Method for Identifying Industry Clusters: 
Assessment of the State of the Art

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A Masters Project submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Regional Planning in the Department of City and Regional Planning.

Chapel Hill
2003

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1. Introduction

The global economy has changed economic strategies both for private and public entities. It is likely that there are no longer permanent enemies in managing business; instead every firm is willing to cooperate in order to survive in an increasingly competitive world economy. Public and government agencies also have tried to provide private enterprises with better business conditions. The forms of the provision vary for issues such as tax abatement, subsidies for starting-up a business, and availability of high-skilled labor, etc. However, no resource can provide more benefit than an industry cluster can. Currently, industry clustering is accepted as the best solution for helping companies cope with the growing economic pressure caused by a competitive world economy because clusters are capable of creating wealth by developing specializations that effectively generate a competitive advantage within markets. That is, clustering industries provides access to more suppliers and customized support services, to experienced and skilled labor pools, and to the inevitable transfer of knowledge. Successful regional economies have clusters that produce goods and services along the entire value chain from basic inputs to final products and services. Among all of the advantages of clustering, nothing is as important as access to innovation, knowledge, and know-how, all of which are actively sought out in today’s business world.

Such a growing concern with industry clusters has called for many theoretical and empirical studies in order to make the concept of a cluster clear and to apply clustering effectively. However, since industry clusters have been defined, developed, and fostered in various ways, the actual definition of industry cluster differs in each case and stage. Both theoretical literature and empirical reports present different definitions of industry
clusters and deal with case studies illustrating different types of clusters. Boekholt (1997, p1) points out that the “multitude of cluster initiatives has led to a wide spread confusion of what clusters really are, and in what way they differ from related phenomenon, such as industrial districts, techno-poles, networks, and industry-research collaborations.” Most theoretical studies have claimed that there is not one correct definition or one desirable method of identifying industry clusters. Given the various definitions and different types of industry clusters that exist, a wide range of methods has been performed to identify industry clusters by policy makers and clustering experts. It has been observed, however, that some methods are used more frequently in current empirical cluster studies and reports. Thus it is necessary to classify and examine the various definitions of industry clusters and methods for identifying clusters that are used in the literature and reports in order to present a clear image of industry clusters as they exist today. In addition, it needs to explore what methods are desirable and what factors should be measured in the process of identifying clusters. With respect to these concerns, this paper starts with a review of the relevant concepts and definitions that have emerged in the literature thus far. The second part establishes the criteria that should be used as a basis for assessing various methods of identifying clusters. Finally, the third part examines which methods are used in empirical studies and how they are applied and then methods are assessed based on the criteria established in the second part.

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2. Approaches to Cluster Characterization and Conceptualization

According to the American Heritage Dictionary, a “cluster” is defined as “a group of the same or similar elements gathered or occurring closely together; a bunch.” Based on this definition, industry clusters can be defined simply as groups of related industries located in the same region. However, this description of industry clusters is too premature to fully explain the current complicated definition of an industry cluster; “the cluster concept normally implies more than literal meaning of density by reference to a hypothesis which states that the geographic agglomeration of economic activity may lead to improved technological or economic performance of the participating units” (Peneder 1999).

The concept of an industry cluster derives from various theories. According to Rosenfeld (2001), the catalyst for cluster strategies in the United States was Northern Italy. He states that Northern Italy is generally accepted as the proto-typical economy of clusters, or of industrial districts, as they are called in Italy. The region of Emilia-Romagna, in particular, was first noticed in the U.S. because of its, by US standards, unusually small, flexible, and specialized firm structure. While this Italian economic style has spread over Europe as well as North America, U.S. government agencies have begun to realize that networks are also a cost-effective means of aggregating demand and delivering services to small firms. Thus, this concern made networks an important tool for many federal programs, such as the Manufacturing Extension Partnership (for supply

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chains and joint R&D); the U.S. Department of Commerce (for marketing cooperatives); and the U.S. Department of Labor (for training alliances) (Rosenfeld, 2001). The famous examples of industry clusters in the U.S. are widely spread over the nation: the Research Triangle in North Carolina; the insurance and financial markets in Hartford, Connecticut; the film industry in Hollywood; carpets in Dalton, Georgia; tourism in south Florida; and technology along Route 128 in Massachusetts and in Silicon Valley, California. When the implications of industry clusters were first being discussed, policymakers and scholars focused primarily on high-tech industries. However, as the concept of the industry cluster has matured, it has been applied to a wider variety of industries.

Most theoretical studies begin by defining industrial cluster as the elaboration of the geographical concentration concept. Among the relatively early studies, Michael Porter’s book ‘The Competitive Advantage of Nations (1990)’ popularized the concept of industry clusters for the first time. He defines clusters as “geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions.”4 Porter explains that the geographic scale can range from the urban scale to even a group of countries and can take varying forms depending on depth and sophistication of its concern. In addition, he extends his definition of a cluster into two types of clusters: vertical clusters and horizontal clusters. According to his explanation, vertical clusters are made up of industries that are linked through buyer-seller relationships. In contrast, horizontal clusters include industries that might share a common market for the end products, use common technologies or labor force skills, or require similar natural resources.

Since Michael Porter has ignited the debate about industry clusters, there have

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been several arguments based upon his hypothesis. In particular, Jacobs and DeMan (1996) argue that “there is not one correct definition of the cluster concept…different dimensions are of interest.” They expand from Porter’s definition of vertical and horizontal industry clusters to identify key dimensions that may be used to define clusters. These include the geographic or spatial clustering of economic activity, horizontal and vertical relationships among industry sectors, use of common technologies, the presence of a central actor, and the quality of the firm network, or firm cooperation (Jacobs and DeMan 1996). Enright also extends the definition of an industry cluster beyond geographical concentration. He explains that “firms are bound together through buyer-supplier relationships, or common technologies, common buyers or distribution channels, or common labor pools.” (Enright, 1996, p.191) In his argument, economic self-interest is ultimately the glue that binds the cluster together. Moreover, ‘related and supporting institutions’ are also very crucial to the competitiveness of the cluster. These related and supporting institutions include industry associations, technical and community colleges with specialized industry programs, universities, government industrial extension programs, and network brokers, etc.

According to Rosenfeld (1997), an industry cluster is “a geographically bounded concentration of similar, related or complementary business entities, with active channels for business transactions, communications and dialogue, which share specialized infrastructure, labor markets and services, and that are faced with common opportunities.

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and threats." His argument seems to focus only on the geographical issue with similar or related entities defining a cluster. However, he also emphasizes the effect of geography on the role of social interaction and firm cooperation in determining the dynamic nature of a cluster. Although the issue of trust and cooperation was a relatively new and fresh approach to analyzing industry clusters, the argument that they exist among cluster firms has been criticized. A cluster comprised of enterprises that gain no real economic advantage from their presence in the group loses all conceptual meaning from a theoretical and policymaking perspective (Bergman and Feser 1999).

