City Growth and Dynamic Externalities

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Abstract

This study investigates the extent of dynamic externalities, particularly knowledge spillovers, in agglomerated industries in English regions. It questions why external economies of scale exist and considers their ramifications for appropriate planning policy. By doing so, it suggests one set of ways in which to revise UK regional planning, with the effect that UK regional disparities could be decreased.

The study examines the predictions of two theories that focus on knowledge spillovers. The first theory is generally attributed to Marshall, Arrow, Romer and Porter, and the second to Jacobs. A statistical model is developed based on assumptions made by Glaeser, Kallal, Scheinkman and Shleifer, and analysed using data on industry output, for standard regions in England.

The findings suggest that knowledge spillovers provide an important policy lever to affect regional growth and development. Within-industry externalities do not show up for most industries in England, and in fact for most industries the evidence shows a disadvantage of industrial clustering. However, the most striking finding is that there is a substantial and statistically significant difference between kinds of industries, with high-growth industries—presumed to include notably new industries—having the most benefits (and the least disadvantages) of clustering.

Ultimately, the findings point toward policy conclusions. Beneficial knowledge spillovers do not happen automatically but only if encouraged through appropriate means. The correct policies must be addressed to appropriate industries; that is, positive externalities through knowledge spillovers should be recognised and supported in new high-technology industries.

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I. INTRODUCTION

Despite the government's attempts to minimise the UK's regional economic imbalance, the north and south regional inequality has been increasing over recent decades. Multiple causes have been identified for such inequality, and these causes need to be tackled by the government. However, changes in the pattern and the nature of the inequality, involving new economic forces and competitive pressures resulting in the relative decline of previously prosperous areas and the emergence of problems even in the growing areas, suggest that the government need to revise regional planning in the UK.

This study considers one set of ways in which to revise UK regional planning, with the effect that UK's regional disparities could be minimised, and moreover, made more competitive internationally. In particular, this study investigates the extent of dynamic externalities, especially knowledge spillovers, in agglomerated industries in English regions. The study questions why external economies of scale exist and considers their ramifications for appropriate planning policy. A better understanding of why and when such externalities arise is important to research in town planning, as well as planning policy, since it can help to resolve questions in the literature on industrial location, city growth and external economies of scale.

I examine the predictions of two theories that focus on knowledge spillovers. The first theory is generally attributed to Marshall (1890), Arrow (1962), Romer (1986) and Porter (1990), and the second to Jacobs (1969). The theories are not necessary mutually exclusive, but they differ in their beliefs about the source of externalities that drive industry growth and regional growth, and about what makes externalities most effective.

In order to examine the effect of externalities in city-region growth, a statistical model is developed based on assumptions made by Glaeser, Kallal, Scheinkman and Shleifer (1992). Their model focuses on the size of industries, measured in terms of employment, as an indicator of the size of industrial cluster, which may propel further growth. They did not have data on industry output, which they admit would have allowed better measurement of cluster size, in this study of England, gross value added is considered as well as employment to better probe the sources of growth in industrial clusters. Glaeser et al's model also focuses on city-region's economic diversity, which Jacobs predicts should enhance the growth of the city-region's economy. Several variants of the Glaeser et al model are used to consider alternative issues about the growth of industrial cluster (and ultimately the regions that contain them) in England. Sample data are collected for eight standard regions in England, at the two-digit industrial classification level from 1981 to 1992, and also at the three-digit level from 1993 to 1997, in ten different regions in England, using census of production data.

The findings of this study suggest that knowledge spillovers provide an important policy lever to affect regional growth and development. Within-industry externalities do not show up for most industries in England, and in fact for most industries the evidence shows a disadvantage of industrial clustering. However, the most striking finding is that there is a substantial and statistically significant difference between kinds of industries, with high-growth industries—presumed to include notably new industries—having the most benefits (and the least disadvantages) of clustering.

Ultimately, the findings point toward policy conclusions. Beneficial knowledge spillovers do not happen automatically but only if encouraged through appropriate means. The correct policies must be addressed to appropriate industries; that is, positive externalities through knowledge spillovers should be recognised and explained in new high-technology industries.

Section II of this thesis discusses the theories of externalities through knowledge spillovers and how they fit into Glaeser et al's model. Section III introduces the evidence used and reports results of alternative statistical tests. Section IV considers the result in terms of conclusions from other factual studies. Section V concludes by considering possible planning policies at the national and regional levels.

II. THEORIES OF DYNAMIC EXTERNALITIES

In evolutionary approaches to urban development, the contemporary development of industrial cities is seen as the direct consequence of industrial-technological revolutions that date back to the early nineteenth century and before. Meadows (1969) indicates that "cities emerge historically when a technological complex (tools, skills and theory) creates an economic surplus" (p13), and his view well represents the non-Marxist evolutionary perspective typical of urban economists such as Jacobs (1969). Meadows sees urbanisation as a process in which "urbanism emerges and develops out of the interaction of technology and society", so that "change and development in technology and society occur in and through urbanism" (Meadows 1969, p12). Indeed, some leading researchers into urban growth, such as Jacobs (1969) and Bairoch (1988), have argued that innovations are most likely to be made in city regions. Such a dynamic view of interlocking urban and technological growth fits with the recent economic studies, which view advantages external to industrial growth (known as positive externalities) particularly advantages associated with knowledge spillovers, as the driving force behind the growth (Romer 1986).

Schumpeter (1945) points out technology as a source of corporation and growth, that the rapid growth in capitalism output had been experienced by nations preceding the depression of the 1930s. Some sort of extrapolation of the growth trend is valid that capitalist economies will continue to grow in the future, he argues, and the driving force behind such a growth of capitalist economies is "the process of creative destruction".[1] Schumpeter sees such a process as a form of economic growth theory, and an essential issue to be considered in the workings of economies and industries. He also points out that the essence of changes in capitalist economies is technological change, which can be seen, for example, in the history of farming, iron and steel, power production, transportation, and town planning itself.

"The opening up of new markets, foreign or domestic, and the organisational development from the craft shop and factory to such concerns as U.S. Steel illustrate the same process of industrial mutation -- if I may use that biological term -- that incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalism concern has got to live in."

Schumpeter (1945), 3rd ed., 1850, ch.7, p83

Schumpeter writes, if economies ignore this process of technological change, then its understandings of long-term economic growth is incomplete. Schumpeter notes that competition in an industry can come from related, but perhaps as yet-to-be-developed technologies, when those technologies pose an ever-present threat. The degree of technological progress of each individual industry cannot be rationalised so that some industries' technological progress is slower than others -- just how many industries fall into slow growing category is an empirical question. However, it is no doubt that many industries certainly grow rapidly, hence are contributing to rapid growth of capitalist economies in which technological change is of supreme importance.

If geographical proximity facilitates transmission of ideas, then knowledge spillovers should be important to city growth. Glaeser, Kallal, Scheinkman and Shleifer (1992, hereafter Glaeser et al) summarised currently existing theories of dynamic externalities and developed a model that encompasses key theories and provides a means to test the theories simultaneously. Hence their work is useful when trying to understand how cities form and why they grow. They identified three branches introduced by (i) Marshall (1890)-Arrow (1962)-Romer (1986), (ii) Porter (1990), and (iii) Jacobs (1969). All three branches deal with technological externalities, whereby, without full economic compensation to technological innovators, innovations and improvements occurring in one firm increase the productivity of nearby firms.

The first theoretical view of the three introduced in Glaeser et al's (1992) paper is the combined work of Marshall-Arrow-Romer (the "MAR theory"). Marshall (1920) discusses how, the concentration of an industry in a city facilitates knowledge spillovers between firms and, therefore, the growth of the industry and the city. Marshall wrote;

1 Schumpeter (1945), 3rd ed. 1950, Chapter Seven, pp.81-86, quoted phrases is the chapter title.

"When an industry has thus chosen a locality for itself, it is likely to stay there long: so greater are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of future new ideas. And presently subsidiary trades grow up in the neighbourhood, supplying it with implements and materials, organizing its traffic, and in many ways conducing to the economy of its material."

Marshall (1920), 8th ed., ch.X, p225.

His point is clear from the above passage; great are the advantages which people following the same skilled trade, as the industrial development of nations depends upon opportunities and upon conditions of the surrounding environment. It is no doubt that the benefits of locating a firm in an industrial cluster are related to the availability of skilled labour and intermediate goods suppliers, and ease of transmitting new ideas.

Arrow (1962) develops an endogenous theory of changes in knowledge, which underlie intertemporal and international shifts in production functions. He termed "learning" as the acquisition of knowledge which "can only take place through the attempt to solve a problem and therefore only takes place during activities" (Arrow, 1962, p155). Romer (1986) stresses Arrow's point further; in his model of long-run growth, knowledge is assumed to be a productive input that has increasing marginal productivity. All three authors focus on knowledge spillovers within an industry.

Hence in the MAR theory, knowledge accumulated by one firm tends to affect (without full compensation) other firms' technological progress. Two examples are microchip manufacturers in Silicon Valley and fashion designers in New York. In both cases, physical proximity facilitates such information transmission: employees move between firms or between offices within a firm taking their accumulated knowledge with them to the new work place, and existing employees interact with each other and learn about useful techniques, tools, products, and services. Hence industries that are regionally specialised benefit more from within-industry transmission of knowledge, and grow faster.

In MAR models of externalities, innovators realise that some of their ideas will be imitated or improved on in their rival's products without compensation. The limitations of property rights to ideas causes innovators to slow down their investment in externality-generating activities, such as research and development. If innovators gain a monopoly market on their products or at least gain a tighter control over patents and copyrights in order to limit accessibility to the knowledge, then the pace and growth of innovation should increase. The MAR models hence imply that local competition is bad for growth, but local concentration is good for growth because innovators internalise the externalities.

The second theory introduced by Glaeser et al, is Porter (1990) who also argues that the knowledge spillovers in specialised and geographically concentrated industries stimulate growth. Porter (1990) noted that successful firms are usually concentrated in particular cities, and something about those locations provides a fertile environment for further development of their industry. Further, Porter (1990) suggests that there is a clear connection between geographical clustering, company growth and innovative success.

The difference between the MAR theory and Porter's theory becomes apparent when competition becomes an issue. The MAR theory indicates, similarly to Schumpeter (1942), that local monopoly is better for growth than local competition: local monopoly restricts the flow of ideas to other firms and so allows externalities to be internalised by the innovator. Consequently, innovation and growth should be faster for local monopolies. In contrast, Porter (1990) claimed that local competition, as opposed to local monopoly, fosters the pursuit and rapid adoption of innovation. His work suggests that externalities and hence growth are maximised in cities with geographically specialised, competitive industries.

The third theory introduced by Glaeser et al is by Jacobs (1969), who argues that the most important knowledge transfers come from outside the industry of concern. Jacobs' (1969) ideas about the survival and growth of cities focus on economic diversity, and attempt to explain what causes a city to grow and expand, while another city that appeared to be almost identical seemed to be under decline.[2] Jacobs argued that the continued growth of cities despite possible failure of some or all of its industries requires a diverse economy. Diversity of an urban area's firms gives wide ranging ideas for new innovation, a broad base of useful equipment, and alternative skills relevant to the development of new kinds of business. The more diverse an economy the more likely it is to grow despite adverse conditions affecting some of its industries, as there is a broader base from which to expand. Therefore firms, and cities as a whole, are more likely to overcome industry specific pitfalls, and grow faster if the cities have diverse economies.

Jacobs (1969) illustrates her ideas with an example. At first, Manchester's efficient specialisation in textiles helped the city's economy to grow in the nineteenth century. However, at the time, the city developed almost no other industries to compensate for possible future loss of its market. This lack of diversity resulted in the city's stagnation when British textiles faced lower-priced competition from abroad. In contrast, Birmingham had lots of small independent trading industries, described as 'a muddle of oddments', with few relatively large industries. When faced with severe competition against the rest of the world, Birmingham's economy did not become obsolete; Birmingham's "fragmented and inefficient little industries" (Jacobs 1969, p89) kept introducing new ideas and innovations to keep the city's economy going.

