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Introduction: Embedded Clusters in the Global Economy

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Abstract *The growing literature on both clusters and regional innovation systems highlights the relevance of networks of interrelated firms as key factors in the ability to produce innovative new products or processes in a timely fashion for global markets. These, and related, bodies of literature recognize that in a global marketplace, local input factors and inter-firm dynamics are critical to a firm's ability to innovate and thereby gain competitive advantage. The key questions that arise from this literature concern the way in which local conditions influence or constrain the developmental path of individual clusters, the extent to which they are grounded in specific local agglomerations of key factors that contribute to their growth, the relative influence of local dynamics in stimulating the competitive capabilities of the cluster and the extent to which external institutional supports in the form of research infrastructure, government policy or more intangible associational supports underpin the vitality of the local cluster. The papers gathered in this special issue synthesize the results of a 5-year study of 26 industrial clusters conducted by members of the Innovation Systems Research Network in Canada.*

Introduction

The growing literature on both clusters and regional innovation systems highlights the relevance of networks of interrelated firms as key factors in the ability to produce innovative new products or processes in a timely fashion for global markets. These, and related, bodies of literature recognize that in a global marketplace, local input factors and inter-firm dynamics are critical to a firm's ability to innovate and thereby gain competitive advantage: although economic borders are disappearing, geography still matters (Boschma & Lambooy, 1999; Cooke, 2005; Iammarino, 2005; Morgan, 2004). Knowledge

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flows within and between clusters are critical to fostering and sustaining innovation. Networks of firms, in turn, rely upon the intangible assets of social capital and trust as part of the glue that holds the networks together. The analysis is further influenced by an evolutionary perspective which recognizes that clusters are the result of historical path dependencies seeded by particular initial conditions (Wolfe & Gertler, 2006).

One stream in the cluster literature, with a focus on competitive dynamics, claims that innovation and growth are primarily driven by local competition and sophisticated demand factors. It argues that industrial agglomeration, or clustering, creates a competitive and demanding environment that compels firms to innovate and helps them acquire the needed tools and resources (Porter, 1998). An alternative perspective situates clusters within a broader body of literature on regional dynamics and innovation systems, emphasizing the importance of agglomeration economies and learning dynamics within a local setting. It focuses on the innovation process, claiming that it is a complex, social and interactive activity that requires firms to learn from each other and other institutional actors. Regional agglomeration enhances learning by facilitating close interactions among firms and supporting the institutions needed to produce and apply knowledge and skills. This interaction helps firms manage uncertainty by creating social norms, conventions and habits or "untraded interdependencies", which guide and constrain firm activities. A cluster's viability depends on its ability to sustain a dense network of knowledge sharing and a high degree of common purpose (Asheim *et al.*, 2006; Breschi & Malerba, 2005).

The key questions that arise from this literature concern the way in which local conditions influence or constrain the developmental path of individual clusters, the extent to which they are grounded in specific local agglomerations of key factors that contribute to their growth, the relative influence of local dynamics in stimulating the competitive capabilities of the cluster and the extent to which external institutional supports in the form of research infrastructure, government policy or more intangible associational supports underpin the vitality of the local cluster. The papers gathered in this special issue synthesize the results of a 5-year study of 26 industrial clusters conducted by members of the Innovation Systems Research Network (ISRN) in Canada (Holbrook & Wolfe, 2005; Wolfe, 2003; Wolfe & Lucas, 2004, 2005). The goal of the project was to analyse how the formation and growth of these clusters contribute to local economic growth and innovative capacity. We now possess descriptive case studies for all of these clusters by industry and by region.[1]

In the course of the study, the researchers analysed cluster components, structures, linkages, governance and interactive processes in each of the individual cases. The selection of industries investigated ranges from highly knowledge-intensive activities such as biotechnology, photonics/wireless equipment, telecom equipment and aerospace to more traditional sectors such as steel, automotive parts, aerospace, specialty food and wine. The study was designed to allow us to examine, whenever possible, the same type of industry in two or more different regions in Canada. Each cluster was examined using a common research methodology, largely based on in-depth interviews with key cluster participants. The central questions in each case were: (i) what role do local institutions and actors play in fostering this transition; (ii) how important is interaction with non-local actors in this process; (iii) how dependent are local firms on unique local knowledge assets, and what is the relative importance of local versus non-local knowledge flows between economic actors; (iv) how did each local industrial concentration evolve over time to reach its present state, and what key events and decisions shaped its path and, finally, (v) to what

extent do these processes, relationships and local capabilities constitute a true cluster? The papers presented here undertake a meta-level analysis in order to discern intra-sectoral commonalities, as well as differences in experience that may have arisen due to regional influences and histories. The cases are distributed across both metropolitan and non-metropolitan regions, reflecting the unique geography of Canada's national economy.

