

**Clusters and Cluster-Based Development: A Literature Review and Policy Discussion**

**Hal Wolman<sup>1</sup>**

**Diana Hincapie<sup>2</sup>**

**December 17<sup>th</sup>, 2010**

George Washington Institute of Public Policy (GWIPP)  
805 21st St NW, 6th Floor  
Washington, DC 20052

WORKING PAPER

**Prepared as background for Implementing Regionalism project, funded by the Surdna Foundation.**

---

<sup>1</sup> Hal Wolman is Director of the George Washington Institute of Public Policy, The George Washington University

<sup>2</sup> Diana Hincapie is a graduate research assistant at the George Washington Institute of Public Policy and a Ph.D. student in the Trachtenberg School of Public Policy and Public Administration at The George Washington University.

# **Clusters and Cluster-Based Development: A Literature Review and Policy Discussion**

**Hal Wolman**

**Diana Hincapie**

**December 17<sup>th</sup>, 2010**

## **1. Justification/Importance:**

Cluster theory and its application and cluster-based economic development policy, have been in the forefront of regional economic development theory and practice during the past decade. Cluster theory suggests that firms that are part of a geographically defined cluster benefit from being a part of that cluster and that these benefits result in growth in economic output for the region. These benefits accrue as a result of co-location or geographic proximity that, in turn, creates lower input costs for firms through agglomeration economies and facilitates knowledge spillovers that produce innovation and increased productivity. Consequently, firms in clusters that generate these benefits will be more competitive<sup>3</sup>, and regions with effective clusters will experience greater growth.

As this suggests, clusters are important for understanding and improving regional economic growth. It is important for policy makers and practitioners to understand how and in what ways they do so and what actions they can take to enhance economic growth through generating additional cluster benefits. In particular, since analysis of and policies based on clusters have become a feature of much modern regional economic development policy, it is critical for practitioners to understand the dynamics of clusters and the limitations as well as advantages of employing cluster strategies.

## **2. What is a cluster?**

Porter (1998), who is the most frequently cited advocate and analyst of cluster policy, defines clusters as “Geographic concentrations of interconnected companies and institutions in a particular field, linked by commonalities and complementarities.” However, Porter’s definition is only one of many in the literature. The meaning of “cluster” is somewhat ambiguous, and the term is often used in different ways by different authors. Despite the widespread use of cluster analysis and strategies the actual meaning of the term is somewhat imprecise and ambiguous. Indeed, Martin and Sunley (2003, p. 16), in a highly critical article argue that the cluster concept “has acquired such a variety of uses, connotations and meanings

---

<sup>3</sup> However, causality may not be clear. Clusters might make firms more productive and thus more competitive, but more productive and competitive firms might come together to form a cluster. See, for example, Duranton (2009, p. 32).

that it has, in many respects, become a ‘chaotic concept’.” Indeed, they list ten different definitions of cluster that they found in their review of the literature (p. 12).

In our review of the literature, we found a wide variety of conceptualizations of clusters, some of which focused entirely on inter-firm relationships and some of which included much broader links:

- Krugman, (1991): New economic geography: Clusters as co-location decisions of firms due to increasing returns to scale, lower costs of moving goods across space, etc.
- Rosenfeld (2005): clusters “are simply geographic concentrations of interrelated companies and institutions of sufficient scale to generate externalities.”
- Cortright (2006): “An industry cluster is a group of firms and related economic actors and institutions, that are located near one another and that draw productive advantage from their mutual proximity and connections”.
- Glaeser and Gottlieb (2009): “People cluster in cities to be close to something. At their heart, agglomeration economies are simply reductions in transport costs for goods, people, and ideas” (p.1005).
- Marshall (1890): Clusters as external economies created by labor market pooling and the benefits of moving people across firms, supplier specialization, knowledge spillovers.
- Porter (1998): “Geographic concentrations of interconnected companies and institutions in a particular field, linked by commonalities and complementarities”. Clusters include: linked industries and other entities (suppliers), distribution channels and customers (demand), related institutions (research organization, universities, training entities, etc) (see also Porter (2000), p.254 for definition)
- Saxenian (1994): Clusters as social and institutional phenomena: technological change, organizations, social networks, and other non-market relationship in which markets are embedded: organization within and between businesses, relationship among firms.
- Hill and Brennan (2000, p. 67-8): We define a competitive industrial cluster as a geographic concentration of competitive firms or establishments in the same industry that either have close buy-sell relationships with other industries in the region, or share a specialized labor pool that provides firms with a competitive advantage over the same industry in other places.”

Nonetheless, there is a common core to the concept. In an attempt to capture the broad meaning of the term (at the expense of brevity) and drawing upon definitions of Michael Porter, Joseph Cortright and others, we define clusters to

consist of firms in a region producing similar or related products, utilizing similar processes, or engaging in similar functions (headquarters; R&D), the regional suppliers and customers of these firms, specialized labor skills (occupations) possessed by workers in the region employed by these firms, public and public-private programs that provide services to cluster members (e.g., customized training by community colleges), and institutions (e.g., universities, community colleges, industry and trade associations, public and private sector organizations) whose presence or *interaction*, to the extent it exists (i.e., the extent of interaction is an empirical question), results in cost-savings to firms and/or knowledge spillovers that produce cost savings and/or product or process innovations.<sup>4</sup>

## 2.1 Implications:

What are the implications of our definition? An obvious first question is whether clusters are simply a new and somewhat more accessible term for agglomerations and whether the benefits of clusters are what urban and regional economists have long termed “agglomeration economies”. Cumber and MacKinnon (2004, p. 960) ask, for example, “What is the added value of the cluster approach to existing theories of agglomeration?” It seems clear that our definition – and that of most, but not all, others - incorporates traditional agglomeration economies. But are clusters more than that? Drawing upon Gordon and McCann (2000, p. 515ff), there are really two different forms of clustering, each coming from different traditions and operating in somewhat different ways.

