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IS THERE EVIDENCE TO SUPPORT PORTER-TYPE CLUSTER POLICIES?

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Abstract

This paper examines the views, often associated with Porter, that clusters with deep collaborative networks and established local supply chains have good performance. The view that good cluster performance is not connected to industrial sector is also assessed. Data from a Department of Trade and Industry (DTI) study on UK clusters is used to assess the impact on performance (employment growth and international competitiveness) of cluster depth, stage of development of local supply chains, and industrial sector. The results of the analysis of the DTI data on clusters does not provide strong support for Porter-type views on cluster policy. Although established clusters are linked to employment growth, deep clusters are not associated with employment growth or international competitiveness, and clusters in the services, and media, computer related and biotechnology sectors are more likely than manufacturing clusters to have good performance. Some of the major policy implications of the results are discussed in the light of the literature on the importance of regional, national and international networks for the performance of clusters.

INTRODUCTION

Interest in clusters to promote competitiveness has been highlighted by the success of well-known clusters such as Silicon Valley and Route 128 (Saxenian, 1994) and the literature on Italian industrial districts (Markusen, 1996; Pyke *et al.*, 1990). The development of theories on the importance of geographic concentrations of firms for organisational learning and innovation (Asheim, 1996; Lundvall, 1992) and for economic and industrial development (Krugman, 1995; Scott, 1995) has also been important in stimulating interest in clusters. The views of Porter on clusters (Porter, 1990, 1998, and 2000) have however been the most influential, especially among important policy makers and opinion formers (European Commission, 2002; DTI, 2001 and 2003; Harvard Business School, 2002).

Clusters are regarded as a major way to obtain external economies of scale and to help firms to develop products, services, and production and distribution systems that engender competitive advantage (Enright, 1998, Porter, 1990 and 2000). Porter stresses the importance of established and deep clusters for the attaining and maintaining of competitiveness (Porter, 2000; Porter and Ketels, 2003). Established clusters have reached a stage of development that is based on extensive local supplier chains. Deep clusters have extensive collaborative local networks between firms and supporting agencies that help to develop and maintain competitive edge for firms in the cluster by sharing information, knowledge and assets. In Porter's analysis the beneficial effects from clusters are considered to be independent of industry sector. This type of analysis postulates that the major requirements for clusters to promote regional development are established local supply chains and deep collaborative networks that result in competitive

advantages, especially in international markets (Porter, 2003).

These Porter-type views have had a strong influence on cluster policy in many countries. A study by the European Commission on cluster policy in 21 European countries found that the main thrust of the policies was to encourage the development of networking between firms and supporting agencies in clusters, and to develop local supply chains (European Commission, 2002). The study concluded that established clusters with deep networks were desirable and that policies should be geared to enabling existing and potential clusters to develop such characteristics.

Porter-type views of clusters are not universally regarded as being sufficient for policy purposes. Martin and Sunley (2003), argue that more complex definitions and analysis of clusters are required to improve our understanding about clusters in order to enable the development of more effective policy making. Research on clusters that focuses on organisational and institutional learning, particularly, in relation to innovation in clusters, suggests that cluster policies should seek to stimulate innovation flows and learning mechanisms by encouraging institutional developments, often involving collaboration between public and private agencies (Amin *et al.*, 2002; Asheim, 1996; Cooke, 2002; Newlands, 2003). Investigation of the role of clusters to promote particular regional development objectives also questions the sufficiency of Porter-type views on the main characteristics of clusters and the subsequent policies that emerges from these views. Alternative views on the characteristics of clusters lead to a variety of policy objectives including the regeneration of regions by encouraging declining clusters to evolve into new and more dynamic clusters (Sadler, 2004), stimulating the growth of high-tech clusters (Cooke and Huggins, 2002; Swann *et al.*, 1998), and developing

clusters to help disadvantaged regions, and groups within regions, to participate in the benefits of economic development (Rosenfeld, 2003).