The overall results contradict some of the most commonly accepted assumptions in the cluster literature. The sectoral bases of the individual clusters exert a strong influence in shaping their internal dynamics; equally important is the regional context in shaping their evolutionary trajectories. In particular, the open nature and smaller size of the Canadian economy relative to that of the USA partly accounts for the distinctive and divergent characteristics of Canadian clusters. This distinction brings to light a key challenge in analysing industrial clusters in Canada: understanding how clusters are influenced by linkages and interdependencies with outside markets and institutions. Sharing a border with the world's largest and most innovative economy creates both advantages and disadvantages for Canadian industry. Many firms generate a significant portion of their revenues from exports, primarily to the US, which means that the critical supply chain relationships extend beyond the local region. These external relationships often overshadow linkages with local organizations that sustain information and labour flows within an industry and underline the need to develop a more precise understanding of the interaction between local and external factors; some of the key factors associated with dynamic and successful clusters in the literature do not operate in the same way in the Canadian cases examined here.

Overview of Key Findings

A considerable amount of research has focused on the factors that give rise to clusters in specific locales, but these analyses tend to include both public and private factors, which does not distinguish between those elements which are amenable to policy influence and those which are not. Similarly, there is a certain lack of clarity around the relative importance of chance events, or serendipity, in the emergence of clusters, as opposed to rational or intentional policy design. The ISRN case studies provide important insights into this relationship. They also underline the sectoral specificity of industrial clusters—far too much of the literature generalizes from a few case studies in selected sectors. Clusters in different sectors draw upon different knowledge bases which influence both the innovation process within the clusters and the underlying relationship between the cluster and the research infrastructure supporting it. Finally, the case studies highlight the centrality of a strong, dynamic talent base or "thick" labour market for the success of most clusters. The ability to draw upon a plentiful supply of labour with the skills required by cluster firms is often the most critical factor that attracts them to, and anchors them in, a specific geographic location. In general, the comparative analysis of the case studies confirms a fundamental point made by Asheim *et al.*, namely, that it is not possible to formulate a comprehensive theory of clusters that covers all cases. "Clusters vary considerably in type, size, origin, structure, organization, dynamics and developmental trajectory. It seems most unlikely that different clusters can all be explained in the same way. We may well need different types of theory and explanation for different clusters" (2006, p. 15).

Path Dependence: Cluster Origins

The cluster literature has focused on the influence of factor endowments in explaining regional concentrations of industry. One approach builds on Marshall's original thinking on agglomeration economies to specify the types of supply-side externalities that generate increasing localized returns (Krugman, 1991). Porter, in contrast, roots the emergence of clusters in a particular location to the components of his "diamond" model of competitive dynamics, particularly the role of factor input conditions. The key factors that attract firms to locate in a region or stimulate the formation of startup companies are the availability of a strong pool of inputs, such as specialized skills and talent, specific areas of expertise in the research infrastructure and especially supportive infrastructure. He suggests that chance events often intervene in the birth or genesis of a cluster, such as the relocation of William Shockley from the east coast to the west; however, he then apparently contradicts himself by asserting that "chance . . . often has locational antecedents, making its role less than it first appears" (1998, p. 238). Citing the case of Medtronic in Minneapolis, he suggests that its emergence "was inextricably entwined with the area's local university and medical institutions" (1998, p. 239). Thus, both perspectives suggest that the presence of key locational assets seeds the ground in which clusters are most likely to emerge. There is an undoubted element of serendipity in many of the ISRN case studies—but in virtually all of them "chance had its locational antecedents" (Wolfe & Gertler 2006).

Clusters as a Sectoral Phenomenon

Another key finding that emerges from the ISRN case studies is the extent to which the cluster/sector distinction that is often made in the literature has masked one of the most significant dimensions of the cluster. While some approaches to cluster analysis stress the generic nature of clusters, placing strong emphasis on the common set of interrelated features that define clusters across a wide cross-section of the economy, recent analyses that draw upon the evolutionary approach stress the way in which major differences in innovation capabilities and production processes define the specific character of clusters embedded in different industrial sectors. Cross-sectoral differences are "likely to affect the relative importance of phenomena such as localized knowledge spillovers; inter- vs. intra-organizational learning; knowledge complementarities fuelled by localized labour mobility; innovative explorations undertaken through spin-offs, and more generally, the birth of new firms" (Breschi & Malerba, 2005, p. 4). The cross-cluster analysis of the 26 case studies summarized in the accompanying papers highlight the extent to which the character of individual clusters is strongly affected by the industrial sectors in which they are based. This finding has critical implications for our understanding of the character of individual clusters and the formulation of cluster policies, as policies which may be appropriate and valuable for clusters with one set of sectoral dynamics may prove inappropriate for clusters in another sector.