The first is what they term “pure economies of agglomeration.” Agglomeration economies result from firms locating in geographic proximity to each other. The cost savings that result from lower input costs and increased productivity are external benefits to firms that come about through their proximity to one another. Gordon and McCann (2000) note agglomeration economies neither presume nor require any cooperation among actors. “The fundamental point here,” they argue (p. 517), “is that a variety of mechanisms by which the external economies are achieved... operate simultaneously, often indirectly, and cumulatively.”

The second is the “social network model” of clustering. While Gordon and McCann (2000) assert that this model arises primarily from the sociological literature on institutions, the concept, captured in the term “knowledge spillover” or MAR externalities, named after the three economists most responsible for contributing to the concept (Marshall-Arrow-Romer), is also clearly present in the agglomeration economy literature. In this model informal networks of individuals *across* firms (and also across other related institutions such as trade associations, universities, research institutes, and labor organizations) result in the transmission of tacit knowledge that leads to innovation, adoption of advanced and improved techniques related to production processes, marketing, research, etc. These networks are based on interpersonal

---

<sup>4</sup>Note: the extent of cost-savings and product or process innovations is an empirical question.

relations and trust and are said to embody social capital that is embedded in them.<sup>5</sup> Gordon and McCann note:

There is nothing inherently spatial about the social-network model although it has explicit spatial applications. This is because social networks are a form of durable social capital, created (and maintained) through a combination of social history and ongoing collective action. In this sense, their strength is inherently problematic, depending upon a prior accumulation of trust, circumstances which facilitate monitoring of others' behavior, a source of leadership and/or a sense of common interest... Many of these pre-conditions are made possible by propinquity, particularly where economic relations have historically been more localized and/or there is a distinctive local economic base and cultural or personal links among key actors. (p. 520)

Given the overlap between social networks and MAR externalities the difference between "clusters" and what are traditionally thought of as agglomeration economies appears rather small. To a large extent this appears to be a case of old wine in new bottles. However, the old wine didn't appear to be very much in demand or to lead to much in terms of implications for economic development policy and practice when it was labeled "agglomeration economies;" replacing the label with the newer and sexier "cluster" seems to have made a major difference in that respect.

A second implication is that all regions have clusters, but not all clusters produce high growth. Indeed, if a region has a cluster consisting of industries the demand for whose products is low and/or declining or whose production processes emphasize low-skilled labor, the contribution to regional economic growth is likely to be small, no matter what other institutions are connected to it.

A third implication is that even within a cluster consisting of the same components (industries, research facilities, educational and training institutes, etc.), a cluster in one region may be more effective than the same cluster in another area at producing economic growth. "The benefits realized from geographical clustering appear to be specific to certain industries at certain stages of development in certain places, and are only realized under particular conditions" (Glasmier, 2000, as cited in Martin and Sunley, 2003, p. 22). Some of the differences may, of course, be due to inherent differences in the economies of the different regions. Some may be due to clusters that are in different stages of the product cycle for output that is at the core of the cluster. But some may be due to the quality of the clusters: the interaction of cluster members, the way in which clusters are organized or embedded in institution and area cultures.

---

<sup>5</sup> It should also be noted that the existence of networks does not necessarily enhance the performance of clusters. For example, certain kinds of highly embedded social networks may actually retard innovation and growth. Porter notes (2000, p. 252) that "when a cluster shares a uniform approach to competing, a sort of groupthink often reinforces old behaviors, suppresses new ideas, and creates rigidities that prevent the adoption of improvements."

As Porter notes (2000), “the mere presence of firms, suppliers, and institutions in a location creates the potential for economic value, but it does not necessarily ensure the realization of this potential... Many of the competitive advantage of clusters depend on the free flow of information, the discovery of value-adding exchanges or transactions, the willingness to align agendas and to work across organizations, and strong motivations for improvement” (p. 264).

For example, certain kinds of highly embedded social networks may actually retard innovation and growth. Porter notes (p. 252) that “when a cluster shares a uniform approach to competing, a sort of groupthink often reinforces old behaviors, suppresses new ideas, and creates rigidities that prevent the adoption of improvements.” Gordon and McCann (2000, p. 521) cite Granovetter (1973) whose research showed that networks with weak ties, “characterized by pluralistic and open-ended network building strategies in which actors cultivate more extensive sets of links” are more likely to produce innovation than strong and tight ties among a smaller number of like-minded people.

The obvious question is the implication for policy and practice: whether and how clusters can be shaped through public policy to be more effective? We return to this question in sections 7 and 8.

A fourth implication relates to scale: what is meant by geographic proximity or co-location. Do some types of clusters require only clustering at the regional level? Do some types require closer clustering at a sub-regional level, and, if so, must they be centralized in a downtown location or can they also be effective if at a suburban node? (For the cluster section we will consider only business-business related clusters in terms of whether and where sub-regional locations might be relevant.) The forms of clusters that require face-to-face contact and personal interaction have historically implied geographic proximity at a relatively circumscribed sub-regional level, e.g., the downtown core city area. One question is the extent to which the telecommunications revolution has eroded the need for proximity at a sub-regional level in favor of clusters more widely dispersed across the region. Other forms of clusters, such as the agglomeration economies resulting from the pooling of labor with a wide variety of skills and experience clearly accrue at the labor market (regional) level.

## 2.2 Coming to Grips with Clusters: Creating Cluster Typologies.

Our ultimate objective is to provide policy makers and practitioners with a means of intervening through strategies and policies that will produce higher regional economic growth. As indicated by the above discussion, clusters are a complex and elusive concept. One way of trying to come to grips with them is to attempt to classify different kinds of clusters according to their characteristics with the expectation that different kinds of clusters will be susceptible to different kinds of interventions (and that some kinds of clusters will be much more susceptible to interventions than will others).

Given the above, what are different kinds of clusters? Are there typologies of clusters, either explicit or implied, in the literature? How can clusters be characterized, i.e., what are the different dimensions on which a typology might be constructed? Can we construct our own cluster typology?

One way of classifying clusters is according to the *process(es)* through which cluster benefits are produced. Gordon and McCann posit three basic models of cluster processes: agglomeration economies, industrial complex, and social networks (see also Iammarino and McCann, 2006). Each of these models produces cluster benefits in very different ways (and, in turn, the agglomeration model has several different forms of benefits that result from quite different processes). As Gordon and McCann suggest, one particular form of distinction is whether the clusters produce benefits automatically or as a result of interaction.