The main criticism of Porter-type views is that they take a reductionist approach that is too simplistic to provide the type of information that is required to develop effective and focused cluster policies (Martin and Sunley, 2003). The view that industrial sector is not important for cluster performance is also questioned by the large volume of studies that link good performance to industries such as media, IT related products and biotechnology (Backlund and Sandberg, 2002; Cooke, 2003; Cooke and Huggins, 2002; Swann *et al.,* 1998). Many studies support Porter-type views that international competitiveness is important, but they focus on the significance of international networks that promote innovation and learning rather than on the importance of established and deep local networks that enhance exports (Cooke, 2003; Hendry *et al*., 2000; Simmie, 2003, Simmie and Sennett, 1999).

These critiques of Porter-type views do not negate the proposition that deep and established clusters are a necessary, but not a sufficient, condition for good performance. Many studies explicitly or implicitly accept that deep and established clusters are important for good performance. Evidence that established and deep clusters are associated with good performance is therefore important for most advocates of cluster policies, albeit that for many, the cluster characteristics highlighted in Porter-type views are not sufficient to promote desirable objectives such as innovation, or to develop particular sectors to aid regional development objectives. It can be argued that policies that encourage the development of deep and established clusters should make a useful input to regional development because such characteristics are a bedrock condition to

enable clusters to make a valuable contribution to development objectives.

This paper assesses the relationship between key cluster characteristics (depth, stage of development and industrial sector) and performance (employment growth and international significance). This is done by using data from a DTI study on clusters in the UK. In the light of this evidence, an assessment is made of the wisdom of pursuing policies that seek to encourage deep and established clusters as a necessary condition for them to make a useful contribution to regional development objectives.

THE DTI STUDY OF UK CLUSTERS

The DTI study used four main criteria to define and assess clusters.

1. Stage of development – classified as embryonic, established and mature.

2. Cluster depth – classified as deep, shallow and unknown.

3. Employment dynamics – defined as growing, declining and stable.

4. Significance – defined as regionally, nationally or internationally competitive.

Established clusters have high and expanding flows of goods and services within local supply chains. Embryonic clusters have low but growing flows, and mature clusters have high flows but they are not expanding in terms of new and significantly modified local supply chains. Deep clusters have extensive network connections with firms and supporting agencies that cover a wide variety of actors within the cluster that help firms to access knowledge and assets that aid them to attain and retain competitiveness. Cluster depth and stage were estimated by using regional input-output tables and activity analysis. Additional information on depth and stage was obtained by using assessments and opinions from leaders in firms, and in public and private sector agencies. National,

regional and local employment data was used to classify employment dynamics. Clusters with employment of +/- 10 per cent growth were defined as stable, below minus 10% were declining and greater than 10 per cent growing. Significance was estimated by calculating the share of the cluster's output of regional and national output for the industry, and international significance was estimated using the cluster's share of national exports.[1]

The DTI study classified clusters by the dominant industry of the final output of the firms in the cluster, but was unable to identify a clear industry classification for about 25 per cent of the clusters. This paper classifies clusters into two broad industrial sectors, manufacturing and non-manufacturing. A more refined classification based on three categories, manufacturing, services, and media, computer related and biotechnology industries (MCRB) was also used to identify the relative importance of the services and MCRB sectors.[2]

The classification of clusters by depth, stage of development, industrial sector, and performance is shown in table1. This shows that about 50 per cent of clusters are deep and established, with nearly 60 per cent experiencing employment growth, and nearly one third being internationally significant. Table 1 also highlights the dominance of the manufacturing sector and the relatively small share of the MCRB sector.

(Table 1 about here)

The regional distribution of clusters by stage of development, depth, industrial sector, and performance is shown in table 2. The London region has nearly twice the national share of deep clusters as the next highest regions. Established clusters are less heavily concentrated in one region, but London, the South East and Eastern regions

account for about 40 per cent of established clusters. The London and the South East regions have nearly 50 per cent of the internationally significant clusters, and about 30 per cent of those were employment is growing. Just over three quarters of the clusters in the MCRB sector are located in the London, South East and Eastern regions and about half of the clusters in the services sector are in the London, South East and South West regions.