The three theories considered by Glaeser et al. address how dynamic externalities may spur growth of regional industrial clusters, and ultimately of the regions themselves. MAR and Porter both focus on advantages that stem from having a large amount of an industry's activity in the same area. Jacobs, on the other hand, focuses on the benefits of a diverse base of economic activities within an area. The theories also have contrasting views as to whether monopoly or competition will yield the fastest growth, with MAR supporting monopoly and Porter and Jacobs supporting competition. However, it will not be possible to test these views of monopoly versus competition in England in this study, given the limitations of UK census data and of case studies to date in the UK.[3]

2 Jacobs (1969) also favours local competition, as with Porter (1990), because she believes that competition speeds up the adoption of technology.

3 UK census data do not report numbers of firms by industry and regions, nor any other measure of local competition.

Analytical Method

Hence important models of city growth stress the role of dynamic externalities, especially knowledge spillovers, in city growth. The hypothesis is that cities grow because people in cities interact with other people, either in their own industry or in other sectors, and learn from them. These knowledge spillovers are considered to be externalities, because people obtain knowledge from outside their firm or their segment of the firm. Proximity makes externalities particularly large in a city, and all the models predict that cities grow faster than rural areas in which externalities are less prevalent.

As Glaeser et al (1992) point out, one way to examine the effect of externalities in city-region growth, then, is to look at the growth of the same sectors in different cities and check in which city-regions these sectors grow faster. The unit of observation in this analysis is an industry in a city-region, as any capitalist production system can be seen as a collection of establishments (i.e. individual units of economic activity) embodying different combinations of capital and labour. Following Glaeser et al's (1992) approach, the analyses in this thesis look at the growth rates of manufacturing industries within regions in England as a function of the size and diversities of their industries. Hence this thesis examines the importance in England of dynamic externalities as a driving force for regional growth.

Following Glaeser's (1992) work, statistical techniques are applied to address the above questions about urban economics and city growth in England. The statistical techniques provide several benefits. First, they provide a means to consider the simultaneous impacts of several variables, while it is difficult or impossible to produce such multi-variable relationship using only two-dimensional graphs. Second, they quantify the effects of random or ad-hoc variables, so that it is possible to know when an apparent relationship is supported by a mass of evidence versus a few possibly chance events. Third, they allow alternative theories to be examined simultaneously in a way that maps directly in to previous research. The dynamic externality theories introduced by Marshall, Arrow, Romer, Porter, and Jacobs can be summarised using the following model.

Derivation of Statistical Model

Take a production function:

$$Q = A_t f(l_t) \qquad [1]$$

A_t = the overall level of technology at time t measured nominally

Therefore changes in A represent changes in technology and changes in price.

$f(l_t)$ = the basic production function ignoring capital inputs[4]

l_t = labour input at time t

Suppose each firm in an industry takes technology, price and wages as given, and maximises its profit π, where

$$\pi = A_t f(l_t) - w_t l_t \qquad [2]$$

To find the value of l that maximises π, take the derivative of equation [2] and set equal to zero:

$$\frac{\delta \pi}{\delta l} = A_t f'(l_t) - w_t = 0$$

Rearrange:

$$A_t f'(l_t) = w_t \qquad [3]$$

Thus the firm sets the labour input equal to the marginal productivity of labour (MPL) with respect to its wages (w_t).

Divide [3] at time t+1 by [3] at time t and take the logarithm of both sides, which yields an expression in terms of rates of growth:

$$\log\left(\frac{A_{t+1}}{A_t}\right) = \log\left(\frac{w_{t+1}}{w_t}\right) - \log\left(\frac{f'(l_{t+1})}{f'(l_t)}\right) \qquad [4]$$

A rate of growth r is defined according to the growth function:

$$N_{t+1} = N_t e^{r[(t+1)-t]}$$

Note that the first term in equation [4] is the growth rate of A_t, and similarly the second and third terms in equation [4] are growth rates of wages w_t and MPL $f'(l_t)$ respectively. To see this, divide both sides of the rate of growth equation by N_t and take the logarithm:

$$\log\left(\frac{N_{t+1}}{N_t}\right) = r[(t+1)-t] = r$$

The level of technology A_t in a region is assumed to have both national and local components:

$$A = A_{local} A_{national} \qquad [5]$$

Equation [4] thus allows for components of technology growth from national technology in an industry and the growth of local technology in the industry:

$$\log\left(\frac{A_{t+1}}{A_t}\right) = \log\left(\frac{A_{local,t+1}}{A_{local,t}}\right) + \log\left(\frac{A_{national,t+1}}{A_{national,t}}\right) \qquad [6]$$

Glaeser et al (1992) assumed that the growth of the national technology captures the changes in the price of the product as well as shifts in nationwide technology in the industry. Similarly, the local technology is assumed to grow at a rate exogenous to the firm but depending on the various technological externalities present in this industry in the city:

$$\log\left(\frac{A_{local,t+1}}{A_{local,t}}\right) = \text{g(specialisation, diversity, initial conditions)} + \rho_{t+1} \qquad [7]$$

Specialisation = measure of concentration of an industry in a region
= random variation

Diversity = measure of variety of activities that a region pursues

Set $f(l)=l^{1-\gamma}$, $0<\gamma<1$, and combine equations [4], [6] and [7] to obtain:[5]

$$\gamma \log\left(\frac{l_{t+1}}{l_t}\right) = -\log\left(\frac{w_{t+1}}{w_t}\right) + \log\left(\frac{A_{national,t+1}}{A_{national,t}}\right)$$
$$+\, g(\text{specialisation, diversity, initial conditions}) + \rho_{t+1} \qquad [8]$$

Taking equation [8], divide both sides by γ.

[4] Because of lack of data sources, labour-saving technological innovations and innovations that result only in further accumulation of physical capital are not taken into account.

[5] To see this, note that $f'(l_t) = (1-\gamma)l_t^{-\gamma}$, so $-\log\left(\frac{f'(l_{t+1})}{f'(l_t)}\right) = \gamma \log\left(\frac{l_{t+1}}{l_t}\right)$.

Let $\alpha = \log\left(\frac{A_{national,t+1}}{A_{national,t}}\right)$, $\beta_1 = -\frac{1}{\gamma}$, and $\varepsilon = \frac{\rho}{\gamma}$, then:

$$\log\left(\frac{l_{t+1}}{l_t}\right) = \alpha + \beta_1 \log\left(\frac{w_{t+1}}{w_t}\right) - \beta_2 g(\text{specialisation, diversity, initial conditions}) + \varepsilon \quad [9]$$

Assuming for simplicity that the function g( ) is linear in the available data variables yields a model of the form:

$$\log\left(\frac{l_{t+1}}{l_t}\right) = \alpha + \beta_1 \log\left(\frac{w_{t+1}}{w_t}\right) + \beta_2 \text{ specialisation} + \beta_3 \text{ diversity}$$
$$+ \beta_4 \text{ initial condition} + \beta_5 \text{ initial condition} + \cdots + \varepsilon \quad [10]$$

All industries in all regions may experience some common forces such as common technological changes (for example, increase in use of computers for administrative purposes), captured by common term α. Equation [10] associates the growth of employment in an industry in a region with measures of technological (and other) externalities given by the models.

Although Glaeser et al focus primarily on employment growth, employment may not adequately capture the true growth of industries. This is particularly true where industries experience different rates of growth in labour productivity. A better measure might be growth in gross value added, or the value of outputs less the value of inputs. Therefore, growth in gross value added rather than employment will be investigated as the dependent variable, although growth in employment will be considered as well.

III. EMPIRICAL DATA AND ANALYSIS

Construction of the Primary Data Set

The unit of observation chosen in this study is an industry in a region. This makes possible an investigation of the growth rates of regional industrial cluster as a function of cluster size and regional economic diversity. If dynamic externalities are important for city-region growth, then examining the growth of identical industrial sectors in different regions should reveal effects of cluster size and/or diversity on the growth of industrial clusters.

For this analysis, the primary data source used is 1981 and 1992 *HMSO Report on Census of Productions Summary Volume*, organised by two-digit level standard industrial classification code. The data pertain only to manufacturing industries. Similar data are not available for other economic sectors. The years 1981 and 1992 were chosen because they are the first and last year that the data were made available in this format. The two-digit level of industrial classification is used because it is the most disaggregated level at which the data were presented by region. The data are available for eight standard regions within England. Additional regions outside England were excluded because of concern about non-comparability, and particularly, about the excessive size of the regions. The data pertain to 21 industries. For some region-industries, data could not be reported in the Census of Production for confidentiality or other reasons, so the final sample sizes come to 144. Unemployment rate data for 1981 were obtained from the *UK Regional Trends 1985* data source. The Stata 6 statistical analysis computer software was used to obtain the statistical results reported here.

The data set include information on gross value added at factor cost, employment, total wages, and wages per head by two-digit industry for 8 standard regions in England. Gross value added at factor cost reflects the value of outputs less the value of inputs. Additional variables, necessary for the statistical analysis calculated using these data, will be described below.

Description of the Data

Table 1 presents a description of key aspects of the data. Panel A of the table describes the six largest manufacturing industries in each region by gross value added (panel A1) and employment (panel A2) in 1981. The panel shows a quite similar set of top six manufacturing industries in each region regardless whether gross value added or employment is used. The larger manufacturing industries appear in multiple regions; some manufacturing industries even appear in more than half, if not, all, of the regions, top six lists. However, there is also evidence of concentration of some manufacturing industries in certain regions. For instance, metal manufacturing is one of the top six industries (by both gross value added and employment) only in the North and in Yorkshire and Humberside. Also, manufacturing industries in total in each region are expanding in terms of gross value added, with the exception of the East Midlands, but employment went down in manufacturing in all eight regions, from 1981 to 1992. This implies that productivity of labour in the regions increased over the period analysed. The South East is by far the largest region in terms of gross value added, and also by far the biggest employer.

Panel B lists the 10 largest region-industries, in 1981, by gross value added (panel B1) and by employment (panel B2). Again, the South East stands out as the leading region. The South East manufacture of paper and paper products, electrical and electronic engineering, mechanical engineering, and food/drink/tobacco manufacturing industries make up the largest four region-industries by both gross value added and employment. The South East region appears six times in panel B1 by gross value added, and five times in panel B2 by employment. The North West and the West Midlands also include some large manufacturing industries, such as food/drink/tobacco manufacturing industries in the North West and manufacture of metal goods not elsewhere specified in the West Midlands.

TABLE 1

DESCRIPTION OF THE DATA

A1. REGIONS' GROSS VALUE ADDED AND LARGEST MANUFACTURING INDUSTRIES

	Goss Value Added at Factor Cost (£ millions)		
Regions	1981	1992	6 Largest Industries in 1981
North	3576.3	6329.4	Metal manufacturing, Manufacture of other transport equipment, Electrical and electronic engineering, Food/drink/tobacco manufacturing industries, Mechanical engineering, Chemical industry
Yorkshire & Humberside	5118.0	9636.5	Manufacture of non-metallic mineral products, Textile industry, Chemical industry, Metal manufacturing, Mechanical engineering, Food/drink/tobacco manufacturing industries
East Midlands	4339.3	3683.8	Footwear and clothing industry, Manufacture of metal goods not elsewhere specified, Electrical and electronic engineering, Textile industry, Food/drink/tobacco manufacturing industries, Mechanical engineering
East Anglia	1864.0	3920.6	Processing of rubber and plastic, Electrical and electronic engineering, Chemical industry, Manufacture of paper and paper products / printing and publishing, Mechanical engineering, Food/drink/tobacco manufacturing industries
South East	16406.4	28381.4	Manufacture of motor vehicles and parts thereof, Chemical industry, Food/drink/tobacco manufacturing industries, Mechanical engineering, Electrical and electronic engineering, Manufacture of paper and paper products / printing and publishing
South West	3863.7	7378.5	Processing of rubber and plastics, Manufacture of paper and paper products / printing and publishing, Electrical and electronic engineering, Mechanical engineering, Food/drink/tobacco manufacturing industries, Manufacture of other transport equipment
West Midlands	6567.0	12726.8	Manufacture of non-metallic mineral products, Food/drink/tobacco manufacturing industries, Electrical and electronic engineering, Manufacture of motor vehicles and parts thereof, Mechanical engineering, Manufacture of metal goods not elsewhere specified
North West	7835.5	13584.9	Manufacture of motor vehicles and parts thereof, Paper and paper products / printing and publishing, Electrical and electronic engineering, Mechanical engineering, Chemical industry, Food/drink/tobacco manufacturing industries
England	49570.1	91642.0	Manufacture of other transport equipment, Chemical industry, Manufacture of Paper and paper products / printing and publishing, Electrical and electronic engineering, Food/drink/tobacco manufacturing industries, Mechanical engineering

The largest industries in each region are listed in order from first to sixth largest by gross value added.

