providers of technical fixes.

In developing and testing propositions about the sources of urban growth we draw as clearly as possible on underlying theory. One contribution of this paper is to test – indirectly - whether local growth policies have any positive impact on growth. We do this, however starting from a theoretical proposition in local public finance and treating the production of additional local growth as if it were the production of a local public good. When we explore the empirical results for evidence and sources of spatial dependence we attempt to provide an economic interpretation for those results, and draw implications for the extent of spatial disequilibrium in Western Europe and the claim that Europe is a 'network of cities' (Kresl, 2007 page 1).

Our conclusion is that city-regions in the EU behave like city-states, but city-states confined by national boundaries. Their trajectories are influenced by conditions in their neighbours within their own countries but they do not behave as simply the spatial units from which an integrated continental economy is constructed. This implies that differences in GDP per capita across EU cities not only reflect differences in productivity but also differences in welfare.

In this paper while we are using cross sectional growth models, we are not taking the convergence approach of the numerous studies following Barro (1990) and Barro and Sala-i-Martin (1991). For recent surveys of the β-convergence literature see, for example, Durlauf and Quah (1999), Temple (1999) or Magrini (2004). We reject the β-convergence approach as uninformative and perhaps misleading for both theoretical and empirical reasons. Theoretical reasons are discussed in Cheshire and Malecki (2004). The analysis done for this paper reinforces the empirical objections to the approach.

The β-convergence approach includes the initial level of GDP p.c. as an independent variable (with a range of additional control variables to account for differences in steady states and idiosyncratic 'shocks') and tests whether poorer nations/regions at the start of the given period grow faster on average than those that were richer. To the extent that they do, this provides a measure of their rate of convergence. Where the observational units are subdivisions of national territories, such as regions, then the standard approach is to include national dummies to control for all country-specific omitted variables. On theoretical grounds our preference is not to use national dummies to control for country-specific effects (such as the temporal incidence of the economic cycle, institutional or policy differences) systematically affecting FUR growth, but to include the rate of growth of the national territories outside the areas of the major FURs. That major FURs do not exhaust national territories is thus turned to advantage, since it allows the estimation of a continuous variable ('non-FUR growth') to account for national specific factors in urban growth differentials. This is consistent with the underlying assumption in cross-sectional regression models that the observational units are representative of a homogeneous statistical population. It also has the practical advantage of avoiding having to pool FURs for those countries with only one or a very small number of major cities (such as Ireland, Denmark, Greece or Portugal).

What emerges is that our preferred variable not only statistically dominates national dummies but, once included, renders the initial level of FUR GDP p.c. non-significant and the parameter estimate unstable. If both the initial level of FUR GDP p.c. and non-FUR growth are included as additional independent variables of interest, in some models apparently (non-significant) convergence emerges; in others non-significant divergence emerges. Clearly including both the initial level of FUR GDP p.c. and the non-FUR growth variables introduces collinearity. The remedy for problems of collinearity, if additional observations are not available, is to exclude the least satisfactory variable associated with the problem. Since we have both theoretical and empirical reasons for excluding it, therefore, we exclude the initial level of FUR GDP p.c. This is consistent with our aim which is to understand more fully drivers of urban growth differentials rather than to investigate β-convergence which we consider theoretically unsatisfactory anyway. Our underlying view is that regional growth differences are multivariate: the impact of some drivers is towards convergence (e.g. factor mobility in sectors without economies of scale) while the impact of others is towards divergence (e.g. those involving agglomeration or economies of scale) and which of the convergence/divergence effects dominates in any particular time period is an empirical issue.

We are interested in testing theoretically derived ideas about urban growth. For this we have three groups of variables; two of these were tested in an earlier paper (Cheshire and Magrini, 2000) but now more rigorously. The first group relates to the systematic spatial effects of European integration on urban growth. Concern about these goes back at least to Clark *et al*. (1969) and it is interesting to use as an independent variable the quantitative measures actually predicted by Clark before the impact of European integration was significantly felt. Theoretical developments of New Economic Geography (summarised in Fujita *et al*. 1999) have given a significant boost to interest in this potential source of differential urban growth. In addition to the variable measuring Clark *et al*'s (1969) change in regional economic potential, associated with EU integration, we now introduce a 'peripherality' dummy, exploiting the insights gained testing for spatial dependence.

The second group of variables we are interested in attempts to capture the role of R&D and highly skilled human capital in urban growth processes. It is admittedly a crude test but does show whether the evidence is or is not consistent with a spatialised adaptation of endogenous growth theory (see, for example, Cheshire, 1995 or Magrini, 1998). In the revised data set used here we have new measures which prove slightly more significant and illuminating than results reported previously.

The third area is entirely new; this is the relationship between systems of local and regional government and city growth performance. This relates to the wider issue of the provision of local public goods when there is also the possibility of what might be called an 'anti-Tiebout' world (Tiebout, 1956) with jurisdictional public good spillovers and geographically immobile people. In such circumstances, optimality may depend also on how jurisdictions are bounded. Local economic growth policies aim to increase the rate of economic growth of the territory/jurisdiction to which they are applied. If we suspend our disbelief and assume such policies might influence growth rates – abstracting for the moment from what form such policies might take – then it is clear that local policy makers would be producing a local quasi-public good. So, the relevant issue is what factors favour the formation of more effective growth promotion 'clubs'? The hypothesis advanced in Cheshire and Gordon (1996) was that such 'clubs' would be more likely to develop and be more strategically effective if the administrative boundaries of the jurisdiction more closely corresponded to those of the functional economic region.

The logic underlying this was that the more closely these boundaries coincided, the smaller would be spillover losses of growth gains to agents in surrounding jurisdictions and the lower would be the transactions costs of forming a 'growth promotion club' because there would be fewer public sector agencies involved and a more obvious and powerful leading agency.

Since our FURs are designed to maximise self-containment[3], they correspond to 'functional economic regions' and we are able, in effect, to test one of the basic propositions of fiscal federalism: that 'the existence and magnitude of spillover effects clearly depends on the geographical extent of the relevant jurisdiction' (Oates, 1999, page 1130). To test this we include as an independent variable a measure of the extent to which the two sets of boundaries coincide for each FUR. If local growth promotion policies have any positive effect then the expectation is that the more closely the two boundaries coincide the faster a FUR's growth rate will be – other things equal.

Since we are analysing urban growth in a cross sectional model, we expect interactions between the growth performance of neighbouring cities. We have, therefore, paid particular attention to issues of spatial dependence. Contrary to the more orthodox spatial dependence literature (see, for example, Rey and Montouri, 1999 or Florax *et al*., 2003), we view indicated problems of spatial dependence as signs of omitted variable(s). If there is a problem of spatial dependence the model does not include variable(s) reflecting mechanisms that cause economic conditions in one FUR systematically to influence developments in its neighbours. If these variables are not included, therefore, not only may parameter estimates be inconsistent (although there are econometric fixes available) but it should prompt researchers to find suitable (spatial) variables reflecting the mechanisms giving rise to the spatial dependence.

Both theory and empirical evidence suggest that there are important spatial adjustment mechanisms and other spatially determined features of urban and regional economies. For example, labour markets and housing markets adjust to price and real wage differences in ways conditioned on measures of

---

[3] As noted they are defined so as to include significant geographical concentrations of jobs and all residents who commute to that employment centre. Thus in the short term all residents within a given FUR will benefit from employment or income growth within it; and the boundaries of the FUR will include the great majority of potential beneficiaries from growth. This is a 'short term' view and excludes induced migration in response to changing employment prospects or wages and also excludes trade and capital flows. Arguably growth promotion agencies are motivated by short run factors ('a week is a long time in politics'); certainly results in the conceptual short run are likely to be extremely influential. But since no data are available for sub national trade or capital flows, from a practical point of view it is reasonable to argue that FURs are the closest spatial units to self-contained economic regions one can construct a data set for and are the most economically self-contained subdivisions of national territories which exist.

accessibility. Both migration and commuting patterns are known to respond to spatial differences in economic opportunities – whether of incomes or house prices – but the impact of a given differential in economic opportunities declines as accessibility falls. Theoretical and empirical investigations of agglomeration economies, human capital and innovation suggest there are important spatial aspects of these, too. These are all possible sources of spatial interaction between cities' economies and, if omitted, they should plausibly cause spatial dependence.

Our results provide strong supporting evidence for this view. Models without variables reflecting spatial adjustment processes display significant problems of spatial dependence. However, when we include appropriate variables, discounted by distance between cities, these are statistically significant and indications of spatial dependence are eliminated.

In addition, the sensitivity of our models to measures of spatial dependence varies with the particular distance weights used. We interpret this, too, as providing insight into economic processes. We systematically experiment with distance weights including 'distance' penalties for national borders. These experiments confirm that problems of spatial dependence only reveal themselves if an additional distance penalty to adjustment between neighbouring FURs is included for national borders, and that this seems to be optimised, in some sense, if the penalty is set at 600 minutes. This, we judge, reinforces our earlier conclusion that urban systems in Western Europe still mainly adjust as a set of national urban systems rather than as a unified EU urban system. European economic space is not a single integrated network of cities.

