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The distinctive determinants of European urban growth : does one size fit all?

The Distinctive Determinants of European Urban Growth: does one size fit all?

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This paper investigates growth differences in the urban system of the EU12. Alternative dependent variables – growth in population and real GDP per capita – are analysed and instructive differences emerge. The US model which assumes perfect factor mobility does not seem well adapted to European conditions. There is evidence strongly suggesting that equilibrating migration flows between cities in different countries are highly constrained in the EU. Models in which growth of real GDP p.c. is the dependent variable perform well and make it possible to test significant hypotheses. Evidence is found which is supportive of a spatial adaptation of the endogenous growth model with the relative size of the university sector having a highly significant role in explaining growth differences. In addition, the analysis supports the conclusion that systems of urban governance are strongly related to growth. The variables are formulated in a way which tests hypotheses derived from 'fiscal federalism' viewing growth promotion as the production of a local public good. While international migration appears to be limited as an adjustment mechanism, the density of urbanisation in some parts of the EU12 produces a strong local 'growth shadow' effect consistent with commuting flows having an important role in spatial economic adjustment processes where cities are densely packed. Finally new evidence is found supporting the conclusion that integration shocks in the EU favour core areas but that this effect tends to fade with time.

1. Introduction[1]

This paper sets out to do two things. The first is to explore differences in the determinants of growth between cities in Europe and those in the US. The second is to test specific hypotheses about the growth processes of cities in general and cities in a European context in particular. Three issues are of special interest. The first is how and to what extent adjustment to localised disequilibria occurs in a European context, characterised by dense urbanisation but relatively immobile labour. The second is to explore the relationship between systems of city government and city growth performance. Here we 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). Specifically we test whether there is a positive relationship between the degree of co-incidence of governmental boundaries with those of functionally defined city-regions and the growth performance of the city-region. The third issue which we explore is the role of human capital in explaining urban growth differentials. Here we are interested in testing a spatialised adaptation of endogenous growth theory (see Cheshire and Carbonaro, 1995 or, for a more rigorous development, Magrini, 1998).

The results strongly suggest that the model widely used in the US - both in the quality of life literature (Blomquist et al, 1988; Gyourko and Tracey, 1991; Gyourko *et al.*, 1999) and in the analysis of urban growth (Glaeser et al, 1995; Rappaport, 1999) - is inappropriate for a European context. The evidence presented here suggests that labour in Europe is geographically immobile and, in as far as there is mobility, it is a within country phenomenon. Therefore the central assumption of perfectly mobile factors and the equalisation of real marginal returns across cities explicit in the US models cannot reasonably be maintained in the European context.

This immediately suggests that the most appropriate variable to measure cities' comparative economic performance within the EU is the rate of growth of real GDP per capita (as with across country studies) rather than population growth. The empirical results reported in this paper are fully consistent with this conclusion. While our analysis of differential rates of urban population growth suggests that migration is a very imperfect means of adjustment across the EU, it does not suggest that labour fails to respond to differential spatial opportunities where adjustment can occur without migration. We find that where cities are closely packed and are contiguous – as in the Benelux countries and much of England and Germany - changes in commuting flows appear to be a significant alternative but more localised source of adjustment.

In our analysis of the variation between cities in their capacity to generate local growth promotion policies we should clarify from the outset that we do not conceive of such policies in the narrow sense in which their advocates often speak of them: as policies aimed at the direct attraction of mobile investment. Apart from the evidence that such policies have a doubtful value even for the regional economies that successfully attract such investment and that inward investment accounts for only a small proportion of local employment growth in any region (Cheshire and Gordon, 1998) we have a much broader definition of 'growth promotion policies' in mind. Such policies include: having a concern for efficient public administration so that uncertainty is reduced; making sure relevant infrastructure is provided

[1] The authors have benefited from many discussions with colleagues as this work has developed. The authors 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.

and maintained; co-ordination between public and private investment; providing training which is relevant and effective; and ensuring that land use policy is flexible and co-ordinated with infrastructure provision and the demands of private sector investors. It would also involve giving a higher priority to output growth as opposed to equity or environmental outcomes. It need not involve the expenditure of a greater volume of resources, even on infrastructure, so a simple measure of local spending is unlikely to be an appropriate measure of the efficacy of growth promotion efforts even were such a variable available. Grand projects such, perhaps, as the Guggenheim museum in Bilbao or a trophy metro system in Toulouse – may be expensive but not productive; efficient public administration and reduction of uncertainty for private investment by rapid decision-making, clearly defined land use policies and infrastructure planning may cost less than their inefficient alternatives.

Since the output of such policies is the impact they have on local growth performance they can be viewed as the provision of a pure local public good[2]. It will be hard to impossible to exclude agents who have not contributed to the policy from any benefits it may generate. And there will be a zero opportunity cost in consumption: if your rents rise so do mine and the increase in yours is not a cost to me; if your employment opportunities improve that, too, is not a cost to mine. Thus the closer the coincidence in the boundaries of the governmental unit providing such policies with those of the economic region within which their impact is contained the less will be the spatial spillovers. In addition, the larger is the central unit of government of an economically self-contained urban region relative to the size of that region as a whole the lower will be the transactions costs in building a 'growth-coalition'. One way of modelling this idea is set out in section 2. We conclude that there is evidence of a strong relationship between the degree of coincidence of governmental and economic boundaries in EU cities and their growth performance. Our evidence is consistent with both the basic premises of fiscal federalism, therefore, and the conditionality of the provision of local public goods. It is, furthermore, consistent with there being some systematic contribution that local public administration can make to local growth performance.

All the analysis is performed on a data set built up over a 25 year period relating to Functional Urban Regions (FURs) defined[3] so far as possible according to common criteria across the EU of 12. Such FURs correspond to the economic spheres of influence of significant employment concentrations and are relatively self-contained in economic terms. The analysis is conducted only for FURs with a population of more than one third of a million and a core city which exceeded 200 000 at some date between 1951 and 1981. Cities of the former eastern Länder of Germany and Berlin have to be excluded because of lack of data. The new basis on which Eurostat estimated regional GDP from 1995 onwards means that the analysis stops in that year. The variables used are defined in Appendix 1 which also provides a brief description of how they were measured and the sources used. All data are defined to common

[2] The local public good, non-excludable and non-rival in consumption, is, of course the growth they may produce. Resources employed in the promotion of growth are simply a cost.

[3] For a detailed discussion of the definition of the FURs used throughout this paper see Cheshire and Hay (1989). They are defined on the basis of core cities identified by concentrations of employment and hinterlands from which more commuters flow to the employment core than to any other, subject to a minimum cut off. They were defined on the basis of data for 1971. They are broadly similar in concept to the (Standard) Metropolitan Statistical Areas used in the US. As has been argued elsewhere (Cheshire and Hay, 1989; Cheshire, 1999) the great variability in the relationship between administrative boundaries and the economic reality of European cities and regions introduces serious error and a strong likelihood of bias into data reported for administratively defined cities. The FUR/city and region of Bremen provide an extreme but not wholly unrepresentative example. Because of population relative to employment decentralisation over the relevant period the growth of GDP p.c. is overstated by some 40% if the published Eurostat data for the administrative region is relied on.

statistical concepts either weighting data available from the Eurostat REGIO database to estimate values for FURs or collected directly from national statistical offices or common data providers and adjusted where necessary to common definitions. There is necessarily some imperfection and imprecision in such data but they have the merit of not only allowing analysis of specifically European cities but also of allowing the investigation of questions which, because of lack of variation, simply could not be investigated in the context of the US urban system.

Since the focus of this paper is regional fixed effects, the analysis employs OLS but we provide substantial testing to ensure the results are not subject to econometric problems. We have also subjected them to tests for spatial autocorrelation. Since the observations represent the population of West European city-regions, the other objections raised by Levine and Renelt (1992) or Levine and Zervos (1993) to the use of cross sectional OLS in cross country growth studies do not seem to apply.

2. Some practical and theoretical considerations

Within the EU geographic labour mobility is an order of magnitude less than in the US. If, for example, we measure net inter-regional population mobility, using similarly sized regions in both the US and the EU, then the incidence of mobility is higher by a factor of 15 in the US. Taking the weighted mean net migration flows between the 51 US states over the decade of the 1990s and expressing that per person in 1992 yields a mobility rate of 0.005255 – or about 0.5%. Data on net migration at an interregional level are not available for all the EU12 countries so we have to exclude Italy and Portugal. But if the remaining large countries – France, Germany, Spain and the UK are divided into their Level 1 regions (in Germany the Länder or in Britain the Standard Regions) and the smaller countries are treated as single units, then for the resulting 47 territorial units the weighted mean net migration flow over the 1990s was 0.000382 per person – or about 0.04%. Since the EU is substantially smaller in geographic terms and has larger regional differences in mean incomes one would have expected that net migration flows between units of roughly equal size would have been greater rather than smaller.

We also know that comparable Eurostat GDP pc data for a complete set of regions (from which the FUR data are estimated) are only available for a discrete period, 1978 to 1994. We are thus analysing a period too short to correspond to a conceptual long run. Even if the system did tend to equalisation of returns to factors on the margin, new shocks and disturbances will occur long before such a position is reached. We need, therefore, to model a system in which real incomes can permanently (in the sense of any period we can observe) vary between cities.

Given that our observational units represent sub-national economic regions as self-contained as are likely to exist, what basis is there for hypothesising that their form of government – specifically the degree of co-incidence of the spatial boundaries of government to those of the FUR – are likely to be directly related to observed differences in growth rates? Let us consider a FUR made up of one or more administrative units and assume that a 'club' of administrative units provides growth promotion policies. For simplicity let us also assume that the largest unit within the FUR – the central unit – is always part of the club, either alone or together with other administrative units, so the FUR is made up of two groups of economies: the policy club and the group of non-participating economies.

The government of the policy club runs a balanced budget, levying a proportional tax on the quantity of output. Tax revenue $T_p = \tau Y_p$ is spent on policy action and, if the club is made up of more than one administrative unit, on transaction costs. Assuming transaction costs are a constant proportion ε of tax revenues, the total amount of resources devoted to policy action is:

$$G = (1-\varepsilon)\tau Y_p$$

where the constant ε increases with the number of units belonging to the policy club[4], and decreases with the relative size of the central unit. Similar to Barro and Sala-i-Martin (1992), we assume that the overall effect of policy action depends on the amount of public resources spent per producer within the club: $g = G / L_p$. However, if the club does not encompass the entire FUR, only a share θ_p (with $0 < \theta_p < 1$) of the potential effect of policy action is effectively retained within the club

$$g_p = \theta_p\, g = \theta_p (1-\varepsilon)\tau\, y_p \qquad (1)$$

while a different portion, θ_n (with $0 < \theta_n < 1$), spills over to non-participating units.[5] In other words, we are assuming that the output of policy action combines two components: the return to the first component is appropriable by producers residing in the club, while the second component represents an externality that positively affects production within the remaining part of the FUR.

The production function for the policy club is thus given by

$$y_p = Ak_p^{\alpha}(\theta_p\, g)^{1-\alpha} \qquad (2)$$

while the production function for the group of non-participating units is represented by:

$$y_n = Ak_n^{\alpha}(\theta_n\, g)^{1-\alpha}. \qquad (3)$$

The representative, infinitely-lived, household populating the FUR seeks to maximise overall utility given by:

$$U = \int_0^{\infty} u(c)e^{-\rho t}dt \qquad (4)$$

where c is consumption per person, $\rho > 0$ is the constant rate of time preference while the utility function is

$$u(c) = \left(c^{1-\sigma} - 1\right)/(1-\sigma) \qquad (5)$$

with $\sigma > 0$.

Let us start from the maximisation of the overall utility for the representative household residing within the club assuming that production factors have no incentive to move across administrative units.[6] As is well known, this maximisation problem implies that the club's growth rate of consumption at each point in time is given by

$$\dot{c}_p / c_p = (1/\sigma)(r_p - \rho) \qquad (6)$$

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4 In particular, there are zero transaction costs when only the central unit engages in growth promotion policies.

5 Note that, given the specific nature of the effects of policy action considered here, the ability of a club to retain the effects of its growth policies would be a positive function of the relative size of the club with respect to that of the FUR. Similarly, the scale of the spillover effect positively depends on the relative size of the group of non-participating units. However, to simplify notation, we leave the explicit formulation for later.