Table 1 (Continued)

A2. Regions' Employment and Largest Manufacturing Industries

	Employment (thousands)		
Regions	1981	1992	6 Largest Industries
North	336.4	245.0	Metal manufacturing, Food/drink/tobacco manufacturing industries, Chemical industry, Manufacture of other transport equipment, Electrical and electronic engineering, Mechanical engineering
Yorkshire & Humberside	556.9	428.4	Manufacture of paper and paper products / printing and publishing, Footwear and clothing industries, Manufacture of metal goods not elsewhere specified, Metal manufacturing, Textile industries, Food/drink/tobacco manufacturing industries
East Midlands	494.5	426.6	Manufacture of metal goods not elsewhere specified, Manufacture of other transport equipment, Food/drink/tobacco manufacturing industries, Footwear and clothing industries, Textile industry, Mechanical engineering
East Anglia	175.4	157.4	Manufacture of motor vehicles and parts thereof, Timber and wooden furniture industries, Manufacture of paper and paper products / printing and publishing, Electrical and electronic engineering, Mechanical engineering, Food/drink/tobacco manufacturing industries
South East	1494.7	1009.6	Chemical industry, Manufacture of motor vehicles and parts thereof, Food/drink/tobacco manufacturing industries, Mechanical engineering, Manufacture of Paper and paper products; printing and publishing, Electrical and electronic engineering
South West	374.2	320.7	Processing of rubber and plastic, Manufacture of paper and paper products / printing and publishing, Electrical and electronic engineering, Mechanical engineering, Food/drink/tobacco manufacturing industries, Manufacture of other transport equipment
West Midlands	740.0	577.2	Food/drink/tobacco manufacturing industries, Manufacture of non-metallic mineral products, Electrical and electronic engineering, Manufacture of motor vehicles and parts thereof, Mechanical engineering, Manufacture of metal goods not elsewhere specified
North West	778.2	536.9	Footwear and clothing industries, Manufacture of paper and paper products / printing and publishing, Electrical and electronic engineering, Chemical industry, Mechanical engineering, Food/drink/tobacco manufacturing industries
England	4950.3	3701.8	Manufacture of motor vehicles and parts thereof, Manufacture of metal goods not elsewhere specified, Manufacture of paper and paper products / printing and publishing, Electrical and electronic engineering, Food/drink/tobacco manufacturing industries, Mechanical engineering

The largest industries in each region are listed in order from first to sixth largest by employment.

TABLE 1 (Continued)

B1. 10 LARGEST REGION-INDUSTRIES BY GROSS VALUE ADDED IN 1981

Region	Industry	Gross Value Added at Factor Cost (£ millions)
South East	Manufacture of paper and paper products / printing and publishing	2544.4
South East	Electrical and electronic engineering	2309.7
South East	Mechanical engineering	2194.9
South East	Food/drink/tobacco manufacturing industries	1842.7
South East	Chemical industry	1612.8
North West	Food/drink/tobacco manufacturing industries	1322.9
South East	Manufacture of motor vehicles and parts thereof	1087.4
North West	Chemical industry	1079.9
W. Midlands	Manufacture of metal goods not elsewhere specified	1015.8
W. Midlands	Mechanical engineering	939.7

B2. 10 LARGEST REGION-INDUSTRIES BY EMPLOYMENT IN 1981

Region	Industry	Employment (thousands)
South East	Electrical and electronic engineering	231.8
South East	Manufacture of paper and paper products / printing and publishing	208.0
South East	Mechanical engineering	199.8
South East	Food/drink/tobacco manufacturing industries	134.4
W. Midlands	Manufacture of metal goods not elsewhere specified	133.8
South East	Manufacture of motor vehicles and parts thereof	113.5
W. Midlands	Mechanical engineering	105.7
W. Midlands	Manufacture of motor vehicles and parts thereof	103.9
North West	Food/drink/tobacco manufacturing industries	96.7
North West	Mechanical engineering	96.4

TABLE 1 (Continued)

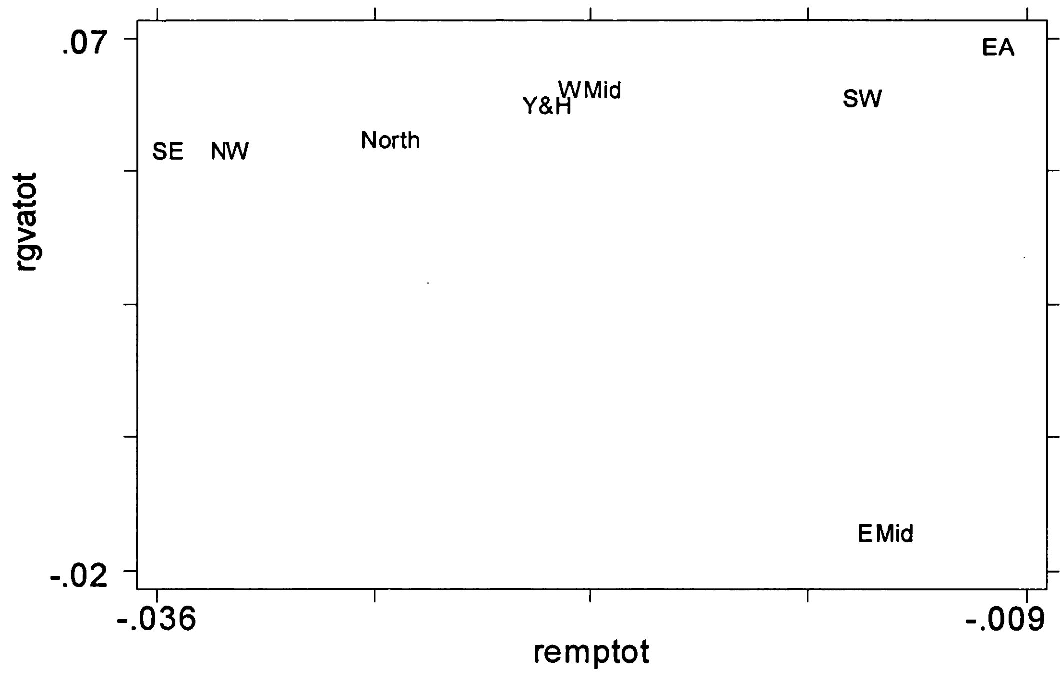
C. REGIONAL GROWTH, 1981 TO 1992

Region	Growth		Non-Diversity Measures			
	Value added	Employment	gvagini	gvashr 3	empgini	empshr3
North	0.059	-0.029	0.59	0.48	0.53	0.38
Yorkshire & Humberside	0.058	-0.024	0.51	0.41	0.51	0.41
East Midlands	-0.015	-0.013	0.52	0.42	0.53	0.41
East Anglia	0.068	-0.010	0.62	0.54	0.59	0.52
South East	0.050	-0.036	0.55	0.43	0.52	0.43
South West	0.059	-0.014	0.57	0.49	0.55	0.47
West Midlands	0.060	-0.023	0.56	0.42	0.58	0.47
North West	0.050	-0.034	0.53	0.43	0.48	0.34
England	0.056	-0.026	0.46	0.38	0.49	0.36

Average annual rates of regional growth from 1981 to 1992 for manufacturing industries.

In panel C, the Growth Columns show the regional growth, by both gross value added and employment, calculated using the total gross value added or employment across all manufacturing industries. The panel shows a clear summary picture of growth activity in each region, recalling an important point. First, the regions' expansion of manufacturing activities is seen in terms of gross value added, with growth rates of 5.0 to 6.8 percent annually over the period from 1981 to 1992, except in the East Midlands where the gross value added growth rate is –1.5 percent. On the other hand, the contraction in employment is apparent from the consistently negative growth rates of –1.0 to –3.6 annually over the period from 1981 to 1992. With the exception of the East Midlands, there tends to be a positive relationship between the growth rates of gross value added and of employment in each region, as illustrated in Graph 1.

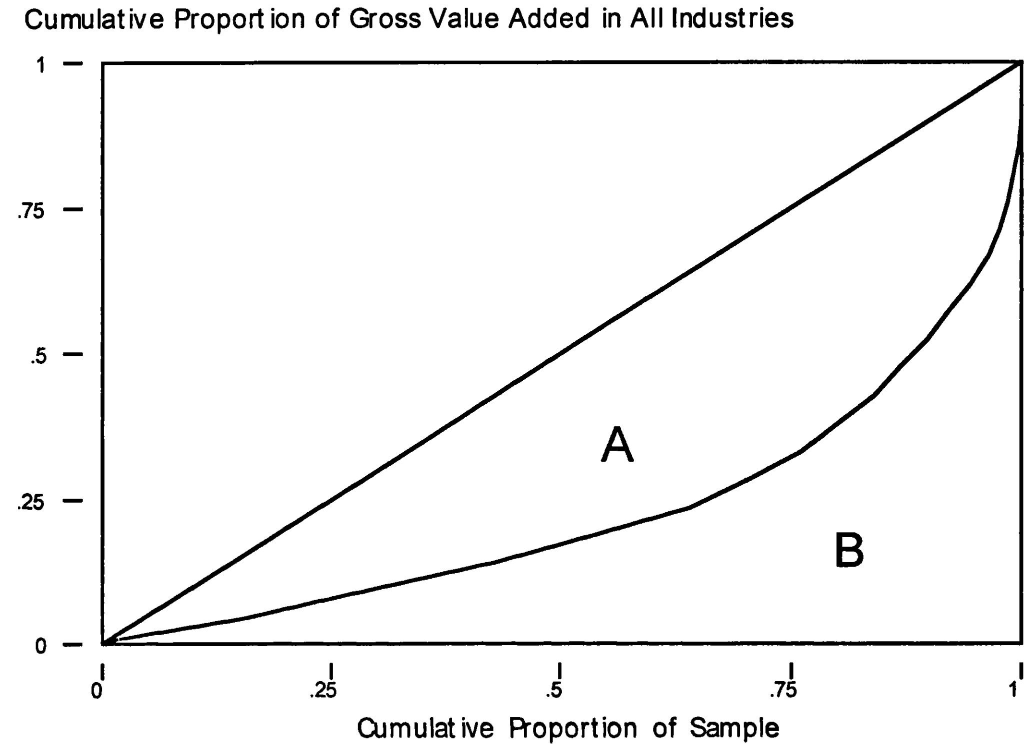
GRAPH 1. GROWTH IN GROSS VALUE ADDED VERSUS GROWTH IN EMPLOYMENT BY REGION (1981 TO 1992)



To examine the importance of Jacobs' notion of diversity, a measure of each region's economic diversity is needed. Different measures of diversity are reported in the panel C of Table 1. Two of the measures, *gvagini* and *empgini*, adapt the concept of the Lorenz curve, a construct used in the calculation of measures of inequality, to show the degree of distribution of manufacturing industries within each region. Data on both of gross value added and employment are used to construct a Lorenz curves in each region and obtain Gini coefficients. The *gvagini* measure indicates the Gini coefficient values for gross value added, and similarly *empgini* measure indicates the Gini coefficient values obtained using employment data.

Gini coefficients are often used to measure inequality in income distributions. In this study, gross value added or total employment in each manufacturing industry has been used to calculate the degree of diversity in a given region. Graph 2 below is an example of a Lorenz curve, constructed using the South East region's data on gross value added. The industries in the South East are ranked in order from lowest to highest gross value added. The bottom axis of the graph reports the fraction of industries considered, and the vertical axis report a fraction of the region's total gross value added. For example, when the 75 percent of industries with lowest gross value added are considered (0.75 on the bottom axis), they account for approximately 30 percent of the total gross value added of all the South East's industries (0.30 on the vertical axis). The Lorenz curve for the South East is the lower of the two curves on the graph. The upper curve is the upper bound possible for any Lorenz curve, and is known as the line of absolute equality; if all industries had equal amounts of gross value added, the Lorenz curve would follow the line of absolute equality.