So:

Cluster typology 1: Type of cluster by process;

- Pure agglomeration economies
- Industrial complex
- Social networks

Cluster Typology 2: Type of cluster by presence of human interaction:

- Cluster benefits occur automatically through market processes
- Cluster benefits occur as a result of human interaction

Another way of classifying clusters would be by their members. As Porter notes (2000, p.254):

“Most clusters include: end-product or service companies; suppliers of specialized inputs, components, machinery, and services; financial institutions; and firms in related industries. Clusters also often include firms in downstream industries (channels or customers); producers of complementary products; and specialized infrastructure providers. Clusters also include a number of institutions, governmental or otherwise, that provide specialized training, education, information, research, and technical support (universities, think tanks, vocational training providers); and standards setting agencies. Government departments and regulatory agencies...can be considered part of it. Finally many clusters include trade associations and other collective sector bodies that support cluster members.”

Which of these potential members are actively involved in a cluster and to what extent does membership affect cluster performance?

Cluster Typology 3: Type of cluster by category of membership. Cluster types can include relationships involving some combination of the following:

- A goods or service producing industry
- Suppliers or consumers of the industry
- Business or professional services related to these industries

- Other industries producing similar products or utilizing similar processes
- Trade associations consisting of firms in an industry or related industries (e.g., high technology)
- Workers with specialized skills or occupations utilized by these industries.
- Workforce development institutions that provide training for workers in these skills (e.g., training programs, community colleges).
- Research institutions tied to products, processes, marketing, etc. related to the cluster (R and D facilities, research universities)
- Government as regulator, facilitator, organizer, provider of incentives, investments, subsidies, etc.

Cluster typology 3A: Type of cluster by breadth of category membership:

- Narrow: includes only one or two of the above categories
- Medium: includes several of the above categories
- Comprehensive: includes many or all of the categories.

Another set of cluster differences may have to do with the extent to which clusters are consciously organized at the regional level through creation of cluster organizations or whether they occur naturally.

Cluster typology 4: Cluster creation method

- Through natural processes
- Through human intervention to create, build upon, or improve a cluster.

Clusters may also be characterized by the cluster member(s) that serves as the cluster core and driver. At the broad level the question is whether the cluster is organized around a particular set of goods and services produced (an industry or set of industries), a particular set of occupational skills and knowledge that may cut across many industries (e.g., optics and photonics in the Rochester region), particular kinds of production processes, or functions (e.g., research and development; headquarters). Within each of these there are obvious sub-classifications (which industrial sectors: automobile manufacturing, furniture, pharmaceuticals, finance, advertizing, etc.)

Cluster Typology 5: Type of cluster classified by cluster core:

- Industry, and if so:
  - Specific industry (e.g., vehicle manufacturing, software, finance, etc.)
- Occupation/skills/knowledge, and if so, what kind



- Specific occupational skills or knowledge (e.g., optics, mechanical engineering, etc).
- Functions (e.g., headquarters, research and development, advertising, finance). Duranton and Puga (2005) present evidence indicating that urban regions have begun to specialize by function much more so than previously, with headquarters clustering more in larger urban regions to take advantage of business services co-located there, while production facilities are increasingly located in smaller urban regions.<sup>6</sup>

Clusters can be characterized by whether the goods and services that they produce are in fast or slow growing sectors nationally or by the nature of the labor force skills at their core.

Cluster typology 6a: Type of cluster by national growth of cluster core

- Slow-growing
- Average
- Fast-growing

---

<sup>6</sup> Duranton and Puga (2004) explain this transformation to functional specialization with respect to headquarters by developing a model in which the choice of organizational form by firms as well as the urban structure depends on how much higher is the cost of providing headquarters services to a plant in a different city as compared to a plant in the same city. When the additional costs associated with managing production from a remote headquarter are high, firms remain integrated (with headquarters and production plant in same city), and because localization economies in production and urban congestion costs increasing in size, this in turn lead cities to specialize by sector. However, when the additional costs associated with managing production remotely fall below certain level, firms become multi-unit organizations (with headquarters and production plant in different cities), and since similar choices are made by a larger number of firms, this affects employment patterns in the cities, which shift from sector specialization to functional specialization. This model explains the urban transformation in the US and suggests that it is closely interrelated with changes in the firms' organization, and specially to the separation of the management and production facilities of individual firms.

Kahn and Vives (2006) found evidence that headquarters are concentrated, increasingly so in medium-size service-oriented metropolitan areas, and the rate of relocation is significant (5%) a year. They find that the larger (in terms of sales) and younger headquarters tend to relocate more often, as well as larger (in terms of number of headquarters) and foreign firms, and firms that are the outcome of a merger. Also, headquarters relocate to metropolitan areas with good airport facilities -with a dramatic impact, low corporate taxes, low average wages, high level of business services, same industry specialization, and agglomeration of headquarters in the same sector of activity, with all agglomeration variables having an important and significant impact.

Davis and Henderson (2004), analyzing the determinants of headquarter agglomerations, found that separation of the white collar activities from production plants benefits headquarters in two ways: the availability of differentiated local service input suppliers and the scale of other headquarter activity nearby. A wide diversity of local service options allows the headquarters to better match their various needs with specific experts producing service inputs from whom they learn, which improves their productivity. A 10% increase in the number of local intermediate business service providers increases the expected headquarter birth in a county by 3.6%. Headquarters also benefit from other headquarter neighbors, because this allows them to exchange information and acquire information about market conditions, although such marginal scale benefits seem to diminish as local scale rises.

Cluster typology 6b: Type of cluster by required workforce skill level for cluster core:

- Low-skilled
- Average
- High-skilled

Cluster typology 5c: Type of cluster by cluster wages

- Low wage
- Average wage
- High wage

There are other typologies in the literature that are relevant to the research purposes of the authors. For example, Markusen (1996) creates a typology of a certain kind of cluster - industrial districts - based on the size of the firms that are part of it, their linkages and networks within and across the district, and the distribution of power among firms. Feldman and Audretsch (1999) classify clusters according to their ranking of the importance of different academic disciplines for the cluster and the level of innovation of the industries related to the cluster. Rosenfeld (1997) (as cited in Martin and Sunley, 2003) describes cluster typologies based on the evolution of the clustering process: working or overachieving clusters; latent or underachieving clusters; and potential clusters.