Recently, many studies have begun focusing on innovative industry clusters. Broersma (2001) defines innovative clusters as “industry groups that have strong innovative links with each other, but weak innovative links with the rest of the industries.” He also argues that successful innovation processes depend crucially on the way in which inputs in the innovation process are transformed into outputs. In other words, they highly depend on the ‘throughput’ process. Indicators of this throughput process reflect the efficiency of the transformation of innovative input into output at the macro, meso and micro level. One such throughput is the extent to which industries are linked to one another. However, innovative activities of firms or industries differ with respect to their intensity, orientation, use of external knowledge, etc. (Arvanitis and Hollenstein 1998). For this reason, a whole series of indicators is needed to describe

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and measure firms’ or industries’ innovative activities.

Arvanitis and Hollenstein claim that these indicators can be obtained from specific patterns of innovative activity (innovative types) or from a ranking of firms according to a composite measure of innovativeness (innovation intensity). For instance, innovation types can be characterized by some structural properties (e.g. firm size, industry, export orientation) and factors relevant for innovation (e.g. market conditions). On the other hand, innovation intensity is relevant for the innovation process, as is human capital intensity, R&D cooperation intensity, etc. The innovative cluster approach seems very difficult to define by a simple word or phrase; therefore, a very complicated method or analysis is now used to identify innovative industry clusters. Innovation will be described more specifically in the next chapter.

One of the salient debates about and approaches to industry clusters is related to small and medium sized enterprises (SMEs). The major conclusions of the SMEs study of industry clusters is that the theories and empirical studies have in common that differences in firm size (large firms versus small firms) seem to be particularly relevant in assessing the role and position of firms participating in an industry cluster. With respect to the cluster participants and the study of SMEs in these industry clusters, Muizer and Hospers (2000) define a regional industry cluster as a “cooperation arrangement with the strategic objective of maintaining or enhancing the competitiveness of its participants. Such an industry cluster includes at least two participants of which one or more SMEs. The geographical dimension is predominant, but the cluster may also consist of horizontal, vertical, institutional dimensions.” This firm size debate extends to

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studies of mega and national enterprises (MNEs) clusters. According to a recent study from a European perspective, “the suggestion that foreign-owned MNEs should be included as potential contributions to the competitive advantage of host-country industry clusters seems likely to have merit in the Irish case…Even in the absence of fully developed Porterian clusters, there generally are appreciable benefits…arising from…a grouping of connected or related companies or industries, and from interactions between them” (O’Malley and van Egeraat, 2000).

The multi-cluster is also an emerging issue in industry cluster debates. In studies of London and Paris and their surrounding regions, Simmie and Sennett (1999) identify multi-cluster types as being comprised of multiple clusters of innovative sectors and associated primarily with international trading nodes or metropolises. The multi-cluster is characterized by minimal linkages with local suppliers, a focus on both local and international markets, the existence of major international airports, and high concentrations of competitive innovation. In addition, the Construction mega-cluster (C-MC) is developed out of and established from the multi-cluster concept. C-MC includes all activities where the end product is a building. The C-MC is thus defined as “activities which together contribute to the construction, maintenance, management and demolition of buildings – no matter what the use of the buildings.”

Construction activities that are related to the broad physical infrastructure are not included in this definition; although, the infrastructure activities are conventionally considered to be part of the construction sector in, for example, national account definitions.

Basically, the study of clusters can be divided into three main levels as

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summarized in table 1. Firstly, at the macro level, for instance, it is used as input in discussions on industrial and innovation policy-making and on how to improve the match between public research and higher education institutions and industries. Secondly, at the meso level, the analyses serve as a starting point for strategic advice on the competitiveness of an individual cluster by identifying key knowledge issues, designing and upgrading strategies and determining how to turn negative competitive dynamics into strategic cooperation and differentiation-based competition. Lastly, at the micro level, cluster studies provide a basis for initiating and supporting innovative micro-level cluster projects aiming to increase cooperation between major companies, their (main) suppliers, (semi-) public knowledge institutes, as well as various other bridging institution (e.g. engineering companies, innovation centers, etc.) (Roelandt et al, 1998).13

Table 1: Cluster analysis at different levels of analysis (Roelandt, et al. 2000. p 11)14

<table>
<thead>
<tr>
<th>Level of analysis</th>
<th>Cluster concept</th>
<th>Focus of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>National level (macro)</td>
<td>Industry group linkages in the economy as a whole</td>
<td>Specialization patterns of a national/regional economy. Need for innovation and upgrading of products and processes in mega-clusters</td>
</tr>
<tr>
<td>Branch or industry level (meso)</td>
<td>Inter- and Intra-industry linkages in the different stages of the production chain of similar end product(s)</td>
<td>Benchmark analysis of industries. Exploring innovation needs</td>
</tr>
<tr>
<td>Firm level (micro)</td>
<td>Specialized suppliers around one or more core enterprises (inter-firm linkages)</td>
<td>Strategic business development Chain analysis and chain management Development of collaborative innovation projects</td>
</tr>
</tbody>
</table>

It is well known that the industry cluster has been widely accepted and used in many countries. Boekholt and Thuriaux (1999) provide examples of dominant

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international cluster models (see table 2). Although Roelandt and Hertog (1999) point out that most countries have cluster-based policies and incentives originating from a trend toward designing governance forms and incentive structures to reduce systemic imperfections within their systems of innovation, each country applies a different approach. Basically, this difference is based on the distinction between a bottom-up approach and a top-down approach. Roelandt and Hertog explain that the bottom-up approach focuses on fostering dynamic market functioning and removing market imperfections, and the starting point lies in market-induced initiatives with the government acting as a facilitator and moderator and not setting national priorities. Also, they state that this approach can be found in the USA and the Netherlands. On the other hand, in the top-down approach, various government agencies set national priorities, formulate a challenging view for the future and decide on the actors to be involved in the dialogue process. However, after the national priorities have been set and the dialogue groups have been initiated, the clustering process is a market-led process without much government interference. Nordic countries adopt this top-down approach.15 Bergman and Feser also introduce the concepts of the top-down and bottom-up industry cluster analyses within a meso level. They describe that the top-down approach attempts to identify industry clusters through various data reduction techniques, such as statistical cluster analysis, factor analysis, and the like. The bottom-up approach identifies industry clusters by beginning with individual sectors and then finding linkages with other industries and related non-business institutions (Bergman and Feser, 1999).16

As discussed before, there are various approaches to conceptualizing the nature of industry clusters. In summary, industry clusters can be defined as geographical concentrations or in diverse ways by the various factors connecting companies within or beyond a cluster. Also it could be said that most cluster studies use a combination of different techniques at different levels of aggregation to overcome the limitations of a single technique and to answer different questions (Hertog et al, 1999)\(^\text{17}\). Each technique will be specifically explored in chapter four to determine how they are used in empirical studies and what they should measure.