(Table 2 about here)

CLUSTER CHARACTERISTICS ASSOCIATED WITH GOOD PERFORMANCE

The DTI study claimed that the findings support the claim that clusters that are established and deep are more likely to be 'successful' (DTI, 2001, Vol. 1, p. 43). Porter and his followers also claim that established and deep clusters are important for good performance (Hallencreutz and Lundequist, 2003; Lundequist and Power, 2002; Porter, 1998 and 2000). The case study based literature tends to support this conclusion, for examples of this literature see, Backlund and Sandberg, 2002; Clarke, 2002; Cooke, 2002; Cooke, and Huggins, 2002; Saxenian, 1994; Swann, *et al.*, 1998. The case study evidence identifies a number of important factors that contribute to 'successful' clusters. The main focus is on the importance of networks that facilitate learning and innovation by agents within clusters thereby promoting flexibility and the harnessing of knowledge to add value to operations. Organisational and institutional systems that enable agents to learn and innovate are also identified as being crucial for the operations of clusters (Admin *et al.*, 2002). The existence of social capital that enables effective networking to flourish is also a prominently feature in much of the case study evidence (Dei Ottati,

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2002; Sforzi, 2002). The case study evidence normally focuses on unique economic, social, historical, geographical, institutional, and technological factors that can be identified with the establishment and evolution of clusters. However, most of this literature links these unique factors to the development of deep and established networks that lead to competitive advantages to firms based in clusters. Thus, the case study evidence broadly supports the conclusions of the DTI study and Porter-type views on the importance of deep and established clusters as baseline determinants of good performance.

Two hypotheses relating to cluster depth and stage of development follow from the conclusions of the DTI study, Porter-type analysis, and the case study literature. The first relates to cluster depth and performance.

H1a Clusters that are deep are more likely than shallow clusters to be associated with employment growth.

H1b Clusters that are deep are more likely than shallow clusters to be internationally significant.

The second hypothesis is connected to the stage of development of clusters and performance.

H2a Established clusters are more likely than embryonic and mature clusters to be associated with employment growth.

H2b Established clusters are more likely than embryonic and mature clusters to be internationally significant.

A large number of the case studies that identify good performance, or the potential to achieve good performance, are centred on the MCRB sector (Backlund and

Sandberg, 2002; Cooke, 2002 and 2003; DTI, 1999; Hallencreutz and Lundequist, 2003; Swann et al, 1998). Some studies have also highlighted good economic performance and fast growth in clusters in the service sector such as financial and business services and high fashion retailing (Clark, 2002; Fernie *et al.*, 1998; Rubalcaba and Gago, 2003; Simmie and Sennett, 1999). The DTI study also discovered that clusters in the services and MCRB sectors were frequently found to have better performance than those in the manufacturing sector. Therefore, it is postulated that clusters in non-manufacturing sectors will have better performance that those in the manufacturing sector. These sector considerations lead to the following hypothesis.

H3a Clusters in the non-manufacturing sectors are more likely than those in the manufacturing sector to be associated with employment growth.

H3b Clusters in the non-manufacturing sectors are more likely than those in the manufacturing sector to be internationally significant.

The final hypothesis is based on the view that industrial sector is more likely to be associated with good performance than stage and depth. This is based on the predominance of case study evidence that finds that high growth of employment and strong international performance is often found in clusters in the services and MCRB sectors. The DTI survey also found that clusters in these sectors tended to have good performance (DTI, 2001). Moreover, many of the studies that found good performance in the services and MCRB sectors discovered that national and international innovation and learning networks within the same industry, were as, or more important as locally based networks (Bathelt, 2005; Fernie, *et al.*, 1999; Swann *et al.*, 1998). This suggests that established and deep local networks may not be as important as national and international

links, especially for clusters in the non-manufacturing sectors.

H4 Good performance is more likely to be associated with clusters in the non-manufacturing sectors than with the stage or depth of clusters.