3. The data and methods

The basic method for defining the Functional Urban Regions analysed in this paper was to identify spatial units where there were at least 20 000 jobs and add to these all contiguous spatial units with a job density exceeding 12.35 jobs per hectare. These then define the 'city-cores' and for each of these, hinterlands were defined from which more commuters flowed to the core than to any other, subject to a minimum cut off level of commuting. They were defined on 1971 employment and commuting data[4]

[4] There are arguments both for and against using fixed boundaries. An argument against is that actual boundaries change over time as the location of employment and people changes. The impact of such changes has been investigated for a subset of 25 FURs in the course of an INTERREG IIB Project (GEMACA, 2003). Details are available from the authors but the range of changes in total population estimates for 1991 using first boundaries defined on 1971 employment and commuting then boundaries defined on 1991 data was mainly from 5 to 10 percent. London was an outlier with population some 35 percent greater on its 1991 patterns of employment location and commuting. Changes in estimated employment were always considerably smaller than for population. In practical terms we can anyway do no better than

and as noted above are broadly similar to the Core Based Areas used in the US although FUR hinterlands tend to be extensive where there are no competing employment centres (examples are Lisbon or Dublin). FURs thus correspond to the economic spheres of influence of significant employment concentrations. Here we are only analysing data for the largest FURs – those with a population of a third of a million in 1981 and a core exceeding 200 000 at some date since 1951. The unification of Germany means that comparable data for the current FUR of Berlin are only available since 1990. So Berlin and the FURs of the former GDR are excluded. This leaves a total of 121 FURs.

Apart from the advantage of being economically self-contained, the great variability in the relationship between administrative and economic boundaries of European cities and regions introduces serious error and potential bias into data reported for administrative boundaries. The EU's Nomenclature des Unités Territoriales Statistiques (NUTS) regions are a nesting set which tries to reconcile different national territorial divisions. The largest are Level 1 regions; the smallest with reasonable data availability are Level 3. The size of these NUTS regions – even within the same 'Level' and country – is highly variable. A further problem is that no 'Level' is represented in every country: in many they exist only for statistical reporting. Thus, the most widely used regions – Level 2 – do not exist in Germany or the UK. Particularly in Germany, this presents serious data problems because the Level 1 regions, corresponding to the Länder, have considerable independence and their own statistical services. In addition, Germany has not had a population census since 1987 and uses its own labour market regions for most labour market data[5].

One of the variables most subject to distortion using NUTS boundaries is GDP p.c. because GDP is estimated at workplaces while people are counted where they live. Because people commute to work across administrative boundaries, this means GDP p.c. is systematically overestimated for regions where the administrative boundaries exclude significant dormitory areas. In reality, this happens for a large number of bigger European cities (Madrid and Paris are two exceptions if we take the Level 1 regions which contain them), so official figures tend to systematically overstate GDP p.c. for large cities. At last, this distortion of GDP p.c. data has been recognised by Eurostat (Eurostat, 2005). Following the 1998 split of Greater London into two official regions[6] – Inner and Outer London – the absurdity of the resulting GDP p.c. measures – with Inner London having a reported per capita GDP 3.15 times the EU

---

use the fixed if obsolescent boundaries.

[5] Since 1999 a uniform statistical system for German Kreise – Level 3 regions – has been established, INKPAR, but this is too recent for our purposes.

[6] The FUR of London used here was nearly 30% larger in population terms than the NUTS Level 1 region of Greater London.

mean – became too great to continue to ignore.

The FUR and NUTS region of Bremen provide an extreme example of how this distorts measured growth rates as well as levels of GDP p.c. as, over time, people move relative to jobs. Because of strong population decentralisation over the period, the growth of GDP p.c. is overstated by some 40% for the 1980s if the Eurostat data for the NUTS Level 1 region identified as Bremen are relied on.

The variables used are identified in Table 1. All variables are scaled so that estimated parameter variables are of similar orders of magnitude to help presentation. Appendix Table 1 gives more detail, including the sources used and descriptive statistics.

FUR growth in real GDP p.c. is estimated from common PPS values of GDP p.c. for Eurostat Level 3 regions. We estimate GDP p.c. for FURs using the proportionate distribution of FUR population between Level 3 regions at the closest practical dates and applying these as weights to the relevant Level 3 GDP p.c.[7] To minimise the effects of measurement error, we take the start and end points of the series as the means for the first and last three years. Regional GDP data have been published for most Level 1, 2 and 3 regions since 1978 although there is fragmentary earlier data. There are, however, gaps even since 1978 – data for Greek and Portuguese regions, for example, did not become available until the mid-1980s. In both cases, Eurostat data have been supplemented with national data. For some countries – Italy for example – data for earlier years were only published for Level 2 regions. National sources of value added for smaller spatial units have been used as necessary to disaggregate from Level 2.

The end point of our GDP series is 1994. Eurostat substantially revised the basis on which regional GDP was estimated in 1995. It switched from a 1979 base for disaggregating national data (ESA79) to (ESA95). For the overlap year the differences between the two sets of values are remarkable – not even country totals coincide. Although some claim to bridge this discontinuity in regional GDP data, we have not been able to do so to our satisfaction. So, our analysis finishes in 1994. We are thus analysing a

[7] To illustrate this process of estimation with the example of Bremen: the population of our FUR was divided between seven NUTS 3 regions for which we had Eurostat GDP p.c. data. In 1991, the proportionate distribution of Bremen's population between these NUTS regions was 0.4345, 0.1508, 0.1128, 0.0942, 0.0767, 0.0713 and 0.0597. These proportions were applied as weights to each of the seven NUTS regions' GDP p.c. to estimate the value of GDP p.c. for the FUR of Bremen. We also have the proportionate distribution of FUR populations between NUTS 3 regions as at 1981. The FUR data for any year were estimated using population weights calculated from national population censuses or registration data closest in time to that for which the Level 3 regions' data (e.g. GDP p.c.) related.

period – 1978-80 to 1992-94 – too short to correspond to a conceptual long run. This further reinforces our belief that we need to model a system in which real incomes can permanently (in the sense of any period we can observe) vary between cities.

All data are defined to common statistical concepts either weighting Eurostat data to estimate values for FURs (as with GDP p.c.) or collecting data directly from national statistical offices or common data providers and adjusting where necessary to common definitions. There is necessarily imprecision where we use estimated data but they have the merit of relating to functionally defined, economically self-contained city-regions. The FURs, all being large metropolitan regions, are also substantially more homogenous than either NUTS regions or countries. This is econometrically helpful and since they do not exhaust national territories we can calculate the rate of GDP p.c. growth in the area of each country outside its major city-regions; as discussed above, this variable is 'non-FUR growth'. This is a continuous variable and is a more elegant and useful control than national dummies for national specific drivers of urban growth differentials. It is also consistent with our implicit claim that our observations – all the large city-regions of the EU of 12 – represent, in a statistical sense, a homogeneous population.

The analysis employs OLS but we test the results exhaustively for econometric problems. Since the observations represent the population of West European city-regions, the force of the standard objections to the use of cross sectional OLS for inference seem to be substantially mitigated. Compared to cross country 'growth regressions', our observations represent a relatively homogeneous population and data are more comparable. Our choice of spatial units should reduce or eliminate systematic spatial error in the data, or 'nuisance' spatial dependence as Anselin and Rey called it (Anselin and Rey, 1991), and we make a strong effort to formulate variables to reflect causal mechanisms and minimise problems of endogeneity. As with all applied econometrics, however, in the end the credibility of the results is not a categorical issue but depends on judgement. We are convinced multicollinearity is not a significant problem and judge that this is also true with respect to endogeneity. But proving endogeneity is neither present nor seriously distorting results is ultimately proving a negative and that is difficult. We necessarily make compromises but believe that the departure from the ideal conditions is not so great that the results are spurious for purposes of inference.

4. Results

4.1 The base model

As discussed above, our approach to testing the hypotheses relating to the role of European integration, human capital and R&D and arrangements for local government builds on previous work (Cheshire and Magrini, 2000). As the first step in our more elaborate strategy to investigate growth drivers we first find a ‘base model’ (see Table 2) and test the resulting model for a range of econometric problems, including spatial dependence. Such tests show that while traditional standards for normality, functional form and heterskedasticity are satisfied, if the spatial weights matrix is formulated in an economically meaningful way (with an added time-distance penalty for national frontiers) there are indicated problems of spatial dependence which can be eliminated, without affecting the significance of other variables, by including a spatial lag of the dependent variable. In a conventional spatial econometrics framework such a result might have been considered satisfactory but we interpret the indications of spatial dependence as implying that variables related to systematic spatial patterns of growth have been omitted.

Since the aim is to understand the drivers of differential patterns of spatial growth better we include the variables designed to test the three hypotheses (Table 3) in the base model. Again exhaustive experimentation with the spatial weights matrix suggests there are some problems of spatial dependence (Table 4). Instead of simply re-estimating with a spatial lagged model and stopping the investigation at this point, however, we include variables to reflect known information on drivers of differential spatial patterns of growth in the EU and on plausible spatial adjustment processes. Such variables are statistically significant when included and eliminate all problems of spatial dependence without changing other estimates.

This section explains the structure of the models and the reasons for variable inclusion. We try to make it self-contained but not too repetitive of previous published work. We concentrate on the results for the new variables and the impact of spatial dependence. In all models, the dependent variable was the annualised rate of growth of FUR GDP p.c. at PPS from the mean of 1978//80 to 1992/4. The ‘base model’ includes a set of control variables and the non-FUR growth variable discussed above. As in previous work the controls for industrial structure relate to measures of old resource-based industries – agriculture, coal mining and ports. These not only work better in statistical terms than broader measures of specialisation in manufacturing industry but, make better sense in economic terms and minimise problems of endogeneity. Past dependence on the coal industry is measured by the geological presence of coal measures, so should avoid any hint of endogeneity, and specialisation in agriculture and the port industry are both measured well before the start of the period to which the dependent variable relates.