Enright (2003) characterizes clusters along various dimensions: geographic scope, density, breadth (range of horizontally related industries), depth (range of vertically related industries), activity base, geographic span of sales, strength of competitive position, stage of development, nature of the technological activities, innovative capacity, and ownership structure. He also uses several categories to characterize the state of development of clusters: working clusters, latent clusters, potential clusters, policy driven clusters (chosen by government to support, but that lack a critical mass of firms), and “wishful thinking clusters” (lacking a mass of firms and any source of advantage).

The key question is whether typologies can be developed that classify clusters according to important characteristics that allow policy makers to address different kinds of interventions to different kinds of clusters.

### **3. What are the *processes* through which clustering fosters economic growth? To what extent is it possible to intervene in these processes to make them work more effectively?**

What are the processes through which we would expect clusters to generate economic growth? We focus on the first and third of Gordon and McCann’s (2000) three forms of clusters – pure agglomeration economies and social networks (although the latter is closely related to the concept of “knowledge spillovers” in the agglomeration economy literature) since these are the

models that produce benefits external to an individual firm as opposed to arrangements initiated and organized by an individual firm.

Agglomeration economies are external benefits that accrue to firms as a result of co-location. That is, they are real benefits to firms in the form of input cost reductions or productivity gains that result from other firms and large numbers of people located in the same area.<sup>7</sup> As Phelps notes (2004, p. 972-973) clustering through external economies of agglomeration fosters economic growth through one or both of two processes:

- 1) By lowering the cost of inputs to production (pecuniary economies) of a firm benefitting from the external economies and/or by
- 2) By increasing the firms' productivity so that it is able to produce more output per unit input (technological economies).

The literature identifies many different kinds of agglomeration economies. An initial distinction is between agglomeration economies that result from the co-location of firms that are similar in nature in terms of goods produced, processes, skills required and/or functions (called "localization economies") and those that result from the co-location of a large number of firms, even if they are diverse (called "urbanization economies," or, if the focus is on their diversity, "Jacobs economies" after writings of Jane Jacobs). While the most common conceptual definitions of clusters focus attention more on localization economies, many of the processes incorporate both and consequently, we will examine both.

There are many different processes through which these benefits may occur. These include labor market pooling, worker-matching (more workers mean better matching), input-sharing, supplier specialization through the growth of supplier and subsidiary industries, development of a common infrastructure, reduction in transportation costs (Glaeser), niche consumer markets, knowledge spillovers (which may result more from social network interaction), competition (see Rosenthal and Strange, 2004, p. 20-21), culture and modeling behavior (Saxenian (1994), Rosenthal & Strange, p. 21-23). Bergman and Feser (1999) provide additional examples of proximity based agglomeration economies such as "increased market power through brokered buying and selling, the better availability and use of specialized repair facilities, shared infrastructure, reduced risk and uncertainty for aspiring entrepreneurs, and better information" (p.8).

Many of the processes produce increasing returns to scale that are external to an individual firm and result from the location of the existence of large numbers of firms located near to each other. Krugman (1991) and others cite these increasing external returns to scale as the core economic process through which agglomeration economies occur.

Below we discuss the various processes, the links through which they presumably affect firm growth and thus regional economic output (empirical evidence on the extent to which they actually do so is presented later in section 5), the extent to which they do so through input cost-

---

<sup>7</sup> Duranton (2009) notes, however, that at some point size diseconomies of agglomeration (e.g., congestion) begin to set in and impose external costs on firms in the area.

reduction and/or through productivity increases (many do so through both), and the extent to which these effects are naturally created through size or density or can be enhanced through interventions.

*Labor market pooling:* Large agglomerations provide a large supply of labor with a variety of different skills and occupational specialties. What are the external economies that result from this?

First, the availability of large numbers of potential employees suggests that, *ceteris paribus*, wages will be lower than otherwise would be the case, resulting in cost savings to all firms regardless of the industry they are in (i.e., an urbanization economy)<sup>8</sup>.

Second, the ability to replace an inferior worker with another more productive one available in the area is a productivity gain that results to a firm through agglomeration. As Duranton and Puga (2004, p. 2086, 2092) note, a large labor pool improves both the probability of a match and the expected quality of the match.

Third, since a large area will have a labor force with many diverse and specialized skills, firms in industries or engaged in processes with needs for specific specialized skills are more likely to find them in a large area, and people with those skills are more likely to be attracted to an area where they know these specialized skills are in demand. These are agglomeration economies that result from both input cost-reduction and productivity gains from firms (input cost reductions because a larger supply of specialized workers will lower wages of these workers; productivity gains because workers with these specialized skills will provide greater output per input than would less specialized workers.)<sup>9</sup> The geographic scope of this, like many of the benefits resulting from labor market pooling, should occur throughout the entire labor market area (the metropolitan area).

*Input sharing/supplier specialization.* The presence of a large number of firms producing the same types of goods or services or requiring the same types of inputs provides external benefits to these firms if specialized suppliers locate within the region to provide that input. Although the process is broadly similar, input sharing agglomeration economies can be categorized as either physical inputs into the production process or producer services related to firm operations. These may be urbanization economies if the specialized services (e.g., accounting, legal, advertising services) apply to a wide range of industries or sectors or they may be localization economies if they are specialized to a particular industry or related set of industries. The latter may be input supplies necessary for the production process or they may be professional services tailored to individual industries.

Suppliers of physical inputs into the production process decide to locate in an agglomeration if there are enough customers in the region so that the reduced cost of transporting supplies to

---

<sup>8</sup> Although tight labor markets may obviously occur, thus limiting labor supply, during times of economic expansion in any labor market.