METHODOLOGY

Two possible approaches can be used with categorical data of the type available in this study – loglinear modelling, or logistic regression techniques (Agresti, 2001; Christensen, 1997; Fingleton, 1984). Logistic regression techniques should be used when researchers wish to use hypotheses that predict the sign and/or strength of the probability of the effect of a series of independent variables on the dependent variable (McFadden, 1984; Tansey, *et al.*, 1996). As this study has hypotheses that predict the sign of the probability of the likely effect of independent variables on the dependent variable, logistic regression techniques are the most appropriate technique. Logistic regression techniques are widely used to test hypotheses using categorical data of the kind used in this study (for example, Beard, 2005; Ivarsson, 2002).

The performance variables (employment growth and international significance) were used as the dependent variables. The explanatory variables were stage of development, cluster depth, and industrial sector. Stage of development and cluster depth variables were derived from the clusters that were classified in these categories in the DTI study. As the focus of this study is on the importance of established clusters, the DTI data was split into established and not established (embryonic and mature) clusters. The DTI study was unable to classify 35 clusters to a depth category. This reduced the number of clusters that could be used to test the data to 119. The 35 missing values were

evenly spread over regions (expect all clusters in Scotland were classified) and in terms of stage of development. However, most of the omitted clusters (32) were in the manufacturing sector therefore the results for the manufacturing sector should be treated with caution. The main thrust of this study was to discover if there was a difference between manufacturing and non-manufacturing clusters therefore industrial sector variable was based on a classification into two sectors manufacturing/non-manufacturing (services/MCRB)

The dependent variables were assigned 1 for employment growth/internationally significant, and 0 for no employment growth/not international significant. The explanatory variables were also allocated a value of 1 or 0, for deep/shallow, and established/not established, and manufacturing/non-manufacturing. A negative and significant coefficient for industrial sector indicates that the non-manufacturing sector is more likely to be associated with employment growth/international significance and positive and significant coefficients for depth and stage indicates that deep and established clusters are more likely to be associated with good performance (Hair et al, 1998).

The logistic regression approach was complemented by investigation of the interactions between the performance variables and stage of development, depth of clusters and industrial sector variables using a hierarchical log linear modelling approach. This approach explores a variety of possible links between the variables with no *a prior* conditions about dependent and independent variables (Christensen, 1997). Moreover, when using categorical data both logistic regression and log linear modelling analysis is recommended by some statisticians. If logistic regressions models and hierarchical log-

linear modelling reveal similar significant relationships between the variables, the results from both of these techniques provide evidence that the identified relationships in the logistic regressions are robust (Tansey *et al.*, 1996).

Hierarchical log linear modelling was used to find the parsimonious models for employment growth and international significance. This approach, which is based on cross tabulations of categorical variables in contingency tables, begins with the saturated model. This model includes interaction between all of the variables, that is, with three-way interactions between the four variables. The modelling process deletes higher order interaction terms until it posited the smallest number of interactions between the four variables that provided as least as good a model (the parsimonious model) as the saturated model. The results from the parsimonious model can be used to reinforce the results from the logistic regression models, that is, provide evidence that the variables identified as dependent and independent by the hypotheses are robustly related to each other. In addition the results reveal the combination of variables that are significantly related to each other in any particular model. For example, in clusters which are internationally significant the parsimonious model indicates the combination of industry, stage and depth variables that are associated with good international performance.

Contingency table analysis of cluster performance was used to explore the simultaneous relationships between performance, stage of development, depth, and three industrial sectors (manufacturing, services and MCRB). Industrial sector was split into three sectors to investigate differences between these three sectors. Complex analysis of the interaction between these variables lead to too many cells for the number of available observations, with many of cells having zero entries and others less than 5 entries. This

made the results suspect, therefore, the contingency table analysis was reduced to stage of development, depth, and three industrial sectors (see table 5).

Findings

The logistic regressions have model chi-squares that are significant and the Hosmer and Lemeshow test reveals no difference in the actual and predicted dependent values. The Cox and Snell and Nagelkerke R^2 measures confirm the better fit for the employment model, but both models have predictive power that is greater than could be achieved by chance (see table 3). To assess if multicollinearity was present variance inflation factors (VIF) tests were run. The VIF for the variables in the employment growth model are 1.44, 1.00 and 1.44, and 1.46, 1.00 and 1.45 for the international significance model. These values indicate no significant problems with multicollinearity (Hair *et al.*, 1998).