The comparative analysis of the ISRN case studies in the accompanying papers reveals that the key factors and processes which hold the elements of an individual cluster together are highly variable. In some cases, it is the underlying dynamics of the labour market; in another, it is the vitality and strength of the research infrastructure upon which it draws; while for a third, the linkages in the supply chain which determines the competitiveness of firms co-located in the cluster. The sectoral specificity of individual clusters

is underlined in a paper on the Ontario automotive clusters, which argues that the predominant conception of cluster dynamics tends "to downplay the industry specific nature of cluster development both within high technology and more traditionally based clusters." It stresses the role of different forms of knowledge and industrial restructuring in mature clusters and the impact of asymmetric power relations between firms, especially in those clusters that have become more tightly integrated into the supply chains of global production networks (Rutherford & Holmes, 2007).

Clusters can also be differentiated in terms of the source of knowledge they draw upon. A *synthetic* knowledge base is typical of industrial settings where innovation takes place mainly through the application or novel combinations of existing knowledge. Innovation in such industries is driven by the need to solve specific problems arising from the interaction with clients and suppliers. Classic examples come from sectors within advanced industrial engineering (such as the development of specialized machinery). In contrast, an *analytical* knowledge base prevails in those sectors where scientific knowledge is highly important and where knowledge creation is normally based on formal models, codified science and rational processes. Obvious examples of such industries are found in the biotechnology and information and communications technology sectors. However, many industrial sectors draw upon *both* synthetic and analytical forms of knowledge; thus, most fall along a continuum from purely analytical to synthetic knowledge bases. The analysis of the ISRN case study results developed a matrix of clusters differentiated by the nature of their knowledge base and the relative importance of the global/local dimensions of knowledge flows within those cases (Gertler & Wolfe, 2006).

Closely related to the sectoral and knowledge base that characterize individual clusters is the centrality of skilled labour as a critical locational asset. If there is one type of input that is overwhelmingly local, it is highly skilled labour. A consistent finding across the case studies is that the depth and breadth of the local labour market is the key ingredient defining a cluster's ability to support knowledge-intensive production. This factor endowment is created and maintained by the attraction and retention of highly educated, potentially mobile workers who are drawn to thick and deep opportunity-rich local labour markets. Recognition of the contribution this element makes to cluster development "stresses the centrality of local labour market processes to the innovative capacity, competitiveness and indeed existence of clusters. It is the dynamism of the local labour market that . . . account(s) for the associated clusters' dynamism" (Malmberg & Power, 2006, p. 60).

The Role of Civic Associations in Cluster Development

The formation of local institutional supports for industry clusters is another key element that contributes to the growth of the clusters. The case studies suggest that the most successful clusters have profited from the development of strong social networks at the community level and the emergence of dedicated, community-based organizations. Once established, local cluster, or even more broadly based civic, associations provide a strong institutional basis for delivering cluster support programmes and helping overcome coordination problems in the delivery of national and regional programmes of benefit to local clusters. These entities link leaders in the individual clusters to a broader cross-section of community leaders involved in the process of local economic development. They are supported by new

institutions of civic governance that identify problems impeding the growth of the cluster and help mobilize support across the community for proposed solutions.

Analysis of the case studies reveals the presence of a large number of local institutions and local actors that help build civic capital in the cluster and the local economy. The concept of *civic* capital is a critical element that local institutions and local actors bring to the process of cluster development. Civic capital consists of interpersonal networks and solidarity within a community based on a shared identity, expectations or goals and *tied to a specific region or locality*. It comprises formal or informal networks between individual community members, between communities, or between community and the state (Wolfe & Nelles, 2009). Civic capital recognizes the role played by local leaders, or civic entrepreneurs, in intensifying and formalizing collaborative networks within and between communities. Civic entrepreneurs can bond members of a community to coalesce and formalize coalitions based on shared identities and interests. However, their most important role is in *bridging* the gap between communities and between the local governments and community actors. Civic entrepreneurs understand the importance of collaboration; they bring business, the community and government together to set and achieve long-term development goals. They can emerge from any sector of society—business, government, education and community organizations—but share similar characteristics of visionary leadership, charismatic personalities, interest in building the economic region and commitment to collaborative solutions. Civic entrepreneurs help to build and intensify civic capital by "creating opportunities for people to work together on specific projects to advance their economic community" (Henton *et al*, 1997, p. 31).