6 Since, in this present context our primary concern is the long-run growth rate of the FUR, we are assuming that the allocation of production factors across administrative units is such that the FUR is always in a position of steady-state growth. We derive this equilibrium allocation of production factors below. It is worth emphasising, however, that allowing for factor migration within the FUR would add transitional dynamics but not alter the flavour of the results.

where r_p is the private (after-tax) marginal return to capital[7]

$$r_p = (1-\tau)\left(\partial y_p / \partial k_p\right) = (1-\tau)\alpha A k_p^{-(1-\alpha)} \left(\theta_p\, g\right)^{1-\alpha} . \tag{7}$$

Isolating y_p from equation (1) and substituting into (2), we get

$$g = \left[\theta_p^{1-\alpha} (1-\varepsilon)\tau A\right]^{1/\alpha} k_p$$

so that the private marginal return to capital can be expressed as

$$r_p = (1-\tau)\alpha A^{1/\alpha} (1-\varepsilon)^{(1-\alpha)/\alpha} \left(\tau\theta_p\right)^{(1-\alpha)/\alpha} . \tag{8}$$

The constant growth rate for all variables – c, k, y and g – can be determined by substituting equation (8) into (6), yielding

$$\gamma_p = (1/\sigma)\left[(1-\tau)\alpha A^{1/\alpha} (1-\varepsilon)^{(1-\alpha)/\alpha} \left(\tau\theta_p\right)^{(1-\alpha)/\alpha} - \rho\right] . \tag{9}$$

From equation (9) it is easy to show that the tax rate that maximises growth within the club is

$$\tau^* = 1-\alpha$$

so that the corresponding growth rate becomes

$$\gamma_p^* = (1/\sigma)\left[\alpha^2 (1-\alpha)^{(1-\alpha)/\alpha} A^{1/\alpha} (1-\varepsilon)^{(1-\alpha)/\alpha} \theta_p^{(1-\alpha)/\alpha} - \rho\right] . \tag{10}$$

In this model, however, the club's government would seek to maximise the level of utility attained by the representative household rather than the growth rate. If the tax rate is constant, not only consumption, capital and production per person start respectively at initial values $c_p(0)$, $k_p(0)$ and $y_p(0)$ and then grow at the constant rate γ_p but, given the initial level of capital, it is also possible to determine the levels of all other variables at any point in time. In particular, it is possible to show that the starting level of capital is

$$c_p(0) = \left[(\sigma/\alpha - 1)\gamma_p + \rho/\alpha\right]\ k_p(0) . \tag{11}$$

Moreover, integrating in equation (4) we can derive the level of utility attained by the representative household

$$U_p = \frac{c_p(0)^{1-\sigma}}{(1-\sigma)\left[\rho - \gamma_p (1-\sigma)\right]} - \frac{1}{\rho(1-\sigma)}$$

where conditions in note (4) ensure that $\rho > \gamma_p(1-\sigma)$. Substituting $c_p(0)$ from (11), U_p can be expressed as a function of γ_p but not separately on τ

$$U_p = \left(\frac{k_p(0)}{\alpha}\right)^{1-\sigma} \frac{\left[\rho - \gamma_p(\alpha-\sigma)\right]^{1-\sigma}}{(1-\sigma)\left[\rho - \gamma_p(1-\sigma)\right]} - \frac{1}{\rho(1-\sigma)}$$

from which it is straightforward to show that attained utility is monotonically increasing in γ_p. Hence, the club's policy maker will effectively choose the growth maximising tax rate $\tau^* = 1 - \alpha$, since it ensures maximisation of the representative household's utility.

Let us now turn to the group of units not participating in the policy club. Maximisation of the representative household's utility described by equations (4) and (5) yields

$$\dot{c}_n / c_n = (1/\sigma)(r_n - \rho) \tag{12}$$

where r_n is the private marginal return to capital

$$r_n = \partial y_n / \partial k_n = \alpha A k_n^{-(1-\alpha)} \left(\theta_n\, g\right)^{1-\alpha} . \tag{13}$$

Concentrating on steady-state growth equilibrium, from equation (12) we obtain

$$r_n = \sigma\gamma_n + \rho$$

[7] As normal, we assume that the production function is sufficiently productive to ensure positive growth, but not so productive as to yield unbounded utility. The corresponding inequality conditions are $r_c > \rho > r_c(1-\sigma)$.

and substituting into equation (13)

$$\sigma\gamma_n + \rho = \alpha A k_n^{-(1-\alpha)} (\theta_n g)^{1-\alpha} .$$

Taking the logs and differentiating with respect to time, we get

$$-(1-\alpha)\frac{\dot{k}_n}{k_n} + (1-\alpha)\frac{\dot{g}}{g} = 0 .$$

Since g and k_n grow at the rates γ_p and γ_n respectively, it is clear that $\gamma_n = \gamma_p$ when both groups of units are in a steady-state growth position. Given that output at the FUR level is simply $Y_f = Y_c + Y_n$ and that population in each unit is constant, it is straightforward to show that the per capita growth rate for the FUR is

$$\gamma_f = \gamma_p = \gamma_n . \tag{14}$$

In other words, if the club policy makers choose the utility maximising tax rate $1 - \alpha$, the entire FUR grows at the per capita rate given in equation (10).

Let us turn finally to the equilibrium allocation of production factors required by the steady-state growth path. Starting from the allocation of capital, we note that equations (6) and (12), together with the fact that per capita consumption grows at the same rate in the two groups of units, imply that the private marginal return to capital must be the same across the FUR. Resorting to equations (7) and (13), this equilibrium condition requires

$$(1-\tau)\alpha A k_p^{-(1-\alpha)} (\theta_p g)^{1-\alpha} = \alpha A k_n^{-(1-\alpha)} (\theta_n g)^{1-\alpha}$$

and, re-arranging terms,

$$k_p / k_n = (\theta_p / \theta_n)(1-\tau)^{1/(1-\alpha)} . \tag{15}$$

Moving now to the labour market, the wage rates in the two groups of regions are

$$w_p = (1-\tau)(1-\alpha) A k_p^{\alpha} (\theta_p g)^{1-\alpha}$$

and

$$w_n = (1-\alpha) A k_n^{\alpha} (\theta_n g)^{1-\alpha}$$

so that their ratio can be expressed as

$$w_p / w_n = (k_p / k_n)^{\alpha} (\theta_p / \theta_n)^{1-\alpha} (1-\tau) . \tag{16}$$

Substituting (15) into (16), the ratio between wage rates becomes

$$w_p / w_n = (\theta_p / \theta_n)(1-\tau)^{1/(1-\alpha)} = k_p / k_n \tag{17}$$

showing that the ratio between wage rates is exactly equal to the corresponding ratio between capital per worker levels when private returns to capital are equalised. Clearly, if the cost of adjustment – via either commuting or change of residence – is trivial, this equilibrium is not stable.[8] In this case, to get a hint of the possible adjustment process and of the resulting equilibrium, we need to provide an explicit formulation for θ_p and θ_n. As emphasised in note (2), these shares should be positive functions of club and non-club populations relative to FUR population respectively. Therefore, the simplest specification we can use is $\theta_p = L_p / L_f$ and $\theta_n = L_n / L_f$. In such an instance, the ratio between wage rates becomes

$$w_p / w_n = (L_p / L_n)(1-\tau)^{1/(1-\alpha)}$$

and intra-FUR wage equalisation requires

$$L_p / L_n = (1-\tau)^{-1/(1-\alpha)} . \tag{18}$$

[8] However, it is possible to conceive a stable equilibrium even in the presence of wage rate differentials provided that the incidence of commuting costs on the wage rate is not lower than τ and that migration costs are not lower than the present value of the difference in wages.

Substituting this result into equation (15), it is straightforward to show that private marginal return to capital equalisation also implies capital per worker equalisation, $k_p / k_n = 1$. In other words, with this specification of θ_p and θ_n, the equilibrium allocation of factors implies a relative size of population in the two groups of units given by equation (18) and the same level of capital per worker throughout the FUR. It is easy to show that this equilibrium allocation of production factors is stable. If, for instance, the initial allocation of labour is such that $k_p > k_n$, then we know from equation (17) that $w_p > w_n$, and workers will move to units belonging to the policy club until capital per worker ratios and wage rates are equalised.

We have shown that representative household's utility maximisation leads to the steady-state growth rate in equation (10) for the policy club; moreover, we have also shown (equation 14) that the entire FUR grows at this same rate

$$\gamma_f^* = (1/\sigma)\left[\alpha^2(1-\alpha)^{(1-\alpha)/\alpha} A^{1/\alpha}(1-\varepsilon)^{(1-\alpha)/\alpha}\theta_p^{(1-\alpha)/\alpha} - \rho\right] \ . \qquad (19)$$

Starting from this result, we can therefore summarise the main implications for the empirical analysis as follows:

1 the growth rate of the FUR is highest when the FUR itself is made up a single unit. There would be no transaction costs while all policy action effects are internalised so that the FUR's growth rate becomes

$$\gamma_f^* = (1/\sigma)\left[\alpha^2(1-\alpha)^{(1-\alpha)/\alpha} A^{1/\alpha} - \rho\right]$$

which is strictly larger than the rate in equation (19);

2 given the size of the policy club, the FUR's growth rate increases the smaller the are transaction costs, i.e. the smaller the number of units in the club and the larger the size of the central unit;

3 given the incidence of transaction costs, the FUR grows faster the larger the size of the policy club;

4 enlarging the club via the inclusion of additional units has conflicting effects on the growth rate. The increase in the number of units in the club and the reduction of the relative weight of the central unit within the club both increase transaction costs and thus have a negative effect on the growth rate. In contrast, an increase in the overall size of the club reduces the incidence of the spillover effects and therefore tends to increase the growth rate. Therefore, only when the latter effect dominates, will additional administrative units actually join the policy club.

5 Finally we can simulate the relationship between the tax rate (τ) and growth rate (γ) for different transaction costs (ε). Other parameter values are assumed to be as in Barro (1990), that is $\sigma = 1$; $\alpha = 0.75$; $\rho = 0.02$; $A^{1/\alpha} = 0.113$, and the results shown in Fig 1.

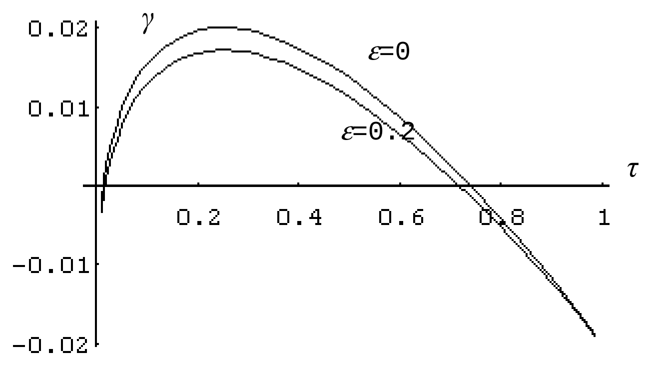

Figure 1

As in Barro (1990), the relationship between the tax rate (τ) and the growth rate of a FUR's per capita GDP (γ) is quadratic: the maximum effect on growth is reached when τ equals 1-α: so other things equal positive transaction costs lead to slower growth. Moreover, since a similar relationship exists between the tax rate and the level of utility attained by representative household the maximum level of utility is also reached when τ equals 1-α.

3. Urban population growth

Glaeser et al (1995) argue that if we assume perfectly mobile factors, a common Cobb-Douglas production function (and factors receiving the value of their marginal product) and quality of life decreasing in city size, then it follows that population growth is the most useful indicator for growth in urban prosperity or welfare. People vote with their feet and if the combination of the real wage and quality of life they could receive in some other city is higher then they will move to it. This will be an equilibrating process, however, with equalisation of the combined real wage and quality of life on the margin. Population growth thus reflects both productivity growth and growth in a city's quality of life.

Between countries, however, there is not free factor mobility and it may be less reasonable to assume a common production technology, so it is more appropriate to adjust for exchange rate and price differences and analyse (rates of growth of) GDP p.c. if the researcher wishes to investigate differences in economic well-being or rates of growth thereof. We have already seen that on one reasonable measure rates of net interregional migration in the US are some 15 times greater than those in the EU. It is also possible that linguistic, cultural and institutional differences between European regions mean that they do not fully share a common production technology and that there are differences in regional rates of technical progress (Rodriguez-Pose, 1998). These considerations suggest the model of urban growth processes frequently applied in the US may be inappropriate in a European context and that in Europe the most relevant variable is growth in real GDP p.c.