The logistic regression results (see table 3) indicate that depth is not significant in the employment growth or the international significance models therefore H1a and H1b are not supported. Established clusters are more likely to be associated with employment growth, but they are not more likely to be internationally significant. Therefore, H2a is supported but H2b is not. Clusters in the non-manufacturing sectors are more likely to be associated with employment growth and to be internationally significant. Consequently, both H3a and H3b are supported. Industrial sector is significant in both the employment growth and international significance models while stage of development is significant associated with only employment growth and depth is not significant in any of the models. These results provide some support for H4.

The results show that industrial sector is an important factor for performance

because clusters in the non-manufacturing sectors are more likely to be associated with internationally significant clusters and with clusters that have employment growth. Established clusters are not more likely to be internationally significant but are linked to employment growth. This may reveal little more than that extensive local buying by firms in clusters, as would as expected, stimulate regional employment. Clusters that are deep are not more likely to experience employment growth, neither is there strong evidence that deep clusters are linked to international competitiveness.

(Table 3 about here)

The failure to find a significant link between established local supply chains and international competitiveness indicates that there maybe over reliance on local sourcing in some clusters. If this is the case this might lead key firms to reduce local sourcing by seeking suppliers in other locations that can supply inputs at lower cost and/or of better quality. This strategy has been observed in German and Italian industrial districts (Paniccia, 2002, Staber, 2001). This type of strategic behaviour is often found in multinational corporations where operations are developed in locations where locally available assets and organizational and institutional structures generate high level benefits, whilst other operations are located or relocated to other more favourable areas. These relocation activities are not limited to areas with low labour costs, but can be induced by access to information and knowledge, and to human and non-human assets that have desirable characteristics. Multinational firms that engage in the internationalisation process in this way develop into differentiated networks based on

subsidiaries that specialise to reap competitive advantages. These subsidiaries are woven together by the headquarters into an effective international network (Birkinshaw and Hood, 1998). Multinational firms that adopt these types of strategies are also likely to locate subsidiaries in clusters in different parts of the world to gain access to the knowledge and assets that are concentrated in clusters (Birkinshaw and Hood, 2000). These types of developments are likely to encourage clusters to develop the type of national and international linkages that are highlighted in some of the cluster literature (Bathelt, 2005; Simmie, 2003; Storper and Venables, 2002).

The results indicate that the links between performance, and depth, stage of development, and industrial sector are not clearly in accord with Porter-type views on clusters. In particular, the significance of industrial sector for both employment growth and international competitiveness contradicts the view that sector does not affect cluster performance (Porter, 2003). The link between established local supply chains and employment growth indicates benefits to the host region, but not necessarily competitive benefits to firms within clusters.

The insignificant ρ values for the likelihood ratio and the Pearson chi square for the hierarchical log linear modelling results reveal that the parsimonious models are as least as good as the saturated models in terms of their explanatory power (Knoke and Burke, 1980). The results from the parsimonious models (see table 4) reveal that employment growth is significantly associated with industrial sector and stage of development, and that international significance is associated with industrial sector. These results support the logistic regression results because they reveal significant

relationships between industrial sector and employment growth and international significance, and between stage of development and employment growth.

The log linear modelling results highlight that stage of development is related to depth in both models. The association between stage of development and depth indicates that firms in clusters with good performance have good networking competencies that enable them to develop extensive local supply chains and also to gather information and knowledge from other firms and supporting agencies. The results of the logistic regression and log linear modelling analysis indicate that stage of development and depth are not more likely to be associated with international significance, and that only stage of development is associated with employment growth. Therefore, there is no support for a view that the ability to develop both established and deep networks is linked to good performance.

The results from the hierarchical log linear modelling provide support for the view that industry is important for international competitiveness and employment performance and well developed local supply chains is linked to good employment performance. However, good networking competencies in terms of both stage of development and depth, although prevalent in clusters with good performance, are not necessarily linked to good performance.