GRAPH 2. LORENZ CURVE FOR GROSS VALUE ADDED OF INDUSTRIES WITHIN THE SOUTH EAST REGION IN 1981



The Gini coefficient is a summary statistic of inequality derived from the Lorenz curve. Let A represent the area between the Lorenz curve and the line of absolute equality, and B represent the area below the Lorenz curve. The Gini coefficient is then:

$$G = \frac{A}{A + B}$$

The Gini coefficient has a maximum value of unity (absolute inequality) and a minimum of zero (absolute equality). The closer the Gini coefficient values to zero, the more diverse are the manufacturing industries in a region; closer to one, the more non-diverse is the region.

As an alternative to the Gini coefficient non-diversity measure, the share of the top 3 manufacturing industries' gross value added, or employment, among all the manufacturing industries within a given region was calculated. The resulting measures are also given in panel C, as *gvashr3* and *empshr3*. Again, the closer the values to zero, the more diverse are the manufacturing industries in a region. Correlation coefficients of 0.96 between *gvagini* and *gvashr3*, and 0.91 between empgini and empshr3, have been obtained from the data, indicating that the Gini and top 3 share measures of non-diversity are closely related.[6]

6 However, the exact figures have different meanings, so they are not directly comparable.

The Initial Analysis

A key goal of the analyses is to understand the economic growth of regions as affected by industries within those regions. Hence a measure is needed of the economic well-being of industries. As described above, an obvious and available measure is the value of outputs from industries less value of inputs. This measure is available from the census data, and is termed gross value added. Therefore, manufacturing industries' gross value added figures are primarily used as the measure of regional growth for the purpose of analysing advantages of industrial agglomeration. Employment also has an important effect on regions, hence this analysis of the regional growth also examines employment as a measure of industry size.

Table 2 lists the means and standard deviations of selected variables to be used in the statistical analyses. The data include 144 observations on regional manufacturing industries organised by two-digit level standard industrial classification code, in eight standard regions of England. The variable *rgvafc* is the rate of growth in gross value added at factor cost. It is calculated as an annual rate of growth, as shown in the general formula in section 3. In particular, the rate of growth is $gvashr = \ln\left(\frac{gvafc_{1992}}{gvafc_{1981}}\right) \div 11$, where 11 is the number of years between 1981 and 1992. The variable *gvashr* is the regional share of an industry's gross value added in 1981. The variables *gvagini* and *gvashr3* are non-diversity measures as described above. The next four variables in table 2 are analogous to the four gross value added-based variables. Note particularly that *remp* is the rate of growth of employment, and *empshr* is the regional share of an industry's employment in 1981. The variable *rwp* is the rate of growth in wage per head within each region industry, calculated analogously to the other rates of growth. The unemployment variable states for each region its 1981 percentage unemployment, taken from *Regional Trends* (HMSO, 1992).

The means of gross value added growth (*rgvafc*) is 0.063, indicating that in an average region-industry in the sample gross value added grew 6.3 percent annually. On the other hand, the means of employment growth came out as a negative number, indicating that there are decreasing in the employment growth of 1.7 percent annually.

The standard deviations for both gross value added and employment growth turned out to be approximately 0.05, indicating substantial variations between region-industries in both growth records. The means and standard deviations are also listed for other key variables.

TABLE 2

VARIABLE MEANS AND STANDARD DEVIATIONS

VARIABLES	Mean	Standard Deviation	Number of Observations
rgvafc	0.063	0.054	144
gvashr	0.14	0.154	144
gvagini	0.556	0.035	144
gvashr3	0.452	0.044	144
remp	-0.017	0.051	144
empshr	0.015	0.018	144
empgini	0.536	0.037	144
empshr3	0.430	0.053	144
rwp	0.079	0.007	144
Unemployment (%)	8.271	2.043	144

In order to analyse how the size of industrial; clusters affects their growth rates, first, a simple approach has been taken. The equation [1] below allows testing whether there are within-industry externalities that benefit firms in the same industries in the same regions.

$$rgvafc_{i,region} = \alpha + \beta \; gvashr_{i,region} + \varepsilon_{i,region} \qquad [11]$$

Where

gvafc = gross value added at factor cost
(value of output - value of input of an industry in a given region)

$$rgvafc_{i,region} = \log\left(\frac{gvafc_{t+1,region}}{gvafc_{t,i,region}}\right)$$

= regional growth rate of Gross Value Added for an industry

$$gvashr_{i,region} \frac{gvafc_{i,region}}{\sum_{region} gvafc_{i}} = \text{regional share of an industry's Gross Value Added}$$[7]

Table 3 below lists the results from three different statistical analyses, beginning with equation [11] and then adding additional variables.[8] Analysis (1) in the table is a simple regression of growth rate of gross value added on the regional share of an industry's gross value added, in accordance with equation [11]. The estimated coefficient of gvashr is negative indicating that larger industrial clusters tend to experience slower growth. The coefficient estimate is significantly different from zero at the 0.05 level, which indicates that if there were no relationship between the growth rate of gross value added and the initial regional share of an industry's gross value added, there would be less than 5% chance of finding this coefficient estimate to be at least this far away from zero. Thus, industrial cluster seem actually to have a damaging effect on growth.

One might speculate that in some regions industries generally have relatively high or low growth rates, and this could affect the growth rates actually observed in industries and hence affect the statistical result. Analysis (2) therefore includes dummy variables for different regions, each equal to one for data points within the relevant region and zero otherwise. The regional dummy variables are assessed relative to the South East, which is the omitted region. The South East region, which includes London, is often considered as one of the leading centres of growth in England, and hence makes a useful comparison group. When the regression is fitted, the coefficient estimates, however, indicates that manufacturing industries tended to grow slightly faster in most other regions during 1981-1992, since the coefficient estimates are mostly positive. Nevertheless, none of the region dummy estimates are statistically significantly different from zero. The estimated coefficient of *gvashr* is

7 Indicated as "gvashr" in table 2 below.

8 See Appendix for an example of robustness tests to check the validity of regression results.

hardly affected, compared to the estimate in model (1). The estimated coefficient of *gvashr* remains approximately –0.09, and is still significant at the 0.05 level.

Technology product life cycle theory suggests that newer industries, which have higher growth rates, also tend to have greater technological knowledge spillovers. The effect of regional share of an industry's gross value added on the growth rate therefore, is expected to be different in high and low growth region-industries. Hence technological knowledge spillovers should benefit firms in industrial clusters more if those firms are in faster growing industries. The mean value of the growth rate of gross value added among the different industries in England as a whole is used as the dividing point between faster growing manufacturing industries and slower growing ones. A growth dummy variable *hiGroInd* is set equal to 1, for high growth industry industries (if the growth rate of the region-industry is higher than the national average), and otherwise is set equal to 0. As a way to treat missing data point, a separate growth dummy variable, *unGroInd* (meaning unknown-growth in industries) is generated. In this dummy variable, the industries with missing data at the England level have values of 1, and other industries have values of 0; the missing data cases may contain both high and low growth industries. The dummies *hiGroInd* and *unGroInd* are multiple by *gvashr* to yield two new variables: *gvashrH* = gvashr × HiGroInd, and *gvashrU* = gvashr × unGroInd.

To consider the effect of product life cycles, the following equation represents the model of analysis (3):

$$rgvafc_{i,region} = \alpha + \beta_1 gvashr_{i,region} + \beta_2 gvashrH_{i,region} + \beta_3 gravshrU_{i,region} \\ + \beta_4 region1_r + \cdots + \beta_{10} region7_r + \varepsilon_{i,region} \qquad [12]$$

Note that equation [12] can be rewritten in the following form:

$$rgvafc_{i,region} = \alpha + gvashr_{i,region}(\beta_1 + \beta_2 gvashrH + \beta_3 gvashr) \\ + \beta_4 region1_r + \cdots + \beta_{10} region7_r + \varepsilon_{i,region} \qquad [13]$$

For a low-growth industry, *hiGroInd* = 0 and *unGroInd* = 0, so:

$$rgvafc_{i,region} = \alpha + \beta_1 gvashr_{i,region} + \beta_4 region1_r + \cdots + \beta_{10} region7_r + \varepsilon_{i,region}$$

For a unknown-growth industry, *hiGroInd* = 0 and *unGroInd* = 1, so:

$$rgvafc_{i,region} = \alpha + (\beta_1 + \beta_3) gvashr_{i,region} + \beta_4 region1_r + \cdots + \beta_{10} region7_r + \varepsilon_{i,region}$$

For a high-growth industry, *hiGroInd* = 1 and *unGroInd* = 0, so:

$$rgvafc_{i,region} = \alpha + (\beta_1 + \beta_2) gvashr_{i,region} + \beta_4 region1_r + \cdots + \beta_{10} region7_r + \varepsilon_{i,region}$$

The estimates of model [12] are column (3) of Table 3. In the analysis (3), the region dummies' coefficient estimates show substantial difference in growth for some regions compared to the South East region. However, again, the region dummies show no statistically significant differences and therefore one cannot make too much out of this statistical result, as it may be just randomness. On the other hand, the estimated coefficients of *gvashrH* and *gvashrU* show that both variables have significant effects. This means that there is a significant difference between high and low growth industries in terms of how clustering matters. The estimated coefficient of *rgvafc* (the estimate of β_1) indicates that in low growth industries clustering is detrimental to growth. Yet, in high growth industries (and unknown-growth industries), clustering is little if at all detrimental to growth, as $\beta_1 + \beta_2$ (and $\beta_1 + \beta_3$) are near zero and are not significantly different from zero.

TABLE 3

REGRESSIONS OF ANNUAL GROWTH IN GROSS VALUE ADDDED

VARIABLES	(1) All Industries	(2) All Industries	(3) All Industries with High vs Low Growth
gvashr	-0.089 (0.031)*	-0.088 (0.041)*	-0.301 (0.056)***
North		0.003 (0.021)	-0.010 (0.021)
Yorkshire & Humberside		0.021 (0.019)	0.012 (0.019)
East Midlands		0.013 (0.020)	0.006 (0.020)
East Anglia		0.003 (0.021)	-0.015 (0.021)
South West		-0.008 (0.020)	-0.017 (0.020)
West Midlands		0.005 (0.019)	-0.000 (0.018)
North West		-0.007 (0.020)	-0.013 (0.018)
gvashrH			0.257 (0.047)***
gvashrU			0.255 (0.061)***
Constant	0.075 (0.006)	0.070 (0.019)	0.091 (0.020)
Adjusted R_	0.0498	0.0320	0.2181
Number of Observations	144	144	144

†p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are given in parentheses.
gvashr = regional share of an industry's gross value added

Analysis Including Clustering, Diversity, and Wage Growth

The prediction of the MAR theory and Porter's theory of dynamic externalities is that clustering of an industry in a city should speed up growth of that particular industry in that city. Jacobs argues that important knowledge transfer occurs outside the particular industry and hence that diversity in a city is advantageous to growth of all industries in the city. In order to test the MAR/Porter and Jacobs hypotheses, equation [10] is used for the regression analyses in this sub-section.

Equation [10] suggests that employment growth in an industry in a region may depend on the diversity/specialisation of that industry in the particular region. As seen in the initial analysis, gross value added is used as the primary measure to assess the region-industry's growth. A Gini coefficient variable is used as a non-diversity measure. Regional dummies are not included in the following analysis because it is not possible to include both region dummies and the measure of unemployment, which varies only by region.

The first two analysis, (4) and (5), will be repeated in (6) and (7), using the top 3 manufacturing industries' share of gross value added, among all the manufacturing industries within a given region, to help ensure that (non-) diversity is measured appropriately. Regression model (5) and (7) include the 1981 regional unemployment rate as a control variable, because a region has more people available to work if there is high unemployment in that region, and hence growth may be higher. Also in analysis (5) and (7), the *gvashrH* and *gvashrU* variables are used as in the previous analysis. Table 4 presents the result for analysis (4) through (7).

Column (4) reports results of a regression analysis with the three key variables from equation [10]. If there are within industry (positive) externalities such as from technological knowledge spillovers, then the coefficient of the regional share of an industry's gross value added (*gvashr*) should be positive. However, the results of analysis (4) come out with a negative value, indicating that it is disadvantageous to a firm to be located in an industrial cluster, as agglomerative externalities tend to slow regional industrial growth.

