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THE BENEFITS (OR NOT) OF CLUSTERS: EVIDENCE FROM THE UNITED KINGDOM

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ABSTRACT

There are now several dozens of industry clustering projects being conducted worldwide aimed at encouraging economic growth and development within countries and regions. However, there are surprisingly few studies that have critically examined the effects of clustering on firm performance. The aim of this study is to test whether or not industry clustering does in fact have a significant effect on competitive performance across a number of different industry sectors using multilevel spatial statistical methods. The study shows that although significant clustering effects can be observed in industries, the link to firm performance is less clear.

INTRODUCTION

There is now substantial research on industry clusters as well several dozens of industry clustering projects worldwide aimed at encouraging economic growth and development within countries and regions. Much of this work has been based on the work of Porter (1990, 2000) and others who argue that the clustering of related and supporting industries in a location contributes to the competitive advantage and growth of firms in a region. However, apart from the early work by Porter (1990), there are only a handful of studies that have reported a significant effect of industry clusters on firm performance. Furthermore, there are few multi-industry studies that have examined the effects of clustering across a range of sectors. This study aims to fill this gap in the literature by testing whether or not industry clustering does in fact have a significant effect on competitive performance across a number of different industry sectors and introduces the use of multilevel spatial modeling to examine this question.

CONCEPTUAL BACKGROUND

The question of where to locate the business has always been a crucial question for entrepreneurs starting up a business and a phenomenon that has been observed in many industries is the clustering or geographical concentration of firms, particularly new start-up firms, in certain regions. Examples are the movie industry in Hollywood, electronics and IT firms in Silicon Valley and the biotechnology industry in the Boston area. Early theories to explain industrial clusters pointed to the importance of minimizing transportation costs. For example, Weber (1909) explained the dense cluster of heavy manufacturers in Bavaria by noting that their location allowed these firms easy and relatively cheap access to coal and iron ore, which are critical inputs in these industries. Marshall (1890), who noted the tendency for specialised companies to be concentrated in 'industrial districts, explained these local concentrations of specialized activity in terms of external economies: the ready availability of skilled labor, the growth of supporting and ancillary trades, and the specialization of different firms in different stages and branches of production. More recent economic research focuses on how concentration of firms in these ‘industrial districts’ facilitate innovation and production. For instance, Audretsch and Feldman (1996) examine the effects of knowledge spillovers on the geography of innovation and production.

Sociological explanations focus on the social ties of entrepreneurs and workers to a particular location and the geographic limitations of social networks of entrepreneurs (Zucker et al., 1998). A number of studies have found that founders of new firms nearly always start their firms in the same communities in which they have been living and working (Figueiredo, et al., 2002; Mitton, 1990). Reasons for the geographical limitations include the following. Perceiving the potential for profit from opening a new venture in a particular industry typically requires both familiarity with the way in which the industry works and access to private information regarding market conditions. Hence, those individuals most likely to consider starting a firm in an industry either have experience working in the industry or a related business (Sorenson and Audia, 2000). After deciding to attempt entry, the nascent entrepreneur must successfully assemble a variety of resources such as skilled workers and financial capital to begin operations. Since these resources will often also be most readily accessible in the entrepreneur's local community, there is a greater chance that the entrepreneur will decide to locate the new venture there rather than in a more distant location.

Other researchers also point to the self-reinforcing nature of location choice by entrepreneurs. Harris (1954) found that high market potential in a region attracts new firms, which in turn enhances the market potential, and thereby induces more firms to move there. Similar results are detected by Pred (1973). More recent work by Krugman (1999) points to the self-reinforcing nature of network externalities to explain the geographical clustering of firms. An externality occurs when the production or consumption activity of an economic agent positively or negatively affects the production or consumption activity of another economic agents without being reflected in the price mechanism. This has its roots in Marshall's argument that agglomerations of firms generate a critical mass and an "industrial atmosphere" that allow businesses to specialize and thereby increase productivity (David and Rosenbloom, 1990).

The concept of industrial clusters has assumed inccreasing importance among industrial policy makers following Porter's (1990)'s work on why some countries are more competitive in in certain industries. Porter argues that the competitive advantage of firms results from the operation of a 'diamond' of four interacting forces - factor conditions, demand conditions, firm strategy, structure and rivalry, and related and supporting industries. Many national and regional governments, on the basis of Porter's work, have since established many initiatives aimed at encouraging the growth of selected industry industries in the hope of obtaining a competitive edge internationally.