**Table 2: The examples of dominant international cluster models**

<table>
<thead>
<tr>
<th>Model</th>
<th>Level</th>
<th>Aim to improve</th>
<th>Typical action</th>
<th>Typical countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Advantage Model</td>
<td>Mega/Meso</td>
<td>National advantage in certain sectors or value chains</td>
<td>Identify clusters and create supporting conditions</td>
<td>Canada, Denmark, Finland, Sweden, the Netherlands</td>
</tr>
<tr>
<td>SME Networking Model</td>
<td>Micro/(Meso)</td>
<td>SME-competitiveness</td>
<td>Increase interactions with external knowledge carriers to compensate for lack of capabilities and to innovate and learn from others</td>
<td>Australia, New Zealand, Norway, USA</td>
</tr>
<tr>
<td>Regional Development Model</td>
<td>Meso/Micro</td>
<td>Attractiveness, economic performance and development of a region</td>
<td>Stimulate business specialization patterns by investments and networking initiatives</td>
<td>Canada, Scotland, Wales, USA</td>
</tr>
<tr>
<td>Industry-Research Link Model</td>
<td>Micro/(Meso)</td>
<td>Collaboration and networking between industry and research</td>
<td>Creating ‘critical mass’ in emerging technology by attracting research facilities, investors and firms</td>
<td>Austria, Germany, the Netherlands</td>
</tr>
</tbody>
</table>

Source: Boekholt and Thuriaux, 1999\(^\text{18}\)

\(^{17}\) Hertog, P., Leyten, J., Limpens, I., and Whalley, J. 1999. *Approaches to cluster analysis and its rationale as a basis of policy*. Ch. 5, RISE project.

3. Assessment Criteria for Cluster Identification

Based on the various definitions and approaches of an industry cluster discussed in the previous chapter, some criteria for assessing the methods of identifying industry clusters can be easily established. Among many considerations we should pay attention to, innovation seems to be one of the most significant factors to be measured in clustering today. Generally, ‘innovation’ refers to “a collective and iterative process and an environment that encourages people to share and play off one another’s ideas and promote innovations in technologies, products, and processes.”19 It is well known that ‘innovation’ through the creation, diffusion and use of knowledge has become a key driver of economic growth and has provided part of the response to many new societal challenges.

In spite of the apparent effectiveness of ‘innovation,’ it seems that specific and clear meanings and outcomes of ‘innovation’ in clustering have not yet been established. According to an OECD report, “the determinants of innovation performance have changed in a globalizing knowledge-based economy, partly as a result of recent developments in information and communication technologies.”20 As this statement suggests, innovation is not easily defined as a simple phase or occurrence; however, a few scholars simply suggest that the innovation process in industry clusters is physically related to institutions or groups of competing and cooperating companies, suppliers, higher education institutions, private and public research institutes, consultancy and technical service providers and regulatory bodies, etc. Since this measurement is

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relatively easy and apparent, it has dominated in the innovation argument for a while. However, current studies concentrate not only on what those innovation entities are doing, but also on how the cluster can access them; the debate has moved to ‘accessibility.’ Access to innovation, knowledge, and know-how is regarded as the most important advantage of clustering today. However, a problem could arise regarding how to measure the accessibility of innovation. Compared to entities, accessibility has not been studied often. Instead, it is likely that accessibility has been dealt with on the level of ‘networks’ or ‘connection’. With respect to partial consideration of innovation matter, innovation entities will be considered to be part of the innovation criteria, and the other factor, accessibility, will be part of the networks study.

Another significant trend in looking at industry clusters is ‘entrepreneurship.’ In fact, ‘entrepreneurship’ is frequently paired with ‘innovation’ because both innovation and entrepreneurship are generally accepted as engines that propel competitive clusters. In an example of this phenomenon it is revealed that “economic clusters emerge most often where there is critical mass of firms allowing economies of scale and scope, a strong science and technology base, and a culture conducive to innovation and entrepreneurship.”21 Among the various features of entrepreneurship, entrepreneurial capacity and climate have been identified as the fuels that drive the expansion of cluster growth. In particular, capacity is heavily dependent on recruitment, and recruitment is strongly related to entrepreneurship in that the genesis of most clusters can be traced to the employees of one or two companies who left to start their own companies. The impetus in some cases was survival when a parent firm downsized, went out of business,

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The entrepreneurial climate can be explained simply as “a continual formation of new business ventures by workers and managers within the cluster based on new, complementary or competitive products or on core competences.” In fact, since the existence of an entrepreneurial climate has been recognized and considered extensively, it is not necessary to explain it any further here. However, a debate might arise regarding what should be measured in the name of entrepreneurship. In fact, although entrepreneurship has been detected by survey or qualitative methods, there are not many related measures. The measure of entrepreneurship would be a good subject for further study.

Beyond the entrepreneurial capacity and climate argument, entrepreneurship has recently been diversified and connected to other concepts. Rosenfeld (2002) claims that a more common stimulus for entrepreneurs has been a desire to exploit a different niche market, become an independent supplier, or develop a new concept. His statement effectively shows how the study of entrepreneurship’s role in clustering has changed. A more thorough investigation into the role of entrepreneurship is beyond this study; however, it is apparent that entrepreneurship, as well as innovation, seems to be a vital factor in determining the successful management of an industry cluster. Thus, it is very important to detect entrepreneurship during the process of identifying industry clusters.

From the point of view of ‘entrepreneurship,’ especially from that of recruitment, the labor force has also emerged as one of the primary factors to be considered. To help clusters become more innovative and entrepreneurial-driven, policymakers need to work with their educational institutions and the private sector to build a skilled labor force.

Some kinds of skills, such as technical skills, a general knowledge of the industry, and entrepreneurial skills, should be taught. However, this is not to say that a larger or more highly skilled labor force is the most preferred method for developing successful clusters today; the argument over the labor force has moved on to a debate over levels of skills. Raising educational levels has long been considered fundamental to achieving a region’s social and economic goals, but the aging of the skilled labor force is making it a necessity. Generally, companies depend on an uninterrupted flow of workers with necessary skills and a knowledge of the industry to apply to both routine and unanticipated situations. In this flow, the critical factor is not highly educated employees, who can be and are recruited globally, but the mid-skilled technical labor force, i.e. people in occupations that generally require less than a baccalaureate degree, such as manufacturing technicians, sales staff, network administrators, medical technicians, etc. These people are educated at local community colleges, technical institutes, and vocational schools, and come predominantly from lower and middle class backgrounds. It should also be noted that they are less geographically mobile. The importance of a local mid-skilled labor force has received much more attention than in the past because of growing concerns about local economic development strategy.