TABLE 4

FULL REGRESSIONS OF ANNUAL GROWTH IN GROSS VALUE ADDED

VARIABLES	(4) All Industries	(5) All Industries with High vs Low Growth	(6) All Industries	(7) All Industries with High vs Low Growth
gvashr	-0.105 (0.032)**	-0.300 (0.045)***	-0.108 (0.032)**	-0.314 (0.047)***
gvagini	-0.125 (0.127)	-0.199 (0.117)†		
gvashr3			-0.106 (0.104)	-0.194 (0.103)†
rwp	1.597 (0.637)**	1.299 (0.592)*	1.608 (0.637)*	1.298 (0.590)*
unemp		0.000 (0.002)		-0.001 (0.002)
gvashrH		0.240 (0.047)***		0.239 (0.047)***
gvashrU		0.266 (0.055)***		0.276 (0.055)***
Constant	0.021 (0.088)	0.094 (0.088)	-0.001 (0.069)	0.081 (0.077)
Adjusted R_	0.0840	0.02521	0.0845	0.2557
Number of Observations	144	144	144	144

†p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are given in parentheses.
gvashr = regional share of an industry's gross value added, *gvagini* = non-diversity measure 1, *gvashr3* = non-diversity measure 2, *rwp* = wage growth per head, *gvashrH* = gvashr× hiGroInd, *gvashrU* = empshr× unGroInd

On the other hand, the coefficient of the non-diversity measure, the Gini variable for an industry's gross value added, shows a negative sign, meaning that diversity helps to generate growth, as Jacobs (1969) argued. As anticipated by Glaeser et al, the control variable for wage growth matters to region-industry growth. However the estimated coefficient of the wage growth variable is positive, rather than negative as anticipated in Glaeser et al's model, perhaps because gross value added has been used rather than the employment variable they used.

Analysis (6) is the same regression as carried out in (4), but using the share of the top 3 manufacturing industries' gross value added among all the manufacturing industries within a given region (gvashr3) as the non-diversity measure, instead of the

Gini variable. As expected, a similar result is obtained. The estimated coefficients of both gvashr and gvashr3 are negative, again showing a favourable result for Jacobs' argument. The estimated coefficient of the wage growth variable is also positive, as seen in analysis (4).

All of the additional control variables are included in analyses (5) and (7), which otherwise accord with equation [10]. The three variables analysed in (4) and (6) have the same estimated signs as seen in the previous regression analyses. The estimated coefficients for the unemployment variable in both analyses (5) and (7) are near zero. This means that a one standard deviation change in unemployment (which is approximately 2 percent) is estimated to result in only a 0.004 percent increase in growth, and only a 0.1 percent decrease in growth, respectively in analyses (5) and (7), and in both analyses the variable is statistically insignificant. Both *gvashrH* and *gvashrU* estimated coefficients with positive signs and are highly statistically significant, indicating substantially more positive effect of cluster size on growth among high-growth and unknown-growth industries, as expected from earlier regressions. From the result, the low growth industries have a strong estimated negative effect of cluster size on growth; i.e. the larger the cluster, the slower the growth. As for the high- and unknown-growth industries, the effect is much more positive; the sum of *gvashr* and *gvashrH* estimated coefficients, and the sum of *gvashr* and *gvashrU* are still negative but very close to zero. From this, there is an important point to learn; both high-growth and unknown-growth industries have significantly higher effect of regional share of an industry's gross value added on growth, and the difference between these industries and low-growth industries are statistically significant. Note that the sums of the two β values ($\beta_1 + \beta_2$ and $\beta_1 + \beta_3$) are not significantly different from zero.

TABLE 5

FULL REGRESSIONS OF ANNUAL GROWTH IN EMPLOYMENT

VARIABLES	(8) All Industries	(9) All Industries with High vs Low Growth	(10) All Industries	(11) All Industries with High vs Low Growth
empshr	-0.814 (0.249)**	-1.716 (0.372)***	-0.854 (0.245)**	-1.735 (0.375)***
empgini	0.085 (0.116)	0.107 (0.118)		
empshr3			0.013 (0.079)	0.066 (0.098)
rwp	-0.286 (0.604)	-0.476 (0.592)	-0.309 (0.604)	-0.493 (0.592)
unemp		0.003 (0.002)		0.003 (0.003)
empshrH		1.650 (0.432)***		1.653 (0.432)***
empshrU		1.212 (0.444)*		1.215 (0.447)**
Constant	-0.028 (0.081)	-0.045 (0.090)	0.014 (0.059)	-0.018 (0.079)
Adjusted R_	0.0702	0.1581	0.0668	0.1559
Number of observations	144	144	144	144

†p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are given in parentheses.
empshr = regional share of an industry's employment, *empgini* = non-diversity measure 1, *empshr3* = non-diversity measure 2, *rwp* = wage growth per head, *empshrH* = empshr× hiGroInd, *empShrU* = empshr× unGroInd

Until now, gross value added has been used as the primary growth measure. However, the following regression analyses consider employment rather than gross value added as a measure of industrial cluster size and growth. Therefore Table 5 presents estimates of statistical models similar to those of Table 4, but using employment in place of gross value added. The regression thus fits more closely with the framework of Glaeser et al.

The analyses presented in Table 5 indicate similar results to the previous analyses using growth rate of gross value added. Three key points become apparent with the listed four models, (8), (9), (10) and (11). First, the disadvantage of clustering within industries still exists. Second, there is no longer evidence of an advantage of diversity, since the coefficients and *empgini* and *empshr3* are positive rather than negative as in analyses (4) through (7), and are statistically insignificant. Third, the difference between high and low growth industries still exists and it matters. Analyses (9) and (11) confirm that low growth industries have definite disadvantages from clustering whereas high-growth industries have only tiny and statistically insignificant disadvantages. It is interesting to note that there is evidence found in favour of neither the MAR-Porter theory nor Jacobs' hypothesis.

Summary of Two-Digit Industry Findings

The above regression model results reveal several interesting findings. All the analyses show that, on average, if an industry is located in, a heavily concentrated region, the industry tends to grow more slowly. The effect is statistically significant, and quantitatively substantial. Analysis (4) for example indicates that a one standard deviation change in *gvashr* (which is approximately 0.15) will result in approximately a 1.5 percent decrease in growth.

The results, however, show that high-growth industries have significantly higher effects of regional share of an industry's gross value added on growth. This means that there is a statistically significant difference between high and low growth industries in terms of how clustering matters. The statistical analyses (3), (5) and (7) indicate that in low growth industries clustering is detrimental to growth, but not in high growth industries.

The results concerning Jacobs' hypothesis, that diversity matters to generate growth, are more ambiguous. The estimates using gross value added support Jacobs' hypothesis, but the estimates using employment contradict her hypothesis. In both cases, the results concerning diversity are statistically insignificant, suggesting that in these analyses, any apparent effects of diversity could be simply misleading impressions resulting from random variation.

Three-Digit Industry Analyses

Evidence for within-industry advantages of clustering is not found in the analyses. One might argue that this is the result of looking at very broad industry categories, with industries defined using two-digit level standard industrial classifications. I therefore obtained what is available for UK manufacturing industry data organised at the three-digit level standard industrial classification for England, to run another set of regression analyses to see whether there are any different conclusions to be reached. The three-digit data sample is collected for the years between 1993 and 1997, the only years for which three-digit census data by region had been released at the time of this work. The data use slightly different regional classifications than the two-digit data, with ten different standard regions in England. The data sample includes 586 non-missing observations, and Table 6 lists the variable means and standard deviations for the three-digit industry data.

TABLE 6

VARIABLE MEANS AND STANDARD DEVIATIONS OF 3 DIGIT INDUSTRY SAMPLE DATA

VARIABLES	Mean	Standard Deviation	Number of Observations
rgvafc	0.065	0.116	586
gvashr	0.154	0.020	586
gvagini	0.744	0.046	586
gvashr3	0.226	0.085	586
remp	0.010	0.097	586
empshr	0.144	0.147	586
empgini	0.731	0.037	586
empshr3	0.214	0.062	586
rwp	0.072	0.071	586

Table 7 lists the results from four different statistical analyses. Analysis (12) is a simple regression of growth rate of gross value added (*rgvafc*) on the regional share of an industry's gross value added (*gvashr*), as in analysis (1) of Table 3. The estimated coefficient of *gvashr* is negative, as expected from the earlier analysis, indicating that larger industrial clusters experience slower growth.

Analysis (13) includes dummy variable for each region equal to one for data points within the relevant region. With the classification of 10 different regions in England instead of 8, London is chosen to be the omitted region. The coefficient estimates indicate that manufacturing industries tend to grow slightly faster in regions other than London, since the coefficient estimates are positive. Nevertheless, most of the region dummy estimates are not statistically significantly different from zero, with the exception of slight significance in the South East and South West regions. The estimated coefficient of gvashr seems hardly affected.

Analysis (14) accounts for different effects of regional share of an industry's gross value added on the industry's growth rate, in high-growth versus low-growth industries. The estimated coefficient of *gvashrH* shows that there is a significantly more positive effect of regional share of an industry's gross value added on growth for high-growth industries. This means that there is a significant difference between high- and low-growth industries in how clustering matters, as expected from other regression results. In fact the high-growth industries have a slightly (but insignificantly) positive effect: within a high-growth industry, the larger regional clusters tends to grow very slightly faster than the smaller regional clusters.

Analysis (15), with the Gini non-diversity variable, and analysis (17), with the *gvashr3* non-diversity variable, in Table 8 represent the regression analyses with the three key variables from equation [10]. The estimated coefficients of the non-diversity variables are near zero, with negative signs that indicate that diversity may help to generate growth, although the estimates are not significantly different from zero. As usual, the estimated coefficients of *gvashr* indicate that greater industrial clustering tends to slow an industrial cluster's growth.

Analyses (16) and (18) use all measures of externalities simultaneously. The three key variables have the expected signs. For low-growth industries, the estimates confirm that industry overrepresentation in a region hurts growth. The fact that the estimated coefficient of gvashr has the wrong sign relative to what the MAR theory predicts and is statistically significant is evidence against the importance of permanent within-industry knowledge spillovers for growth. Again, the *gvashrH* variable shows a positive sign. When adding the estimated coefficients of *gvashr* and *gvashrH*, the result comes out slightly positive indicating that there are slight (but statistically insignificant) advantages of clustering within high-growth industries. Since the growth rates of industries classified with *unGroInd* = 1 (meaning unknown-growth industries) are not known, and the variable is created as a way to treat missing data points in the collected sample, it is hard to make much out of the analysis result for unknown-growth industries.

The estimated coefficient of the wage growth variable in all of the analyses given in Table 8 is positive at the three-digit industry classification level, as it was at the two-digit level. According to the model shown in section II, the estimated coefficients of the wage growth variable should be less than –1 (since $0<\gamma<1$), suggesting that some of the specific assumptions made in Glaeser et al's model may be overly restrictive. Indeed, Glaeser et al may have found a similar result, since they chose to exclude the growth of wage (*rwp*) as an independent variable in their regressions.

As before, the analyses are repeated using growth of employment rather than gross value added and the estimated, and results are presented in Table 9. The findings are similar to the earlier regression analyses, and the estimated coefficients of all three key variables (*empshr*, the non-diversity measure and wage growth) have the same sign as the analogous estimates in Table 8. The estimated coefficients of both non-diversity variables, *empgini* and *empshr3*, indicate a statistically insignificant benefit from diversity. High growth industries have a slight benefit of clustering, while in low-growth industries areas with larger clusters suffer substantially lower growth than areas with very small clusters.