However, apart from Porter's (1990) work, which argued that industry clustering leads to superior firm performance, there has been surprisingly much less work which has tested the link between industry clustering and performance at the firm level. Some notable exceptions are the following. Baptista & Swann (1998) reported a positive effect of industry clustering on the innovation of technology-based firms in the UK as measured by patenting. Stuart & Sorenson (2003) examined biotechnology startups in the US and reported a greater likelihood for biotechnology firms located in clusters to IPO compared with firms not located in clusters. Even fewer have examined effects on financial performance. Two of the few studies that have examined effects of industrial clustering financial peformance are that of Boasson & Macpherson (2001) and Boasson, Macpherson and Shin (2005) who reported a significant positive effect of firm clustering on the profitability of US pharmaceutical firms.

Many explanations of clustering effects are based on the benefits of access to scarce knowledge resources such as skilled workers in industrial clusters so effects would be expected to vary across industry sectors. However, an extensive search of the literature revealed no studies that that have examined the effects of clustering on financial performance across a range of industries. Therefore, this paper tested the followng hypotheses:

H1: Geographic clustering of firms will improve the performance of firms located in the cluster.

H2: Effects of clustering will be greatest in knowledge-based industries.

METHODOLOGY

First, using the ORBIS database, a random sample was prepared of UK firms in 6 different industry sectors where significant industry clusters have been identified by previous studies (R&D companies, instrumentation, scientific testing laboratories, electronic components, chairs and music publishing).

Secondly, the UK county in which each firm was headquartered was determined from the company website or other websites. Then for each industry sector the following were tested. In the first phase, the effects of the county and neighbouring counties on the clustering of firms in that sector . In the next phase, the effects of firm clustering on firm performance as measured by ROA, ROS and sales growth was determined for each industry.

In order to distinguish effects of geographic clustering of firms on firm performance this paper applies multilevel, spatial modeling (Lawson and Denison, 2002). Such models are well-established in geostatistics (Cressie, 1993) and epidemiology (Langford et al., 1999) and have a number of advantages over the single-level models that have been used in most previous studies of industry clusters. First, it allows geographic clustering effects to objectively measured. Second, it allows geographic clustering in the structure of the data to be considered in assessing the effects on firm performance and the spatial effects on firm performance to be distinguished from non-spatial effects.

In the first phase, to determine whether or not there was significant industry clustering. This study used a three-level spatial model in MLWin consisting of firm, county and neighbouring county levels in which one or more firms are located within a county and each county has one or more neighbouring counties. Two types of spatial model were tested: a multimembership model and a conditional autogressive model (Browne et al., 2001).

In the multimembership model the effect of each neighbouring area is included:

$$\log(\pi_i) = \log(e_i) + X_i\beta + u^{(2)}_{area[i]} + \Sigma_{j\in neighbour[i]} w^{(3)}_{i.j} u^{(3)}_j$$

where π_i represents the expected count, area[i] represents the area from which that count was taken and neighbour[i] represents the set of neighbouring areas. The weights $w^{(3)}_{i.j}$ give the relative importance of the various areas, constrained to sum 1. The area and neighbouring area random effects are assumed to have a Gaussian distribution i..e. $u^{(2)}_j \sim N(0, \sigma^2_{u(2)})$, $u^{(3)}_j \sim N(0, \sigma^2_{u(3)})$. The ratio of observed versus expected counts is assumed to follow a Poisson distribution i..e $(y_i \mid \pi_i) \sim \text{Poisson}(\pi_i)$ where y_i represents an observed count.

In the conditional autoregressive model the average of neighbouring effects is used

$$(y_i \mid \pi_i) \sim \text{Poisson}(\pi_i)$$

$$\log(\pi_i) = \log(e_i) + X_i\beta + u^{(2)}_{0,\,area[i]} + u^{(3)}_{0,\,area[i]}$$

$$[u^{(3)}_{0,\,area(i)}] \sim N(\underline{u}^{(3)}_{0,area(i)}, \Omega^{(3)}_u / r^{(3)}_{area(i)})$$

$$\underline{u}^{(3)}_{0,\,area(i)} = \Sigma_{j\in neighbour[area(i)]} w_{area(i),\,j}\, u^{(3)}_{0j} / r^{(3)}_{area(i)}$$

$$[u^{(2)}_{0,area(i)}] \sim N(0, \Omega^{(2)}_u)$$

In the second phase the effect of each county on firm performance was estimated using a multilevel model with a random intercept and a random slope for firm concentration:

$$ROA_i = \beta_{0i}cons_i + \beta_{1i}\ln(assets)_i + \beta_2 concentration_i$$

$$\beta_{0i} = a_0 + u^2_{0,\,county}$$

$$\beta_{2i} = a_2 + u^2_{2,\,county}$$

FINDINGS

Tables 1 and 2 show the results of the models estimating clustering effects. As table (1) shows, the multimembership model showed a statistically significant geographic clustering of firms in 5 out of the 6 sectors (R&D, Testing, Electronics, Chair, Music) while, as table 2 shows, the CAR model also showed a significant clustering effect in 5 sectors (R&D, Testing, Instrumentation, Electronics, Music), the only disagreement being that the Chair manufacturing sector is estimated to show significant clustering in the multimembership model but not in the CAR model and the Instrumentation sector is estimated to show significant clustering in the CAR model but not in the multimembership model.

The models with ROS and sales growth as dependent variables showed no significant effects. However, as Table 3 shows, there is a significant county level effect on firm performance as measured by ROA. As table 4 shows, when firm concentration in the county is entered as an explanatory variable, although county level effects remain highly significant in all sectors, there was a moderately significant effect of firm concentration in the county on firm performance in only 3 out of the 6 sectors (instrumentation, electronics and chair manufacturing). Furthermore, the effect of clustering on performance was negative in the case of the electronics sector.

The clustering effects remained after controlling for firm size (table 5). What is also noteworthy is that, contrary to what might be expected, the effect of firm size on performance is negative in the case of 3 out of the 6 sectors (Testing, Chair, Music). This is in contrast to models where the effect of firm size is considered alone where the effect is positive for all sectors (table 6).

A regression of firm concentration on firm size showed a significant relationship between firm size and firm concentration only in the case of the R&D firms (table 7).

DISCUSSION

The results suggest that the relationship between geographic clustering of firms in an industry and firm performance is more complicated than has often been assumed in many previous studies of industry clustering. Although significant clustering effects were observed in all of sectors examined, not all sectors showed effects of clustering on performance that were significant.

Contrary to expectations, the industry sectors that showed the greatest positive effects of clustering on performance were manufacturing industries where significant physical assets were required (electronic components, instruments and chair manufacturing). This is surprising given that the arguments in many studies are based on spillover effects of skills and other intangible resources. However, it may be the case that skills are more transferable when a significant part of the process is mechanized as is the case in these sectors as the skills required are not highly specialized. This would be consistent with the finding that no effects on clustering on performance were observed in the R&D, testing and music industries even though these show the greatest geographic clustering as shown tables 1 and 2. It may be that the resources in these industries are more firm specific and so less transferable to other firms in the area. In the case of R&D and testing the activities are particularly specialized so resources such as skilled workers may not necessarily be easy to transfer to other firms. In the case of the music industry, much of the knowledge is relationship-based i.e. based on personal contacts and so may be less transferable to new firms unless the owner of that knowledge moves. This suggests a need to examine in more detail levels of skills and their transferability to other firms in future studies.

The finding that the effect of clustering on performance was negative in two sectors (electronics and music) is also puzzling. One explanation is that that firms in these sectors located in less-clustered areas have been able to benefit from access to required resources e.g land, plant and skilled personnel at lower cost. Another possible explanation is that overcrowding of firms in highly clustered areas reduces their performance. For instance, many music firms are located in Central London which provides easy access to performers and key deal-makers but which is an extremely expensive place to operate a business compared with the rest of the country. This suggests a need to examine not only availability of resources but also relative costs in different areas.

The finding that the effect of firm size on performance is reversed in some cases when firm concentration in the locality is considered suggests some trade-off effect between the effects of firm size and concentration of firms in the same sector and locality. However, the results showed a significant (negative) relationship between firm size and firm concentration in only the R&D firms so the relationship is not simple and requires further investigation.

However, these findings require some caveats. The models do not enable us to determine the direction of causality so it may be that increased clustering arises in locations where firms have been able to gain significant profit rather than the other way round. This is similar to Florida's (2000) argument that high technology firms are atttacted to locations where there is a high concentration of creative workers. To investigate this question requires more complex models that are able to examine changes in clustering patterns and profit over time. Second, the study did not examine the presence of related and supporting industries in each county, which could also be an explanation for some of the findings.

CONCLUSIONS

The study shows that although significant clustering effects can be observed in industries, the link to firm performance is less clear. The industries that showed the greatest clustering effect showed the least performance effects. Overall the results suggest that firms are more able to benefit from clustering effects from tangible resources rather than intangible resources.