(Table 4 about here)

The contingency table analysis (see table 5) highlights that the services and MCRB sectors are consistently associated with better performance compared to the manufacturing sector regardless of stage of development and depth. Moreover, clusters in the MCRB sector have a higher proportion of internationally significant clusters than

both the manufacturing and service sectors. Shallow and embryonic/mature clusters in the manufacturing sector have lower numbers of successful clusters than established and deep clusters. This provides support for the Porter-view that deep and established clusters have some connection to good performance but only for the manufacturing sector. The difference is most pronounced in the case of established clusters in the employment growth case. Established local supply chains are likely to lead to good employment growth, but they may not be delivering international competitiveness because of over reliance on expensive or poor quality inputs. Moreover, the services and the MCRB sectors are more likely to be associated with good performance in both employment growth and international significance.

(Table 5 about here)

IMPLICATIONS FOR POLICY

The main thrust of current cluster policies are to encourage the development of deep local network relationships with other firms and supporting agencies and to remove barriers that hinder the development of clusters in terms of expansion of numbers and types of firms in clusters. Incentives for firms to strengthen local supply chain linkages are also a prominent feature of most cluster policies (DTI, 2003; European Commission, 2002; Porter and Ketels, 2003). This policy focus fits into Porter-type views that deep and established clusters are more likely to be successful, and can also be seen to support the view that such cluster characteristics provide the bedrock on which to develop other policy objectives such as regional regeneration, boasting innovation and learning, and other types of economic and social objectives.

Enhancing effective learning and innovation by transferring knowledge from

established and deep clusters to promote the development of embryonic clusters (Garofoli, 2002) is only useful if there is strong evidence that deep and established clusters provides the necessary conditions to help to obtain regional competitiveness. Top down or bottom up policies involving boosting local learning and innovation systems, and strengthening local supply chains based on Porter type approaches to developing clusters (Lundequist and Power, 2002) only make sense if deep and established clusters provide at least the bedrock foundations that will lead to good performance. The results of this analysis of UK clusters indicate that there is no strong evidence that established local supply chains are significantly associated with international competitiveness. Although there is a link between established local supply chains and employment growth this need not be a strong indicator of long-term regional competitiveness in terms of international competitiveness. Good performance in clusters in the services and MBRC sectors are not consistently sensitive to depth and stage of development but they are more consistently linked to good performance than clusters in the manufacturing sector. Clusters in the MCRB sector have the highest concentration of internationally significance. Therefore, promoting deep and established clusters maybe less important than policies that promote clusters in industrial sectors that are viable and/or that have the potential for good performance.

Consideration should also be given to the possibility that local networks may not be as important as links to national and international networks, particularly for flows of information and knowledge (Hendry *et al.*, 2000; Oerlemans and Meeus, 2005; Simmie, 2003, Simmie and Sennettt, 1999; Torre and Rallet, 2005). Thus, policies to promote local networks to boost the depth and stage of development of clusters may not be a

necessary condition for improved performance, even as the bedrock for other regional development objectives. Helping firms in clusters to connect 'regional buzz' to national and international networks by encouraging the growth of national and international pipe lines (Bathelt, *et al.*, 2002; Storper and Venables, 2002) maybe more, or as, important as developing local networks.

Cluster policies to promote a variety of economic and social objectives (Sadler, 2004; Rosenfeld, 2003) may require a focus on employment growth and improvements in income distribution rather than the development of international competitiveness. However, the results from this study indicate that clusters in the services and MCRB sectors are more likely than manufacturing clusters to deliver employment growth. This may imply that policies that promote clusters in the services and MCRB sectors maybe a better policy approach than seeking to revive existing but moribund manufacturing clusters. Promoting clusters in industrial sectors that can effectively use locally available assets and organizational and institutional networks to reap the benefits of regional competitiveness is an important bedrock requirement for achieving economic and social objectives such as improved employment and increased income levels. Developing regional competitiveness is clearly an important condition for effective regional development policy, but promoting deep locally based networks and established local supply chains may be less important than developing national and international linkages in industrial sectors that have a long-term competitive advantage in increasingly internationally competitive markets.