<sup>9</sup> Note that while input cost-reductions through greater supply of specialized labor will reduce wages, higher productivity of a worker will increase worker wages, and the result may well be higher wages per worker.

their customers will make up for the increased costs of locating there (higher land costs, higher labor costs, greater congestion, etc.). As a consequence of the clustering of these specialized suppliers in the region, firms purchasing these inputs will pay lower transportation costs for inputs than they otherwise would have. These are cost-reducing economies that ought to accrue through location of these supplier firms anywhere in the region (and even beyond), although the closer these firms are located to their customers in terms of transportation time and costs, the greater the savings should be. This also suggests that if the firms purchasing the inputs are themselves clustered geographically within a sub-regional area, the more likely supplier firms will be able to locate close to all of them, again reducing transportation costs for all. Supplier firms locating close to their customers will also benefit from increased physical accessibility to their customers, who will in turn receive more customized service (a productivity enhancing external benefit).

Suppliers of producer services to firms may also decide to locate in close proximity of their customers in order to reduce the accessibility costs of personal contact and to increase their understanding of customer needs, that is, co-location will reduce transaction costs. These may be urbanization economies if they apply to a wide range of firms in diverse industries within the region (accounting, legal, advertizing, or architectural services) or localization economies if they are tailored only to firms in a particular sector (e.g., precision engineering, professional consulting, testing labs).

*Market aggregation:* The cost of distribution and selling goods or services to consumers may be reduced substantially in large agglomerations. Goods or services for which there is sufficient final demand in the area to justify producers to locate there will increase regional economic growth through import substitution (i.e., rather than importing these goods from outside of the region, consumers will purchase them within the region), with resulting positive economic multiplier effects as local employees of these firms spend money throughout the regional economy. For goods or services whose demand is confined to a relatively small percentage of the population (niche goods) and whose purchase requires physical presence (a smaller number now, perhaps, as a result of internet sales), location in a large agglomeration may be necessary in order to aggregate enough purchasers to make a profit or to be close to the few buyers. Expensive and personalized goods that require personal inspection are examples. To reduce transaction costs to consumers, these specialist shops are likely to be located in a very small and easily accessible geographic area (traditionally in or close to the central business district).

Note that all three of the processes described above occur largely or completely through market processes; they do not require human intervention in order for the external benefit to be achieved, although it is possible to envision policies that would enhance these processes. For example, providing land or transportation infrastructure may encourage suppliers to locate in greater proximity to each other; workforce development programs focused on cluster-specific skills may increase the skill levels needed for the cluster; labor force intermediary institutions may help to provide more efficient worker-job matching processes, and other supporting institutions could provide specific support to the industry at the core of the cluster through research and development, innovations and technology transfer.

*Knowledge spillovers:* Knowledge spillovers or MAR externalities, named after the three economists most responsible for contributing to the concept (Marshall-Arrow-Romer), are

frequently discussed in the literature on agglomeration economies. However, the processes through which they occur are perhaps better understood through the social network model that Gordon and McCann (2000) posit. “MAR” externalities result from the concentration of many people working on problems in a similar or related set of industries, skill sets, processes, etc. that produces a widely shared understanding of the problem and its workings. The result is greater innovation with respect to product/process/marketing etc. that lowers costs and/or generates greater productivity for firms in the region. This in turn provides a competitive advantage for firms in the region and consequently greater regional economic growth and greater innovation as a result of knowledge spillovers through interaction and face-to-face communication that facilitates learning.

The logic of these knowledge spillovers is straightforward, but how they actually occur is less so. Marshall, in his original exposition on agglomeration economies, writes, with respect to knowledge spillovers:

When an industry has thus chosen a locality for itself, it is likely to stay there... The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is rightly appreciated; inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further ideas. (Quoted in Rosenthal and Strange, 2004, p. 11)

Duranton and Puga (2004, p. 2098) observe that:

A fundamental feature of learning is that in many (if not most) cases, it is not a solitary activity taking place in a void. Instead, it involves interactions with others and many of these interactions have a ‘face-to-face’ nature. *Cities, by bringing together a large number of people, may thus facilitate learning...* Moreover, the advantages of cities for learning regard not only cutting-edge technologies, but also the acquisition of skills and ‘everyday’ incremental knowledge creation, diffusion, and accumulation.

Cumbers and MacKinnon (2004, p. 962) extend this directly to firms and argue that “Spatial proximity between specialist firms facilitates the creation and exchange of tacit knowledge, viewed as a crucial form of competitive advantage in a work in which codified knowledge is easily replicated and rendered ubiquitous.”

But what are the processes through which these knowledge spillovers occur. Do they require personal interaction and face to face communication? Do they occur through informal networks and of what sort? Can they be encouraged through creation of more formal networks? Are they part of a region’s culture or of the culture of an industry or skilled workers in a region? Those who approach knowledge spillovers through social network analysis emphasize culture and embeddedness: the social relationships among economic actors, many of which are geographically localized. Economic systems are embedded in social systems, not separate from them (social connections, culture of particular places, institutions). Presumably certain kinds of cultures (work ethos?) are more likely to produce economic growth. It is also hypothesized that certain kinds of networks and network relationships are more likely to produce sustained economic growth (see Putnam’s study of Italy (1993), Granovetter’s

findings on the strength of weak ties (1973), and Safford's (2009) study comparing Allentown and Youngstown.)

Porter (2000), for example, argues that "Social glue binds clusters together, contributing to the realization of this potential... Relationships, networks, and a sense of common interest undergird these circumstances. The social structure of clusters thus takes a central importance (p.264)."<sup>10</sup>

However, despite these claims by Porter and others, Martin and Sunley (2003) contend that, "the social dimensions of cluster formation and cluster dynamics remain something of a black box in Porter's work... [and] the problem of conceptualizing and empirically analyzing knowledge networks and other 'soft' socio-cultural-institutional features of clusters and spatial economic agglomerations is not, of course, confined to Porter's work" (p. 16).