Table 3.1 : Dependent Variable Population Growth 1979 to 1994: No Geographic Variables

R^2	0.2590	0.3464	0.3621
Constant	0.0252742	0.0216404	0.0187202
s.e.	0.0071047	0.0065337	0.0066752
LPOP79	-0.0011988	-0.0008343	-0.0007224
s.e.	0.0004776	0.0004335	0.0004346
IND	-0.0001185	-0.0001342	-0.0001299
s.e.	0.0000441	0.0000439	0.0000521
COAL1	-0.0041312	-0.0041709	-0.0036017
s.e.	0.0011319	0.0010264	0.0010864
COAL2	-0.003039	-0.0030921	-0.0027498
s.e.	0.0008313	0.0010805	0.0011096
PORT		-0.0013931	-0.0013066
s.e.		0.0004035	0.0004186
PORTSQ		0.0000768	0.0000733
s.e.		0.0000205	0.0000212
AGR			0.0002169
s.e.			0.0001221
AGRSQ			-0.0000058
s.e.			0.0000034

We test this proposition with a series of estimated models for EU FURs in which growth in population is the dependent variable. All results are estimated with robust standard errors. They provide evidence consistent with the hypothesis set out above so re-enforce our doubts as to whether population growth should, in a European context, be interpreted as an indicator of differential growth in urban welfare or prosperity. The results nevertheless yield interesting insights into adjustment processes in the EU space economy.

Table 3.1 presents the results of a simple model of population growth for 121 major EU FURs including only the log of start of period population and alternative measures of industrial structure. All variables are defined in Appendix 1. IND and AGR measure the proportion of the labour force employed in industry and agriculture respectively in the encompassing level 2 region in 1975. COAL1 and 2 measure the coincidence respectively of the FUR core and the FUR commuter hinterland with a physical coal measure; and PORT is a measure of the tons of traffic through ports in 1969. Employment even by such broad sectors as agriculture, industry and services is only available for all relevant regions for one year before 1980. It is reasonable to argue that the more specific resource based industries – coal mining and port activity – will have had a more influential negative effect on a FURs' growth than the broader sector – industry. Both may have had a particular effect on population growth. If quality of life differences are a significant influence on the rate of population growth then both the coal industry and port activity which have negative impacts on the physical environment and perhaps also on the social environment of cities, as well as leaving a poor endowment of human capital, would be expected to have had a specific and identifiable impact. It is partly because of the environmental effect that it leaves behind that the influence of the coal industry is measured in terms of the physical co-incidence of the FUR with coal measures; the influence of a past specialisation in coal mining would endure after the industry itself had disappeared as a source of employment. Even by 1979, a significant number of the traditional mining areas of Europe had nil or negligible employment left in mining. Thus, the coal variable is and was intended to be independent of when mining employment declined.

Ports have received little attention in the literature on declining regions. Given their historic importance as locations for processing industries (see for example Alonso 1964), however, and the way in which the technological transformation of port activity has entirely eliminated this role by eliminating their function as transhipment locations, the legacy of problems ports have left their host cities seems likely to be significant. A further aspect of the transformation of port activity is that it has involved a very substantial increase in capital : labour ratios. An industry which was labour intensive has become capital intensive. Therefore, it is reasonable to expect that while the general effect for a city's growth of having specialised in port activity would be negative some of the very largest ports might have benefited from the concentration of port activity in few locations.

In understanding population growth, therefore, it would seem that these more precise measures of industrial structure which capture not just declining economic opportunity but also aspects of quality of life differences should provide more explanatory power than a broad measure of specialisation in industry. The results confirm this. In addition the results reported in Table 3.1 provide provisional evidence consistent with the assumption of Glaeser et al (1995) that quality of life is declining in city size. There is a negative relationship between city size and population growth.

Given the belief that environmental factors are significant in determining the attractiveness of a city in terms of its quality of life, and hence its population growth, it would seem appropriate to explore the role of the most obvious and systematic environmental factor -

climate. Glaeser et al (1995) found that dummies for cities in the south and west were highly significant in their models of rates of population growth across US cities. We have defined four continuous variables: distance south (west) within each country relative to the national capital and distance south (west) within the EU as a whole relative to Brussels. Given the evidence on the low incidence of population mobility across the regions of the EU and our resulting scepticism that the EU operates as one integrated economic system in the way that the US may, we should expect to observe a greater response to quality of life variations within countries than across the EU as a whole. Hence, the expectation is that there will be a significant relationship between a FUR's population growth and relatively how far south it is within its country, but not between its population growth and its relative position within the EU as a whole. Since east-west is not nearly so closely related to climatic variation we do not necessarily expect any relationship between population growth and either measure of westness: within country or within EU.

Table 3.2: Dependent Variable Population Growth 1979 to 1994: with Geographic variables

R^2	0.2575	0.5062	0.2683	0.5314	0.3002
Constant	0.0334424	0.0254005	0.0296826	0.0160868	0.0150911
s.e.	0.0084205	0.0063664	0.0084119	0.0055494	0.007746
LPOP79	-0.0011558	-0.0009316	-0.0010407	-0.0008514	-0.0008782
s.e.	0.0004877	0.0003967	0.0004792	0.000371	0.0004878
IND	-0.0002448	-0.0001572	-0.0002406		
s.e.	0.000046	0.000037	0.0000441		
COAL1				-0.0032113	-0.0054866
s.e.				0.0008997	0.0011659
COAL2				-0.0039564	-0.0039031
s.e.				0.0009198	0.0011152
PORT				-0.0008946	-0.0012339
s.e.				0.0003501	0.0004176
PORTSQ				0.0000519	0.0000701
s.e.				0.0000172	0.0000206
UR7781	-0.0004915	-0.0003648	-0.0004353	*-0.0000684*	*-0.0000273*
s.e.	0.0001505	0.0001218	0.0001788	0.0001216	0.0001685
NFPG7994	*-0.1614547*	*-0.1296449*	*0.1142153*	*0.0687244*	*0.4046884*
s.e.	0.1842812	0.1656065	0.2776958	0.1660468	0.3072756
SOUTH		0.00000899		0.00000897	
s.e.		0.00000148		0.00000139	
WEST		*-0.000000703*		*-0.000000896*	
s.e.		0.00000137		0.00000134	
EUWEST			*-0.000000909*		*-0.00000068*
s.e.			0.00000121		0.00000114
EUSOUTH			*0.000000993*		*0.00000113*
s.e.			0.000000806		0.000000946

Parameter estimates shown in *italics* are not significant at 10%

The evidence amply supports this hypothesis. The only variable reflecting geographical position that is significant is south *within* the country. This is highly significant; and since west is not at all significant, we can say that including the 'south within country' variable effectively increases the adjusted R^2 from 0.26 to 0.51. The conclusion is that within the EU, only inter-FUR migration *within* countries is significant; and even that is restricted compared to the US[9]. Table 3.2 also shows the effects of including the start of period unemployment rate (a variable included in the Glaeser et al 1995 models). While this is significant if only the broad measure of industrial structure is included as a control, once the detailed measures of structure are included it ceases to be significant. It is therefore dropped from subsequent models.

Table 3.3 : Dependent Variable Population Growth 1979 to 1994: Country Dummies compared to Net fertility rates as controls

R^2	0.5450	0.5052	0.5648	0.6321
Constant	0.0213986	0.0255701	0.0187674	*0.0082421*
s.e.	0.0060631	0.0063797	0.0061624	0.0055608
LPOP79	-0.0009193	-0.0009414	-0.0007668	*-0.0004933*
s.e.	0.0003762	0.0003958	0.0003874	0.0003427
IND	-0.0001095	-0.00016	-0.0000887	
s.e.	0.0000518	0.0000371	0.0000528	
COAL1				-0.0020092
s.e.				0.0007538
COAL2				-0.0037376
s.e.				0.0010325
PORT				-0.0007609
s.e.				0.0002975
PORTSQ				0.0000414
s.e.				0.0000146
UR7781	-0.0003245	-0.0003541	-0.0003078	*-0.0001193*
s.e.	0.0001381	0.0001129	0.0001355	0.0001385
NFPG7994		*-0.1452559*		
s.e.		0.1584277		
AGR				0.0001037
s.e.				0.0000558
POPDEN			-0.00000114	-0.00000093
s.e.			0.00000065	0.00000052
SOUTH	0.00000864	0.00000907	0.00000884	0.00000795
s.e.	0.00000178	0.00000147	0.00000176	0.00000159
COUNTRY DUMMIES	✓		✓	✓

Parameter estimates shown in *italics* are not significant at 10%

Table 3.3 reports the results of two further experiments. It would seem obvious that a control should be introduced for background differences in net fertility rates. Two possibilities suggest themselves: country dummies and the rate of natural increase in population in the area of each country outside the area of its major FURs (NFPG7994). Because of small numbers of observations in small countries, these have to be grouped to construct dummies. This grouping was based on differences in net fertility rates. In addition there is a very substantial difference in net fertility rates between the north and south of Italy so a separate dummy was included for

[9] The reasons for the relatively low incidence of inter-regional migration within countries in Europe are likely to be various. There is clear evidence that housing market systems restrict mobility both with the higher incidence of social housing (Hughes and McCormick, 1981), high transactions costs associated with house sale/purchase, rent controls in some countries (e.g. Italy) and planning constraints in land markets causing substantial differences in regional elasticity of supply of housing and in house prices. Other factors, such as institutional, cultural and linguistic differences are also likely to play a role.

FURs located in the lower birth rate regions of the north of Italy[10]. The country dummies are: northern Italy; France; the UK and Ireland; Greece, Spain and Portugal; Germany and Denmark; and the Benelux countries. A further question is whether city size really has a negative effect on urban growth. It would seem more reasonable that quality of life would be decreasing with urban density rather than with size.

The country dummies seem to work quite well in terms of the overall R^2 but none are statistically significant except in the fourth model in which the more specific measures of industrial structure are included; and even in that model the dummies for Denmark, Germany, northern Italy, the UK and Ireland are not significant. Indeed in none of the many models fitted was the dummy for northern Italy ever remotely significant so it is excluded from the 'best' models reported in Table 3.4. The background rate of net fertility is not only not significant but has a perverse sign. Various experiments were conducted with population density and urban size although only two are reported in Table 3.3. As expected, population density performed better than urban size, and always did so when the preferred, more specific measures of industrial structure were included, so urban size is dropped from subsequent models.

Table 3.4 presents the result of another two experiments and shows what can be thought of as the best models. The theoretical models of urban growth set out in Magrini, 1998[11], predict that research and development activity would concentrate spatially and its concentration would be associated with rising per capita incomes, other things equal. The converse of this process was that manufacturing tends to concentrate in the non-R & D specialised regions and this concentration would be associated with falling per capita incomes but rising population. Thus – if anything – we should expect a negative relationship between specialisation in R & D and FUR population growth. This is tested in what appears to be the best model constructed and the results are reported in Table 3.4. Secondly, although inter country migration may be constrained, more local migration is cheaper. In those parts of the EU where urbanisation is very dense people may move between FURs in response to changes in the real wage (remembering that FURs occupy space so such moves might be very local: from outlying parts of the hinterland of one urban region to neighbouring parts of the hinterland of a contiguous one with consequently very modest changes in commuting times). Differential employment growth in one FUR in such a densely urbanised area may bid up local prices, particularly house prices. The resulting reduction in expected real wages may tend to drive out residents who substitute longer journeys to work for lower housing costs in neighbouring FURs. If this were the case then, with a suitable lag, we should expect a FUR's resident population to fall as its employment increased relative to neighbouring FURs, other things equal. This is tested by constructing a variable – SDGE100 – calculated as the sum of differential employment growth between each FUR and all other FURs within 100 minutes road time, discounted by time distance. To provide a lag the time period chosen is 1979 to 1987 (data for 1986 not being available – see below). This variable is significant and has the expected negative sign.

[10] The birth rate in Campania is 1.76 times that in Liguria for example. The net effect of this procedure is that the five regions of southern Italy act as datum.

[11] It should be noted that this model although broadly neo-classical in spirit, does not require convergence of regional per capita incomes. Whether such convergence occurs, or alternatively whether there is divergence, depends on the particular values of key parameters. It is argued that non-convergence is the more likely outcome in a European context.

The last three columns of this table show the results of controlling for the effects of outliers using the procedure available in Stata[12]. We do indeed observe a negative relationship between R & D specialisation (see Appendix 1 for how this is constructed) and FUR population growth but this is only significant in the version of the model which uses the natural rate of increase of population in the areas of the country outside the major FURs as the control for background population increase. This is now correctly signed and significant. The model with country dummies as the control performs slightly better but then, although negatively signed, the R & D variable is non-significant.