The dominance of high performance clusters in the London and South East regions in the services and MCRB sectors suggests that cluster policies in the rest of the

UK regions should aim to foster the conditions that would encourage the development of clusters in these successful industrial sectors in their regions. However, it is often not possible to '..copy or imitate a successful model from elsewhere' (Boschama, 2004, p. 1001). Moreover, there is evidence that policies targeting at promoting specific industries for cluster development are often not effective because regions can lack the correct type of locally based assets and organizational/institutional structures that are necessary for good performance (Learmonth, *et al.*, 2003; Turok, 2003). It may be better to seek to revive, or develop new, clusters in any industrial sector that can provide viable and long-term regional competitive advantages. Problems however exist in defining the major factors that determine regional competitiveness (Kitson, *et al.*, 2005). Finding and developing the type of industrial sectors that can flourish, given the existing (and likely future) asset and organizational/institutional base in regions, is plainly an important condition for effective cluster policies. Establishing the correct balance between local networks relative to national and international network connections is also an important element for effective cluster policies. This study indicates that Porter-type cluster policies that focus on developing local supply chains and locally based collaborative networks are unlikely to be sufficient, and in some cases may not be necessary, to create and develop clusters that promote regional development objectives.

CONCLUSION

Analysis of data from the DTI survey does not provide strong support for the current thrust of cluster policies. The link between the depth of clusters, stage of development and performance is complex, and industrial sector factors are clearly important. Indeed,

industrial sector factors seem to be more important than depth and stage of development. The current Porter-type views on cluster policy may not be sufficient to create even the bedrock conditions that would permit clusters to provide a good basis for attaining regional development objectives. Consideration of industrial sector factors and the balance between local, national, and international networks in the context of both flows of goods and services, and flows on information and knowledge need to be central in cluster policies.

There are limitations with the data used for this study that need to be corrected to improve our understanding of the key factors necessary for clusters to make a significant contribution to regional development objectives. The DTI survey did not provide data on the importance of geographical proximity of flows of goods and services therefore data on the relative importance of local, national and international linkages was not available. The study provided no data on flows on information and knowledge in terms of both inter and intra organizational networks. More and better data is required on industrial sector, and on measures of performance. Longitudinal data on the evolution of clusters in terms of characteristics and performance is needed to assess the key factors that contribute to the long-term performance of clusters. The provision of such data would enable more robust testing of the links between cluster characteristics and performance. Evidence on these links could be used to formulate more effective cluster policies. Cross-country studies are also required to identify country specific factors.

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Endnotes

[1] See Technical Annex of the DTI Report for details on how the characteristics of clusters were determined DTI (2001).

[2] Clusters in the manufacturing sector includes, aerospace, automobiles, ceramics, chemicals, civil engineering, clothing, construction products, electrical products, footwear, furniture, ICT products, medical equipment, mechanical equipment, nuclear fuel, oil and gas equipment, perfume, pharmaceuticals, plastics, printing, shipbuilding and marine, toys and games, wood and paper products. Service sector includes advertising, antiques selling, business services, financial services, oil and gas services, property services, publishing, and tourism, travel and leisure services. The MCRB sector includes biotechnology, digital media products, music products, photography products, software products, TV and radio products, and web design.

Acknowledgement

Table 1 Classification of UK Clusters

Stage of Development	%	Employment Dynamics	%	Industrial Sector	%
Embryonic	12.3	Declining	17.0	Manufacturing	63.6
Established	55.8	Static	24.2	Services	21.5
Mature	31.8	Growing	58.8	MCRB	14.9
Cluster Depth	%	Significance	%		
Shallow	31.8	Regional	21.4		
Deep	45.5	National	46.1		
Unknown	22.7	International	32.5		