Malmberg and Maskell (2006) respond to these critiques by setting forth three processes through which learning occurs as a result of knowledge spillovers that arise through agglomeration. They term the first, learning by interaction, "the vertical dimension of spatial proximity" (p. 4-7) . The vertical dimension refers to firms that interact with each other in a production chain relationship which requires some kind of coordination through interaction. They note that, "Studies of industrial innovation quite consistently show that new products are developed in response to signals from, and often in interaction with, customer firms. The most sophisticated and demanding customer firms are of particular importance here, especially if their demand is in some way anticipatory, i.e., help producer firms understand what the global market will request tomorrow, or the day after tomorrow" (p. 5). The horizontal dimension of spatial proximity relates to firms in the same industry located close enough to each other that they can observe, compare, and monitor the behavior of each other. Malmberg and Maskell (2006) observe that, "Spatial proximity helps firms identify and imitate superior solutions while combining them with ideas of their own" (p. 7).

Finally, there are knowledge spillovers that occur as a result of what Malmberg and Maskell (2006) term "neighborhood effects." They refer to these as "local buzz." Buzz refers to "the information and communication ecology created by numerous face-to-face contacts as people and firms within the same industry collocate... This buzz consists of specific information and continuous updates of this information, intended and unanticipated learning processes in organized and accidental meetings; the application of the same interpretative schemes and mutual understanding of new knowledge and technologies; as well as shared cultural traditions and habits, which taken together make interaction and learning less costly" (p.7). This appears to be an elaboration of Marshall's famous "in the air" statement and, unfortunately, provides little more understanding of the processes through which this kind of knowledge spillover occurs. Borrowing from the organizational learning/networking literature, we know that learning occurs primarily through interaction in informal networks of near-peers, but it also

---

<sup>10</sup> However, despite these claims by Porter, Martin and Sunley (2003) contend that, "the social dimensions of cluster formation and cluster dynamics remain something of a black box in Porter's work... [and] the problem of conceptualizing and empirically analyzing knowledge networks and other 'soft' socio-cultural-institutional features of clusters and spatial economic agglomerations is not, of course, confined to Porter's work" (p. 16).

may occur through leadership replacement and/or new hires who bring their experience from other organizations. All of these processes are arguably more likely to occur when similar firms and similar occupational clusters are geographically proximate to each other.

#### **4. Describing and measuring clusters: how do we know one when we see one?**

Identifying clusters, describing them in terms of their components, and assessing their effects on regional economic performance is an obvious concern for policy makers and practitioners as well as researchers. Our conceptual definition of clusters – and our discussion of other definitions – suggests that clusters can be composed of very different components. As Porter (2003) observes, “A major constraint to the analysis of clusters has been the lack of a systematic approach to defining the industries that should be included in each cluster and the absence of consistent empirical data on cluster composition across a large sample of regional economies” (p. 562).

The various typologies suggested in the previous section provide a possible approach, but one that has been rarely applied. Instead, the most common approach by researchers is to engage in intensive individual qualitative case studies of a specific cluster or clusters in a specific place or places (for examples of such work, see Saxenian, 1994; Bacheller, 2000; Waits, 2000; Rosenfeld, 2000). As a result of such a case study, an attempt can be made to identify the individual components of the cluster that are involved (the extent to which various industries, suppliers, trade associations, research institutes, etc. are involved in the cluster). Saxenian, for example, describes her methodology as (1994), ‘ethnographic in nature, with the empirical material accumulated over the course of nearly a decade living in and observing the two regional economies. The core of the argument is built from more than 160 in-depth interviews with entrepreneurs, industry leaders, corporate executives, and representatives of local business associations, governmental organizations, and universities in Silicon Valley and Route 128” (p. 209).

Practitioners, often assisted by local researchers or consultants apply much the same approach; in some cases these case studies follow initial quantitative analyses that identify possible clusters. Reid, Smith and Carroll (2008) note that these qualitative case studies usually rely upon “expert opinions or key informants to isolate clusters” (p. 346). An example of the typical case study methodology is provided by Allen and Potiowski (2008) in their study of Portland’s “green” building cluster. They relied upon, “a combination of surveys and interviews targeted at “key informants” to develop an understanding of the industry cluster... Fifteen individuals or firms were interviewed or responded to a questionnaire for this study. Respondents included developers, green building consultants, and representatives of architecture firms, landscape architecture firms, engineering firms, wood products companies, certifying organizations, and nonprofits.” (p. 303)

In addition to interviews with cluster leaders, many of the qualitative case studies present “cluster maps,” identifying the cluster components and relating them to each other through arrow diagrams or through placing them in the relevant part of the value chain. Austrian (2000) reviews several of these studies, usually done on a consultant basis for economic development professionals in a specific region, and concludes (p. 109), “case studies and



cluster maps... bring forward institutional detail and qualitative richness that are absent from the quantitative portion of cluster analysis, which identifies the regional clusters. The case studies analyze the clusters' special characteristics in terms of structure, growth opportunities, and common issues on which cluster participants could collaborate.”

There are several difficulties with this approach, not the least of which are the expense, the difficulties in generalizing beyond individual cases studies, and the problems of selection on the dependent variable (researchers tend to focus only on presumed successful clusters which make it difficult to determine in what ways they are different from unsuccessful ones). However, the more serious problem is in actually identifying cluster participants and processes if they do not engage in interactions that are visible to the researcher. This is particularly problematic with respect to agglomeration components of clusters. In addition, cluster maps with arrows, as they are usually presented, are a summary tool rather than an analytical one; they show that there is a relationship of various parts of the cluster to each other, but provide little or no information on the extent, importance or nature of the relationship.

There have also been quantitative efforts to identify cluster components and to measure the effects of clusters across clusters and regions. However, most of these employ measures of clusters (operationalizations) that do a very poor job of capturing what is meant conceptually by the term “cluster” as we and others have defined it. The most commonly used measure is based on the sectoral composition of the regional economy, including location quotients (the share of a regions employment in a particular industry relative to the share of the nation’s employment in that industry – see, for example, Glaeser, Kallal, Scheinkman & Shleifer, 1992; Ohuallachain, 1992) in each industry across metro areas (Cortright & Mayer, 2001, and Hill & Brennan, 2000), sectoral specialization weighted by sector size (OECD, 2008), and a Herfindahl index (Henderson, Kuncoro & Turner, 1995), which is a measure sectoral diversity for a region’s industries).