Other controls are designed to reflect underlying (urban) economic theory and evidence. The log of population size is included with the expectation that larger cities would have grown faster because of productivity gains in larger urban areas (see Costa and Kahn, 2000 for a convincing account of at least one potential source for such gains). Dynamic agglomeration economies are another possible explanation. Theory tells us that in an unregulated and unconstrained world, population density would be a positive function of city size. Indeed population or employment density have been used in the literature as variables to proxy for potential agglomeration economies. But there are severe regulatory constraints applied in Europe influencing population density independently of city size. Rigid urban containment policies have, for example, been applied in the UK since 1947 and other countries, such as the Netherlands, have policies for 'urban densification'. So initial population density was included to capture such impacts. Once agglomeration economies are controlled for with city size, cities with higher density will have higher costs of space and greater congestion. A negative relationship is expected. In our judgement, the main source of variation in initial population density is likely to be differences in the constraint on urban land supply variations in land use regulation impose. Higher density, other things equal, signals a tighter constraint imposed on development. Topography and the inertia of inheritance embodied in the built environment no doubt contribute to differences in densities but probably less than land use policy which varies substantially both across countries and between cities (for recent evidence, see Cheshire and Hilber, 2008).

The results for the base models are shown in Tables 2a & b which also report diagnostic statistics. All variables are significant and have the expected sign and the adjusted R^2 is 0.56. Test statistics for the OLS model are generally satisfactory except those for spatial dependence. Table 2b reports the results of including a spatial lag. The results are effectively unchanged except that test results for spatial dependence are now satisfactory.

4.2 Testing Hypotheses

We then include independent variables designed to test our hypotheses. The theoretical reasons for expecting a concentration of R&D activity and highly skilled human capital to have a positive impact on local economic growth follow the analysis of Romer (1990) adapted to a spatial context (see Magrini, 1998). An extensive literature on the role of human capital in economic growth and the tendency for innovation to be localised with respect to R&D has developed over the past ten years, so little justification seems necessary. They are reflected here by two variables. One used in previous work is the concentration of the R&D facilities of large companies relative to population in each FUR. For some recent evidence on the spatial diffusion of innovation see Barrios *et al*, 2007. The second is a new variable, university students per employee. Both these variables are measured for the start of the period to minimise problems of endogeneity.

Our next hypothesis is that there is a relationship between systems of city government and city growth performance: specifically that the more closely the administrative and functional boundaries of a city-region correspond, the more likely it will be that effective local growth promotion policies develop. We conceive of 'growth promotion policies' in a much broader sense than as policies just designed to attract mobile investment. We would count as growth promotion policies: efficient public administration, reducing uncertainty and making decisions transparently and quickly; providing relevant infrastructure; more effective co-ordination between public and private investment; providing relevant and effective training; and ensuring that land use policies are flexible and co-ordinated with infrastructure provision and the demands of private sector investors. They could also involve giving a higher priority to output and productivity growth compared to equity or environmental outcomes.

More effective local growth promotion policies may not involve spending more, even on infrastructure, so a simple measure of local public expenditure is unlikely to capture the efficacy of growth promotion efforts even were such a variable available. Grand projects such as Bilbao's Guggenheim museum, London's Millennium Dome or a trophy metro system in Toulouse, are expensive but not necessarily productive; efficient public administration and rapid public decision-making, clearly defined land use policies and infrastructure planning, may cost less than their inefficient alternatives.

Any 'output' of such policies – extra growth – is a local quasi-public good. It will be hard to exclude non-contributing agents from any benefits policies generate: if policies paid for and implemented by the central city of a FUR increase output growth in its territory, it will be impossible to exclude commuters from surrounding jurisdictions from sharing the benefits, even though they pay no taxes within the central city. There will also be a zero opportunity cost in 'consumption' of any dividends the policy yields: if your rents rise, so do mine and that is not a cost to me; if your employment opportunities improve that, too, is not a cost to mine. There is thus a classic problem of market failure so local growth promotion polices will be likely to be produced by government or some 'club' of actors, usually local and regional governments and private sector agencies in a public-private partnership. Such clubs face varying problems of spillover losses and transaction costs. A proportion of the growth gains will leak out to agencies or residents of surrounding jurisdictions who are not members of the 'growth promotion club'. The relative size of such 'leaks' will vary with the size of the area the 'club' represents relative to that of the whole FUR (which, as discussed, maximises the proportion of the benefits retained). The closer the coincidence in the boundaries of the governmental unit within which such policies are pursued with those of the economic region/FUR within which their impact is largely contained, the proportionately less will be these spillovers. In addition, the larger is the central unit of government relative to the size of the self-contained FUR, the lower are likely to be the transactions costs in building a 'growth promotion' club[8].

Any FUR is composed of one or more jurisdictions so a 'club' of jurisdictions (also usually including private sector actors) will have to be formed to implement growth promotion policies: in essence that is what regional development agencies are. If a 'club' forms it is reasonable to assume that the largest jurisdiction within the FUR will always be a member. In our data set the largest jurisdiction in all FURs represents the historically oldest and central jurisdiction of the core or, in some cases, the whole core city. The larger this is relative to the other jurisdictions within the FUR, the more dominant it is likely to be and the more clout it will have; so the larger is the central jurisdiction relative to the FUR as a whole, the lower are transactions costs likely to be. Whether an effective growth promotion club is formed for a city-region is not, therefore, inevitable but will be conditioned primarily on the structure of the incentives faced by these governmental and other economic actors who might form a 'growth promotion club'.

Even if expenditures are very imperfectly related to outcomes, growth promotion policies cost resources and there will be transactions costs in forming and maintaining an effective club. The expected growth gains any club might achieve will vary with local circumstances and existing policies. The club's expected gross payoff will be a direct function of the additional growth that a given club expects it can generate. Since a FUR's boundaries contain the maximum proportion of such benefits as might be generated by local growth promotion policies, for a given potential gross growth gain, the expected payoff for any growth club will fall as the size of its jurisdiction/territory falls in relation to that of the relevant FUR because the spillover losses to areas of the FUR not represented in the club increase. Equally, assuming other factors are constant, the expected net payoff would fall as the transactions costs incurred to form the club increase. Transactions costs will be positively related to the number of relevant potential members and the institutional dominance of the lead actor (which we can assume will be a governmental unit). Thus other things equal, expected net benefits will increase and transactions costs fall as the size of the largest effective governmental unit increases relative to the size of the FUR.

Arguments such as these led Cheshire and Gordon (1996, page 389) to conclude that growth promotion policies would be more likely to appear and be more energetically pursued where 'there are a smaller

[8] This may be somewhat simplified. There may be political or cultural links between some cities which are strong enough to lend some sense of joint enterprise to development efforts. Glaswegians may be happier with the thought of residents of Edinburgh sharing in their growth gains than might be the case, for example, between the citizens of Brussels and Antwerp. But even to the extent that this is true it might be regarded simply as statistically random noise and so not bias our proposed measure.

number of public agencies representing the functional economic region, with the boundaries of the highest tier authority approximating to those of the region…'.

We can specify a variable closely reflecting this feature of FURs: the ratio of the total population of the largest (relevant) jurisdiction representing the FUR to the population of the FUR as a whole. This will normally be the jurisdiction with the largest population, representing the central administrative unit of the FUR, but this is qualified by 'relevant': the jurisdiction must have significant powers of action. Given the abolition of the Greater London Council in mid-period, the largest NUTS region with a territory overlapping that of the London FUR during the period of our analysis was the South East Region. But this was not a 'relevant' jurisdiction because it had essentially no powers[9]. The rules by which such 'relevant' local government units were identified were established before any models were estimated so that the variable could be defined blind of the data. These rules are set out in Appendix 1 and necessarily varied from country to country since the powers and structure of local governments vary widely across the EU.

We call this the 'policy incentive' variable because it is designed to measure the incentive to implement policies promoting growth at the FUR level. Since one criterion used to select the 'relevant' governmental unit for each FUR was that it should have significant administrative and decision making powers, the Level 1 regions were potentially available for selection in countries with a regional level of government. In practice, this meant that the value of the variable could range from only about 0.125 (in France) to over 2 (in Spain). We might further hypothesise that if the value of the variable were very high, so that the size of the 'relevant' unit of government substantially exceeded the size of the FUR, then the incentive to generate growth promoting policies for the FUR might weaken. The interests of the FUR would begin to be lost in those of the larger unit which might favour rural areas or smaller centres. As an illustration one might contrast Madrid, where the boundaries of the powerful regional government are only a little larger than those of the FUR with Aviles/Gijon in Asturias. There the region is very much bigger than the FUR of Aviles/Gijon and contains the smaller independent FUR of Oviedo. Oviedo is not large enough to be in our data set but is the regional centre of government for Asturias. Thus the growth policies of Aviles/Gijon might actually suffer from the much larger size of the regional jurisdiction containing it. This would imply a quadratic functional form with a maximum positive impact for the policy incentive variable where the value was between 1 and 2.

---

[9] During the period analysed there was a South East Regional Planning Council (SERPLAN) but this was effectively no more than a forum for discussion.

Table 3 shows the results of adding variables to our 'base' model. Model 2 is directly comparable with the OLS model reported in Table 2a but includes the additional variables to test the hypotheses described above. The policy incentive variable is included in quadratic form but although the variable is significant the squared term is not. The variables measuring R&D activity and highly skilled human capital are highly significant and the overall adjusted R^2 rises from 0.56 to 0.64. Full results of other models (for example, including the policy incentive in linear form and/or a spatial lag) are available from the authors but the essential results are unchanged.