Source: Department of Trade and Industry (2001) n = 154

Table 2   Regional Characteristics of Clusters

Region	% Int sig	% Emp growth	% Deep	% Est	% Man	% Services	% MCRB
East Midlands	4.0	5.6	8.6	8.1	11.0	0.0	4.8
Eastern	8.0	10.0	10.0	12.8	6.0	6.1	19.0
London	28.0	15.5	20.0	12.8	3.0	21.2	38.0
North East	0.0	4.4	1.5	3.5	9.0	0.0	0.0
Northern Ireland	4.0	4.4	4.3	2.4	8.0	0.0	0.0
North West	8.0	11.1	7.2	11.6	13.0	12.1	0.0
Scotland	10.0	7.8	11.2	5.8	8.0	12.1	4.8
South East	20.0	15.5	11.4	15.1	8.0	15.1	19.0
South West	6.0	12.2	7.2	9.3	7.0	15.1	4.8
Wales	6.0	4.5	4.3	8.1	11.0	6.1	4.8
West Midlands	4.0	2.3	8.6	5.8	9.0	6.1	0.0
Yorks & Humberside	2.0	6.7	5.7	4.7	7.0	6.1	4.8

Notes: Figures in columns are the percentage of clusters in each region.
For example, of the 32.5% of clusters that are internationally significant (Int sig)
4.0% of these clusters are located in the East Midlands. The total number of
clusters are 154 in all columns except for depth. This column is based on 119 clusters.

Table 3   Summary of the Regression Results

Dependent Variables	Employment Growth				International Significance			
Independent Variables	Coef	Wald	Sig	Exp(B)	Coef	Wald	Sig	Exp(B)
Depth	-0.174	0.109	0.742	0.841	0.749	2.939	0.086	2.115
Stage	2.078	14.560	0.000 *	7.989	0.086	0.040	0.842	1.089
Industrial Sector	-3.064	23.235	0.000 *	0.047	-1.139	8.019	0.005 *	0.032
Constant	1.622	7.551	0.006	5.062	-0.340	0.646	0.421	0.712

	Employment Growth	International Significance
-2 log likelihood	155.871 to 102.911	158.789 to 146.230
Model Chi-square	54.219 p = .000	12.294 p = .006
Hosmer and Lemeshow Test	χ^2 4.936 df 5 sig 0.424	χ^2 4.132 df 5 sig 0.531
Cox and Snell R^2	0.370	0.098
Nagelkerke R^2	0.503	0.133
n	119	119

Table 4   Summary of Parsimonious Hierarchical Log Linear Modelling Results

Significantly related variables	df	goodness of fit	Implications
Employment growth & Industrial sector Employment growth & Stage Depth & Stage	8	Likelihood ratio chi square= 9.82870 $\rho = .277$ Pearson chi square = 8.94535 $\rho = .347$	Employment growth is associated with industrial sector and stage. Depth is associated with stage
 International significance & Industrial sector Stage& Depth	9	Likelihood ratio chi square = 10.84450 $\rho = .287$ Pearson chi square = 10.54698 $\rho = .308$	International significance is associated with industrial sector. Stage is associated with depth

n = 119

Table 5   Performance, Sector and Cluster Characteristics (%)

Characteristics of cluster	Clusters with Employment Growing	Manufacturing	Service	MCRB	Cramer's V	Approx. significance
Shallow	58.3	32.1	92.3	100	0.630	0.000
Deep	65.7	47.5	93.8	85.7	0.447	0.001
Embryonic/mature	38.8	17.0	100.0	80.0	0.694	0.000
Established	74.4	62.0	87.0	100.0	0.348	0.005
Characteristics of cluster	Clusters with International Significance	Manufacturing	Service	MCRB	Cramer's V	Approx. significance
Shallow	28.6	17.2	30.8	71.4	0.408	0.017
Deep	45.7	35.0	50.0	71.4	0.285	0.058
Embryonic/mature	26.5	14.6	50.0	60.0	0.422	0.002
Established	37.2	26.0	39.1	76.9	0.366	0.003

Notes: Figures in columns are percentage in categories. For example, 58.3% of shallow clusters have employment growing and 32.1% of clusters in the manufacturing sector that are shallow have employment growing.

 n = 119