Table 3.4: Dependent Variable Population Growth 1979 to 1994: 'Best Models' including R & D

R^2	0.6337	0.5932	0.6123	Downweighting outliers		
Constant	*0.000633*	*0.001564*	*0.001348*	*0.000673*	0.001943	*0.001756*
s.e	0.001165	0.001161	0.001118	0.001042	0.001111	0.001069
COAL1	-0.002448	-0.003084	-0.003036	-0.002621	-0.003101	-0.003019
s.e	0.000785	0.000911	0.000869	0.000890	0.000963	0.000924
COAL2	-0.004651	-0.003923	-0.004099	-0.004859	-0.003905	-0.004070
s.e	0.000994	0.000726	0.000684	0.001197	0.001292	0.001243
PORT	-0.000924	-0.001003	-0.000886	-0.000805	-0.001159	-0.000796
s.e	0.000253	0.000302	0.000310	0.000273	0.000595	0.000291
PORTSQ	0.000049	0.000056	0.000047	0.000043	*0.000092*	0.000043
s.e	0.000013	0.000015	0.000016	0.000018	0.000104	0.000019
AGR	0.000110	0.000108	0.000094	0.000096	0.000090	0.000071
s.e	0.000048	0.000042	0.000040	0.000042	0.000039	0.000037
POPDEN	*-0.0000008*	-0.0000008	-0.0000008	*-0.0000007*	*-0.0000008*	*-0.0000007*
s.e	0.0000005	0.0000005	0.0000005	0.0000005	0.0000005	0.0000005
SOUTH	0.000007	0.000009	0.000008	0.000006	0.000008	0.000008
s.e.	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
R&D			-0.000526			-0.000536
s.e			0.000174			0.000230
SDGE100	-0.094707	-0.106658	-0.112404	*-0.096792*	*-0.108284*	-0.112909
s.e.	0.043320	0.043065	0.042154	*0.052444*	*0.057701*	0.055476
NFPG7994		0.417870	0.609756		*0.347697*	0.528789
s.e		0.189618	0.199173		*0.180789*	0.190917
COUNTRY DUMMIES (excl. North Italy)	✓			✓		

Parameter estimates shown in *italics* are not significant at 10%

The authors are not sympathetic to the mechanical elimination of the effects of outliers. These contribute to variance and contain information. However, it is reasonable to argue that one should test the extent to which results obtained are conditioned on the impact of outliers. Calculation of Cook's distance shows that there is essentially only one outlier and that is Rotterdam. This, as substantially the largest port in Europe has a noticeable effect on the estimated significance of the PORT variable: in particular on the issue of the appropriate functional form. Dropping Rotterdam and systematically down weighting values for outliers makes it less clear that a quadratic functional form is the most appropriate even though such a form has an economic logic and retains its statistical significance when the R & D variable is included. Perhaps more interestingly, however, the values of the estimated co-efficients are hardly – certainly not significantly – affected.

[12] All other models were also fitted using this downweighting procedure. This both excludes extreme outliers where Cook's Distance >1, and uses Huber and then biweights to downweight remaining outliers. The impact on estimated parameters was generally so small that they have not been reported separately. Results are available on request from the authors.

4. Growth in GDP per capita

Although some reasonable models with population growth as the dependent variable can be constructed and some hypotheses tested, the overall performance of even the best models is not strikingly good. The hypothesis for which the results provide the most powerful supporting evidence is with respect to the immobility of labour across the regions of the EU. We see significant signs of environmentally driven labour mobility within countries - other factors constant - but there is no evidence supporting the conclusion that there is such labour mobility across the urban system of the EU as a whole. This strongly supports the presumption that GDP p.c. is the more relevant dependent variable if one is to investigate the relative performance of urban economies across Europe. It is to this therefore that we now turn.

The data used are derived mainly from Eurostat regional data, accessed via REGIO. Regional GDP data have been published for most Level 1, 2 and 3 regions[13] since 1978 although for some it is available from 1977. There are however gaps – data for Greek and Portuguese regions, for example, only became available later. In both cases REGIO data have been supplemented with national data. For some countries, such as Italy, data for earlier years were only published for Level 2 regions. Estimates of GDP p.c. for FURs are derived by using the distribution of FUR population between Level 3 regions at the closest Census date as weights and then applying those weights to the relevant Level 3 GDP p.c. data. National sources, for example of value added in Italy, have been used to disaggregate from Level 2 to Level 3 values where none are published by Eurostat.

Despite the work put into cleaning the data and improving the estimates by supplementing Eurostat values with national data where appropriate, the FUR level GDP estimates contain noise. Estimates for 1978 are inferior to succeeding years. For this reason our preferred approach is to use the mean value of three years as start and end dates (although some illustrative results for single start and end dates are reported in Appendix Table A3). In passing, we may note that there is only a small correlation between population and GDP growth: the R between GDP p.c. growth between 1978/80 and 1992/4 (hereafter called 1979-93) and population growth over the same period is 0.0879. The strongest correlation is between GDP p.c. growth 1979-93 and population growth rate in the previous decade, 1971-81. Even here R is only 0.2257.

In the following discussion we focus on the effects of three main variables. The first is the impact of the capacity to generate local growth promotion policies and differential urban performance. The second is the role of human capital and R & D in regional growth processes in the EU. The third is on the spatial adjustment mechanism between neighbouring urban economies: what we call the 'growth shadow effect'.

Local growth promotion policies have been the object of increasing attention in the EU with integration and the associated development of *territorial competition*. To the extent that there is an ‘output’ from such policies it is local economic growth and can be viewed as a local quasi-public good. As was argued above, therefore, there are the usual problems associated with the provision of (local) public goods, including a classic problem of spatial spillovers. Whether or not such policies are engaged in will be conditioned primarily on the structure of the incentives faced by the economic actors who may attempt to form a public/private consortium or ‘growth

[13] The EU institutions deal in so-called Nomenclature des Unités Territoriales Statistiques (N.U.T.S.) regions. This is a nesting set of regions based on national territorial divisions. The largest are Level 1 regions; the smallest for which a reasonable range of data is available are Level 3. These correspond to Counties in the UK, Départements in France; Provincies in Italy or Kreise in Germany.

promotion club'. The expected gross payoff will be a direct function of the additional growth that a given club expects it can generate for its members. As was concluded in section 2, for a given potential growth gain for an economic region (or FUR) containing the benefits of the growth, the expected payoff for a growth club will fall as the spillover losses to areas of the region not represented in the club increases. Equally, assuming other factors are constant, the expected net payoff would fall as the transactions costs necessarily incurred to form the club increase. The most obvious and certain source of spillover losses is to actors within the functional economic region but outside the territory covered by the actors within the club. Transactions costs will be negatively related to the number of relevant potential members and the institutional dominance of the lead actor (assumed to be a governmental unit). Thus expected net benefits will increase and costs fall as the size of the 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 number of public agencies representing the functional economic region, with the boundaries of the highest tier authority approximating to those of the region…'

It is possible to specify a variable closely reflecting this feature of FURs. This is ratio of the total population of the largest (relevant) unit of government representing the FUR to the population of the FUR as a whole. Since transactions costs will fall both with the dominance of the lead actor and the number of actors/local governments that have to combine we could add that we are implicitly assuming that the relative size of the largest government unit is also a proxy for leadership capacity. We are implicitly assuming this will be the governmental unit with the largest population, but this is qualified by 'relevant', by which we mean that the governmental unit concerned must have significant powers of action. Even though it might be the largest N.U.T.S. region with a territory overlapping that of the London FUR, for example, the South East Region would not have been a 'relevant' governmental unit because it had essentially no powers[14].

We call this the ***policy units*** variable and it is designed to measure the capacity to prosecute policies promoting growth at the FUR level[15]. In identifying the largest 'relevant' unit of government representing the FUR, 'relevant' is defined as a sub-national unit of government with an administrative area encompassing or corresponding to (some proportion of) the territory of a FUR and which has significant administrative and decision-making powers. Since the largest 'relevant' unit was selected it was also in all cases the highest tier of sub-national government relating to the territory of the FUR. Since one criterion was that the unit of government selected should have significant administrative and decision making powers the Level 1 regions were potentially available for selection in European countries with a regional level of government. This means that the value of the variable can range from only about 0.125 to over 2. We might further hypothesise that if the value of the variable were very high, so that the size of the 'relevant' unit of government considerably exceeded the size of the FUR, then the capacity to generate local growth promoting policies would weaken. This is because the interests of the FUR would begin to be lost in those of the larger unit which might pursue policies favouring rural areas or smaller centres. If this were the case then we would expect to observe a quadratic functional form with a maximum positive impact where the value of the policy units variable was between 1 and 2.

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

[15] Implicitly we assume FURs – since they are self contained and therefore minimise spillover losses of growth to other territories in an integrated spatial economy – approximate the most appropriate territorial units at which to pursue local growth promotion policies.

Since the structure of government powers and local government structure vary from country to country within the EU the rules for identifying the largest 'relevant' unit of government associated with each FUR, while explicit and decided blind of the data, had to vary from country to country. The ‘rules’ used are set out in the Appendix 1.

Table 4.1: Dependent Variable Annualised Rate of Growth of GDP p.c. Mean 1978/80 to mean 1992/4: Basic Model

Model	1	2	3	4	5	6	7
R^2	0.1514	0.3817	0.3670	0.3988	0.5471	0.5767	0.5852
Constant	0.076955	0.087126	0.068073	0.062490	*0.011706*	*0.006685*	*0.004766*
s.e	0.025996	0.025225	0.020158	0.020822	0.018326	0.017005	0.017682
LGDP79A	-0.007257	-0.008481	-0.005832	-0.005395	*-0.002486*	*-0.002086*	*-0.002024*
s.e.	0.003293	0.003046	0.002359	0.002414	0.001985	0.001928	0.001996
LPOP79	0.003490	0.003396	0.003411	0.003416	0.001921	0.001936	0.001876
s.e	0.000763	0.000699	0.000723	0.000734	0.000573	0.000538	0.000535
IND	*0.000005*	*0.000121*					
s.e	0.000076	0.000081					
COAL1		-0.007831	-0.006896	-0.007499	-0.007034	-0.007614	-0.007561
s.e		0.001423	0.001251	0.001262	0.001058	0.001066	0.001073
COAL2		-0.007087	-0.006300	-0.005826	-0.006698	-0.006239	-0.006052
s.e.		0.001516	0.001351	0.001358	0.001457	0.001511	0.001594
PORT		-0.001384	-0.001546	-0.001600	-0.001444	-0.001497	-0.001514
s.e		0.000581	0.000566	0.000567	0.000443	0.000440	0.000446
PORTSQ		0.000056	0.000060	0.000064	0.000063	0.000067	0.000069
s.e		0.000028	0.000028	0.000028	0.000022	0.000022	0.000022
PU				0.003467		0.003339	0.008259
s.e				0.001389		0.001204	0.003179
PUSQ							-0.002429
s.e.							0.001305
NFG7993A					0.757989	0.753200	0.763857
s.e					0.085277	0.082618	0.085022

Parameter estimates shown in *italics* are not significant at 10%

The results of a simple model are reported in Table 4.1. The same control variables are used for industrial structure as were used in the models in which population growth was the dependent variable. The results for these are essentially the same. The more detailed measures relating to old resource based industries work best. The broader measure of specialisation in aggregated industrial sectors in the wider Level 2 region in 1975 is dropped from subsequent models.

The log of population size is included with the expectation that larger cities will have grown faster in terms of GDP p.c. because of productivity gains in larger urban areas (see Costa and Kahn, 2000 for a convincing account of at least one important source of such productivity gains in larger cities). A measure of the ‘background’ rate of economic growth, NFG7993A, the rate of growth of GDP p.c. in the area of each country outside the major FURs, is included. As would be expected this is highly significant. It controls for institutional, policy and other factors which may have led to countries having differences in their growth rates over a given period and which relate to their whole territory. The variable should also effectively control for national differences in the incidence of the economic cycle. This may explain why it is so significant. Adding the variable increases the R^2 from about 0.4 to 0.55. Although national dummies have been the way in which this problem has been handled in the literature, it seems more elegant and powerful to use the continuous variable employed here. As can be seen the results are strong and significant. Also, interestingly, it eliminates the significance of LGDP79A, the initial level of GDP p.c. Previous work has shown that both the significance and even sign of this commonly used variable were highly dependent on model specification (Cheshire and Carbonaro, 1995) and this confirms that result. It suggests that there is more variance in FUR growth rates across countries than within them and that the initial level of GDP p.c. acts in large measure as a national dummy. Given the ambiguity of our preferred theoretical model of urban growth in the EU with respect to the issue of convergence (Magrini, 1998) the initial level of GDP p.c. is omitted from later models although its inclusion has no noticeable effect on estimated parameter values for other variables.