TABLE 7

REGRESSIONS OF ANNUAL GROWTH IN GROSS VALUE ADDED USING 3 DIGIT INDUSTRY SAMPLE DATA

VARIABLES	(12) All Industries	(13) All Industries	(14) All Industries with High vs Low Growth
gvashr	-0.823 (0.233)***	-0.837 (0.236)***	-1.489 (0.283)***
North East		0.022 (0.022)	0.014 (0.022)
North West		0.016 (0.020)	0.016 (0.020)
Merseyside		0.018 (0.025)	0.009 (0.025)
Yorkshire & Humberside		0.012 (0.020)	0.008 (0.020)
East Midlands		0.003 (0.020)	0.000 (0.020)
West Midland		0.019 (0.020)	0.013 (0.020)
Eastern		0.032 (0.020)	0.028 (0.020)
South East		0.044 (0.021)*	0.043 (0.021)*
South West		0.036 (0.021)†	0.034 (0.021)†
gvashrH			1.541 (0.377)***
gvashrU			-0.766 (1.919)
Constant	0.078 (0.006)	0.058 (0.015)	0.058 (0.015)
Adjusted R_	0.0192	0.0182	0.0439
Number of Observations	586	586	586

†p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are given in parentheses.
gvashr = regional share of an industry's gross value added, *gvagini* = non-diversity measure 1, *gvashr3* = non-diversity measure 2, *rwp* = wage growth per head, *gvashrH* = gvashr× hiGroInd, *gvashrU* = empshr× unGroInd

TABLE 8

FULL REGRESSIONS OF ANNUAL GROWTH IN GROSS VALUE ADDED USING 3 DIGIT INDUSTRY SAMPLE DATA

VARIABLES	(15) All Industries	(16) All Industries With High vs Low Growth	(17) All Industries	(18) All Industries with High vs Low Growth
gvashr	-0.819	-1.523	-0.806	-1.505
	(0.234)**	(0.282)***	(0.233)**	(0.282)***
gvagini	-0.008	0.006		
	(0.130)	(0.101)		
gvashr3			-0.059	-0.051
			(0.056)	(0.055)
rwp	0.129	0.162	0.126	0.159
	(0.670)†	(0.666)*	(0.067)†	(0.067)*
gvashrH		1.637		1.621
		(0.376)***		(0.376)***
gvashrU		-0.377		-0.483
		(1.910)		(1.908)
Constant	0.062	0.058	0.082	0.074
	(0.076)	(0.075)	(0.015)	(0.015)
Adjusted R_	0.0220	0.0505	0.0239	0.0520
Number of Observation	586	586	586	586

†p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are given in parentheses.
empshr = regional share of an industry's employment, *empgini* = non-diversity measure 1, *empshr3* = non-diversity measure 2, *rwp* = wage growth per head, *empshrH* = empshr× hiGroInd, *empShrU* = empshr× unGroInd

TABLE 9

FULL REGRESSIONS OF ANNUAL GROWTH IN EMPLOYMENT USING 3 DIGIT INDUSTRY SAMPLE DATA

VARIABLES	(19) All Industries	(20) All Industries with High vs Low Growth	(20) All Industries	(22) All Industries with High vs Low Growth
empshr	-0.101	-0.356	-0.107	-0.360
	(0.028)***	(0.037)***	(0.028)***	(0.036)***
empgini	-0.044			-0.116
	(0.110)			(0.060)†
empshr3		-0.069	-0.123	
		(0.101)	(0.065)†	
rwp	0.043	0.053	0.042	0.052
	(0.057)	(0.053)	(0.057)	(0.052)
empshrH		0.392		0.390
		(0.040)***		(0.040)***
empshrU		0.352		0.353
		(0.054)***		(0.053)***
Constant	0.054	0.071	0.049	0.046
	(0.081)	(0.075)	(0.016)	(0.015)
Adjusted R^2	0.0171	0.1630	0.0229	0.1677
Number of observations	586	586	586	586

†p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are given in parentheses.
empshr = regional share of an industry's employment, *empgini* = non-diversity measure 1, *empshr3* = non-diversity measure 2, *rwp* = wage growth per head, *empshrH* = empshr× hiGroInd, *empShrU* = empshr× unGroInd

IV. DISCUSSION: LOCALISATION VERSUS URBANISATION

An urban agglomeration is often defined as a geographic concentration of economic activities. It is commonly accepted that spatial proximity of economic activities makes these activities more efficient than if they are spatially dispersed. External economies occur when there are some kind of services or benefits from co-locating that would be unavailable or more costly elsewhere. Agglomerative externalities include the transmission of (technological) knowledge, and Henderson (1974, 1986) has studied the effects of externalities on location extensively. Baptista (1998) summarises Henderson's four sources of location externalities, which are widely recognised by many urban economics and planning literatures.

- *Economies of intra-industry specialisation, when greater industry size permits firms to pursue greater specialisation;*
- *Labour market economies, where industry size reduces search costs for firms looking for workers with specific training relevant to that industry;*
- *Enhanced communication among firms, which can accelerate the adoption of innovations;*
- *Public intermediate inputs tailored to the particular need of local industries.*

Baptista, 1998, p21.

The list above is similar to Marshall's (1920) much older account of the forces generating industrial districts. Indeed, industrial clusters are found in a wide variety of industries. In England, industries within strong clustering have included for example, cotton, computer and biotechnology industries.

Goldstein and Gronberg (1984) points out three different approaches to the scale concept underlying "agglomerative economies" (Goldstein and Gronberg, 1984, p91). There are:

- economies internal to a firm at a given location,
- economies external to firms at a given location, but internal to an industry at that location, called *localization economies*, and
- economies external to both firms and the specific industry at a particular location, called *urbanisation economies*.

All three approaches mentioned here imply that the benefits that firms derive from operating in an urban environment are based on scale concept. Urban areas are considered as a driving force for the spatial integration process.

The empirical evidence described in the previous section rejects the benefits of localisation externalities, opposing the MAR-Porter theory of specialisation advantages. One possible explanation for this may be, as Glaeser et al also mention in their analysis, that the analysed manufacturing industries have already clustered in the past, so that they have maximised their benefits of being together. The clusters grew quickly in past, but they are not now growing as quickly as they used to grow. Since the collected sample data sets are recent (two-digit data from 1981, three-digit data from 1993 to 1997), this argument seems plausible.

The results thus could actually be consistent with the importance of localisation externalities, as long as the firms are taking advantage of being close to each other. This implies, for example, that newer industries, in which firms enter to take advantage of localisation externalities, as technology product life cycle theory would predict, should have a greater impact of technological knowledge spillovers on their growth. Indeed, the empirical work indicated that there is a significant difference between high and low growth industries regarding how clustering matters. The findings suggest that the benefits of clustering may occur only in the earlier, high-growth eras of young industries. Alternatively, the higher-growth industries may tend to be higher-technology industries, which have more opportunities to benefit from local knowledge spillovers.

So, a regional industrial cluster can be advantageous to firms within an industry, and hence may spur regional growth in many circumstances. Some firms actively choose to locate their activities inside the main industrial cluster, and there are several reasons for such a movement. Natural resource and/or transport advantages often favour a particular location, and these advantages apply equally to all firms in the industry (Glaeser et al, 1992). Indeed, Bairoch's (1988) evidence suggests that many new cities formed near energy supplies during the industrial revolutions. Marshall (1920, and also discussed in Krugman, 1991a, and 1991b) found that agglomeration of an industry in one area is beneficial because an industrial centre allows a pooled market for workers with specialised skills.[9] In lien with a

9 Krugman presents his models of urbanisation externalities in his work, 1990a and 1990b, and related issues in Krugman 1995.

separate point by Marshall, a whole industry might locate near the place of common suppliers, to reduce the cost of getting supplies as well as to have a closer flow of information to suppliers. More generally, when firms share inputs that are costly to relocate, it pays them to locate together near their inputs to save on the costs of moving inputs (Henderson, 1986). Henderson (1986) concludes that a region needs concentrations of employment for an industry to maintain high levels of growth. Finally and most importantly, nearness increases the frequency of exchange of information about product and process technologies and thus improve approaches for marketing and management.

Nearness by itself, however, does not guarantee an advantage. Saxenian (1994) makes this point clear by contrasting Silicon Valley with the Route 128 area near Boston, in the process uncovering the characteristics that seem to be necessary for regional agglomeration to give an advantage. Saxenian points out the following differences between the two regions' cultures:

- Openness and interchange of ideas among engineers and managers in Silicon Valley, versus Boston. There was very little interaction noted around the latter place.
- The normality of rapid job-change in Silicon Valley, versus job change taken as a danger sign about a potential employee around Boston.
- Readily available start-up money, especially from previously successful entrepreneurs, in Silicon Valley, targeted to particular technology areas by venture capital firms. Past failures were not barriers to getting start-up money in Silicon Valley whereas it was difficult to obtain loans from conservative Boston banks.
- Close links between university research and educational programs are observed in Silicon Valley, but very little around Boston.
- Firms in Silicon Valley tended to work closely with local government and volunteered executives' time to try to resolve regional problems. More combative and political corporate-government relations characterise the Boston area.
- Willingness of firms in Silicon Valley to share facilities when special needs arose and the facilities were not in use. This did not happen in the Boston area.

Saxenian claims that Silicon Valley had a culture that encouraged openness, communication, and interchange in all these ways, whereas the Boston area did not.

Saxenian attributes the success of Silicon Valley to its culture of openness, communication, and interchange.

It was by observing industry localisation that Marshall (1920) derived the concept of advantageous dynamic externalities. The above types of positive economies of scale provide a strong reason for some firms to locate close together. Although cities are usually specialised in a few lines of work, many cities engage themselves into other activities, which are often entirely unrelated to each other, and this suggests another type of externality operating in a city. Henderson (1986,) in particular refers to such an effect as urbanisation externalities.

Urbanisation externalities imply that local payrolls rise as an industry grows, and hence local demand grows and contributes to the growth of other industries which are not necessarily related in that city-region. Consequently, growth rates of different industries in the same city-region show positive correlation. Such an argument is most compelling for local businesses and services that grow as the city-region expands. Baptista (1998) concludes that external effects become more pronounced, thus making the region even more attractive, as more firms locate in the same region. "Eventually", Baptista continues, however, "increasing costs from concentration and congestion would slow down the entry of firms, and the agglomeration would stop short of excessive concentration" (Baptista, 1998, pp.21-22).

Crowding hence acts against urbanisation benefits, as Glaeser et al (1992) also mention. Glaeser et al (1992) explain, "When an industry in a city grows, it raises wages and rents and so makes it more expensive for other industries to expand in that city. Conversely, when an industry in a city shrinks, it frees up land and labour and so makes growth of other industries more attractive" (Glaeser et al, 1992, p1150). If this is true, then urbanization (i.e. local demand) externalities and crowding effects would have opposite implications for the statistical analysis results.

The work of Forrester (1969) indicates that as an urban area changes from growth to equilibrium, changes occur in its population mix and economic activities. During such a development, he claims, continuing renewal is necessary lest the accumulation and ageing of capital plus possible decline in industry cause stagnation in cities. Further, Harvey (1985) conceptualised the significance of investment in the built environment, suggesting links between urban restructuring and further economic development. According to his theory, a city's economic growth gradually slows until all viable space is used, as more capital is invested in the built environment.

Hence eventually investment in new, relatively efficient capital tends to move to new sites. Moreover, as the existing built environment becomes relatively low in quality, capital has further incentives to move elsewhere to maintain profitability. Harvey also considers social and political struggles, which can attempt to maintain the viability of a city against an economic force, to ensure the survival of urban infrastructures.

The relationship between social conflict and capitalist development lies at the heart of Massey's (1984) approach to urban development. Massey's theory places great importance on industrial restructuring, avoiding pure economic accounts, and considers the social qualities of labour in attracting capital. Massey (1984) points out that social conditions of an area condition the effects of technological knowledge spillovers; the spatial division of labour will change if there are diseconomies in a region, resulting from congestion, excessive growth, and the development of multi-regional and multinational companies. As a result, Massey argues, Britain could increasingly be seen as a country divided between two parts. Britain could have a prosperous South (especially around the South East region), where the control functions of large organisations are concentrated, and a depressed North, where employment tends to be concentrated in branch plants and which largely involves manual workers.

V. CONCLUSIONS: ASPIRATIONS FOR PLANNING POLICY

A commonly cited fact is that some regions are endowed with faster growing industries than other regions. The formation of a successful industrial cluster is not a single evolutionary process with a uniform routine; every city, every region has its own process. This point is clear from the empirical findings of section III showing that some regions' manufacturing industries grow faster than others and hence these regional economies cannot all be assimilated into one model. Further, survival of a cluster depends on individual firms' abilities to evolve and to adapt to continuously widening global competition.

The empirical analysis in this study provides evidence for England that, in recent periods, dense industrial clusters tend to have suffered slower growth than smaller clusters in the same industry. The results also indicate, however, that for some industries—apparently especially new high-technology industries—larger clusters did not have a disadvantage and many had an advantage. In addition, there may be some advantage to economic diversity in cities, although the evidence is mixed on this matter.