In clusters with social capital, knowledge and innovation is transferred much more readily. Social capital, that is, a soft external economy, depends on personal relationships and connections for acquisition of tacit knowledge, which is buried in the minds of individuals and the routines of organizations and thus is not easily communicated except through personal interactions. Rosenfeld (2002) claims that “the mechanisms and entities for collecting and disseminating knowledge—the gatekeepers,
brokers, and intermediaries that encourage and facilitate all forms of associative behavior—provide the value embodied in social capital that is so important to cluster competitiveness."

Likewise, social capital in cluster debates should be discussed in conjunction with ‘connections or intermediaries.’ In other words, the limits of or constraints to active participation in a successful cluster are largely a function of a lack of ‘connection’ or deficits in social capital. Some regions’ stock of social capital resides in its civic and professional associations, and its economic value is deeply embedded in the functions of groups that bring people together to share ideas and knowledge. A variety of entities that work with clusters, including technology centers, NGOs, or skills councils, serve as gateways to information, knowledge, and labor and as linking agents (Rosenfeld, 2002).

This concept of connection to social capitals can be easily extended to ‘networking.’ Networking is the process that moves and spreads ideas, information, and best practices throughout a cluster and imports them from other places. Networking in clustering is the primary concept of today’s debate about small and mid-sized enterprises (SMEs). From the late 1980s, when SMEs were flourishing, networks had become popular policy tools throughout the industrialized world. These networks were formally structured coalitions of firms that ranged from joint ventures created by legal contracts to business associations formed by nothing more binding than annual membership dues. In addition, most theoretical reports have dealt with ‘external connections’ as an individual factor. However, this seems to cause confusion because ‘networks’ and ‘external connections’ are very similar factors in clustering. Of course, the concept of networks has a tendency to suggest internal connections, but each firm or entity is connected externally
as well as internally. In other words, both internal and external connections influence each other, and they cannot act individually or separately. Therefore, the concept of external connections is included in the ‘networks’ section of this study.

Geographic concern plays a big part in determining which kinds of systemic relationships among members are possible to develop and affect and is one of the basic factors of clustering. In particular, geographic concern generally refers to ‘proximity’ between suppliers and customers and it has allowed them to grow vertically. It is well known in many mature clusters that ‘proximity’ matters most for critical components or supplies that are knowledge-intensive and that historically depend on interactive research and design or special support in assembly or utilization. For example, inner city businesses depend heavily on proximity to their customers, including those living in surrounding suburbs. The same can be said about rural communities in terms of directly reducing transportation costs and maximizing interaction. The geographic concern can be measured in terms of supply chains, number of suppliers, etc.

Based on the above argument about proximity, specialized services should also be concerned with measuring clusters. Generally, specialized services include bankers and accountants with a deep understanding of the industry’s technologies and markets; suppliers and customers who share expertise; faculty and graduate students at universities; trusted consultants available to help solve specific problems; and business support centers that can assess production methods and business procedures and advise. The reason why clusters matter to specialized services is that it is necessary to create sufficient efficiencies to yield economies of scale. According to Rosenfeld, “the successes of northern Italy, as transmitted and interpreted throughout the U.S., were first attributed not
to the clustering of companies but to the intensity of inter-firm collaboration and to the specialized services created by the government and trade associations that gave the small companies access to external economies of scale.**24** Currently, services are too diversified; therefore, many resources, such as time or money, are wasted. One common solution to this problem is to integrate the services for specific clusters either by creating a cluster hub or center or creating a set of specialized intermediaries to serve as linking agents. This method combines various specialized services; therefore, it is worthwhile to measure specialized services in order to examine their integrity. Also, specialized services directly relate to networks in that networks allow firms access to specialized services at lower costs. Typical measures of specialized services vary depending on the services, which might be for the public or private sector. Simply stated, both sectors’ services measure the number of consultants who specialize in the cluster, services that employ specialists from clusters, dollar value of local outsourced services, etc.

The most effective and easiest ways to accumulate knowledge and skills within clusters are to cooperate with institutions located near the clusters. This R&D consideration has been thoroughly investigated both in theoretical and empirical studies. Generally, firms aggressively seek out new information and ideas to compete with growing business competition. Active professional associations providing the channels for dissemination can continue the diffusion of ideas and technologies. Although they are sometimes too slow, they are steady and very effective. R&D capacity is very important compared to the other factors discussed earlier. It includes R&D expenditures from government and private sources.

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<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
<th>Typical Measures/Proxies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation</td>
<td>New and enhanced technologies and products that are conceived, developed, and</td>
<td>Patents and copyrights; Dollar investments in new technologies; New product lines started.</td>
</tr>
<tr>
<td></td>
<td>adopted or brought to market; Dispersion of innovations to other local firms</td>
<td></td>
</tr>
<tr>
<td>Entrepreneurship</td>
<td>Continual formation of new business</td>
<td>Number of new startups generated by cluster; Number attracted to cluster.</td>
</tr>
<tr>
<td></td>
<td>ventures by workers and managers within the cluster based on new, complementary, or competitive products or on core competences</td>
<td></td>
</tr>
<tr>
<td>Workforce skills and</td>
<td>Degree to which labor force skills are tailored to the cluster’s needs (i.e.,</td>
<td>Number of enrollment in relevant programs; Graduates hired by cluster; Number of local mid-skilled labor force.</td>
</tr>
<tr>
<td>availability</td>
<td>technical skills, general knowledge of the industry, and entrepreneurial skills)</td>
<td></td>
</tr>
<tr>
<td>Networks</td>
<td>Frequency of formal cooperation among cluster members in, for example, joint ventures, production, marketing, training, or problem solving</td>
<td>Number of joint ventures, skills alliances, marketing consortia, etc.</td>
</tr>
<tr>
<td>External Connections</td>
<td>Joint ventures, contracts, alliances with firms, contacts/communications with experts in other regions; Knowledge of international benchmark practices</td>
<td>Study or benchmarking tours, travel to trade shows; Alliances that include external members.</td>
</tr>
<tr>
<td>Social Capital</td>
<td>Scale and degree of activity among local business and civic associations in the region; Frequency of interaction; Informal networks of personal business-related contacts</td>
<td>Number of professional, business, and trade associations; Membership in each, level of activity; Survey of connections.</td>
</tr>
<tr>
<td>Geographic concern</td>
<td>Nearby sources of primary and secondary suppliers, materials, and services that minimize transaction costs and maximize interaction</td>
<td>Input/output analysis of supply chains; Number of potential first-, second-, and third-tier suppliers; Survey of actual suppliers.</td>
</tr>
<tr>
<td>Specialized services</td>
<td>Public-sector services, such as technology extension services, technology centers, export assistance, or small business centers and private-sector services provided by designers, engineering consultants, accountants and lawyers that have special knowledge of the cluster</td>
<td>Number of consultants who specialize in the cluster; Services that employ specialists from clusters; Dollar value of local outsourced services.</td>
</tr>
<tr>
<td>R&amp;D capacity</td>
<td>Institute of public or private research in areas related to cluster’s products or processes; Expert individual researchers that are available or accessible</td>
<td>R&amp;D expenditures from government and private sources that involve cluster members, products, or processes.</td>
</tr>
</tbody>
</table>