Table 4.2: Dependent Variable Annualised Rate of Growth of GDP p.c. Mean 1978/80 to Mean 1992/4: Including Policy & Human Capital Variables

Model	8	9	10	11	12
R^2	0.6180	0.6298	0.6718	0.6767	0.6955
Constant	*-0.009130*	*-0.018284*	*-0.023042*	*-0.031480*	*-0.001745*
s.e	0.024740	0.025048	0.022007	0.023857	0.025912
LGDP79A	*-0.001312*	*-0.000604*	*-0.000856*	*-0.000054*	*-0.003920*
s.e	0.002544	0.002552	0.002248	0.002451	0.002841
LPOP79	0.001968	0.002104	0.002145	0.002115	0.002237
s.e	0.000506	0.000489	0.000484	0.000475	0.000462
COAL1	-0.006266	-0.005869	-0.006396	-0.006202	-0.006174
s.e.	0.001184	0.001143	0.001083	0.001079	0.001059
COAL2	-0.005321	-0.005036	-0.004431	-0.004169	-0.005140
s.e	0.001733	0.001742	0.001734	0.001815	0.002075
PORT	-0.001342	-0.001407	-0.001429	-0.001468	-0.001329
s.e	0.000444	0.000437	0.000454	0.000460	0.000405
PORTSQ	0.000062	0.000066	0.000074	0.000076	0.000063
s.e	0.000022	0.000022	0.000023	0.000023	0.000021
AGR	0.000473	0.000417	0.000457	0.000507	0.000538
s.e	0.000149	0.000151	0.000147	0.000148	0.000148
AGRSQ	-0.000013	-0.000012	-0.000013	-0.000013	-0.000013
s.e	0.000004	0.000004	0.000004	0.000004	0.000003
PU	0.009188	0.009231	0.003299	0.007503	0.009739
s.e	0.003287	0.003280	0.001027	0.003581	0.003617
PUSQ	-0.002971	-0.003036		*-0.002085*	-0.002717
s.e.	0.001426	0.001413		0.001543	0.001536
NFG7993A	0.819452	0.850136	0.941290	0.944089	0.923894
s.e	0.087022	0.089180	0.102830	0.104959	0.097029
POPDEN		-0.000001	-0.000002	-0.000002	-0.000002
s.e		0.0000004	0.000001	0.000001	0.000001
UNSTUD			0.000036	0.000031	0.000030
s.e			0.000013	0.000014	0.000014
R&D			0.000761	0.000804	0.000958
s.e			0.000224	0.000221	0.000221
CEP					0.004174
s.e					0.001638

Parameter estimates shown in *italics* are not significant at 10%

The results for the policy units variable, included in models 4, 6 and 7, are also significant although the evidence for a quadratic functional form appears inconclusive. Table 4.2 reports the results of adding additional variables: initial population density; agricultural specialisation in the wider Level 2 region; the R & D and human capital variables; and a variable intended to capture the direct spatial impacts of European integration. Population density is included since, other things equal, cities with higher density will have higher rents and greater congestion. A negative relationship is expected. The R & D and university students per employee variables are included to test for the influence of highly skilled human capital and specialisation in R & D following Romer, 1990 as adapted to a spatial context by, for example, Cheshire and Carbonaro, 1995; 1996 and Magrini, 1998.

The overall performance of the model improves and all variables are significant, with the human capital variables having a strong and positive association with growth in GDP p.c. compared to the weakly negative association with population growth. The policy units results are re-inforced in the more completely specified model although the evidence for a quadratic functional form is still not conclusive.

At least since the 1960s there have been arguments that (European) integration would have systematic spatial effects, economically favouring core regions. An early empirical attempt to quantify such effects was embodied in the work of Clark et al (1969). More recently theoretical work by Krugman and Venables has produced more formal arguments with essentially the same conclusions (see Fujita *et al* 1999 for an up to date survey). The Change in Economic Potential (CEP) variable, selected to measure the direct spatial impacts of European integration, is calculated from the work of Clark et al (1969), supplemented with the estimates for the regions of Spain and Portugal provided by Keeble et al (1988) and scaled to Clark et al’s values. Values for Athens, Lisboa, Porto and Saliniki have been interpolated to provide coverage of all the regions of the EU of 12. Since our interest is in growth we have calculated the *change* in the values of 'economic potential'[16] 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 with respect to the variable used here. Clark's calculations are for different hypothetical states of the world but with regional GDP data estimated for and fixed at 1966. Any differential spatial growth induced by integration might have been fastest where economic potential increased most in the initial stages. But such growth would tend to bid up local factor costs and produce additional congestion, other things equal. In turn, this would tend with a fixed and single integration shock to produce deconcentration over time from the core to surrounding regions. Therefore, in the absence of further integration shocks, by the 1980s the relationship between differential urban growth and Clark et al's (1969) estimates of the change in economic potential might be expected to be quadratic. The greatest gains would no longer have been in the core regions but in the outer core/near periphery. The introduction of the Single European Market and then of monetary union might be expected to have provided new integration shocks, however, and so have given additional impetus to the spatial impact of European integration. Thus, with the extension of the observations into the 1990s, there might be a reinforcing of the influence of the change in economic potential on FUR growth. Such an increase in the influence of European integration on local growth would be reflected in an increased significance of the estimated co-efficient of the change in economic potential variable and a reversion to a linear functional form. This would reflect a re-concentration of the strongest impact in the inner core regions. This is exactly the result reported in model 12 where the variable is significant and the functional form linear

[16] Economic potential is a measure of the accessibility at any point to total GDP allowing for costs of distance including tariffs. For further discussion see Clark et al 1968

(compared to the results reported in Cheshire and Carbonaro, 1996, using data to 1990 in which the functional form was quadratic and the variable only weakly significant).

As has already been shown, labour mobility in the EU - as migration - appears to be very restricted between countries and restricted between FURs within the same country. However, as was also discussed above, there are alternative forms of labour mobility, likely to be particularly important in Europe, because of both the dense nature of urbanisation and the relatively effective transport systems and the long distance commuting these render feasible. In the EU, there are swathes of densely urbanised territory where FURs are not just tightly clustered but their boundaries are contiguous. In such conditions, if the relative economic attractions of a FUR increase relative to its neighbours it will attract in additional commuters; or, as was suggested by the evidence reported in section 3, if consumer prices – notably house prices – fall relative to those in neighbouring FURs it would attract additional residents. Since changes in commuting patterns are cheap relative to migration, the major adjustment mechanism would be expected to be changes in the former in response to changes in the spatial distribution of economic opportunities between neighbouring FURs. This assumes that conditions influencing the quality of life are constant over time between neighbouring FURs.

If commuting patterns act in this way as spatial adjustment mechanisms between neighbouring FURs then we should expect a 'growth shadow effect'. A FUR will grow faster the closer it is to other more slowly growing FURs: and vice versa. This may arise for three separate reasons. The least interesting is simply one of measurement. Since GDP is measured at workplace and people are counted where they live if output expands but resident population does not there will be a spurious apparent increase in the GDP p.c. of the resident population (FUR boundaries are fixed as at 1971 commuting patterns). Since long distance commuters (and perhaps those reacting to changes in the pattern of spatial economic opportunities) have higher human capital and perhaps favourable unmeasured productivity characteristics then there would also be a composition effect. The productivity of the labour force of the FUR attracting additional commuters would grow relative to that of its neighbours. Finally, there might also be dynamic agglomeration effects favouring productivity growth in the faster growing FUR.[17]

This is tested by means of two variables. SDG 100A is calculated as the sum of the differences in the growth rate of GDP p.c. in a FUR and those of all other FURs within 100 minutes divided by distance over the period 1979 to 1986. One would expect commuting patterns to adjust with a lag to changes in the pattern of opportunities between neighbouring FURs, but calculating the variable this way has the additional benefit of reducing the likelihood of endogeneity problems. Since the sum of growth differences is divided by distance and only calculated for FURs within 100 minutes travel time of each other, for many FURs its value is zero. As the correlation matrix in Appendix 2 shows the simple correlation between the SDG 100A variable and the FUR's growth over the whole period is small. However, since there might still be concerns with endogeneity, a second variable based on growth in employment is also constructed. This is SDGE100: the sum of the difference in the growth rate of employment in a FUR and employment growth rates of FURs within 100 minutes divided by distance calculated over 1979 to 1987 (there are gaps in 1986 regional employment data). The results are reported in Tables 4.3

[17] In an ESRC Cities Initiative project, we addressed these issues directly. The growth shadow effect was significant whether the dependent variable was growth in GDP p.c. or growth in output per employee. This showed that there were significant effects independent of any purely statistical measurement issue. In addition, changes in commuter flows between a set of 114 EU FURs with cores within 100 minutes travel distance were modelled. It was found that with appropriate lags inward commuting increased as GDP p.c. increased in a FUR, outward commuting increased as unemployment increased in any FUR and the responsiveness of all inter FUR commuting to changes in economic variables declined with time-distance (Cheshire et al 2001)

and 4.4. It will be seen that the pattern of results and co-efficient estimates is very similar but that the variable constructed from GDP data is more significant. In the models in Table 4.3, a dummy variable for FURs in northeastern Italy is also included. This is significant but does not change the essential behaviour of the model nor the parameter values. It is included on the well worn argument that there are 'two Italies', so that the simple growth in the whole territory of the country outside its major FURs (NFG7993A) does not capture the north-south Italy distinction.

Table 4.3: Dependent Variable Annualised Rate of Growth of GDP p.c. Mean 1978/80 to Mean 1992/4: +Policy, H-C, Spatial Interaction & N. Italy Dummy

Model	13	14	15
R^2	0.7514	0.7900	0.7993
Constant	*0.004142*	*0.016189*	*0.007947*
s.e	0.028026	0.024205	0.024905
LGDP79A	*-0.003625*	-0.005347	-0.004668
s.e	0.002993	0.002697	0.002763
LPOP79	0.002127	0.002212	0.002172
s.e	0.000521	0.000446	0.000432
COAL1	-0.005255	-0.006067	-0.005795
s.e.	0.000949	0.000910	0.000868
COAL2	-0.003166	-0.003279	-0.002989
s.e	0.001146	0.001229	0.001284
PORT	-0.000961	-0.000977	-0.001006
s.e	0.000376	0.000332	0.000326
PORTSQ	0.000050	0.000049	0.000050
s.e	0.000020	0.000017	0.000017
PU		0.004071	0.010052
s.e		0.001007	0.002980
PUSQ			-0.002918
s.e			0.001236
NFG7993A	0.922725	0.900816	0.903705
s.e	0.094462	0.079173	0.079088
AGR	0.000304	0.000300	0.000372
s.e	0.000136	0.000127	0.000128
AGRSQ	-0.000009	-0.000009	-0.000009
s.e	0.000003	0.000003	0.000003
POPDEN	-0.000002	-0.000002	-0.000002
s.e	0.0000004	0.0000004	0.0000004
UNSTUD	0.000037	0.000037	0.000030
s.e	0.000010	0.000009	0.000010
R&D	0.000567	0.000693	0.000768
s.e	0.000218	0.000188	0.000188
CEP	*0.001410*	0.003384	0.003837
s.e	0.001562	0.001468	0.001438
SDG100A	0.242806	0.236205	0.241621
s.e	0.041552	0.036762	0.037471
DNEI	0.007570	0.007813	0.007582
s.e	0.001146	0.001223	0.001636

Parameter estimates shown in *italics* are not significant at 10%

The extra variables improve the overall fit and performance of the models. All variables are significant including the quadratic term in the policy units variable. When the policy units variable is included the change in economic potential variable is linear and significant suggesting that other factors constant FURs in the core of the EU grew most over the period. Both the human capital variables are significant and positive and there is strong evidence for a 'growth shadow' effect in Europe. This remains whether the interaction incentive is measured in terms of the sum of lagged differential growth discounted by distance or as the sum of lagged differential employment growth discounted by distance (Table 4.4).[18]

Table 4.4: Dependent Variable Annualised Rate of Growth of GDP p.c. Mean 1978/80 to Mean 1992/4: Alternative Spatial Interaction & South within country