One of the main findings of the statistical analysis is that higher-growth industries have more benefit of clustering on growth. However, is not this just a statistical artefact, because within high-technology industries is not it no surprise that growth is higher? This thinking would miss the point. The statistical estimations do not address whether growth is higher in high-growth industries; instead, they address whether the effects of cluster size differ in high-growth (versus low-growth) industries. That is, the statistical results indicate that within a given high-growth industry, the larger geographic clusters tend to experience similar or even slightly higher growth compared to the smaller geographic clusters. This pattern contrasts dramatically with the low-growth industries. Within a given low-growth industry, the larger geographic clusters tend to experience substantially lower growth compared to the smaller geographic clusters.

The findings of this study suggest that technology knowledge spillovers provide an important policy lever to affect regional growth and development, if, and only if, the policies are addressed to appropriate industries and methods. That is, positive externalities through knowledge spillovers do not occur in every industry, but only in certain kinds of industries. Beneficial knowledge spillovers do not happen automatically but only if encouraged through appropriate means.

Externalities of industrial clusters, however, seem to be case specific. The British models of industrial clustering, namely computers and biotechnology, which are often discussed in planning and urban economics literatures, capture most of the characteristics of industrial clustering advantages discussed above, although, these characteristics do not apply to many other industries scattered across regions. Also, there is little evidence when it comes to the initial choice of location; Baptista (1998, p43) points out that "[t]he location of innovative (and, more particularly, high-technology) industries results from a more spontaneous unplanned choice". This suggests that appropriate regional policies may be able to influence where clusters form, in the very industries where clustering matters and can enhance regional growth.

Baptista (1998) summarises three properties that are common to all successful clusters:

- Formal and informal networking, encouraging knowledge spillovers and other structural and organisational capabilities;
- Close user-producer collaboration, encouraging new innovations;
- Mobility in the local labour market.

The most positive links between knowledge spillover externalities and regional growth seemed according to Baptista to concern the supply-side benefits, such as ease of information flow, availability of skilled labour (shaped by education and migration), and the size distribution of industries in a region.[10] Any policy implication to enhance these opportunities for networking, spillovers, collaboration, and job mobility should, therefore be welcome.

Policies designed to stimulate co-operative research behaviours may give regions an opportunity to enhance their potential capability and stimulate regional growth. As seen in US experiences, such as Silicon Valley, well established networks help people to interact freely and exchange their knowledge vital to new innovation, and hence to regional growth.[11] If the agglomerative economy has the characteristics

10 These findings agree with those of Saxenian (1994), as well as with research on the sources of innovation such as Johnston and Gibbons (1975) and von Hippel (1988).

11 Saxenian (1994). The point is also discussed in Swann and Prevezer (1996).

of local public goods as the work of Helsley and Strange (1990) points out, then some means of local collective activities encouraged by government may be of great help.

Many economists might argue that such co-operative behaviour could result in collusive, anti-competitive behaviour. However, Schumpeter (1945), and many more recent economists including Solow (1957), point out that this concern with collusion and prices misses the point, because what drives growth is technology, not low prices. Further, Temple (1998) points out that cooperation is unlikely to result in anti-competitive behaviour in the case of local collaboration, if the collaboration is set up to meet the challenges of the international market as the new international division of labour theory suggests.

From Saxenian (1994), Harvey (1985) and Massey's (1984) points, it can be concluded that the characteristics of clusters are highly dependent on the social, political and economic environment of the regions. Hence all of those aspects should be carefully considered when formulating policy options. However, it is important to recognise that the solution to problems involving the restructuring of intra-urban spaces requires a recognition of the role of the government, in particular, regional planning to encourage the formation and benefits of appropriate clusters.

Regional Growth: The Role of Planners

The concepts of the spatial division of labour and industrial clusters have led to many regional policies. The main aim of UK regional policy used to be equalising wealth distribution. In the UK, for instance, one of the important aims of planning policy at national and regional scales, throughout the period from the mid-1940s to 1980, was to create employment, in another words to reduce the unemployment rate and the rates of out-migration from less-developed areas. Such a mission was to be accomplished not only by positive inducements to locate economic activities in lagging areas, but also by negative controls over location of new industries and extensions to existing industries in prosperous areas. The controls were applied mainly to the manufacturing industries, although more rapid growth was in the service sectors, and the inattention to the service sectors was not remedied until the change in control of zoning of new office space in the mid-1960s. Behind this movement lay a belief that "once the question of the social and economic infrastructure had been solved, the bulk of manufacturing unemployment was actually 'footloose', so that there were negligible social costs handicapping the growth of chosen regions" (Temple, 1998, p292). Not surprisingly, the distribution of investment skewed towards the problem regions.

The changing form of state intervention has had pronounced effects under the Conservatives since 1979. Releasing public sector investments to the private sectors changed the direction of governmental policies toward a more free market economy. Related changes are still ongoing under the labour government. The growth of overseas inward investment in the regions over the past years, and cross-border mergers and takeovers, especially in the 1980s, have had important implications for regional development. Such inflows have been associated with decreasing investment and rationalisation of domestic productive capacity. As a result, international investment and international competition harm most local economies while helping a few, and the regions becoming increasingly linked into networks of investment, competition, exchange and technological development that are transnational and global. The future portends increasing economic and social integration with Europe. The effects of being a member country in the 'Single European Market' since 1992, and of movement towards a single currency, will certainly yield competitive pressure and further restructuring. Again, this will require a response from UK regional planners.

The rolling back of regional policy over the past twenty years has been accompanied by a distinct shift towards urban assistance, which now makes up half of the government aid. Further, a wave of technological innovation based on information processing, begun in the early 1970s, generated opportunities for new types of industries to prosper, and increasingly transformed the nature of existing jobs. Southern regions possess active entrepreneurial sectors since the birth rate of new firms is higher in the South than in the North (Taylor 1992). Also, loss of managerial control in the North due to acquisitions by firms located in the Southeast seems to have occurred, as the Southeast becomes the prime location of head offices. It seems the advantages of being near other head offices and high-skill firms make the Southeast an attractive location for firms, and undoubtedly this helps to attract a large share of highly educated and skilled workers to the region. Access to and application of new information technologies are now key determinants of successful regional economic restructuring.

Although urban aid programmes are not regarded as regional policy, they are part of a growing trend towards central government localism in area assistance.

Selectivity of individual projects and individual enterprises involved can actually contribute to the spatial fragmentation of assisted areas. Programmes such as the Urban Development Corporation, enterprise zones and the urban task forces area encourage such localism. Other locally based alternatives have evolved to fill the gap as central government's regional policy slimmed down. Economic development initiatives by local authorities proliferated across the country, as authorities tried to promote their local economies with limited financial resources. Governments tried to promote new small firms, establishing businesses, science parks, enterprise boards and venture capital funds, often in partnership with the private sector.

Along with the changing economic pattern and policy perspective, many local efforts have aimed at stimulating entrepreneurship, especially in high-technology areas. Policy instruments are often specially directed at the development of knowledge resources, with implications for several of the processes vital for technological change. For example, one major change in regional economic activities is the ongoing process of flexibilization, in production processes, labour utilisation, service provision, management and marketing. Efficiency in each of these economic activities has increased through the manipulation of inputs, and hence it may have been affected by changing policies.

As the nature and the pattern of the regional problem changed, it became clear that traditional regional policy was failing to halt the widening disparities between the regions. Although this was due in part to the real spending cut on regional policy during the 1970s by the Labour Government, it also reflected the inherent limitations of traditional policy itself, with its concern with intra-regional industrial location rather than development, and its lack of strategic direction.

Existing Regional Policy Guidance has been criticised, indicating that the notes lack regional focus, that much effort was put into reiterating narrow land-use based national policies, and that the notes do not command the confidence of regional stakeholders. In order to remedy these problems, the "willingness to consider economic instruments and other modern policy tools to help meet the objectives of positive planning" (DETR, 1998, p5) on the part of the government becomes very important, especially when trying to take full advantage of both localisation and urbanisation externalities. A suggested key to achieve such a goal of sustainable growth in cities is for the government to realise the importance of knowledge as a resource, and as a useful economic tool to enhance industrial activities and hence city-region growth. It is important to understand the state of economic growth in each region, thus regional guidance frameworks should include the views of local businesses, as well as the needs of residents, reflecting the current state of the regions. Suggested plans for the government to improve regional planning through the decentralisation of decision making, and the responsibility for the preparation of Regional Policy Guidance documents should be handed over to the Regional Development Agency. Close attention to communication between the locals and the authority may help to reveal the true nature of local necessities. It is important to have a "bottom up" element to the regional growth guidance that will be created.

Policies to Enhance Appropriate Clusters and Knowledge Spillovers

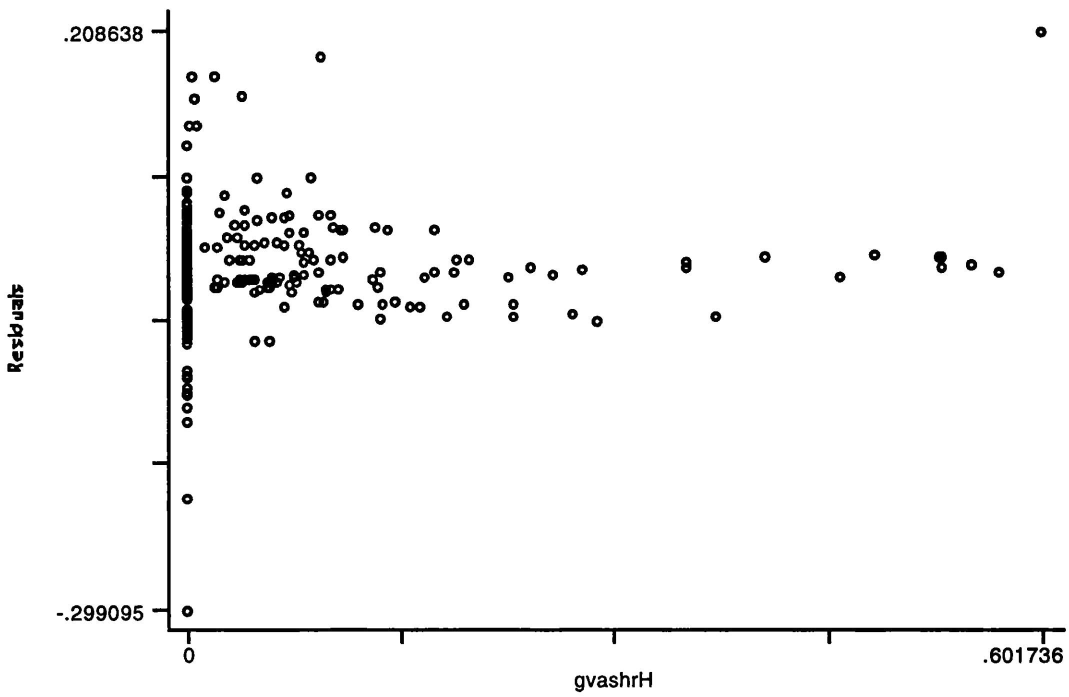
Two key types of policies emerge from the statistical analysis and literature review. First, regions in England, and the national government, should do what they can to attract and nurture new high-technology clusters in growth industries. Possible regional policies include relevant zoning of land at the right times, and the creation of infrastructure to support the needs of entrepreneurial high-tech firms. Educational institutions are one important part of this infrastructure. Possible national policies include high-tech entrepreneurial funds and support programs targeted toward particular industries in appropriate locations for a successful cluster, and support for regionally and technologically targeted areas of research and education.