Table 4 gives test statistics, including tests for spatial dependence. Two significant points emerge. The first is that there are no signs of classic econometric problems – multicollinearity, heteroskedasticity or non-normality of errors. Spatial dependence is a potential problem, however. As is well known, a key issue in testing for spatial dependence is the specification of the 'proximity' of one observation to another. There is no *a priori* basis for selecting distance weights. As is often the reality with applied work, insight and experimentation are complementary. Our insight grew with experiment and tests were conducted using 28 different distance weight matrices, applying all the distance measures found in the literature, including contiguity, crow-fly distance and road distance, in various formulations. Here, we report only the results for distance measures which seem most reasonably to represent underlying spatial processes and which also induced the most measured sensitivity to spatial dependence.

Test statistic values for spatial dependence were highly sensitive to how distance was measured. We could easily 'eliminate' indications of spatial dependence by just choosing a suitable measure of 'proximity'. This, in itself, should be a warning but it suggested that a useful indicator of how to test for spatial dependence most rigorously was that the proximity measure made economic sense and indicated the greatest problems, or most frequently indicated problems, of spatial dependence. Happily, measuring distance as the inverse of time-distance between FURs, using the standard road freight software, including ferry crossings, not only seems to represent 'proximity' in an economically meaningful way but also always provided the greatest measured sensitivity to spatial dependence. Table 4 reports results for two formulations – the inverse of time-distance and the inverse of time-distance squared.

From the bottom panel of Table 4, relating to Model 2, we find only minor indications of spatial dependence. Results for our preferred measure of proximity are perfectly acceptable for two recommended test statistics, LM (error) and LM (lag), although the value of the Moran's I is suspect at

10 percent. Cheshire and Magrini (2006) found that there was quality of life associated adjustment within but not between countries. The implication was that national borders represented substantial barriers to spatial adjustment. This prompted us to include in the spatial weights matrix an additional 'time-distance penalty' for national borders. Here we have systematically tested border time-distance penalties from zero to infinity. The results were generally most sensitive to spatial dependence if national borders were represented as an additional time-distance of 600 minutes. The test statistics for Model 2 illustrate this clearly. With that time penalty added to the distance weights matrix the key test statistics for spatial dependence are significant. If an infinite time-distance penalty is imposed for national borders then implied problems of spatial dependence are reduced. This implies that if 'distance' between FURs is represented in the most economically meaningful way, Model 2 really embodies problems of spatial dependence.

We interpret these test results as indicating an underlying problem of omitted variables. We should not expect the growth behaviour of a FUR to be independent of its neighbours; nor should we be surprised to discover that there are systematic differences in urban growth performance resulting from location.

Our final set of variables is designed to test these explanations and further illuminate the drivers of differential urban economic growth rates. It has long been argued that location within Europe should have systematic effects on patterns of spatial growth. From at least the contribution of Clark *et al*. (1969) there has been a powerful argument that the process of European integration systematically favoured 'core regions' – those gaining most in terms of economic accessibility, the more centrally located. This provided the intellectual support for EU policies to reduce spatial disparities and develop stronger instruments of regional development as a complement to steps towards integration. More recently, 'New Economic Geography' has produced formal models with essentially the same conclusions (see Fujita *et al.,* 1999, for a survey).

An early empirical attempt to estimate the spatial economic effects of European integration was the influential work of Clark *et al*. (1969). Using GDP data they estimated themselves for all regions for the years 1960-64, Clarke *et al* (1969) estimated regional 'economic potential'[10] for the six original members of the EEC and the then four candidate members, for three alternative states of the world: with tariffs at pre-Treaty of Rome levels; with all 10 countries having no tariffs on manufactures; and with no tariffs and two transport improvements – containerisation and roll-on roll-off ferries. Thus the change in

[10] The concept of 'economic potential' is an old measure dating from the work of Harris (1954) and measures the accessibility to income (in Clark *et al*. measured as total GDP) at every point in space allowing for full costs of transport including, where appropriate, tariffs.

economic potential for each region associated with the reduction of trade and transport costs to be brought about by European integration and anticipated technical progress provided a measure of these systematic spatial economic impacts. The 'integration gain' variable used here is taken directly from Clark *et al*s' values, supplemented with the estimates for the regions of Spain and Portugal provided by Keeble *et al*. (1988), scaled to Clark *et al*s' values. Values for Athens, Lisbon, Porto and Saliniki were interpolated to provide coverage of all the major FURs of the EU of 12. Since our interest is in *growth*, we use the *change* in the values of 'economic potential' from the pre-Treaty of Rome values to those estimated as being associated with an elimination of tariffs, the EU's enlargement of the 1980s and a reduction in transport costs following the introduction of roll-on roll-off ferries and containerisation. The theoretical arguments as to why integration should favour core regions do not imply that the relationship measured for the 1980s or the 1990s should necessarily be linear but experimentation suggested the linear form reported here performed best in statistical terms.

As an additional variable to account for systematic spatial patterns in growth we include a straightforward dummy for peripherality. There has been much discussion in the literature of the impact of peripherality. The 'integration gain' variable already accounts for the systematic effects of European integration but peripheral regions may have common features (such as lower factor costs, for example). More obviously, they have been recipients of regional aid from the EU. Although the impact of such aid has been questioned (Midelfart and Overman, 2002, or Rodriguez-Pose and Fratesi, 2004) still it is unlikely to have been systematically negative. To avoid subjective judgements about what regions are – or are not – peripheral, this is formulated simply in terms of time-distance from Brussels: any FUR 600 minutes or more from Brussels is classified as peripheral.

Models 3 and 4 (see Table 3) include these variables. It will be seen that both are significant. There is an apparent systematic integration gain effect. Perhaps more interesting is the fact that the peripherality dummy is not only significant but also positively signed. Offsetting for all other variables, including the direct effects of 'integration gain', FURs more than 600 minutes from Brussels experienced faster growth in GDP p.c. than those nearer. Neither of these variables raises any significant endogeneity concerns.

Models 3 and 4 also include three variables (plus an additional control for the initial level of unemployment[11]) designed to reflect more localised spatial patterns of urban growth resulting from the

[11] The impact of this control variable is modest and has no significant effect on the estimated value of other coefficients.

influence of conditions in one city on the growth performance of its neighbour(s). Systematic interactions between FURs' growth rates should decline with distance between them. In regions of dense urbanisation, such as the German Ruhr, Benelux countries, the British midlands or northern Italy, one would expect the economic development of urban regions to be highly interdependent. The most obvious reason is the literature on labour market search behaviour and vacancy chains. If productivity, wages or job opportunities are relatively improving in one FUR, then economically active non-residents who can access those opportunities at the lowest cost – who live nearest – will tend to do so. Migration is expensive but changes in commuting patterns respond to only small differences in opportunities (Gordon and Lamont, 1982 or Morrison, 2006). These variables are all measured as densities across the set of neighbouring FURs. In calculating the value of each density variable for any FUR_i the weight attached to the value of the variable in surrounding FUR_{j-n} is discounted by the inverse of time-distance (with the same 600 minute time-distance penalty for national borders as maximised the value of spatial dependence and an upper limit on time-distance to identify the members off the set FUR_{j-n}). This upper limit was determined for each density variable by experiment but the results seem reasonable in terms of economic behaviour. In all cases, the selected cut-offs worked best in an empirical sense: in the case of formulating the distance weights matrix to test for spatial dependence, they tended to produce the greatest sensitivity to tests; in formulating the density variables to represent spatial adjustment processes, they produced the best results, both in terms of significance and eliminating indications of spatial dependence.

The first is the spatial density of unemployment. If a FUR's growth rate is negatively influenced by a concentration of unemployment in it at the start of the period, then a concentration of unemployment in closely surrounding FURs should also have a negative impact. Given the possibility of job search in surrounding areas we would expect higher unemployment not to be just localised, moreover, but if neighbouring FUR labour markets are accessible, we would expect unemployment rates for workers of comparable skills to even out over the set of neighbouring FURs. Since job search areas and commuting distances of the less skilled (over-represented among the unemployed) are relatively shorter, we should also expect the influence of localised unemployment to be relatively short range and experiment showed the best results were obtained applying a two hour time-distance to identify 'neighbouring' FURs.

As with job search, the literature on the spatial pattern of innovation shows a distance decay effect, with patents tending to be applied more frequently nearer to their point of origin. So, the impact of R&D with respect to innovation is likely not to be purely localised but to be subject to a distance decay effect (Audretsch, 1998; Barrios *et al*, 2007). So R&D in one urban area should have some positive differential impact on innovation and growth in neighbouring urban areas but that effect would diminish with distance. An upper time-distance of 2.5 hours between FUR centroids to identify ‘neighbouring’ FURs worked best. This gives us our second spatial adjustment variable.

The third of these variables is the relative concentration of university students in neighbouring FURs at the start of the period. An initially higher stock of university students within a given FUR directly increases its growth performance (captured in our ‘University Student’ variable). Furthermore, this additional growth will increase relative job opportunities and tend to suck in complementary labour, including high human capital labour, from surrounding FURs. Consequently, we expect a negative impact on growth in a particular FUR of a stronger relative concentration of university students at the start of the period in neighbouring FURs; moreover, we also expect the distance over which such an effect would be measured to be longer than with unemployment. As with the spatial effects of R&D concentration, the best results were obtained if the cut off was set at 2.5 hours, to which was again added a 600-minute national border time-distance penalty.

The results of including these variables to reflect systematic spatial patterns in FUR growth and spatial adjustment mechanisms between neighbouring FURs are set out in the final two columns of Table 3, with the relevant diagnostic statistics in Table 4. The results for our ‘policy incentive’ variable are significant although the squared term is still not well defined - only significant at 10 percent. Nevertheless, an F test shows that a quadratic functional form is significantly better at the 5 percent level. All other variables are significant at 5 percent and have the expected signs.