Model	16	17	18	19	20	Downweighting outliers
R^2	0.7025	0.7648	0.7760	0.7150	0.6995	
Constant	-0.036499	-0.033074	-0.030480	-0.033716	0.0221635	-0.0333814
s.e	0.008028	0.008203	0.008052	0.007875	0.0074172	0.0094239
LPOP79	0.002017	0.001770	0.001736	0.001977	0.0017181	0.002123
s.e	0.000459	0.000450	0.000451	0.000462	0.0004867	0.0005834
COAL1	-0.005468	-0.005527	-0.006028	-0.005994	-0.0057963	-0.0058931
s.e.	0.000933	0.000873	0.000925	0.001019	.00011148	0.001215
COAL2	-0.003341	-0.002427	-0.002439	-0.003331	-0.003476	-0.0034801
s.e	0.001581	0.001155	0.001185	0.001517	0.0016642	*0.0016668*
PORT	-0.001334	-0.001038	-0.001111	-0.001408	-0.0014795	-0.0024733
s.e	0.000387	0.000329	0.000332	0.000390	0.0003719	0.0007893
PORTSQ	0.000068	0.000055	0.000058	0.000071	0.0000724	0.0002678
s.e	0.000020	0.000017	0.000017	0.000020	0.0000194	0.0001366
PU	0.010790	0.010910	0.010109	0.009949	*0.0084165*	0.0113432
s.e	0.003443	0.003079	0.003038	0.003411	*0.0035211*	0.0035203
PUSQ	-0.003366	-0.003528	-0.003303	-0.003132	*-0.0022328*	-0.0037341
s.e	0.001426	0.001248	0.001235	0.001422	0.0014647	0.001609
NFG7993A	0.968474	0.981087	0.953948	0.939837		0.8999815
s.e	0.098714	0.096301	0.091396	0.093287		0.1007857
AGR	0.000612	0.000518	0.000548	0.000643	0.00054	0.00067
s.e	0.000142	0.000129	0.000133	0.000145	0.0001693	0.000159
AGRSQ	-0.000014	-0.000012	-0.000012	-0.000015	-0.0000143	-0.000015
s.e	0.000003	0.000003	0.000003	0.000004	0.0000045	0.00000041
POPDEN	-0.000002	-0.000002	-0.000002	-0.000002	-0.000002	-0.0000072
s.e	0.000001	0.0000004	0.0000004	0.000001	0.0000008	0.0000007
UNSTUD	0.000027	0.000029	0.000031	0.000030	0.0000304	0.000023
s.e	0.000014	0.000013	0.000012	0.000014	0.0000145	0.0000115
R&D	0.000985	0.000862	0.000777	0.000895	0.0006757	0.0009891
s.e	0.000219	0.000208	0.000195	0.000215	0.000267	0.0002922
CEP	0.003180	0.002656	0.002533	0.003048	*0.0032621*	0.0029964
s.e	0.001345	0.001212	0.001240	0.001369	*0.0023522*	0.0013884
SDGE100	0.154950			0.155433	0.167448	0.1473923
s.e	0.081269			0.078228	0.0792688	0.0728706
SDG100A		0.254774	0.252569			
s.e		0.040537	0.040639			
SOUTH			-0.000003	-0.000003	*-1.07e-0*	-0.000003
s.e.			0.000002	0.000002	0.0000022	0.00000159
COUNTRY DUMMIES					✓	

Parameter estimates shown in *italics* are not significant at 10%

[18] We experimented with alternative distance cut-offs and measuring in terms of kms rather than road time. The version reported here performed best.

A final experiment is the inclusion of the South within country variable used in the population growth models. This is only significant in models where the growth shadow effect is formulated using the sum of lagged differential GDP growth discounted by distance. However, it is always estimated with a negative sign. This is consistent with population growth responding to environmental or quality of life factors being self-selective for unmeasured negative productivity differences. People choosing sunshine over income tend to be less productive in other words.

Table 4.4 reports two further sets of results in what we regard as the best models. These use the sum of differential employment growth to capture the growth shadow effect. The first experiment is to substitute country dummies for the growth in national remainders variable. The second provides tests for the sensitivity of model 19 to the effects of outliers.

As expected the cruder country dummies perform significantly less well than the continuous variable: growth in the national territory outside the area of its major FURs (NFG7993A). Not only is this an interesting result in its own right, since country dummies are so widely used, but it is also interesting how, as the models become more fully specified the estimated parameter associated with NFG7993A gets closer to 1. In the simplest model for which we report results the estimated parameter is only 0.76 whereas in the more fully specified models reported in Tables 4.3 or 4.4 the estimate ranges from 0.9 to 0.98.

The final column of Table 4.4 reports the results obtained using the routine available in Stata to offset for the effects of outliers. We can see that as expected the only parameter estimate significantly conditioned by outliers is the functional form for the PORT variable. Dropping the observation for Rotterdam and systematically down weighting outliers renders the quadratic form only marginally significant. Overall the performance of the model hardly changes, however, and the significance of the policy units variable increases. The results reported in Table 4.4 for this procedure are typical of other models. In addition, tests have been performed for spatial autocorrelation. These revealed no problems once non-FUR growth and the spatial interaction variables (whether SDGE100 or SDG100A) were included in the model[19]. A final test was to fit the model on growth rates calculated from single start and end dates. The results are reported in Appendix Table A3. As expected – since there is more noise in the data – the model does not fit as well and the standard errors associated with the parameter estimates increase but the main results are very similar. The functional form for the policy unit variable ceases to be significantly quadratic (although the estimated values are neither significantly nor substantially different.) The only other variable affected is that for university students per employee. The parameter estimate is effectively unchanged but the variable ceases to be significant except at 10%.

5 Conclusions

This paper tests a series of propositions relating to the European spatial economy and particularly to the mechanisms of adjustment within it (implicitly contrasted with those in the US). It investigates what makes it tick and also what impact variation in the arrangements for urban government may have on urban growth performance. Policies that encourage local economic growth can be seen as the provision of a local public good. Conditions increasingly favour the development of growth promoting clubs, therefore, as spillover losses and transactions costs fall. The policy units variable, measured as the ratio of the size of the

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[19] Other results downweighting outliers and those for the spatial autocorrelation tests are available from the authors.

largest governmental unit to that of the economic region (FUR) is designed to reflect this capacity to develop local growth promotion clubs and produces statistically powerful results.

Policies encouraging local economic growth are here conceived of as being neither particularly concerned with inward investment nor even, necessarily, with explicitly promoting growth at all. They may consist mainly of efficient local public administration, the 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 planning rather than redistribution. It is not possible to measure these comparably across the urban areas of the EU as a whole. Indeed, it is difficult to think of any general direct quantitative indicator. Work in the US, for example Rappaport 1999, has used measures of individual policies, such as expenditures on elementary and secondary school education. The variable used in the present paper seems justified on theoretical grounds (see section 2) but is an indirect measure designed to measure not the policies themselves but the capacity of an urban government to generate such policies. There is a strong positive association between this variable and economic growth performance in the functional urban region concerned. This is apparent even in a very simple model but more fully specified models confirm its statistical significance and provide evidence of a quadratic functional form. This suggests that if the government unit is too large relative to the functional urban region concerned the interests of the FUR may tend to get lost in those of the larger region.

The results also offer strong support for the view that one size does **not** fit all. Models, which may be appropriate for US conditions, are not necessarily appropriate for conditions in Western Europe. The evidence is that labour migration – despite European integration – is very imperfect as an adjustment mechanism across the urban system of the EU as a whole. There is evidence consistent with migration between cities within countries having some equilibrating role in terms of real wages, but no evidence for it playing such a role across Europe as a whole. One conclusion from this is that income growth rather than population growth is a more appropriate indicator of improvements in welfare in a city. There is, however, evidence that commuting flows do play a significant role in Europe in spatial adjustment. We observe a significant 'growth shadow' effect with cities in contiguously urbanised regions (such as most of the Benelux countries or large areas of Germany, northern Italy or England) growing faster the closer they are to other less rapidly growing cities. This seems to reflect adjustment in commuting patterns to take advantage of changing patterns of spatial economic opportunity. There are even indications that in the faster growing cities (where, by implication, costs of living are rising) there is some local migration outwards to the surrounding cities.

The empirical results also provide support for the theoretical work of Magrini (1997; 1998) on the role of human capital in regional growth and its interaction with the effects of integration. In this, a plausible outcome of the process of European integration is that regional economic growth diverges and the disparities in per capita income increase rather than converge. Integration similar to that which has characterised recent European history is seen as a possible cause for the emergence of a new steady-state equilibrium characterised by a further concentration of research activities in the regions which were already relatively specialised in research. While the adjustment takes place through the reallocation of unskilled labour and human capital, the average per capita income in the more innovative, relatively research-intensive region(s) grows at a faster rate than in the other region(s). At the same time 'unskilled' labour (and population) increases in the non-research specialised regions. This leads to a new steady-state distribution of per capita income characterised by an increase in disparities.

The significant association found between measures of human capital intensity and R & D is also consistent with recent empirical work on the migration patterns of university students[20]. This finds that while students are drawn from catchment areas which are more extensive the higher the research reputation of the university concerned, students also had a predictable propensity to move into the labour markets local to their universities. The proportion of graduates entering the labour market hosting their university was a function of the dynamism and structure of the local economy. Together with the results in this paper, this suggests that the role of universities is not just to generate a supply of highly qualified human capital for their host economies but also differentially to attract those with the potential to acquire high levels of human capital. Such explanations are neither mutually exclusive nor do they imply that there is not a direct generation of applicable knowledge in universities favouring local application as found, for example, by Audretsch and Feldman, 1996.

Table 5.1:Impact on growth of moving from 1st to 3rd quartile*

Dependent Variable	Absolute change in growth rate	% Change relative to mean growth rate	% Change relative to 1st Quartile growth rate
PU	0.00176	2.9	3.1
PU+UNSTUD+R&D	0.00464	7.6	8.2

*Impact calculated from Model 19 Table 4.4

Table 5.1 shows some calculations to illustrate the impact of three key variables on urban growth rates. In each case, we consider the impact on estimated growth associated with the value of the independent variables identified increased from that of the first to the third quartile observed in the distribution. The first column shows the absolute impact, the second the percentage impact if the FUR in question had a growth rate equal to that of the mean and the last column if its growth rate was equal to that of the first quartile of the distribution. As can be seen the impacts are small but not trivial. For a slow growing FUR, increasing the value of the policy units variable from the value of the first to third quartiles was associated with a 3.1 percent increase in its average growth rate.

The results do not identify a policy lever one could pull to change the outcomes observed. It does not follow, for example, that if every city were given the same proportion of university students per employee they would all have grown at the same rate as those actually best-endowed with universities did. While true that the differences in endowment with universities was 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. The unobserved characteristics of the cities with the highest ratios of university students probably 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 total employee and maintaining a constant quality of university students (and students who then disproportionately join the local labour force).

It is much more plausible to think of the findings on the policy units 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 results from the problems of spillovers and transaction costs entailed in

[20] See McCann and Sheppard (1999) and Sheppard and McCann (2000).

forming effective growth clubs, the outcome should be more effective growth 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 capacity to develop them, may be significantly competitive and diversionary. Some local growth may be zero sum. The success of the successful may significantly be a function of the poor performance of the unsuccessful. As is argued in Cheshire and Gordon (1998), however, it does not follow that all policies designed to promote local growth are zero sum. It is reasonable to expect that there could be net efficiency gains for the EU's urban system as a whole if government boundaries – at least for the highest strategic tiers of local government – were aligned more closely with those reflecting economically relevant patterns of behaviour and spatial economic organisation. .