The report ‘A Governor’s Guide to Cluster-Based Economic Development (2002)’ introduces a set of benchmarking guides that best define the benefits and outcomes of
clustering. They are: (1) R&D capacity, (2) workforce skills and availability, (3) education and training, (4) proximity to suppliers, (5) capital availability, (6) specialized services, (7) machine builders and software designers, (8) networks and alliances, (9) social capital, (10) entrepreneurial climate, (11) innovation and imitation, (12) presence of market leaders and innovators, (13) external economies, (14) shared vision and leadership. While all of the above are important to the firms in a cluster, table 3 shows the preferred factors that should be taken into account when identifying industry clusters. They can be determined by reviewing literature that discusses the current trend in clustering, and each are already specifically described here. Perhaps the eight factors in table 3 are not enough to identify clusters in the current complicated environment. However, the task of finding more factors is better left for further studies and should be discussed in more depth in both theoretical and practical fields. The next chapter uses the criteria shown in table 3 to explore and assess the methods of and techniques for identifying industry clusters.
4. Methods and Techniques for Identifying Industry Clusters

Due to the various definitions of and approaches to industry clusters introduced earlier, there are differing arguments regarding the methods of and techniques for identifying clusters. Bergman and Feser (1999) classify current methodologies for identifying industry clusters into six basic analytical approaches, especially for the meso-level of industry cluster analysis they labeled:

1) Expert opinion
2) Location quotients (LQs)
3) Trade-based input-output analysis
4) Innovation-based input-output analysis
5) Network analysis
6) Surveys

According to their argument, expert opinion gathered from interviews, focus groups, Delphi survey techniques, and other means of gathering key informant information, is probably the most common approach to identifying regional clusters. In particular, this method is most commonly used in micro-level studies. However, they point out that “the literature on clusters pays scant attention to valid expert data collection techniques.”

Another common method of identifying regional industry clusters is the location quotient (LQ). This methodology is very simple and easy to use; however, Berman and Feser indicate that “location quotients say absolutely nothing about regional industry clusters, and are an industry-based technique and therefore offer no insight on interdependences between sectors.” (1999, p23) Another limitation of the LQ technique is that it can be used in only bottom-up analyses as one of several measures of sector performance. Among various techniques, input-output analysis seems to be used most widely and frequently. Basically, this analysis can overcome the limitation of the LQ
technique, its lack of concern for interdependence between sectors; therefore, input-output analysis is especially useful in an analysis of a vertically-integrated cluster, in which the buyer-seller linkages are more obvious. In addition, input-output analysis has been applied to a number of OECD countries. Because of its abundant applications, many researchers are using it more and more frequently.

Unlike other methods, network analysis is not confined to only one technique; instead, it uses both quantitative analysis, such as trade- or innovation-based input-output tables, and qualitative analysis, such as surveys of regional experts or other qualitative sources of connections between regional industries. The primary concern of network analysis is to examine linkages between firms or sectors. Finally, the survey is one of the frequently-used methods of identifying industry clusters. However, it seems that the cases using only surveys are rare. Besides, survey-based methods are very expensive. Thus, many empirical reports seem to use surveys in conjunction with other quantitative methods.

Roelandt et al. (2000) group the techniques used in the literature to identify clusters into four categories:

1) Input-output analysis
2) Graph analysis
3) Correspondence analysis
4) Qualitative case study approach

Among them, he argues that input-output analysis is the most focused on the economic linkages between the identified actors in networks or value chains. This method allows for the systematic mapping of network relations of production and/or innovation. His argument for the input-output technique is not very different from Bergman and Feser’s explanation. Also, he introduces ‘Graph Analysis,’ founded in the graph theory to
identify cliques and other types of network linkages between firms or industry groups. This method looks very similar to the network analysis mentioned above because the two techniques aim at examining linkages within clusters. He also introduces a relatively confusing method, correspondence analysis. He argues that it is similar to factor analysis, principal components analysis, multi-dimensional scaling and canonical correlation. All these techniques aim at identifying groups or categories of firms or industries with similar innovation styles. Graph analysis and correspondence analysis look very similar. However, Roelandt claims that there is a minor difference between them because correspondence analysis focuses more on similar innovation than graph analysis does.

Finally, the qualitative case study approach is often based on Porter’s diamond and is used as a frame of reference for studies conducted in various countries. Roelandt also mentions that input-output analysis and graph analysis can be used to identify network linkages of production or innovation (using input-output tables or innovation interaction matrices). On the other hand, correspondence analysis and the qualitative case study approach can be applied to identify styles of innovation and different styles of division of labor when innovating.

Compared to Bergman and Feser’s classification, Roelandt’s distinction of the techniques does not seem as clear. His lack of clarity might result from the different ways that Europeans and North Americans approach and identify industry clusters; many studies and reports use different terminologies to describe methods of identifying industry clusters despite that the techniques are similar and have the same objective. Besides, few studies use the methods Roelandt classified. Thus, based on Bergman and Feser’s and Roelandt’s classification, each method will be specifically discussed in the
next section with the empirical industry cluster reports. Also, each method will be examined by the criteria presented previously in order to determine which methods are most effective today. In particular, eight factors will be scrutinized with each method, and then the results will be introduced briefly.

4-1. Porter’s Diamond Approach

Porter developed the “Diamond of Advantage,” which consists of the four factors that he determined create a competitive advantage for firms. The four corners of the diamond include factor conditions, demand conditions, industry strategy/rivalry, and related and supporting industries. To be more specific, factor conditions can be explained as basic endowments or conditions with which the firm seeks to compete (e.g., cost-related basic factors, such as ready supplies of natural resources or inexpensive, unskilled labor, versus knowledge and/or technology-related advanced factors); demand conditions can be described as the nature of local demand, for example, the needs and wants of the consumer for foreign and domestic goods as well as the existence of a local industrial demand for related intermediate goods; industry/rivalry is the nature of the firms’ strategies, structure and rivalry in the country, including attitudes toward competition, market institutions, the degree of local competition, and other cultural and historical factors affecting how firms do business with each other, their workers, and the government; lastly, related and supporting industries include suppliers and successful competitors (Bergman and Feser 1999). In addition to these conditions, Porter includes the roles of government and chance. Historical accident and/or government actions tend to play significant roles in the development or location of industry clusters. Porter used
the diamond to determine which firms and industries had competitive advantages, and his emphasis on the importance of related and supporting industries encouraged interest in clusters. Thus, this method is used to identify leading industries in a specific region. While his original thesis was applied to nations as a whole, Porter recognized that the majority of economic activity takes place at the regional level. Thus, his ideas are commonly applied to cities and regions.