The regression diagnostics indicate that there are none of the common econometric problems of cross sectional models. More interestingly, including the spatial variables eliminates any sign of spatial dependence. This supports our view that finding spatial dependence frequently derives from omitting variables. We have formulated variables designed to measure factors leading to systematic spatial patterns in growth performance and interaction between neighbouring FURs and they are not only statistically significant but eliminate all indications of spatial dependence. This suggests we should now not only have consistent parameter estimates but better analytical insight into the drivers of urban economic growth including how mechanisms of spatial adjustment modify growth performance in areas of denser urbanisation.

Finally Table 5 shows the impact on growth performance of a change of one standard deviation in each independent variable. Perhaps unsurprisingly the single greatest influence is the performance of the economy outside the area of the major FURs. But other variables have substantial influence particularly when taken in groups of related variables such as those reflecting concentrations of R&D and highly skilled human capital or those relating to systematic spatial patterns and spatial interactions in densely urbanised areas of Europe.

5. Conclusions

One conclusion is, therefore, that by including variables reflecting theoretically relevant spatial adjustment mechanisms it is possible effectively to eliminate problems of spatial dependence. So, a finding of spatial dependence – at least in the context of recent patterns of European urban growth – largely reflects model specification. If theoretically appropriate variables reflecting spatial processes are included, spatial dependence is eliminated. Testing for spatial dependence is itself, however, very demanding. It was only when we realised the barrier that national borders represented for labour mobility (Cheshire and Magrini, 2006) and experimented with time penalties for national borders in the distance weights matrix, that tests revealed any problems of spatial dependence in our models of GDP p.c. growth.

Models 3 and 4 should provide consistent estimates and support the interpretation that they are a sufficiently good approximation of the underlying economic processes which generated our dependent variable, FUR growth rates in real GDP p.c., to provide insight into causal processes – so we can conclude that the evidence supports the main hypotheses summarised in the introduction:

1. Local differences in human capital and R&D activity are important factors in explaining differential rates of urban economic growth;
2. European integration has had a significant impact in accelerating growth in regions gaining most in terms of economic potential – mainly ‘core’ regions – but at the same time, offsetting for all other factors including these systematic impacts of integration itself, peripheral regions, on average, grew faster relative to the rest; and
3. Administrative and government arrangements for cities systematically influence their economic growth performance. Where there is a jurisdiction approximating the boundaries of an economically self-contained city-region, growth is stronger, other things equal. This is consistent with the expectations conceptualising the promotion of growth as the provision of a local public good and the resulting advantage in forming an effective ‘growth promotion club’ of local actors since spillover losses and transactions costs are minimised.

We stress that policies encouraging local economic growth are not conceived as being just geared to inward investment nor even, necessarily, with explicitly promoting growth at all. They may consist of efficient local public administration, avoidance of waste and a focus on activities that government at an urban level can effectively influence, such as the supply of skills or infrastructure, rather than redistribution. We cannot measure these factors comparably across the urban areas of the EU as a whole. The variable used in the present paper seems justified on theoretical grounds but is an indirect measure, reflecting not the policies themselves, but the incentive and capacity to generate such policies faced by local actors. This variable is significant even in a very simple model but more fully specified models and further testing confirms its statistical significance and suggests a quadratic functional form. So, for growth promotion, the optimal size of government areas associated with city-regions is perhaps a little larger than the area covered by the functional economic boundaries.

The results also support the conclusion of Cheshire and Magrini (2006) that an assumption of 'full spatial equilibrium' is not appropriate in Europe with its geographically immobile population. Moreover it also implies it is inappropriate to argue there is one unified European urban system. National borders still represent significant obstacles. We only observe indications of spatial dependence if a substantial, 600-minute, time-distance penalty is added where FURs are separated by national boundaries. A comparable effect is revealed in specifying variables to reflect process of spatial interaction between geographically neighbouring cities. Conditions in cities geographically close to each other – common in densely urbanised Europe – do significantly influence economic growth patterns in each other: but not if they are separated by a national border. Borders seem, for example, to eliminate the tendency for innovations to be localised. The nature of our methodology, of course, does not allow us to discriminate so that is consistent with the barrier represented by a national border being greater in some contexts and less in others. The results, therefore, lend further support to the conclusion that in a European context of restricted labour mobility and continuing national border effects, income growth rather than population growth is a more appropriate indicator of welfare improvements in a city.

The empirical results also provide support for the theoretical work of Magrini (1998) on the significant role of human capital in regional economic growth. In models investigating urban population growth neither concentrations of highly skilled nor of R&D establishments had any influence (Cheshire and Magrini, 2006). As drivers of economic growth we find they are highly significant. It may be stretching our results rather far but this is consistent with self selection in migration with less productive workers more influenced by climate (not significant in explaining difference in rates of economic growth) in choosing where to live and the highly skilled by wages and employment opportunities. The results also provide indirect evidence supporting the increased importance of agglomeration economies since the late 1970s and the negative impact on economic performance of increasing urban density. There was a systematic tendency for larger cities to have a faster rate of economic growth but a negative effect –

once size and other factors were allowed for – of density. This is interesting in the debate about the sources of agglomeration economies since it implies that it is not density *per se* that is conduce to agglomeration economies but opportunities for productive interactions. While density rises with city size it is a negative since it reduces the propensity for productive interactions other things equal by raising congestion and the price of space.

The results do not identify strong policy levers with which to boost a city's rate of growth. It does not follow, for example, that if in the late 1970s every city had been endowed with the same proportion of university students per employee they would all have grown at the same rate as the actually best endowed with universities did. While these differences were one factor in explaining growth differences – and that helps understand what was going on – there is no necessary symmetry about the impact of giving all cities the same sized relative university sectors. It is probable that the unobserved characteristics of the cities with the highest ratios of university students were, and still are, different in important ways from cities with the lowest ratios; and were not independent of the concentration of universities in them. Nor is it possible to think in practical terms of providing all cities with equally high ratios of university students per employee and maintaining a constant quality of university students (and students who then disproportionately join the local labour force).

It is perhaps more plausible to think of the findings on the policy incentive variable as identifying a 'policy lever'. Local and regional government boundaries and functions could be restructured and, if an important element of the disadvantage FURs with fragmented local government structures face in effectively promoting growth, results from spillovers and transaction costs, the outcome should be more effective policies all round. A problem is that, of course, 'effective' local growth promotion policies at present, in circumstances in which not all city regions are equally well endowed with the incentive to develop them, may be significantly competitive and diversionary. Some local growth may be zero sum. The success of cities endowed with beneficial systems of government may significantly be a function of the poor performance of those less favourably placed. It does not follow that all policies designed to promote local growth are zero sum, however. It is reasonable to expect that there could be net efficiency gains for the EU's urban system as a whole if city government boundaries were aligned more closely with those reflecting economically relevant patterns of behaviour and spatial economic organisation.

This also should remind us of the limitations of the Tiebout hypothesis (1956). That is an important and influential idea but it is elaborated in a world in which local public policies have no spillovers beyond the jurisdiction in which they are implemented and people are perfectly mobile.

References

Anselin, L., Rey, S.J. (1991), Properties of tests for spatial dependence in linear regression models, *Geographical Analysis*, 23: 112-131.

Audretsch, D.B. (1998), Agglomeration and the location of innovative activity, *Oxford Review of Economic Policy*, 14: 18-29.

Barro, R.J. (1990), Government spending in a simple model of endogenous growth, *Journal of Political Economy*, 98: S103-S125.

Barro, R.J., Sala-i-Martin, X. (1991), Convergence across states and regions, *Brooking Papers on Economic Activity*, 1: 107-182.

Barro, R.J., Sala-i-Martin, X. (1992), Convergence, *Journal of Political Economy*, 100: 223-251.

Barro, R.J., Sala-i-Martin, X. (1995), *Economic Growth*, New York: McGraw-Hill.

Barrios, S., Bertinelli, L., Heinen, A., Strobl, E. (2007), Exploring the link between local and global knowledge spillovers, Working Paper 6301, MPRA.

Cheshire, P.C., Hay, D.G. (1989), *Urban Problems in Western Europe: an Economic Analysis*, Unwin Hyman: London.

Cheshire, P.C., Gordon, I.R. (1996), Territorial competition and the logic of collective (in)action, *International Journal of Urban and Regional Research*, 20: 383-399.

Cheshire P.C., Hilber, C. (2008), Office space supply restrictions in Britain: the political economy of market revenge, *Economic Journal*, 118: F185-F221.

Cheshire, P.C., Magrini, S. (2000), Endogenous processes in European regional growth: implications for convergence and policy, *Growth and Change*, 32: 455-479.

Cheshire, P.C., Magrini, S. (2006), Population growth in European cities: weather matters – but only nationally, *Regional Studies*, 40: 23-37.

Cheshire, P.C, Malecki, E.J. (2004), Growth, development and innovation: a look backward and forward, *Papers in Regional Science*, 83: 249-267.

Clark, C., Wilson, F., Bradley, J. (1969), Industrial location and economic potential in Western Europe, *Regional Studies*, 3: 197-212.

Costa, D.L., Kahn, M.E. (2000), Power couples: changes in the locational choice of the college educated, 1940-1990, *Quarterly Journal of Economics*, 115: 1287-1315.

DiPasquale, D., Wheaton, W. (1996), *Urban Economics and Real Estate Markets*, Englewood Cliffs, NJ: Prentice-Hall.

Duranton, G., Puga, D. (2005), From sectoral to functional urban specialization, *Journal of Urban Economics*, 57: 343-370.