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Appendix 1: Variable Definitions and data

Table A1: In Population models the dependent variable was in all cases the annualised rate of FUR population growth between 1979 and 1994. All GDP growth models used as the dependent variable the annualised rate of FUR growth in GDP p.c. converted at OECD PPS. Growth measured either between means of 1978/80 and 1992/94 or between 1979 and 1994

LPOP79	Total population in the FUR in 1979: estimated by applying Level 3 population growth rates between the nearest Census year and 1979 weighted by the actual distribution of population between Level 3 regions from national population Censuses
POPDEN	Density of population in FUR in 1979
IND	Percentage of labour force in industry in surrounding level 2 region in 1975: source Eurostat
COAL1	A dummy=1 if the core of the FUR is located within a coalfield
COAL2	A dummy=1 if the hinterland of the FUR is located within a coalfield
PORT	Volume of port trade in 1969 in tons
PORTSQ	Volume of port trade in 1969 in tons squared
AGR	Percentage of labour force in agriculture in surrounding Level 2 region in 1975
WEST	Distance west of centre of FUR from national capital city (Amsterdam taken as capital of Netherlands; Bonn of Germany)
SOUTH	Distance south of centre of FUR from national capital city (Amsterdam taken as capital of Netherlands; Bonn of Germany)
EUWEST	Distance west of centre of FUR from Bruxelles/Brussel
EUSOUTH	Distance south of centre of FUR from Bruxelles/Brussel
NFPG7994	Annualised rate of growth of population in territory of country outside major FURs between 1979 and 1994
UR7781	Unemployment rate in FUR: mean of 1977 to 1981: Eurostat Level 3 data weighted by distribution of FUR populations
DBENL	Dummy for Belgium and Dutch FURs
DDEDK	Dummy for German and Danish FURs
DUKIE	Dummy for British and Irish FURs
DFR	Dummy for French FURs
DESPTGR	Dummy for Spanish, Portuguese and Greek FURs
DNIT	Dummy for Northern Italian FURs: 'northern' determined by regional fertility rates. Thus southern Italian FURs act as datum in models including country dummies
LGDP79A	FUR GDP p.c. at PPS mean 1978/80: estimated using FUR distribution of population for nearest Census year between Level 3 regions applied to Eurostat Level 3 GDP supplemented by national data (see text)
NFG7993A/ NFG7994	Annualised growth rate of non-FUR GDP p.c. between the means of 1978/80 and 1992/4 (or 1979 to 1994 where dependent variable is single start and end date)
CEP	Change in economic potential for FUR resulting from movement from individual nation-states to post enlargement EU with reduced transport costs (estimated from Clark et al 1969 and Keeble et al 1988)
PU	Policy Units (see text) but measured as the ratio of the FUR population in 1981 to the population of the largest governmental unit associated with the FUR.
PUSQ	Policy units squared
R_D	R & D Laboratories of Fortune top 500 companies per million population – 1980
SDG100A	Sum of difference in growth rate of GDP p.c. in a FUR and growth rates of FURs within 100 minutes divided by distance. Growth rates for 1979 to 1986
SDGE 100	Sum of difference in growth rate of employment in FUR and employment growth rates of FURs within 100 minutes divided by distance. Growth rates for 1979 to 1987
DNEI	Dummy for FURs of North East Italy: Padua, Verona and Venice

To estimate the Policy Units 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 Land (a NUTS 1 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 radical change to the system of government in the middle of the period. The Greater London Council was abolished in 1985 and 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 half 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.

Table A2: Descriptive Statistics (

	Mean	Minimum	Maximum	Std.Dev.
GR7993A	0.060907	0.045705	0.080905	0.006863
GR7994	0.058504	0.042371	0.082582	0.007208
PG7994	0.00312	-0.00945	0.021158	0.004636
NFG7993A	0.062222	0.054982	0.080061	0.004157
NFG7994	0.059215	0.052076	0.080435	0.004015
LGDP79A	8.898295	8.180563	9.409974	0.249838
LGDP79	8.897684	8.176764	9.40438	0.250391
LPOP79	13.84606	12.75663	16.12136	0.692935
SDGE100S	6.25E-17	-0.02548	0.027523	0.005586
SDG100A	-0.00072	-0.05581	0.031092	0.00791
COAL1	0.157025	0	1	0.365337
COAL2	0.066116	0	1	0.249517
PORT	0.855784	0	19.0447	2.168479
AGR	9.593636	0.36	40.9	9.463737
IND	39.71851	13.9	61.4	9.408668
CEP	0.699174	0	1.6	0.397596
POPDEN	533.7143	44.80827	4478.422	637.7799
UNSTUD	49.0553	0	211.234	38.4697
R_D	1.061977	0	6.865	1.602266
PU	0.49266	0.092686	2.503212	0.363279
WEST	86.48842	-536.664	494.209	232.3885
SOUTH	42.04555	-493.28	639.973	267.6218
EUWEST	16.68476	-1359.79	1304.023	465.4893
EUSOUTH	325.89	-1077.71	1571.106	599.8814
UR7781	7.865207	1.86	17.74	3.316884

Table A 3: Single start & end date: Dependent Variable Annualised Growth in GDP p.c. 1979 to 1994

R^2	0.6671	0.6870	0.6913
Constant	-0.034134	-0.036763	-0.038289
s.e	0.009849	0.009044	0.008955
LPOP79	0.002019	0.002030	0.002038
s.e	0.000585	0.000551	0.000551
COAL1	-0.005819	-0.006243	-0.006051
s.e.	0.001120	0.001108	0.001073
COAL2	-0.003572	-0.003446	-0.003268
s.e	0.001333	0.001365	0.001400
PORT	-0.001509	-0.001528	-0.001539
s.e	0.000363	0.000347	0.000350
PORTSQ	0.000071	0.000071	0.000072
s.e	0.000019	0.000018	0.000018
PU		0.003058	0.007372
s.e		0.001346	0.003821
PUSQ			*-0.002078*
s.e			0.001562
NFG7994	1.035124	1.036209	1.027465
s.e	0.116819	0.107441	0.106941
AGR	0.000490	0.000491	0.000538
s.e	0.000171	0.000169	0.000169
AGRSQ	-0.000012	-0.000012	-0.000012
s.e	0.000004	0.000004	0.000004
POPDEN	-0.000002	-0.000002	-0.000002
s.e	0.000001	0.000001	0.000001
UNSTUD	0.000029	0.000029	0.000024
s.e	0.000013	0.000013	0.000014
R&D	0.000576	0.000689	0.000747
s.e	0.000259	0.000247	0.000255
CEP	0.002710	0.003759	0.004258
s.e	0.001302	0.001332	0.001440
SDGE100	0.173013	0.171889	0.180567
s.e.	0.075854	0.074110	0.074128
SOUTH	-0.000004	*-0.000003*	*-0.000003*
s.e.	0.000002	0.000002	0.000002

Table A4: Correlations : Set of variables used in population growth models

	PG7994	NFG7993A	NFG7994	LPOP79	SDGE100S	COAL1	COAL2	PORT	AGR	IND	POPDEN	R_D	PU	WEST	SOUTH	EUWEST	EUSOUTH	UR7781	DBENL	DDEDK	DUKIE	DFR	DESPTGR	DNIT
PG7994	1.0000	-0.1521	-0.1789	-0.1515	-0.0309	-0.3603	-0.1528	-0.1125	0.3471	-0.3725	-0.2444	-0.3706	-0.1517	-0.1639	0.6276	-0.0414	0.2150	-0.1146	0.0328	0.1173	-0.4112	0.2899	0.1770	-0.2809
NFG7993A	-0.1521	1.0000	0.9477	0.2502	0.0329	-0.0092	0.0017	-0.0818	0.0387	0.0940	0.1547	0.0087	0.0314	0.3785	-0.1717	-0.1051	-0.1036	-0.1155	-0.0338	0.4538	0.0675	-0.8245	0.2040	0.0632
NFG7994	-0.1789	0.9477	1.0000	0.2301	-0.0187	-0.0386	-0.0058	-0.0291	0.1252	-0.0230	0.0856	0.0160	0.0548	0.2438	-0.2517	-0.1043	-0.0353	0.0228	0.0963	0.2463	0.1029	-0.8417	0.2358	0.1416
LPOP79	-0.1515	0.2502	0.2301	1.0000	0.0973	-0.0922	-0.0709	0.1740	-0.1407	0.0581	0.1909	0.0063	-0.0268	0.0556	-0.0570	-0.1306	-0.0629	-0.1141	0.0974	0.1252	-0.1201	-0.2105	0.0507	0.0854
SDGE100S	-0.0309	0.0329	-0.0187	0.0973	1.0000	-0.0347	-0.3141	-0.1024	-0.0165	-0.0267	0.1653	0.0134	0.0305	0.1268	0.0335	-0.0678	-0.0245	-0.1453	-0.1537	0.1298	0.0000	-0.0446	0.0000	0.0000
COAL1	-0.3603	-0.0092	-0.0386	-0.0922	-0.0347	1.0000	-0.1148	-0.0765	-0.2486	0.2915	0.2105	0.3140	0.1858	0.1443	-0.2961	0.2294	-0.2905	0.1129	-0.1148	-0.0295	0.4530	-0.0857	-0.1309	-0.1295
COAL2	-0.1528	0.0017	-0.0058	-0.0709	-0.3141	-0.1148	1.0000	-0.0383	-0.1459	0.1635	0.0912	-0.0163	-0.1175	0.0510	0.0387	-0.0620	-0.1075	0.0699	0.1969	0.0844	-0.0536	0.0470	-0.1184	-0.0799
PORT	-0.1125	-0.0818	-0.0291	0.1740	-0.1024	-0.0765	-0.0383	1.0000	-0.1164	-0.1274	0.0233	0.0578	-0.0272	-0.0218	-0.0637	-0.0026	-0.1367	0.0924	0.3443	-0.1026	0.0216	-0.0355	-0.0862	-0.0208
AGR	0.3471	0.0387	0.1252	-0.1407	-0.0165	-0.2486	-0.1459	-0.1164	1.0000	-0.5971	-0.3146	-0.4294	0.0578	-0.2265	0.1383	0.0366	0.5818	0.1887	-0.1698	-0.2969	-0.3384	0.0303	0.5631	-0.0005
IND	-0.3725	0.0940	-0.0230	0.0581	-0.0267	0.2915	0.1635	-0.1274	-0.5971	1.0000	0.3187	0.2139	-0.2014	0.3199	-0.2564	-0.2759	-0.3049	-0.4173	-0.1085	0.3591	0.1084	-0.0320	-0.5417	0.2852
POPDEN	-0.2444	0.1547	0.0856	0.1909	0.1653	0.2105	0.0912	0.0233	-0.3146	0.3187	1.0000	0.1502	-0.0392	0.3326	-0.0133	-0.1351	-0.2106	-0.1660	0.0456	0.3088	0.0363	-0.1840	-0.2018	0.0053
R_D	-0.3706	0.0087	0.0160	0.0063	0.0134	0.3140	-0.0163	0.0578	-0.4294	0.2139	0.1502	1.0000	-0.0185	0.0847	-0.2715	0.2757	-0.4338	-0.0161	0.0458	-0.1335	0.7121	-0.2335	-0.2818	-0.0399
PU	-0.1517	0.0314	0.0548	-0.0268	0.0305	0.1858	-0.1175	-0.0272	0.0578	-0.2014	-0.0392	-0.0185	1.0000	-0.0248	-0.1879	0.2618	0.1817	0.1693	-0.1275	-0.1036	0.0615	-0.1032	0.3089	-0.0050
WEST	-0.1639	0.3785	0.2438	0.0556	0.1268	0.1443	0.0510	-0.0218	-0.2265	0.3199	0.3326	0.0847	-0.0248	1.0000	-0.1651	-0.1629	-0.3546	-0.3114	-0.1058	0.5852	0.0867	-0.3494	-0.2271	0.0864
SOUTH	0.6276	-0.1717	-0.2517	-0.0570	0.0335	-0.2961	0.0387	-0.0637	0.1383	-0.2564	-0.0133	-0.2715	-0.1879	-0.1651	1.0000	-0.1247	0.0632	-0.0417	-0.0253	0.2744	-0.3896	0.3430	-0.0765	-0.3976
EUWEST	-0.0414	-0.1051	-0.1043	-0.1306	-0.0678	0.2294	-0.0620	-0.0026	0.0366	-0.2759	-0.1351	0.2757	0.2618	-0.1629	-0.1247	1.0000	-0.0258	0.3819	-0.0526	-0.3930	0.4771	0.0361	0.4085	-0.4274
EUSOUTH	0.2150	-0.1036	-0.0353	-0.0629	-0.0245	-0.2905	-0.1075	-0.1367	0.5818	-0.3049	-0.2106	-0.4338	0.1817	-0.3546	0.0632	-0.0258	1.0000	0.1337	-0.2009	-0.3723	-0.4871	0.1365	0.5821	0.3583
UR7781	-0.1146	-0.1155	0.0228	-0.1141	-0.1453	0.1129	0.0699	0.0924	0.1887	-0.4173	-0.1660	-0.0161	0.1693	-0.3114	-0.0417	0.3819	0.1337	1.0000	0.0924	-0.5633	0.2287	0.0405	0.2528	-0.1354
DBENL	0.0328	-0.0338	0.0963	0.0974	-0.1537	-0.1148	0.1969	0.3443	-0.1698	-0.1085	0.0456	0.0458	-0.1275	-0.1058	-0.0253	-0.0526	-0.2009	0.0924	1.0000	-0.1494	-0.1358	-0.1254	-0.1184	-0.0799
DDEDK	0.1173	0.4538	0.2463	0.1252	0.1298	-0.0295	0.0844	-0.1026	-0.2969	0.3591	0.3088	-0.1335	-0.1036	0.5852	0.2744	-0.3930	-0.3723	-0.5633	-0.1494	1.0000	-0.2865	-0.2647	-0.2498	-0.1685
DUKIE	-0.4112	0.0675	0.1029	-0.1201	0.0000	0.4530	-0.0536	0.0216	-0.3384	0.1084	0.0363	0.7121	0.0615	0.0867	-0.3896	0.4771	-0.4871	0.2287	-0.1358	-0.2865	1.0000	-0.2406	-0.2271	-0.1532
DFR	0.2899	-0.8245	-0.8417	-0.2105	-0.0446	-0.0857	0.0470	-0.0355	0.0303	-0.0320	-0.1840	-0.2335	-0.1032	-0.3494	0.3430	0.0361	0.1365	0.0405	-0.1254	-0.2647	-0.2406	1.0000	-0.2098	-0.1415
DESPTGR	0.1770	0.2040	0.2358	0.0507	0.0000	-0.1309	-0.1184	-0.0862	0.5631	-0.5417	-0.2018	-0.2818	0.3089	-0.2271	-0.0765	0.4085	0.5821	0.2528	-0.1184	-0.2498	-0.2271	-0.2098	1.0000	-0.1336
DNIT	-0.2809	0.0632	0.1416	0.0854	0.0000	-0.1295	-0.0799	-0.0208	-0.0005	0.2852	0.0053	-0.0399	-0.0050	0.0864	-0.3976	-0.4274	0.3583	-0.1354	-0.0799	-0.1685	-0.1532	-0.1415	-0.1336	1.0000