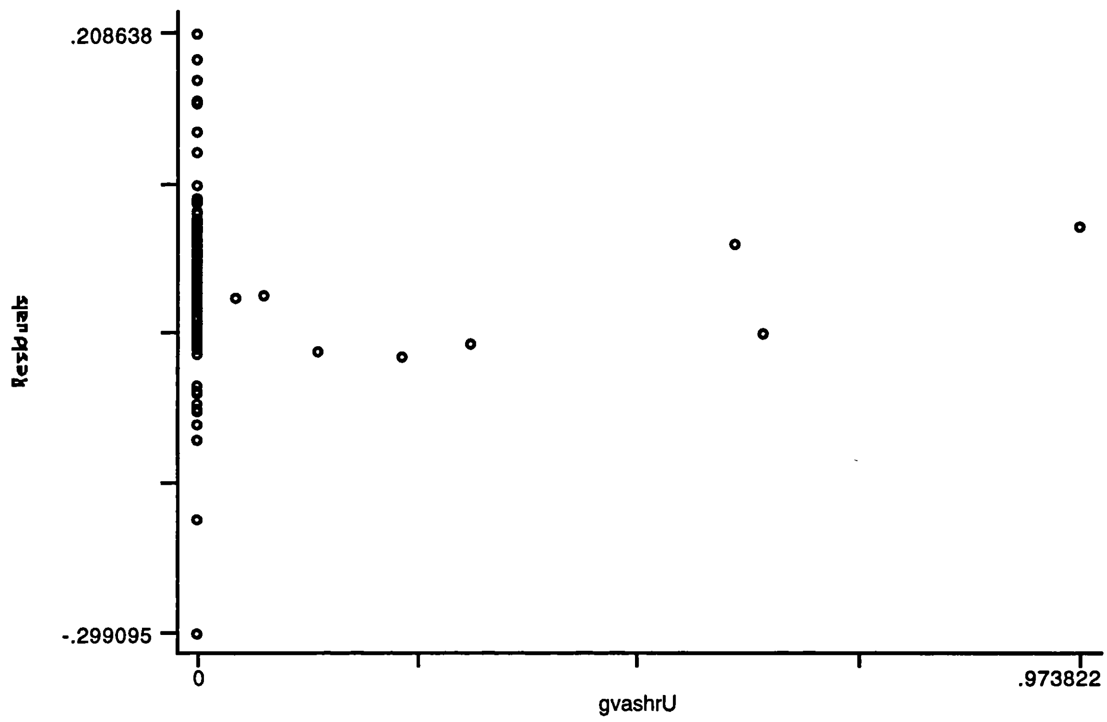
Second, the regions and the national government should enhance interpersonal interchange and spillovers. Regional governments could establish community centre buildings with a place for personal interaction, and encourage employers and managers of diverse businesses to attend these centres through appropriate siting, direct communications, and organised discussions and events. Similar programmes could tie into appropriate educational opportunities targeted at the further skills enhancement of highly-skilled employees in high-technology industries. When relevant planning issues arise, the joint input of multiple public and private sectors should be solicited, to encourage their interaction on planning-related issues. The national government could provide further support for similar initiatives.

Such policies could lead to more effective development of economic clusters within the UK. This would enhance the country's competitiveness within the EU and globally, in addition to any impacts it might have to lessen regional inequalities. This would also target regional development toward the high-growth industries, particularly those in the area of high-technology, which seems to contribute most to economic growth.

Appendix: Robustness Checks for Regression Analyses

Examining the residuals from the regressions provided a check on the validity of the regression models. In particular, residual plots helped ensure that the linear form in which model variables enter the regression equations is appropriate. If it were not, the residual plots might show an upward or downward trend, a curvilinear trend, or some other pattern. As examples, two residual plots are shown below for regression analysis (3), with residuals plotted versus *gvashr* and *gvashrH* respectively. In both cases, the distribution of plotted residuals is approximately flat with respect to the relevant variable, suggesting that the model's use of *gvashr* and *gvashrH* is appropriate.





The residual plots do suggest that the random errors may not be normally distributed. Indeed, other checks on the residuals suggest a somewhat non-normal distribution of the errors. As a result, standard errors and confidence intervals reported for the regressions could be misleading. To ensure that the conclusions drawn from the regressions are valid, bootstrap statistical analyses were used to estimate standard errors and confidence intervals without requiring any assumption of normally-distributed errors.

Bootstrapping is a process of repeatedly drawing random samples from the data (Hamilton 1998). After each draw, the process allows the replacement of the data point. Instead of trusting theory to describe the sampling distribution of an estimator, bootstrapping approximates that distribution empirically.

In this study, the technique was used to test for reliability of the results regardless of the sample data distribution. Below, bootstrap estimates with a bootstrap sample sizes of 2000 (example 1, with 95 percent confidence intervals) and 20000 (example 2, with 99 percent confidence intervals) are shown as examples of such a processes carried out during the course of data analysis. Both of the examples pertain to regression analysis (3). The actual commands and output used in estimation with the program Stata are shown for clarity.

To help understand Stata's commands and output, regression analysis (3) is shown first:

Example Used: **Regression Analysis (3)**

Stata command for a regression analysis: `regress rgvafc gvashr region1 region2 region3 region4 region6 region7 region8 gvashrH gvashrU if usethis`

Result:

Source	SS	df	MS		
Model	.112786268	10	.011278627	Number of obs =	144
Residual	.300656331	133	.002260574	F(10, 133) =	4.99
				Prob > F =	0.0000
Total	.413442599	143	.002891207	R-squared =	0.2728
				Adj R-squared =	0.2181
				Root MSE =	.04755

rgvafc	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
gvashr	-.3006683	.0559854	-5.370	0.000	-.4114053	-.1899314
region1	-.0100765	.0205884	-0.489	0.625	-.0507996	.0306466
region2	.0115551	.0186967	0.618	0.538	-.0254262	.0485365
region3	.0060701	.019551	0.310	0.757	-.032601	.0447412
region4	-.0149507	.0212243	-0.704	0.482	-.0569316	.0270302
region6	-.016525	.0197987	-0.835	0.405	-.0556861	.0226361
region7	-.00081	.0183042	-0.044	0.965	-.037015	.0353951
region8	-.0125864	.0184879	-0.681	0.497	-.0491547	.0239819
gvashrH	.2567771	.0473382	5.424	0.000	.1631439	.3504103
gvashrU	.2554525	.061034	4.185	0.000	.1347296	.3761755
_cons	.0906768	.0195812	4.631	0.000	.0519459	.1294077

Example 1:Bootstrap estimates with bootstrap sample size of 2000.

Stata Command for bootstrapping: `bs "regress rgvafc gvashr region1 region2 region3 region4 region6 region7 region8 gvashrH gvashrU" "_b[ gvashr] _b[ region1] _b[ region2] _b[ region3] _b[ region4] _b[ region6] _b[ region7] _b[ region8] _b[ gvashrH] _b[ gvashrU] ", rep(2000)`

Result:

```
command: regress rgvafc gvashr region1 region2 region3 region4 region6 region7 region8
gvashrH gvashrU

statistics:  b[ gvashr]  _b[ region1]  _b[ region2]  _b[ region3  _b[ region4]  _b[ region6]
_b[ region7]  _b[ region8]  _b[ gvashrH]  _b[ gvashrU]  (obs=144)

Bootstrap statistics

Variable |  Reps   Observed       Bias   Std. Err.   [ 95% Conf. Interval]
---------+-------------------------------------------------------------------
     bs1 |  2000  -.3006684  -.0049773   .0964078   -.4897387  -.111598   (N)
         |                                           -.5016137  -.146424   (P)
         |                                           -.4985802 -.1455505  (BC)
---------+-------------------------------------------------------------------
     bs2 |  2000  -.0100765  -.0027173   .0243333   -.0577977  .0376448   (N)
         |                                           -.0626302   .030799   (P)
         |                                            -.061032  .0338728  (BC)
---------+-------------------------------------------------------------------
     bs3 |  2000   .0115551   -.003206    .022819   -.0331963  .0563066   (N)
         |                                           -.0410889  .0488837   (P)
         |                                            -.036583  .0523488  (BC)
---------+-------------------------------------------------------------------
     bs4 |  2000   .0060701  -.0029091   .0209264   -.0349698    .04711   (N)
         |                                           -.0418749  .0384221   (P)
         |                                           -.0401911  .0404319  (BC)
---------+-------------------------------------------------------------------
     bs5 |  2000  -.0149507  -.0028645   .0258051   -.0655585  .0356571   (N)
         |                                           -.0740896  .0286809   (P)
         |                                           -.0713673  .0302729  (BC)
---------+-------------------------------------------------------------------
     bs6 |  2000   -.016525   -.001447   .0300149   -.0753888  .0423388   (N)
         |                                           -.0782559  .0305677   (P)
         |                                           -.0778457  .0308596  (BC)
---------+-------------------------------------------------------------------
     bs7 |  2000    -.00081  -.0027642   .0187445   -.0375708  .0359509   (N)
         |                                           -.0435497  .0270648   (P)
         |                                           -.0413633  .0275919  (BC)
---------+-------------------------------------------------------------------
     bs8 |  2000  -.0125864  -.0024671    .018035   -.0479558   .022783   (N)
         |                                           -.0533003  .0163046   (P)
         |                                           -.0521872  .0174409  (BC)
---------+-------------------------------------------------------------------
     bs9 |  2000   .2567771  -.0019174   .0495627    .1595772  .3539771   (N)
         |                                            .1722116   .358219   (P)
         |                                            .1771859  .3778493  (BC)
---------+-------------------------------------------------------------------
    bs10 |  2000   .2554525   -.032609   .1077743    .0440907  .4668143   (N)
         |                                                   0  .4287463   (P)
         |                                            .1009523  .5188995  (BC)
-----------------------------------------------------------------------------
                               N = normal, P = percentile, BC = bias-corrected
```

Example 2: Bootstrap estimates with bootstrap sample size of 20000.

Stata Command for bootstrapping: `. bs "regress rgvafc gvashr region1 region2 region3 region4 region6 region7 region8 gvashrH gvashrU" "_b[gvashr] _b[region1] _b[region2] _b[region3] _b[region4] _b[region6] _b[region7] _b[region8] _b[gvashrH] _b[gvashrU] ", rep(20000) level(99)`

Result:

```
command: regress rgvafc gvashr region1 region2 region3 region4 region6 region7 region8
gvashrH gvashrU statistics:  _b[gvashr]  _b[region1]  _b[region2]  _b[region3]
_b[region4]  _b[region6]  _b[region7]  _b[region8]  _b[gvashrH]  _b[gvashrU]  (obs=144)
```

Bootstrap statistics

Variable	Reps	Observed	Bias	Std. Err.	[99% Conf.	Interval]	
bs1	20000	-.3006684	-.0050841	.0945319	-.5441896	-.0571471	(N)
					-.5708735	-.1186401	(P)
					-.5710537	-.1186451	(BC)
bs2	20000	-.0100765	-.0025015	.0235767	-.0708118	.0506588	(N)
					-.0829771	.0408014	(P)
					-.0799595	.042299	(BC)
bs3	20000	.0115551	-.0025169	.022106	-.0453916	.0685019	(N)
					-.0577575	.0626386	(P)
					-.0534417	.0649551	(BC)
bs4	20000	.0060701	-.0024407	.0205051	-.0467527	.0588928	(N)
					-.0622319	.0450667	(P)
					-.0617026	.0452559	(BC)
bs5	20000	-.0149507	-.0023823	.0259157	-.0817116	.0518102	(N)
					-.0934869	.0404888	(P)
					-.0920527	.0416534	(BC)
bs6	20000	-.016525	-.0009525	.029	-.0912311	.0581811	(N)
					-.0978373	.0402741	(P)
					-.0986229	.039993	(BC)
bs7	20000	-.00081	-.0022049	.0189125	-.04953	.0479101	(N)
					-.0631223	.0347172	(P)
					-.0631036	.0347246	(BC)
bs8	20000	-.0125864	-.0019123	.0174719	-.0575952	.0324224	(N)
					-.0694984	.023264	(P)
					-.0681986	.0237791	(BC)
bs9	20000	.2567771	-.0008612	.0506829	.1262141	.3873401	(N)
					.1517254	.4067422	(P)
					.1592619	.4198581	(BC)
bs10	20000	.2554525	-.0338795	.1067741	-.0196056	.5305107	(N)
					-.1002371	.4936237	(P)
					0	.572871	(BC)

N = normal, P = percentile, BC = bias-corrected

As seen in the examples, the standard errors from the bootstrap estimation are generally similar to those obtained in the regression analysis, despite that the bootstrap estimates do not assume normally-distributed errors. Two standard errors are larger using the bootstrap estimates: the standard errors of *gvashr* and *gvashrU*. However, even so, the estimates of *gvashr* and *gvashrU* remain statistically significantly different from zero, at $p<0.01$ for *gvashr* and $p<0.05$ for *gvashrU*. Therefore, the statistical significance of these variables seems to be robust to the possibility of non-normally distributed errors.

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