Durlauf, S.N., Quah, D. (1999), The new empirics of economic growth, in Taylor, J.B., Woodford, M. (Eds), *Handbook of Macroeconomics*, Volume 1A. Amsterdam: North Holland.

Eurostat (2005), *News Release 47/2005*, April 7.

Florax, R.J.G.M., Folmer, H., Rey, S.J. (2003), Specification searches in spatial econometrics: the relevance of Hendry's methodology, *Regional Science and Urban Economics*, 33: 557-579.

Freeman, A. (2005), Towards a common standard. Comparing European and American cities, Economics Working Paper 13, London: GLA.

Fujita, M., Krugman, P., Venables, A. (1999), *The Spatial Economy*, Cambridge MA: MIT Press.

Glaeser, E.L., Scheinkman, J.A., Shleifer, A. (1995), Economic growth in a cross-section of cities, *Journal of Monetary Economics*, 36: 117-143.

Gordon, I., Lamont, D. (1982), A model of labour-market interdependencies in the London region, *Environment and Planning A*, 14: 238-264.

Hall, P.G., Hay, D.G. (1980), *Growth Centres in the European Urban System*, London: Heinemann Educational.

Harris, C. (1954), The market as a factor in the localisation of industry in the U.S., *Annals of the Association of American Geographers*, 44: 315-348.

Keeble, D., Offord, J., Walker, S. (1988), *Peripheral Regions in a Community of Twelve Member States*, Office of Official Publications, Luxembourg.

Kresl, P.K. (2007), *Planning Cities for the Future: The Successes and Failures of Urban Economic Strategies in Europe*, Cheltenham: Edward Elgar.

Magrini, S. (1998), Modelling regional economic growth: the role of human capital and innovation, Ph.D. Thesis, London School of Economics.

Magrini, S. (2004), Regional (di)convergence, in Henderson, V., Thisse, J.-F. (Eds), *Handbook of Regional and Urban Economics*, Volume 4. Amsterdam: North-Holland.

Midelfart, K.H., Overman, H.G. (2002), Delocation and European integration: is European structural spending justified?, *Economic Policy*, 35: 321-359.

Mills, E.S., Hamilton, B.W. (1994), *Urban Economics*, 5th Edition, New York: HarperCollins.

Morrison, P.S. (2005), Unemployment and urban labour markets, *Urban Studies*, 42: 2261-2288.

Oates, W.E. (1999), An essay on fiscal federalism, *Journal of Economic Literature*, 37: 1120-1149.

Office of Management and Budget (2000), Standards for defining metropolitan and micropolitan areas: notice. Federal Register, Volume 65, December 27.

Rappaport, J. (2007), Moving to nice weather, *Regional Science and Urban Economics*, 37: 375-398.

Rey, S.J., Montuori, B.D. (1999), US regional income convergence: a spatial economic perspective, *Regional Studies*, 33:143-156.

Roback, J. (1982), Wages, rents, and the quality of life, *Journal of Political Economy*, 90: 1257-1278.

Rodriguez-Pose, A., Fratesi, U. (2004), Between development and social policies: the impact of European structural funds in Objective 1 regions', *Regional Studies*, 38: 97-113.

Romer, P. (1990), Endogenous technological change, *Journal of Political Economy*, 98: S71-S102.

Temple, J. (1999), The new growth evidence, *Journal of Economic Literature*, 37: 112–156.

Tiebout, C. (1956), A pure theory of local expenditures, *Journal of Political Economy*, 64: 416–424.

Table 1: Variable Definitions

No	Variable Name	Description
	Constant	
1	Population Size	Population size in 1979 (natural logarithm)
2	Population Density	Density of population in FUR in 1979 (1000 inhabitants/Km^2)
3	Coalfield: core	Dummy = 1 if the core of the FUR is located within a coalfield
4	Coalfield: hinterland	Dummy = 1 if the hinterland of the FUR is located in a coalfield
5	Port Size *	Volume of port trade in 1969 (100 tons)
6	Agriculture *	Proportionate share of labour force in agriculture in surrounding NUTS 2 in 1975
7	Unemployment *	Unemployment rate (average as proportion of LF between 1977 and 1981)
8	National Non-FUR Growth	Growth of GDP p.c. in the territory of each country outside the major FURs (annualised rate between 1978/80 and 1992/94)
9	Policy Incentive *	Ratio of the population of the largest governmental unit associated with the FUR to that of the FUR in 1981
10	Integration Gain	Change in economic potential for FUR resulting from pre-Treaty of Rome EEC to post enlargement EU with reduced transport costs normalised.
11	Peripherality	Dummy = 1 if the FUR is more than 10 hours away from Brussels
12	University Students *	Ratio of university students (1977-78) to total employment (1979)
13	R&D Facilities *	R&D laboratories of Fortune 500 companies per 1000 inhabitants in 1980
14	Unemployment Density	Sum of differences between the unemployment (average as proportion of LF between 1977 and 1981) of a FUR and the rates in neighbouring FURs (within 2 hours), discounted by distance (with 10 hours time penalty for national borders)
15	University Students Density	Sum of university students per employees in neighbouring FURs (within 2.5 hours), discounted by distance (with 10 hours time penalty for national borders)
16	R&D Facilities Density	Sum of R&D laboratories per 1000 inhabitants in neighbouring FURs (within 2.5 hours), discounted by distance (with 10 hours time penalty for national borders)

Note: * denotes variables tried with a quadratic specification for reasons explained in the text: never entered as squared value alone.

Table 2a: Dependent Variable Annualised Rate of Growth of GDP p.c. Mean 1978/80 to mean 1992/4: Base Model

R^2	0.5903	
Adjusted R^2	0.5570	
LIK	485.56	
Constant	-0.0205	
t-test - prob	-2.05	0.04
National Non-FUR Growth	0.8600	
t-test - prob	8.06	0.00
Coalfield: core	-0.0054	
t-test - prob	-4.25	0.00
Coalfield: hinterland	-0.0057	
t-test - prob	-3.29	0.00
Port Size	-0.1364	
t-test - prob	-3.18	0.00
Port Size squared	0.6166	
t-test - prob	2.28	0.02
Agriculture	0.0409	
t-test - prob	2.55	0.01
Agriculture squared	-0.1125	
t-test - prob	-2.51	0.01
Population Size	0.0021	
t-test - prob	3.16	0.00
Population Density	-0.0015	
t-test - prob	-2.00	0.05

Regression Diagnostics			
Multicollinearity			
Condition Number	67.27		
Normality of Errors	DF	value	prob
Jarque-Bera	2	1.6276	0.44
Heteroskedasticity	DF	Value	Prob
Breusch-Pagan test	9	5.9155	0.75
Spatial Dependence	MI/DF	value	prob
weight matrix	600_1		
Moran's I (error)	0.0473	3.5250	0.00
Lagrange Multiplier (error)	1	3.8883	0.05
Robust LM (error)	1	0.5522	0.46
Kelejian-Robinson (error)	10	1.7005	1.00
Lagrange Multiplier (lag)	1	4.2253	0.04
Robust LM (lag)	1	0.8896	0.35
weight matrix	600_2		
Moran's I (error)	0.0954	2.2077	0.03
Lagrange Multiplier (error)	1	2.6838	0.10
Robust LM (error)	1	0.5048	0.48
Kelejian-Robinson (error)	10	1.7005	1.00
Lagrange Multiplier (lag)	1	6.9056	0.01
Robust LM (lag)	1	4.7266	0.03

Note: weight matrices are calculated as the inverse of time distance; the first 3 characters describe the size of the time penalty for national borders; the last digit reports the power of the inverse function.

Table 2b: Dependent Variable Annualised Rate of Growth of GDP p.c. Mean 1978/80 to mean 1992/4: Base Model with Spatial Lag (Maximum Likelihood estimate)

R^2	0.6053	
LIK	488.74	
Constant	-0.0240	
t-test - prob	-2.55	0.01
Spatial Lag of dep. variable	0.2648	
t-test - prob	2.61	0.01
National Non-FUR Growth	0.7119	
t-test - prob	6.24	0.00
Coalfield: core	-0.0050	
t-test - prob	-4.13	0.00
Coalfield: hinterland	-0.0054	
t-test - prob	-3.37	0.00
Port Size	-0.1416	
t-test - prob	-3.56	0.00
Port Size squared	0.6550	
t-test - prob	2.61	0.01
Agriculture	0.0254	
t-test - prob	1.67	0.10
Agriculture squared	-0.0737	
t-test - prob	-1.75	0.08
Population Size	0.0019	
t-test - prob	3.11	0.00
Population Density	-0.0015	
t-test - prob	-2.19	0.03

Regression Diagnostics			
Heteroskedasticity	DF	value	prob
Breusch-Pagan test	9	5.0579	0.83
Spatial Breusch-Pagan test	9	5.0583	0.83
Spatial Dependence	DF	value	prob
weight matrix	600_2		
Lagrange Multiplier (error)	1	1.0500	0.31

Table 3: Dependent Variable Annualised Rate of Growth of GDP p.c. Mean 1978/80 to mean 1992/4 – Models excluding and including 'Spatial Variables'