Hill and Brennan (2000) employ a particularly sophisticated set of techniques to identify clusters. Starting with individual industrial sectors, they characterize each sector by a set of variables related to the sector’s competitiveness, exports, centrality, and employment specialization (p.72) They then make use of a mathematical technique called “hierarchical cluster analysis” to sort the various industrial sectors into groups of sectors that are most like each other and different from other groups. They next use “discriminant function analysis” to identify the important dimensions along which the various cluster groups differ. They applied these techniques to the Cleveland-Akron CMSA and used a region specific input-output model and focus groups to identify the “driver” industries at the core of the industry clusters in the region.

All of these measures have serious problems either of conceptualization or of difficulty of applying or both. Industrial sectors measure the type of goods and services produced, but they do not include other features that conceptually might be associated with clusters (e.g., trade associations, government programs, occupational specialties, etc.). In addition clusters are likely to cut across industrial classifications since these are essentially artificial constructs. Suppliers, for example, may be in a different industrial classification than the industry that is core to the cluster. Clusters based on area occupational specialties may be captured in many different industrial classifications.

An obvious way of tracing these relationships across sectors would be through an input-output table that detailed for each industry the various inputs used from other sectors within the region and to which it sold what it produced, as Hill and Brennan did. Such tables do not usually exist at the regional level.

Porter (2003, 2010) addresses this problem by identifying geographic clusters through correlation analysis across states (2003) and regions (2010, Cluster Mapping Project). His methodology is somewhat fuzzy, but, as best as can be reconstructed, he first selects a prominent “core” industry and then, with the state or region as unit as the unit of analysis, correlates industry employment at the four-digit level of that industry with that of all other industries. In a second approach, he estimates locational correlations between pairs of industries, and defines the cluster as those set of industries with significant intercorrelations. He then uses national input-output tables to eliminate “spurious correlations.” However, the *assumption* is that industrial sectors with high correlations among states or regions constitute a cluster. Using states or economic areas (EAs, which are essentially regions) as his unit, Porter (2003) identifies 41 traded clusters in the US economy, with an average of 29 industries in each cluster. The next step is to examine each unit (state or EA) to determine which of the clusters identified through the above method the unit has a strong presence in. Note, however, that not only does he assume that sectoral correlations are necessarily evidence of a cluster, but also that clusters are defined completely by industrial classification employment measures.

Other efforts to measure clusters systematically are even more remote. Measures of agglomeration economies are frequently employed in the research literature, but they do not identify cluster components, nor do they usually distinguish which of the various processes that lead to economies of agglomeration are employed. Urbanization economies are sometimes proxied through use of population size or population or employment densities with the expectation (largely validated through empirical research) that economic growth and productivity are directly related to density (and the assumption that this relationship results from external economies of agglomeration).

Identifying clusters based on knowledge spillovers and communications networks is even more problematic. Efforts have either proceeded through inference (i.e., the importance of human capital in economic growth increases with agglomeration thereby suggesting the existence of knowledge spillover<sup>11</sup>) or case studies of individual regions that strongly suggest (suggest, because knowledge spillovers are not visible) communication linkages and networks. Presumably formal network analysis approaches would be possible to apply, but they are difficult, complex, and expensive. Reid et al. (2008) argue for such an approach and illustrate its utility by conducting a social network analysis of collaboration among greenhouse firms in the Northwest Ohio region.

## **5. The relationship of clusters to economic growth: What does the empirical evidence say?**

---

<sup>11</sup> See Glaeser (2000, p. 90-91) and Hanson (2000, p.483-484) for reviews of literature utilizing this approach.

To what extent has empirical research supported the positive effect of clusters on economic growth that the theoretical propositions discussed above suggest? Relatively little literature is directed at testing the effects of clusters in terms of the broad, cross-cutting way that we (along with Porter, Cortright and others) define them. There has been a very substantial research literature directed at agglomeration economies, which are, as we have noted, at the core of the cluster concept. Most of this literature is directed at whether cities/regions that are larger or more dense have better economic performance, which would imply that firms operating in these areas are taking advantage of the agglomerations provided in these areas (though it is sometimes pointed out that may also be possible that more productive and profitable firms choose to locate in large urban regions). Some literature is focused on why agglomerations occur, i.e., why do cities grow.

The empirical literature consists of two quite different strands: econometric studies where  $\text{growth} = a + b(\text{measure of clusters}) + c(\text{other control variables})$  and intensive case studies of clusters in one or two locations.

The former literature consists mainly of studies that attempt to explain the growth in aggregate regional output, personal income, wages, or employment by using variables that theory and the empirical literature have identified as determinants of growth. Examples of possible explanatory variables employed include measures of physical capital, human capital, labor market performance or labor force characteristics and geographical characteristics. These serve as control variables to which an independent variable is added as a measure for the extent of clustering or of agglomeration economies. The variable added to measure cluster or agglomeration differs substantially depending on the particular aspect of clustering or agglomeration economies that each paper wants to test, and in many cases these variables bear little relationship to the concept of clustering as we have defined it. (See Appendix 1 for a discussion of the kinds of measures that have been used.)

Many of the studies use some measure of industrial concentration (e.g., location quotients<sup>12</sup> or a Herfindahl index<sup>13</sup>). However, as Porter observes, if parts of a cluster fall within a different traditional industrial or service categories (as his own conceptual definition suggests is likely to be the case), then a real cluster may be obscured or even go unrecognized. Cluster boundaries rarely conform to standard industrial classifications systems, which fail to capture many important actors in competition as well as linkages across industries. Indeed, as Cortright notes clusters conceptually are likely to *cut across* industrial classifications. The binary classifications of industries (for example, an industry is either high technology or it isn't) implies that there is great homogeneity among these firms... "Classifications are imperfect means of describing the activities of diverse and quickly changing enterprises" (Cortright & Mayer, 2001, p.3). Porter, as noted above, responds to this problem by trying to identify industrial sectors that are highly correlated with one another as constituting clusters.