Table A5: Correlations : Set of variables used in gdp per capita growth models

	GR7993A	GR7994	NFG7993A	NFG7994	LGDP79A	LGDP79	LPOP79	SDGE100S	SDG100A	COAL1	COAL2	PORT	AGR	IND	CEP	POPDEN	UNSTUD	R_D	PU	SOUTH	DNEI	DBENL	DDEDK	DUKIE	DFR	DESPTGR	DNIT
GR7993A	1.0000	0.9860	0.5397	0.5476	-0.1831	-0.1988	0.2949	0.2018	0.3942	-0.3514	-0.2062	-0.1603	0.2161	-0.1193	-0.1145	-0.1451	0.1392	-0.0862	0.1421	-0.0806	0.2624	-0.0243	0.0803	-0.1393	-0.4363	0.2172	0.2988
GR7994	0.9860	1.0000	0.5830	0.5875	-0.1547	-0.1743	0.2952	0.1818	0.3714	-0.3484	-0.1696	-0.1452	0.2016	-0.0906	-0.0528	-0.1236	0.1045	-0.0859	0.1065	-0.1216	0.2901	0.0238	0.1179	-0.1491	-0.4566	0.2034	0.3032
NFG7993A	0.5397	0.5830	1.0000	0.9477	-0.2060	-0.2151	0.2502	0.0329	-0.0051	-0.0092	0.0017	-0.0818	0.0387	0.0940	-0.1124	0.1547	-0.2764	0.0087	0.0314	-0.1717	0.0336	-0.0338	0.4538	0.0675	-0.8245	0.2040	0.0632
NFG7994	0.5476	0.5875	0.9477	1.0000	-0.2859	-0.2940	0.2301	-0.0187	0.0054	-0.0386	-0.0058	-0.0291	0.1252	-0.0230	-0.1642	0.0856	-0.2250	0.0160	0.0548	-0.2517	0.0752	0.0963	0.2463	0.1029	-0.8417	0.2358	0.1416
LGDP79A	-0.1831	-0.1547	-0.2060	-0.2859	1.0000	0.9989	0.2191	0.0740	0.0290	-0.0051	0.0308	0.1459	-0.6540	0.5556	0.7263	0.2554	-0.0813	0.1475	-0.0888	0.0291	0.0246	0.1135	0.4256	-0.1012	0.2555	-0.6553	0.2005
LGDP79	-0.1988	-0.1743	-0.2151	-0.2940	0.9989	1.0000	0.2179	0.0755	0.0221	0.0047	0.0251	0.1543	-0.6600	0.5564	0.7180	0.2586	-0.0813	0.1593	-0.0890	0.0295	0.0091	0.1074	0.4172	-0.0838	0.2589	-0.6669	0.1946
LPOP79	0.2949	0.2952	0.2502	0.2301	0.2191	0.2179	1.0000	0.0973	0.0708	-0.0922	-0.0709	0.1740	-0.1407	0.0581	0.1098	0.1909	-0.0577	0.0063	-0.0268	-0.0570	-0.0837	0.0974	0.1252	-0.1201	-0.2105	0.0507	0.0854
SDGE100S	0.2018	0.1818	0.0329	-0.0187	0.0740	0.0755	0.0973	1.0000	0.4295	-0.0347	-0.3141	-0.1024	-0.0165	-0.0267	-0.0768	0.1653	0.1099	0.0134	0.0305	0.0335	0.0347	-0.1537	0.1298	0.0000	-0.0446	0.0000	0.0000
SDG100A	0.3942	0.3714	-0.0051	0.0054	0.0290	0.0221	0.0708	0.4295	1.0000	-0.0172	-0.2518	-0.1497	0.0549	-0.0506	-0.0261	-0.0082	0.0760	-0.0018	0.0375	0.0157	0.1122	-0.0668	-0.0448	-0.0120	0.0147	0.0180	0.0879
COAL1	-0.3514	-0.3484	-0.0092	-0.0386	-0.0051	0.0047	-0.0922	-0.0347	-0.0172	1.0000	-0.1148	-0.0765	-0.2486	0.2915	-0.0507	0.2105	-0.1124	0.3140	0.1858	-0.2961	-0.0688	-0.1148	-0.0295	0.4530	-0.0857	-0.1309	-0.1295
COAL2	-0.2062	-0.1696	0.0017	-0.0058	0.0308	0.0251	-0.0709	-0.3141	-0.2518	-0.1148	1.0000	-0.0383	-0.1459	0.1635	0.2358	0.0912	-0.1401	-0.0163	-0.1175	0.0387	-0.0424	0.1969	0.0844	-0.0536	0.0470	-0.1184	-0.0799
PORT	-0.1603	-0.1452	-0.0818	-0.0291	0.1459	0.1543	0.1740	-0.1024	-0.1497	-0.0765	-0.0383	1.0000	-0.1164	-0.1274	0.1424	0.0233	-0.1539	0.0578	-0.0272	-0.0637	-0.0119	0.3443	-0.1026	0.0216	-0.0355	-0.0862	-0.0208
AGR	0.2161	0.2016	0.0387	0.1252	-0.6540	-0.6600	-0.1407	-0.0165	0.0549	-0.2486	-0.1459	-0.1164	1.0000	-0.5971	-0.5641	-0.3146	0.2583	-0.4294	0.0578	0.1383	0.0432	-0.1698	-0.2969	-0.3384	0.0303	0.5631	-0.0005
IND	-0.1193	-0.0906	0.0940	-0.0230	0.5556	0.5564	0.0581	-0.0267	-0.0506	0.2915	0.1635	-0.1274	-0.5971	1.0000	0.5276	0.3187	-0.2931	0.2139	-0.2014	-0.2564	0.1382	-0.1085	0.3591	0.1084	-0.0320	-0.5417	0.2852
CEP	-0.1145	-0.0528	-0.1124	-0.1642	0.7263	0.7180	0.1098	-0.0768	-0.0261	-0.0507	0.2358	0.1424	-0.5641	0.5276	1.0000	0.2279	-0.1161	0.0112	-0.2959	0.0575	0.0406	0.5382	0.3777	-0.2619	0.1633	-0.6172	0.1219
POPDEN	-0.1451	-0.1236	0.1547	0.0856	0.2554	0.2586	0.1909	0.1653	-0.0082	0.2105	0.0912	0.0233	-0.3146	0.3187	0.2279	1.0000	-0.0422	0.1502	-0.0392	-0.0133	-0.0220	0.0456	0.3088	0.0363	-0.1840	-0.2018	0.0053
UNSTUD	0.1392	0.1045	-0.2764	-0.2250	-0.0813	-0.0813	-0.0577	0.1099	0.0760	-0.1124	-0.1401	-0.1539	0.2583	-0.2931	-0.1161	-0.0422	1.0000	-0.1484	-0.0026	0.2107	0.0258	-0.1241	-0.1585	-0.1540	0.3117	0.0169	0.1091
R_D	-0.0862	-0.0859	0.0087	0.0160	0.1475	0.1593	0.0063	0.0134	-0.0018	0.3140	-0.0163	0.0578	-0.4294	0.2139	0.0112	0.1502	-0.1484	1.0000	-0.0185	-0.2715	0.0062	0.0458	-0.1335	0.7121	-0.2335	-0.2818	-0.0399
PU	0.1421	0.1065	0.0314	0.0548	-0.0888	-0.0890	-0.0268	0.0305	0.0375	0.1858	-0.1175	-0.0272	0.0578	-0.2014	-0.2959	-0.0392	-0.0026	-0.0185	1.0000	-0.1879	-0.0434	-0.1275	-0.1036	0.0615	-0.1032	0.3089	-0.0050
SOUTH	-0.0806	-0.1216	-0.1717	-0.2517	0.0291	0.0295	-0.0570	0.0335	0.0157	-0.2961	0.0387	-0.0637	0.1383	-0.2564	0.0575	-0.0133	0.2107	-0.2715	-0.1879	1.0000	-0.2606	-0.0253	0.2744	-0.3896	0.3430	-0.0765	-0.3976
DNEI	0.2624	0.2901	0.0336	0.0752	0.0246	0.0091	-0.0837	0.0347	0.1122	-0.0688	-0.0424	-0.0119	0.0432	0.1382	0.0406	-0.0220	0.0258	0.0062	-0.0434	-0.2606	1.0000	-0.0424	-0.0895	-0.0814	-0.0752	-0.0710	0.5312
DBENL	-0.0243	0.0238	-0.0338	0.0963	0.1135	0.1074	0.0974	-0.1537	-0.0668	-0.1148	0.1969	0.3443	-0.1698	-0.1085	0.5382	0.0456	-0.1241	0.0458	-0.1275	-0.0253	-0.0424	1.0000	-0.1494	-0.1358	-0.1254	-0.1184	-0.0799
DDEDK	0.0803	0.1179	0.4538	0.2463	0.4256	0.4172	0.1252	0.1298	-0.0448	-0.0295	0.0844	-0.1026	-0.2969	0.3591	0.3777	0.3088	-0.1585	-0.1335	-0.1036	0.2744	-0.0895	-0.1494	1.0000	-0.2865	-0.2647	-0.2498	-0.1685
DUKIE	-0.1393	-0.1491	0.0675	0.1029	-0.1012	-0.0838	-0.1201	0.0000	-0.0120	0.4530	-0.0536	0.0216	-0.3384	0.1084	-0.2619	0.0363	-0.1540	0.7121	0.0615	-0.3896	-0.0814	-0.1358	-0.2865	1.0000	-0.2406	-0.2271	-0.1532
DFR	-0.4363	-0.4566	-0.8245	-0.8417	0.2555	0.2589	-0.2105	-0.0446	0.0147	-0.0857	0.0470	-0.0355	0.0303	-0.0320	0.1633	-0.1840	0.3117	-0.2335	-0.1032	0.3430	-0.0752	-0.1254	-0.2647	-0.2406	1.0000	-0.2098	-0.1415
DESPTGR	0.2172	0.2034	0.2040	0.2358	-0.6553	-0.6669	0.0507	0.0000	0.0180	-0.1309	-0.1184	-0.0862	0.5631	-0.5417	-0.6172	-0.2018	0.0169	-0.2818	0.3089	-0.0765	-0.0710	-0.1184	-0.2498	-0.2271	-0.2098	1.0000	-0.1336
DNIT	0.2988	0.3032	0.0632	0.1416	0.2005	0.1946	0.0854	0.0000	0.0879	-0.1295	-0.0799	-0.0208	-0.0005	0.2852	0.1219	0.0053	0.1091	-0.0399	-0.0050	-0.3976	0.5312	-0.0799	-0.1685	-0.1532	-0.1415	-0.1336	1.0000