The Northeast Minnesota Industry Cluster Study (2001)\textsuperscript{25} shows how Michael Porter’s Diamond of Advantage concept, as well as other methods, can be used and applied. This study identified four clusters for the region, including forest products, tourism, health services, and information technology, using quantitative and qualitative modes of research. Although this study refers to Porter’s four concepts, the quantitative method is mainly used to identify clusters. The first step of the method is to use detailed 528-sector employment and output data from an IMPLAN input-output model. Also, Location Quotient (LQ) and shift-share analyses are employed to identify highly concentrated and competitive industries. Through these techniques, eight industry clusters with existing or emerging signs of competitiveness are identified. As the next step, an advisory committee of local economic development professionals and analysts is assembled to assist in the selection of four industry clusters out of eight candidate industry clusters. Then, the committee votes to examine four industry clusters. After those steps are conducted, the identified four industries are specifically described according to each of the diamond conditions described by Porter. Thus, strictly speaking, other quantitative techniques, such as input-output, location quotients, and shift-share

analyses, performed to identify leading industries in Northeast Minnesota are much more significant than Porter’s diamond approach. In addition, surveys and focus groups are typically used in conjunction with quantitative techniques. As this report shows, many empirical studies have used Porter’s diamond approach as an examining or analytical tool for already acquired results. This proof shows that Porter’s approach is not appropriate as an individual method of identifying clusters.

Based on the criteria established in the previous chapter, the diamond approach has several strong points; running factor conditions and related and supporting industries are highly capable of finding geographic concern, especially suppliers, and workforce skills, because, as discussed, they can be explained as activities for finding efficient suppliers and an appropriate labor force. Demand conditions and industry/rivalry seem to be measured to a small extent by social capital and networks; however, the extent to which they are measured is not high compared to factor conditions and supporting industries. Summarily, it could be said that Porter’s conditions are just used as a theoretical base and descriptive classification of their findings. Therefore, Porter’s diamond method does not seem to be an effective technique for finding industry clusters; rather, it is used to verify and explain the results of the observed leading sectors in study regions.

4-2. Input-Output Analysis

Input-Output analysis is a frequently-used method of identifying industry clusters.

It is well known that I-O analysis has a lot of strong points compared to other methods, and many empirical reports have used it; therefore, it is not necessary to mention them
again here. However, the ways in which the trend of I-O analysis has changed should be noted. According to Bergman and Feser, “an important input-output approach applied in a number of OECD countries is based on analysis of innovation interaction matrices rather than (or sometimes in concert with) traditional production flow matrices.” In addition, DeBresson (1996) argues that innovation matrices derived from surveys describe the flows of innovations between innovation-producers and innovation-users. DeBresson, C. 1996. *Economic Interdependence and Innovative Activity*. Cheltenham, UK: Edward Elgar.


In other words, their explanation means network factor information can also be obtained by using innovation matrices. In addition, traditional matrices also have a good tool for detecting the production flows that make up one kind of network. On the other hand, geographic concern can be found to a greater extent using a traditional input-output method.

Traditional input-output analysis focuses on commercial links between industries or firms and can illustrate the inflow or goods in a society that depends upon the demand for an end product. This information can be summarized in an input-output table wherein deliveries between different sectors can be indicated. Inputs, such as imports, labor and capital and their delivery to end use, and export are tabled (Almqvist et al 1998).

The argument about innovation and traditional input-output derives from the different approaches used by the U.S. and Europe. They each have their own way of applying the input-output method to find clusters. In the case of the U.S., the first step in

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the process involves statistically analyzing industry clusters (inter-industrial linkages) for the U.S. economy as a whole, irrespective of geographical location. Location quotients and shift-share analysis are frequently used in this step. Then, identified clusters are examined in more detail at the level of the state and smaller geographic regions. Actually, the principal source of input-output data in the United States is the Benchmark Input-Output Accounts of the United States, produced twice every decade in years ending in 2 and 7. Also, it is observed that the U.S. Staffing Patterns Matrix, which provides a useful approach for identifying industries that draw from the same broad labor pool, is used.\textsuperscript{29} The Benchmark (I-O) Accounts provide for a useful characterization of industries that fall within the same value chain. These two sets of data provide a way of understanding the vertical and horizontal linkages. This ability to understand vertical and horizontal linkages makes the use of input-output analysis in U.S. cases very effective. Clusters are defined by examining each 2-digit SIC sector to determine which other 2-digit SIC sectors are highly related to the sector being considered. Also, most U.S. input-output studies are developed using the IMPLAN computer software.

On the other hand, European cases present somewhat different features when applying input-output analysis. For example, input-output analysis used in the Austrian state of Styria analyzes and interprets the evolution of industrial linkages in Styria from 1980 to 2000.\textsuperscript{30} The main focus of the study is directed toward examining how the interrelationships of selected industrial clusters, both to themselves as well as to the rest of the economy, have changed over time. Compared to other U.S. studies, the method of

\textsuperscript{29} Stough, Roger, Peter Arena, Raj Kulharni, Jim Riggle and Mark Trice. December 1999. \textit{Industrial Cluster Analysis of the Virginia Economy}. The Mason Enterprise Center of George Mason University

the investigation is a time series of input-output tables obtained via a regional econometric input-output model (named as STYR-I-O). The model subdivides the Styrian economy into 42 sectors, which roughly correspond to the two digit NACE-code industries. Although not all European reports use a time series input-output model, no cases that use time series have been observed in empirical North American studies. Also most European cases focus on innovation within business entities; therefore, it is observed that innovative input-output analysis is frequently observed in European studies.

4-3. Specialization Indicators - Location Quotients

The location quotient is simply a ratio of employment shares. This technique measures the relative importance of a sector compared to a reference economy, which is the U.S. national economy. Also, any other measure of economic activity or reference area could be used depending on the analysis. Generally, location quotients exceeding 1.25 are taken as initial evidence of a regional specialization in a given sector. Despite being very simple and easy to use, LQ is not the only method used in most case studies. In fact, I have found few reports using only LQ to identify clusters. The transportation equipment industry cluster in New York State, especially in the New York Central (Syracuse), Finger Lakes (Rochester) and Western (Buffalo, Niagara Falls) regions is known for being home to significant employment at firms producing transportation equipment. These three regions are analyzed by the number of employees obtained by SIC, and the LQ technique is used to examine where the industry clusters are concentrated31. Also, Rosenfeld’s empirical report on the auto supplier chain analysis is a study of an

acknowledged and heavily recruited cluster, with the purpose being to learn about the diffusion of economic benefits into non-metro counties.\textsuperscript{32} Nashville Metropolitan Statistical Area (MSA) has already been known as “Auto Alley” ever since larger automobile manufacturers rushed into the region. Based on the MSA, the auto supplier clusters are identified using quantitative methods, such as LQ and percentage of employment. Another example in which the LQ technique is used is The Communications & Media Services Industry Cluster in New York State. Compared with national employment patterns, communication and media services employment is most concentrated in New York City where there are two and a half times as many jobs as would be expected from the national data.\textsuperscript{33} This report examines the two industries that are identified by LQ techniques. In comparison to other cluster reports, it depends highly on the LQs.