Overview of the Comparative Studies

The first paper, by Lucas, Sands and Wolfe, reports on the results of a comparative study of eight information and communication technology (ICT) clusters across Canada. The dramatic growth of Silicon Valley in the last decades of the twentieth century reflected the growing prevalence of ICTs in the economy more broadly and sparked a dramatic interest in the development of comparable clusters in other locations. Several cases discussed in this paper emerged in the same period, or shortly after Silicon Valley, raising the question of whether they followed the same developmental trajectory or whether they were the product of a different combination of factors anchored in the specific character of their individual locations. The paper surveys the key findings from the cases and poses several questions: what are the critical factors that contributed to the emergence and development of the individual clusters? What is the relative importance of local versus nonlocal factors in supporting the dynamism of the clusters? And what are the most important factors that contribute to the ongoing competitiveness of the clusters? In conclusion, it summarizes the import of the findings for the cluster literature in general and sets out the main policy implications.

New media is quintessentially part of the new information economy; its roots lie in computer graphics and in creative specialized services used in motion picture production, advertising and other programming especially for television. The second paper by John Britton examines the similarities and differences between Canada's three new media concentrations in the metropolitan centres of Vancouver, Toronto and Montreal. It investigates whether the industry emerged from similar activities and whether differences in the pattern of development in each region explain contemporary new media activities.

It evaluates differences in local market opportunities and whether local specializations have emerged. A third focus is on the predominance of small firms in new media and whether there are differences in the social foundations of production.

The third paper by Meric Gertler and Tara Vinodrai surveys the results of six case studies in life science and medical technology clusters across the country. Biotechnology and life sciences have come to be viewed as quintessential knowledge-intensive activities in the contemporary economy. As a field of economic activity, they have been recognized as important drivers of economic growth and dynamism in developed and developing countries alike. Life science-related activity is expected to generate employment and income for regions and nations, thereby contributing to their economic competitiveness and prosperity. High levels of geographical concentration or clustering within particular locations is a characteristic pattern of this sector. What is less well understood within the literature on the emergence of bioscience and life sciences regions is how these regions have emerged and evolved through time. This paper presents findings from the study of life sciences activity in Canada's three largest city-regions (Montreal, Toronto and Vancouver), as well as in three smaller regions (Saskatoon, Ottawa and Halifax). In taking a comparative perspective, it elucidates both the similarities and differences that exist in the development of life sciences activity within various regional and institutional contexts.

The next paper by Betsy Donald examines how different notions of "quality" are used to shape the direction of a food and wine cluster. It explores the powerful role of the retailer–distributor in shaping that direction. The retailer–distributor can be either public or private, but ultimately plays a significant role in shaping the food and wine supply chain. "Alternative" quality-claiming retail and distribution venues have exploded in numbers recently (i.e. farmers markets, internet sellers, community supportive agriculture and direct tourist-inspired farm-gate sales). She argues for a more modest estimation of their "paradigmatic potential" to shape the future "quality" direction of food and wine clusters in Canada—especially as the larger food and wine retail–distributors continue to dominate the food and wine supply system. That said, given the political and social tensions surrounding the public regulation of food, there is still room for the growth of more localized "quality"-based agro-food–wine clusters if policy-makers deem them important to grow.

The last paper by Peter Warrian and Celine Mulhern looks at the current impact of industrial restructuring in six advanced manufacturing, materials and mining clusters across the country. Pressures to innovate and sustain competitive advantage in global markets are shifting the structure of advanced manufacturing industries towards a pattern typical of nimbler, high technology clusters. Industries that have historically been structured through vertical supply chains and internalized R&D are adopting a clustered pattern of industrial organization, characterized by regional concentrations of networked suppliers, inter-firm learning and a decentralized and flattened production chain. This paper synthesizes the findings on innovation and learning in these six clusters in advanced manufacturing and mining sectors, as they face the challenge of making the transition from one form of industrial production to another.

Conclusion

The papers gathered in this special issue, and the broader collection of individual case studies which they summarize, represent a comprehensive and valuable addition to our

knowledge and understanding of cluster dynamics. They are far from the last word on the subject, but the breadth and depth of the case studies analysed here provide a wealth of insights that contest some accepted doctrines in the cluster literature and confirm others. A key lesson is that the path dependencies for cluster creation are highly variable, and the chance events that provide the trigger for cluster formation can come from many sources. There is a strong element of serendipity in many of the cases analysed. However, virtually all the cases reinforce the point concerning the intersection of locational antecedents and chance occurrence in launching a regional or local economy along a certain trajectory of development.

The presence, or absence, of key institutional elements of the local or regional innovation system also affects their innovative capacity and their potential to serve as nodes for cluster development. Many clusters enjoy the knowledge assets and research infrastructure that are necessary for the development of an innovation-based development strategy, but they differ dramatically in their capacity to mobilize these assets in the pursuit of such a strategy. Experience demonstrates that regional and local governments, as well as cluster members themselves, can generate associational strategies to improve their chances of economic development. The successful initiation of this kind of process depends upon the ability to collaborate across boundaries, both geographic and social.

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Note

1. A comprehensive bibliography of all publications resulting from the study can be found online at http://www.utoronto.ca/isrn/cluster_initiative/biblio.html

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