	Model 2		Model 3		Model 4	
R^2	0.6765		0.7413		0.7555	
Adjusted R^2	0.6372		0.6986		0.7095	
LIK	499.86		513.38		516.80	
Constant	-0.0320		-0.0233		-0.0261	
t-test - prob	-3.14	0.00	-3.52	0.01	-2.84	0.01
National Non-FUR Growth	0.9442		0.8975		0.9050	
t-test - prob	9.22	0.00	9.07	0.00	9.31	0.00
Coalfield: core	-0.0062		-0.0051		-0.0051	
t-test - prob	-5.18	0.00	-3.99	0.00	-4.00	0.00
Coalfield: hinterland	-0.0042		-0.0034		-0.0032	
t-test - prob	-2.61	0.01	-2.23	0.03	-2.06	0.04
Port Size	-0.1474		-0.1003		-0.0932	
t-test - prob	-3.69	0.00	-2.62	0.01	-2.46	0.02
Port Size squared	0.7634		0.4871		0.4669	
t-test - prob	3.04	0.00	2.02	0.05	1.97	0.05
Agriculture	0.0508		0.0384		0.0478	
t-test - prob	3.22	0.00	2.48	0.01	3.02	0.00
Agriculture squared	-0.1345		-0.1126		-0.1231	
t-test - prob	-3.21	0.00	-2.82	0.01	-3.12	0.00
Unemployment			-0.0332		-0.0312	
t-test - prob			-2.45	0.02	-2.29	0.02
Population Size	0.0021		0.0016		0.0016	
t-test - prob	3.53	0.00	2.90	0.00	2.87	0.01
Population Density	-0.0015		-0.0015		-0.0013	
t-test - prob	-2.25	0.03	-2.36	0.02	-2.07	0.04
Integration Gain			0.0073		0.0082	
t-test - prob			3.20	0.00	3.61	0.00
University Students	0.0309		0.0367		0.0303	
t-test - prob	2.67	0.01	3.62	0.00	2.87	0.01
R&D Facilities	0.8079		0.8947		0.8512	
t-test - prob	2.84	0.01	3.26	0.00	3.10	0.00
Policy Incentive	0.0075		0.0026		0.0086 [a]	
t-test - prob	2.24	0.03	2.45	0.02	2.49	0.01
Policy Incentive squared	-0.0021				-0.0027 [a]	
t-test - prob	-1.32	0.19			-1.72	0.09
R&D Facilities Density			0.0531		0.0703	
t-test - prob			2.19	0.03	2.70	0.01
Peripherality			0.0059		0.0054	
t-test - prob			4.51	0.00	4.10	0.00
University Students Density			-0.0025		-0.0030	
t-test - prob			-2.46	0.02	-2.93	0.00
Unemployment Density					-0.0036	
t-test - prob					-1.92	0.06

Note: [a] Test of joint significance: $\chi^2(2) = 10.4333$ (0.01).

Table 4: Regression diagnostics for spatial dependence

Regression Diagnostics	Model 2			Model 3			Model 4		
Multicollinearity									
Condition Number	80.61			98.80			100.76		
Normality of Errors	DF	value	prob	DF	value	prob	DF	value	prob
Jarque-Bera	2	3.3273	0.19	2	0.4241	0.81	2	1.3092	0.52
Heteroskedasticity	DF	value	prob	DF	value	prob	DF	value	prob
Breusch-Pagan test	13	19.3825	0.11	17	19.5586	0.30	19	20.6820	0.35
Spatial Dependence	MI/DF	value	prob	DF	value	prob	DF	value	prob
weight matrix	inf_1								
Moran's I (error)	0.0434	1.8729	0.06	-0.0579	-0.3974	0.69	-0.0486	-0.1666	0.87
Lagrange Multiplier (error)	1	0.9212	0.34	1	1.6391	0.20	1	1.1546	0.28
Lagrange Multiplier (lag)	1	6.6183	0.01	1	1.0262	0.31	1	1.3544	0.24
weight matrix	inf_2								
Moran's I (error)	0.0559	1.4068	0.16	-0.0693	-0.2919	0.77	-0.0622	-0.2051	0.84
Lagrange Multiplier (error)	1	0.6996	0.40	1	1.0746	0.30	1	0.8658	0.35
Lagrange Multiplier (lag)	1	7.1177	0.01	1	1.4014	0.24	1	1.8558	0.17
weight matrix	600_1								
Moran's I (error)	0.0303	2.8693	0.00	-0.0168	0.6264	0.53	-0.0157	0.6486	0.52
Lagrange Multiplier (error)	1	1.5984	0.21	1	0.4929	0.48	1	0.4311	0.51
Lagrange Multiplier (lag)	1	5.8394	0.02	1	0.5179	0.47	1	0.8431	0.36
weight matrix	600_2								
Moran's I (error)	0.0662	1.7888	0.07	-0.0381	0.1429	0.89	-0.0367	0.1314	0.90
Lagrange Multiplier (error)	1	1.3233	0.25	1	0.4378	0.51	1	0.4074	0.52
Lagrange Multiplier (lag)	1	7.1366	0.01	1	1.1324	0.29	1	1.4065	0.24
weight matrix	000_1								
Moran's I (error)	0.0143	2.3972	0.02	-0.0169	0.3574	0.72	-0.0160	0.3824	0.70
Lagrange Multiplier (error)	1	0.5553	0.46	1	0.7746	0.38	1	0.6966	0.40
Lagrange Multiplier (lag)	1	2.4908	0.11	1	0.0516	0.82	1	0.3381	0.56
weight matrix	000_2								
Moran's I (error)	0.0573	1.7963	0.07	-0.0291	0.1811	0.86	-0.0304	0.1068	0.91
Lagrange Multiplier (error)	1	0.0304	0.86	1	0.3489	0.55	1	0.3824	0.54
Lagrange Multiplier (lag)	1	1.5536	0.21	1	0.0370	0.85	1	0.1366	0.71

Note: weight matrices are calculated as the inverse of time distance; the first 3 characters describe the size of the time penalty for national borders; the last digit reports the power of the inverse function.

Table 5: Growth Impact: effect on predicted growth of a change (+ or - 1sd) of an independent variable

	GROWTH IMPACT Model 4	
	+ 1 std	**- 1 std**
Population Size	1.81%	-1.81%
Population Density	-1.34%	1.34%
Coalfield: core	-3.06%	3.06%
Coalfield: hinterland	-1.29%	1.29%
Port Size *	-2.68%	3.40%
Agriculture *	3.74%	-5.57%
Unemployment	-1.70%	1.70%
National Non-FUR Growth	6.18%	-6.18%
Policy Incentive *	2.24%	-2.24%
Integration Gain	2.97%	-4.13%
Peripherality	2.91%	-2.91%
University Students	3.36%	-3.36%
R&D Facilities	1.92%	-1.92%
Unemployment Density	-1.26%	1.26%
University Students Density	-2.69%	2.69%
R&D Facilities Density	4.16%	-4.16%

Note: * the effects of Port Size, Agriculture and the Policy Incentive variables are calculated through the estimated quadratic relationship

Appendix 1: Variable Definitions and data

Appendix 1 Table 1: The dependent variable was in all cases the annualised rate of FUR growth in estimated GDP p.c. converted at OECD PPS. Growth measured between means of 1978/80 and 1992/94 and estimated from Eurostat NUTS 3 and national data as described in text

No	Variable Name	Description
	Constant	
1	Population Size	Population size in 1979 (natural logarithm)
2	Population Density	Density of population in FUR in 1979 (1000 inhabitants/Km^2)
3	Coalfield: core	Dummy = 1 if the core of the FUR is located within a coalfield
4	Coalfield: hinterland	Dummy = 1 if the hinterland of the FUR is located in a coalfield
5	Port Size *	Volume of port trade in 1969 (100 tons)
6	Agriculture *	Proportion of labour force in agriculture in surrounding NUTS 2 in 1975
7	Unemployment *	Unemployment rate (average as proportion of LF between 1977 and 1981)
8	National Non-FUR Growth	Growth of GDP p.c. in the territory of each country outside the FURs (annualised rate between 1978/80 and 1992/94)
9	Policy Incentive *	Ratio of the population of the largest governmental unit associated with the FUR to that of the FUR in 1981
10	Integration Gain	Change in economic potential for FUR resulting from pre-Treaty of Rome EEC to post enlargement EU with reduced transport costs, normalised.
11	Peripherality	Dummy = 1 if the FUR is more than 10 hours away from Brussels
12	University Students *	Ratio of university students (1977-78) to total employment (1979)
13	R&D Facilities *	R&D laboratories of Fortune 500 companies per 1000 inhabitants in 1980
14	Unemployment Density	Sum of differences between the unemployment rate (average as proportion of LF between 1977 and 1981) of a FUR and the rates in neighbouring FURs (within 2 hours), discounted by distance (with 10 hours time penalty for national borders)
15	University Students Density	Sum of university students per employees in neighbouring FURs (within 2.5 hours), discounted by distance (with 10 hours time penalty for national borders)
16	R&D Facilities Density	Sum of R&D laboratories per 1000 inhabitants in neighbouring FURs (within 2.5 hours), discounted by distance (with 10 hours time penalty for national borders)

Note: * denotes variables tried with a quadratic specification for reasons explained in the text: never entered as squared value alone.

To estimate the **Policy Incentive** variable the rules determining the selection of the largest 'relevant' governmental unit were:

Belgium	The central communes for all except Bruxelles for which the capital region (Arrondissement) was taken;
Denmark	Central Municipality;
Germany	The Kreisfreie Stadte except for Bremen and Hamburg where the NUTS 1 Land region was taken and Frankfurt where the Umlandverband was taken;
France	Since there is a NUTS 1 region, the Ile de France, which has significant powers, was selected for Paris. Elsewhere in France the central Commune was selected except for those FURs for which a Communité Urbaine exists; in those cases the Communité Urbaine was selected
Greece	The central Municipality;
Ireland	The County Borough (of Dublin);
Italy	The central Commune was selected in all cases. Unlike the situation in France (Paris) or Germany (Bremen and Hamburg) there is no NUTS 1 or 2 region corresponding to any city nor is there any city with a city wide tier of government (such as the Communité Urbaine).