In these three studies, the LQ technique is mainly used to re-examine industries which are already historically identified as clusters or almost accepted as leading sectors. According to the criteria established in the previous chapter, LQ is not likely able to find or detect any factors that should be considered in current studies. However, it is apparent that LQ analysis typically compares industry employment concentration; this is relatively related to workforce availability, even though LQ cannot fully gauge entire industries. Besides, LQ does not offer insights into interdependencies between sectors, as mentioned earlier. Recently, many empirical studies have been focusing on linkages or network within and among clusters; therefore, LQ itself is not an appropriate method. However,


\textsuperscript{33} \textit{The Communications & Media Services Industry Clusters in New York State}. 2001. Empire State Development.
this is not to say that LQ is just an embryonic technique that we should not use; rather it should be noted that LQ can be an initial measurement in the process of identifying clusters. It can be very useful if used in concert with various methods, especially with an input-output technique that provides information on industrial interdependence. Also, the LQ technique is appropriate for only micro- and meso-level analyses because of its functional limitation.

4-4. Competitive Shifts – Shift Share

Shift-share analysis is a method of data analysis that isolates the effects of regional differences on growth from those that affect the industry at the national level. Shift-share analysis determines whether a region’s share of employment or number of establishments in a particular industry is changing faster or slower than that of the nation as a whole. Individual firms may not be aware of these changes, and education, training and employment agencies may not understand the reasons behind shifting patterns of job demand.34

It is apparent that shift-share analysis is not a major method of identifying industry clusters; therefore, it is hard to find empirical reports using it. Shift-share analysis has limited use because it requires selecting appropriate intervals to measure the change. Besides, shift-share analysis needs more detailed SIC-level numbers. Generally, LQ and shift-share analyses are performed at the level of major industry groups (the two-digit SIC level) or, better, industry groups (the three-digit level). LQ analysis typically

compares industry employment concentration, and shift-share analysis is used for isolating the effect of economy-wide and sectoral trends on regional industry performance. The results of shift-share analysis at the industry division are so general that they are practically useless. At the four-digit level, problems of data suppression or non-availability would be swept. However, LQ is not hard to do. For these reasons, shift-share analysis is not frequently used in empirical studies. Among the various empirical reports, only the Northeast Minnesota studies adopted shift-share as one of its techniques for identifying industries. However, like LQ, shift-share is used as an initial and complementary method. In general, theoretical studies do not seem to deal with shift share as a significant method at all.

4-5. Expert Opinion

Like the other quantitative methods mentioned earlier, expert opinion gathered from interviews, focus groups, and surveys is a very attractive method because it can make up for the challenges inherent in a quantitative analysis of secondary data. Also, expert opinion can add a fresh and perhaps totally different perspective. Asking local actors through various methods what they see as dominant or vital to the economy can reinforce or alter the results of the quantitative analyses. Most empirical studies adopt the expert opinion method; the Northeast Minnesota industry cluster study, for example, uses surveys and focus groups; a study of Houseboat manufacturers in Kentucky uses surveys; a study of an industry cluster in Toronto uses Network Structure; and a study of Swiss

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Manufacturing uses Cluster Analysis with Firm-level Data. All these studies include expert opinion as an additional method in order to make up for the pitfalls of quantitative analyses. Generally, expert opinion can be used to detect all factors discussed in the previous chapter. In particular, expert opinion can be significantly applied to qualitative factors, such as entrepreneurship. For this reason, it should be noted that expert opinion can be a good source when it examines existing quantitative results of identifying clusters.

However, Feser and Luger point out that there are serious risks to the expert-opinion method in cluster analysis as well. According to their argument, the validity of expert opinion depends heavily on how many responses are given and how proper experts are selected. In particular, they mention that “business officials are far less inclined to fill out surveys, grant interviews, and attend focus groups. Thus the university and government sectors are usually much better represented than in industry.” 37 A serious problem with this method is that disqualified experts’ opinions might give incorrect information regarding identifying industry clusters and could result in a big loss. Besides, the method of expert opinion is a very time-consuming process. Regarding all situations, although expert opinion can detect or measure almost all of the factors, its plausibility and reliability are uncertain.

4-6. Graph Analysis / Network Analysis

One of the outstanding examples of graph analysis is Meeusen and Dumont’s research

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paper on micro-clusters in the Belgian National Innovation System. In this paper, particular attention is devoted to the clustering issue: how to define micro-clusters in a graph-theoretical context, which micro-clusters of actors emerge, and what their main characteristics are. They mention that the graph-theoretical method for the detection and analysis of micro-clusters begins with the assumed importance of R&D co-operation between firms and other actors of the innovation system as one of the main mechanisms weaving the network-issue of the NIS (Meeusen and Dumont, 1997). From this assumption, they observe the nodal points of the graph defined on the level of microeconomic agents, such as companies, research institutions, universities and government institutions, etc.. The network criterion requires that two actors be partners in the same joint research project or agreement. They also consider personal linkages. Although it is obvious that both types of lines carry a different meaning, one might say that the R&D lines are stronger when they are backed by a personal line. As their methods and models show, the most important features of the graph-theoretical analysis seem to be that it finds the relationship between entities based on R&D and other ways. After finding the relationship, it needs to delineate lines between entities based on previous research on the linkages. Graph-theoretical analysis is actually more complex and difficult to utilize than other methods, and an entire explanation of it is beyond this study. However, it should be noted that it focuses on individual entities to clarify the innovation of clusters found at higher levels of aggregation compared to the analyses based on national borders and traditional sectoral classification since Porter’s elaboration. With regards to all considerations, network analysis is a very good method of finding

networks and social capital that can refer to individual connections compared to a general term of networks. In addition, the drawing lines can increase its ability of detecting them. Finally, the R&D capacity factor can also be detected using network analysis.

4-7. Correspondence Analysis

Correspondence analysis, which is a recently developed multivariate statistical mapping technique, provides a means of analyzing tables of categorical data in order to determine the relationships between the variables of interest. It has the advantage of making it considerably easier to see the relationship between a large numbers of variables. In fact, this technique has been used to provide further insights into how close or distant various business strategies are. In particular, various approaches and analyses, such as factor analysis, principal components analysis, multi-dimensional scaling and canonical correlation, are used under the name ‘correspondence analysis’ to identify industry clusters. In addition, Roelandt (2000) claims that all these techniques aim at identifying groups or categories of firms or industries with similar innovation styles. A good example of correspondence analysis can be seen in Arvanitis and Hollenstein’s (1998) survey of the innovative activity of Swiss private enterprises in 1996. Their study was based on a stratified random sample. The sample was classified once more as subsample of manufacturing firms that were asked to fill out a questionnaire about their innovative activities and a large set of other variables relevant to the description of the innovation process and the explanation of innovation performance. Essentially, the primary purpose of the survey was to search for innovation types based on a subsample of innovative firms. Consequently, the information collected makes it possible to construct fifteen
innovation indicators. Eight of them refer to the input- and output-side of the generation of innovations with separate measures for product and process innovations, whereas the third type of indicators is oriented towards the introduction of novelties on the market. All input- and output-oriented measures used are qualitative variables (five-point Likert scale); the corresponding quantitative measures, for example, R&D expenditures or total innovation costs as a percentage of sales, though available, are not used in the present study because of the larger number of missing values as compared to ordinal measures. This approach is a very complicated statistical technique, and it uses many steps to analyze innovation styles. However, it can be simply defined as a survey and quantitative approach used to find innovation-related features.
5. Summary of methods for identifying industry clusters and concluding remarks

I have looked over various methods of identifying industry clusters that are frequently used and introduced in both the theoretical and empirical literature. There are many methods, and they all have different characteristics and approaches. Table 4 shows the advantages and pitfalls of each method that is explored in this paper.