The study suggests a need to examine levels of skills and their transferability to other firms in future studies. It also suggests a need to examine not only availability of resources but also relative costs in different areas. The results also suggest a need for more dynamic models of industry clustering in which the growth of clusters are linked to the performance of firms in the cluster. There are also a number of areas that were not examined in the present study and that require further examination such as the influence of related and supporting industries in the locality.

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Table 1: County Level Effects On Firm Concentration: Multimembership Model

Industry	County effect	S.E.	Neighbouring county effect	S.E.
R&D	0.381	**0.176**	0.894	**0.646**
Testing	0.126	**0.076**	0.375	**0.29**
Instruments	0.481	**0.281**	0	0
Electronics	0.091	0.091	1.414	**0.707**
Chair	0.27	0.277	2.758	**2.097**
Music	0.115	0.144	2.933	**1.479**

Table 2: County Level Effects On Firm Concentration: Conditional Autoregressive Model

INDUSTRY	ESTIMATED COUNTY EFFECT	S.E.
R&D	1.161	**0.359**
TESTING	0.289	**0.119**
INSTRUMENTS	1.444	**0.416**
ELECTRONICS	0.718	**0.295**
CHAIR	0.001	0.001
MUSIC	0.907	**0.497**

Table 3: County Level Effects On ROA

Industry	*constant*	*s.e.*	*County effect*	*s.e.*
R&D	-0.035	0.191	2.006	**0.383**
Testing	1.331	0.732	32.164	**5.872**
Instruments	0.057	0.031	0.055	**0.010**
Electronics	-5.258	5.257	1575.401	**295.100**
Chair	0.274	0.097	0.326	**0.078**
Music	29.536	28.946	28487.150	**6909.149**

Table 4: Effect Of Firm Concentration On ROA

Industry	Constant	s.e.	Firm Concentration	s.e.	County effect	s.e.
R&D	-0.146	0.215	24.586	35.046	**26648.57**	**5081.682**
Testing	0.799	0.402	35.114	88.441	**261739**	**47786.79**
Instruments	-0.092	0.048	**14.077**	**10.336**	**3295.479**	**622.787**
Electronics	1.256	1.069	**-296.982**	**203.103**	**1030718**	**193070.9**
Chair	0.021	0.153	**10.031**	**9.166**	**779.654**	**186.373**
Music	0.084	0.062	-0.325	7.44	**451.613**	**109.532**

Table 5: Effect Of Firm Size And Firm Concentration On ROA

Industry	Const.	s.e.	Size effect	s.e.	Concentration	s.e.	County	s.e.
R&D	0.2	0.709	0.028	0.055	20.496	35.863	**26522.15**	**5057.577**
Testing	8.841	2.557	**-0.742**	**0.233**	43.003	81.857	**224013.8**	**40899.14**
Instruments	-0.568	0.196	**0.038**	**0.015**	**13.934**	**9.803**	**2964.387**	**560.216**
Electronics	0.712	3.446	0.05	0.3	**-297.486**	**203.076**	**1030219**	**192977.8**
Chair	0.876	0.411	**-0.075**	**0.034**	**9.971**	**8.581**	**683.234**	**163.324**
Music	0.257	0.174	-0.013	0.012	-0.948	7.344	**437.196**	**106.036**

Table 6: Firm Size Effect On ROA

Industry	*constant*	*s.e.*	*Size effect*	*s.e.*
R&D	-7.829	1.181	**0.989**	**0.139**
Testing	-2.698	0.968	**2.131**	**0.217**
Instruments	-1.416	0.375	**0.132**	**0.034**
Electronics	-17.528	5.492	**8.853**	**1.084**
Chair	-1.426	0.586	**0.142**	**0.056**
Music	-1.416	0.375	**0.132**	**0.034**

Table 7: Effect Of Firm Concentration On Firm Size

Industry	Constant	s.e.	Firm Concentration	s.e.	County effect	s.e.
R&D	12.329	0.527	**-145.649**	**85.952**	160297.3	30567.52
Testing	10.838	0.206	10.629	45.25	68516.1	12509.27
Instruments	12.487	0.397	3.771	85.93	227797.2	43049.62
Electronics	10.914	0.472	10.09	89.598	200588.3	37573.61
Chair	11.399	0.717	-0.806	42.964	17128.54	4094.505
Music	13.247	0.858	-47.915	102.16	85144.48	20650.57