The Netherlands	The central Municipality (as Italy);
Portugal	The central Municipality (as Italy);
Spain	Where there was one major FUR in a Communidad Autonoma (a NUTS 2 region), the Communidad Autonoma was selected; where there was more than one major FUR in the Communidad Autonoma but only one in the Provincia (a NUTS 3 region), the Provincia was selected; where there was more than one major FUR within a Provincia then the central Municipio was selected;
United Kingdom	In England, the District was selected except in London where Inner London was used; in Scotland, the regions of Lothian and Strathclyde were taken and for Belfast the NUTS 1 region of Northern Ireland was the government unit identified.

The only case, then, for which no obvious rule was available, was that of London because of the abolition of London-wide government in the middle of the period. In 1985, local government powers were re-assigned down to the 32 boroughs and up to committees of boroughs and to central government. There were further changes to this system in the later part of the period when the Government Office for London was set up. The only stable unit of government relating to London was the City of London or the individual London boroughs but there was a regional authority – Greater London – for some of the period. The selection of Inner London - not really a governmental unit at all - represented no more than the most reasonable compromise. We tested alternatives and as might be expected, substituting the value for the largest borough or the GLC as a whole made no material difference to the results reported here.

Appendix 1 Table 2: Sources for other data

Variable Number	
1	National Censuses of population or – where unavailable – national registration data
2	Area from administrative maps
3	*Oxford Regional Economic Atlas*, Oxford: OUP, 1971
4	*Oxford Regional Economic Atlas*, Oxford: OUP, 1971
5	Hanbusch der Europaischen Seehafen Band II, III, IV, V, VI, VII, VIII, IX & X Hamburg: Verlag Weltarchiv, various dates from 1968
6	Eurostat NUTS2 data
7	Estimated from Eurostat NUTS3 data
8	GDP data from Eurostat: see text for further explanation.
9	See text and above for details.
10	Estimated from Clark *et al* 1969 and Keeble *et al* 1988
11	Time distance measured using standard road freight software: Microsoft
12	University Students taken from *The International Association of Universities*, *International Handbook of Universities*, 1978, (seventh edition), London: The Macmillan Press; *Association of Commonwealth Universities, Commonwealth University Yearbook 1979*, 1978, (fifty-fifth edition) London: The Association of Commonwealth Universities; and *The World of Learning 1978-1979*, 1978, (twenty-ninth edition), London: Europa Publications: total employment estimated from Eurostat data
13	R&D laboratories of Fortune top 500 companies as reported in *Directory of European Research*, London: Longman, 1982
14	Unemployment as per variable 7: time-distances here and elsewhere from standard road freight software - Microsoft.
15	University Students as per variable 12: time-distance as elsewhere
16	R&D Facilities as per 13: time-distances as elsewhere

Appendix 1 Table 3: Descriptive Statistics

Variable	Mean	S.D.	Min.	Max.
FUR Annualised Growth Rate	0.0609	0.0069	0.0457	0.0809
Population Size	13.8461	0.6929	12.7566	16.1214
Population Density	0.5337	0.6378	0.0448	4.4784
Coalfield: core	0.1570	0.3653	0.0000	1.0000
Coalfield: hinterland	0.0661	0.2495	0.0000	1.0000
Port Size	0.0086	0.0217	0.0000	0.1904
Agriculture	0.0959	0.0946	0.0036	0.4090
Unemployment	0.0787	0.0332	0.0186	0.1774
National Non-FUR Growth	0.0622	0.0042	0.0550	0.0801
Policy Incentive	0.4927	0.3633	0.0927	2.5032
Integration Gain	0.4370	0.2485	0.0000	1.0000
Peripherality	0.3223	0.4693	0.0000	1.0000
University Students	0.0490	0.0387	0.0000	0.2113
R&D Facilities	0.0011	0.0016	0.0000	0.0069
Unemployment Density	0.0000	0.2142	-0.8426	1.0740
University Student Density	0.3404	0.5405	0.0000	2.7126
R&D Facilities Density	0.0142	0.0252	0.0000	0.1497

Appendix 2: Major Functional Urban Regions (FURs)

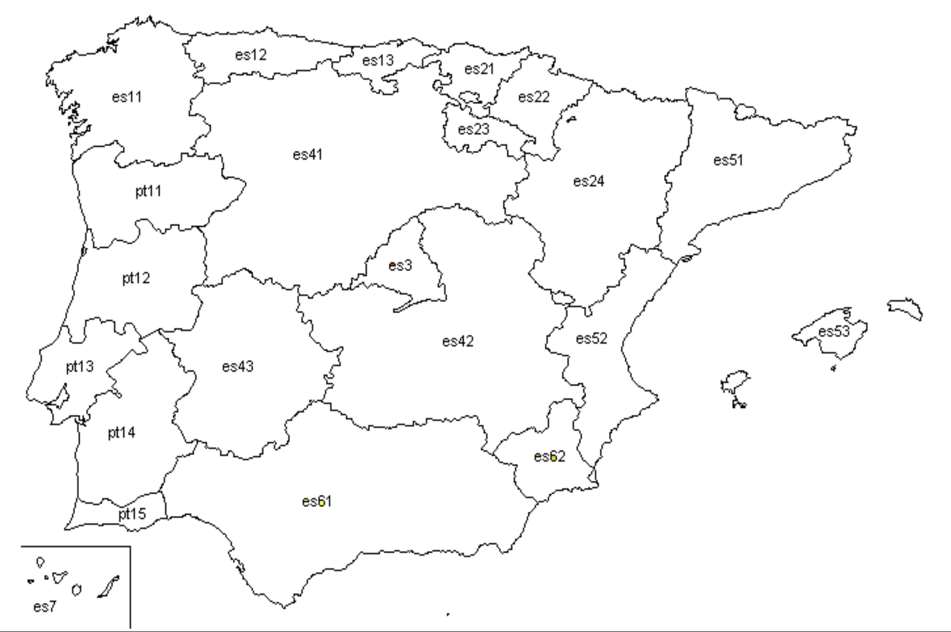
Appendix 2 Table 1: List of the Major FURs in EU12.

Code	Name	Code	Name	Code	Name
1	Antwerpen	42	La Coruña	83	Milano
2	Bruxelles-Brussel	43	Madrid	84	Napoli
3	Charleroi	44	Málaga	85	Padova
4	Liège	45	Murcia	86	Palermo
5	Århus	46	Palma De Mallorca	87	Roma
6	Københavns	47	Sevilla	88	Taranto
7	Aachen	48	Valencia	89	Torino
8	Augsburg	49	Valladolid	90	Venezia
9	Bielefeld	50	Vigo	91	Verona
10	Bochum	51	Zaragoza	92	Amsterdam
11	Bonn	52	Bordeaux	93	Rotterdam
12	Braunschweig	53	Clermont-Ferrand	94	S-Gravenhage
13	Bremen	54	Dijon	95	Utrecht
14	Dortmund	55	Grenoble	96	Lisboa
15	Düsseldorf	56	Le Havre	97	Porto
16	Duisburg	57	Lille	98	Belfast
17	Essen	58	Lyon	99	Birmingham
18	Frankfurt	59	Marseille	100	Brighton
19	Hamburg	60	Montpellier	101	Bristol
20	Hannover	61	Mulhouse	102	Cardiff
21	Karlsruhe	62	Nancy	103	Coventry
22	Kassel	63	Nantes	104	Derby
23	Köln	64	Nice	105	Edinburgh
24	Krefeld	65	Orléans	106	Glasgow
25	Mannheim	66	Paris	107	Hull
26	Mönchengladbach	67	Rennes	108	Leeds
27	München	68	Rouen	109	Leicester
28	Münster	69	St. Etienne	110	Liverpool
29	Nürnberg	70	Strasbourg	111	London
30	Saarbruecken	71	Toulon	112	Manchester
31	Stuttgart	72	Toulouse	113	Newcastle
32	Wiesbaden	73	Valenciennes	114	Nottingham
33	Wuppertal	74	Dublin	115	Plymouth
34	Athinai	75	Bari	116	Portsmouth
35	Saloniki	76	Bologna	117	Sheffield
36	Alicante	77	Brescia	118	Southampton
37	Barcelona	78	Cagliari	119	Stoke
38	Bilbao	79	Catania	120	Sunderland
39	Cordoba	80	Firenze	121	Teesside
40	Gijon/Aviles	81	Genova		
41	Granada	82	Messina		

The boundaries of the above FURs are shown in the figure below. In order to make boundary comparisons, recent maps of European NUTS regions are freely accessible from the EUROSTAT's website (http://ec.europa.eu/eurostat/ramon/nuts/overview_maps_en.cfm?list=nuts).

Appendix 2 Figure 1: Map of the Major FURs in EU12

Appendix 2 Figure 2: Map of NUTS2 and Major FURs in Spain and Portugal

NUTS	FURs
	

Appendix 2 Figure 3: Map of NUTS1 and Major FURs in UK and Ireland

NUTS	FURs
	

Spatial Economics Research Centre (SERC)
London School of Economics
Houghton Street
London WC2A 2AE

Tel: 020 7852 3565
Fax: 020 7955 6848
Web: www.spatialeconomics.ac.uk

SERC is an independent research centre funded by the Economic and Social Research Council (ESRC), Department for Business, Enterprise and Regulatory Reform (BERR), the Department for Communities and Local Government (CLG) and the Welsh Assembly Government.