Table 4 Characteristics of methods of Identifying Industry Cluster

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Pitfalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert opinion</td>
<td>Very easy, Low cost</td>
<td>Not generalizable</td>
</tr>
<tr>
<td></td>
<td>Detailed contextual info</td>
<td>It’s just opinion, not axiom</td>
</tr>
<tr>
<td>Porter’s Diamond Approach</td>
<td>A very comprehensive and clear view of related and supported firms</td>
<td>Too biased to a qualitative view</td>
</tr>
<tr>
<td></td>
<td>Provides strong theoretical background</td>
<td>May need a lot of time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very difficult</td>
</tr>
<tr>
<td>Specialization indicators (LQs)</td>
<td>Very easy, Inexpensive</td>
<td>Focuses on sectors, not clusters</td>
</tr>
<tr>
<td>Competitive Shift (Shift-Share)</td>
<td>Easy, Provides shifting change of job demand</td>
<td>Need detailed SIC level analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More difficult to calculate than LQ</td>
</tr>
<tr>
<td>Input-output analysis (trade and Innovation I-O)</td>
<td>Only major source of data on interdependence in the U.S.</td>
<td>May be dated</td>
</tr>
<tr>
<td></td>
<td>Comprehensive and detailed</td>
<td>Industry definitions imperfect</td>
</tr>
<tr>
<td></td>
<td>Key measure of interdependence (innovation I-O)</td>
<td>Neglects supporting institutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data not available in U.S. (innovation I-O)</td>
</tr>
<tr>
<td>Graph theory/network analysis</td>
<td>Visualization aids interpretation and analysis</td>
<td>Methods, software still limited</td>
</tr>
<tr>
<td>Surveys (including Correspondence analysis)</td>
<td>Flexibility with collecting ideal data, up-to-date</td>
<td>Costly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Difficult to implement properly</td>
</tr>
</tbody>
</table>

Source: refer to Feser’s Introduction to Regional Industry Cluster Analysis (power point slide)

Expert opinion is a very useful method, and it has many advantages, such as low cost, ease of use, etc. However, it also has some pitfalls; most important, its reliability is uncertain. On the other hand, Porter’s diamond approach is a very comprehensive qualitative method that creates a clear image of the relationships between firms. In addition, it can provide a strong theoretical background and therefore, is more reliable.
than expert opinion. However, this method also has a problem; it lacks a quantitative perspective and needs a lot of time to apply well. Besides, it is relatively difficult to apply in practical fields. Among a variety of quantitative methods, input-output analysis seems to be used most frequently. It is not necessary to describe the advantages and disadvantages of input-output method because it is well known and is used in many practical reports. However, there is a difference between applying it in U.S. and in Europe. As mentioned earlier, the European perspective seems to be much more biased toward the innovation input-output method, while the U.S. focuses more on trade-based methods because data for innovation is not available. Network analysis appears to be a good method because it gives a clear image of the status of connections within a cluster. Although it is limited in terms of software application, network analysis can complement other methods. Finally, correspondence analysis is effective for gathering up-to-date information. Thus, if there is a data limitation, it might be a good method to use; however, as with surveys, it is expensive.

Each method is examined according to the criteria established in the previous chapter. As table 5 shows, each technique has its own advantage and can detect factors that should be considered in current studies. Porter’s Diamond approach is very effective for examining workforce skills and availability and geographic concern factors. Also, networks and social capital can be dealt with by using Porter’s approach. Input-output analysis can be used effectively in innovation and geographic concern findings. Networks also can be detected to a small degree by I-O analysis. Location Quotient and Shift Share analyses do not have the power to find factors for industrial clustering findings. Only the workforce factor can be identified by those methods. On the other hand, expert opinion
seems very useful for finding all the factors shown in table 5. However, it has not been considered to be the best method because of its potential reliability problem. As discussed earlier, it does not have one hundred percent confidence; it should be accepted as just an expression of people’s opinions. Network analysis is a good method for finding networks and determining the social capital factor. Also R&D capacity can be identified by this method. Moreover, drawing networks increases its ability to detect those factors in the process of identifying clusters. Finally, correspondence analysis is accepted as a very good technique for finding innovation because most current surveys pay attention to identifying innovation-related factors.

**Table 5 Summary of advantages of methods**

<table>
<thead>
<tr>
<th></th>
<th>Innovation</th>
<th>Entrepreneurship</th>
<th>Workforce skills and availability</th>
<th>Networks</th>
<th>Social Capital</th>
<th>Geographic concern</th>
<th>Specialized service</th>
<th>R&amp;D capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porter’s Diamond approach</td>
<td>O</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>I-O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>LQ</td>
<td></td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift Share</td>
<td></td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expert Opinion</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>Network Analysis</td>
<td>▲</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>▲</td>
</tr>
<tr>
<td>Correspondence Analysis</td>
<td>O</td>
<td></td>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
<td>O</td>
</tr>
</tbody>
</table>

O: highly measurable, ▲: roughly measurable

As the previous two tables show, all methods that are mentioned in this study have their own advantages and disadvantages. However, it is apparent that there is not one best or most preferred method for identifying industry clusters. In other words, the most desirable approach is to determine the appropriate method for each case after due
consideration. Most empirical reports provide good evidence for this argument; it is hardly necessary to find industry clusters using only a single method. Today, it is most appropriate to combine various methods in order to significantly decrease the natural limitation of each method. For example, if researchers pay attention to workforce and geographic concern relations, they could use Porter’s diamond approach, input-output analysis, and expert opinion together. These methods can supplement one another and work cooperatively to find the relevant factors. Despite close relationships between the factors and methods, ‘entrepreneurship’ and ‘specialized-service’ factors cannot be highly measured by the methods discussed in this study. Thus, it would be worthwhile to develop methods that detect them. In addition, the very fast changing business environment must keep increasing the number of factors that should be measured when identifying clusters; therefore, scholars should continue to observe how clustering will change.
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