---

<sup>12</sup> Location quotient is the ratio of the percentage employment in a particular sector in the regional economy to the percentage of employment in that sector in the national economy.

<sup>13</sup> A Herfindahl index is an index of diversity (or concentration).

Thus, the empirical evidence is difficult to interpret, both because researchers do not always use the same conceptual definition of clusters and because the operational definitions – i.e., the way in which clusters are measured – vary enormously. As a result findings may differ substantially because researchers are examining different things but calling them all clusters.

There are several literature reviews of the econometric literature, and there is broad agreement that the agglomeration component of the cluster concept has positive effects on various measures of regional economic performance.<sup>14</sup> For example, after reviewing the literature, Glaeser and Gottlieb (2009) conclude that:

There is abundant evidence that manufacturing firms choose location to reduce transport costs, but this does not seem to be an important part of urban comparative advantage today... Numerous researchers have argued that dense agglomerations provide labor market pooling so that workers can move from less productive to more productive firms, yet the empirical evidence supporting this claim is still modest... The largest body of evidence supports the view that cities succeed by spurring the transfer of information. Skilled industries are more likely to locate in urban areas and skills predict urban success. Workers have steeper age-earning profiles in cities and city-level human capital strongly predicts income. (p.1023)

At the international level, the OECD (2008) analyzed the determinants of economic growth in the OECD economies. In their model, agglomerations economies were captured by a specialization index for each of the sectors (proportion of employment in the sector weighted by the relative size of the sector). They found that agglomeration economies are partly responsible for regional growth.

Duranton (2009, p. 31ff) cite Rosenthal and Strange to summarize the findings from the empirical literature: “The range of estimates for the mean elasticity for labor productivity to local industry employment is between 2 and 10% with a midpoint around 4 or 5%” (p.31). In other words, doubling specialization in an activity and area is associated with an increase in productivity of approximately 4%, although the numbers can be lower or higher depending on the industry. He concludes that there are positive effects of clustering, but the literature also strongly suggest that it takes extremely large increase in specialization to get more than marginal effects on local productivity and wages.

Duranton (2009, p.31-32) argues that the effects estimated in the literature are very modest, and that even these modest effects may exaggerate the true causal benefits of clustering on productivity. First, many studies do not estimate a “pure” effect of clustering (i.e., where clustering is defined as an increase in specialization keeping total employment constant), but the effect of an increase in the size of the industry of employment on total employment, keeping employment in all other industries constant. This procedure conflates the effect of increased clustering with the effect of being in an area with more employment overall (since increasing the size of one industry keeping all other industries equal means an overall increase in employment). Second, most studies fail to control for possible reverse causation or

---

<sup>14</sup> Behrens et al. (2010), however, note that income inequality also rises with regional size.

simultaneity, e.g., the possibility that clustering may not lead to high local productivity and wages, but instead that high local productivity and wages may lead to clustering. If causation in the latter direction, then most results from the literature would be biased, exaggerating the magnitude of clustering effects. Finally, the authors are concerned that the skills of workers need to be properly controlled for in the estimation of localization effects: if better workers in the industry work in a larger cluster, then the estimates in the literature might be biased upwards again.

Another type of studies tries to tests whether localization economies of agglomeration or urbanization economies of agglomeration will produce greater growth. These studies provide support for the existence of agglomeration economies in general, since they nearly all find some effects of agglomeration, whether through localization (which is closer to our own conception of clustering) or urbanization economies or both, on economic outcomes.

A closely related research literature examines whether diverse urban environments or more concentrated ones, usually measured by the degree of industry concentration, are more likely to lead to economic growth and innovation. A high degree of industry concentration indicates strong clusters and the presence of localization economies, while industrial diversity is seen as evidence of broader urbanization economies and, is less consistent with clusters as a driver of growth. Thus some researchers argue that a positive relationship between industrial concentration and growth is evidence of the importance of clusters, while evidence of a relationship between diversification and growth indicates clusters are less important.

Jacobs (1969) argues, for example, that more diverse cities will grow faster than concentrated cities. New ideas are formed by combining older ideas. Cities allow for the mixing of many different industries and occupations; ideas from different areas get combined and growth occurs. So more diverse cities will tend to grow faster than concentrated cities (as referenced by Glaeser, 2000).

Rosenthal and Strange (2004, p. 2132-36), Feldman (2000, p. 303) and Cortright (2006, p. 39-42) review these studies and find mixed results. Rosenthal and Strange, (2004, p. 2135-2136) observe that in many of the studies specialization (measured through some measure of industry concentration) is not related to employment growth, births, etc while diversification is. But in a large region an industry could have a large enough presence even though it represented only a small percentage of total employment, to still garner localization economies in a diversified economy. In other words, it may be absolute size of a sector rather than the relative degree of concentration of the sector in the economy that matters.

The above studies are mostly concerned with the agglomeration economy component of the cluster concept, although in some cases this also incorporates the knowledge spillover (MAR) concept. However, the knowledge spillover, networking component of the concept is not directly tested in these studies.

Baptista and Swann (1998) analyzed the relationship between industrial clusters or regions and innovation in the UK. In this study, the authors regress the number of innovations introduced by each company in each time period (INNOV<sub>it</sub>) on regional employment in the firms own industry, regional employment in other industries, the firms' market shares, industry concentration, and industry fixed effects. The different models show a significant and

moderately positive effect of own sector employment on the probability that a firm would innovate. Therefore firms located in clusters that are strong in their own industry are considerably more likely to innovate. In general, the results of this paper suggest that innovation, entry and growth tend to be stronger in clusters. One way in which clusters can affect economic growth is precisely through innovation: knowledge workers are attracted to knowledge firms, and knowledge firms are attracted to knowledge workers, and that concentration of occupation and functions (i.e. clusters) fosters innovation in that cluster of knowledge, generating growth.<sup>15</sup> Hanson (2000) revises the literature on the topic, noting the impacts of spillovers of clustered firms on innovation. For example, Barkley, Henry, and Nair (2006) examine concentrations of innovative activity and find that regions with higher concentrations of high-tech occupations are more innovative.

The studies that attempt to focus more directly on “knowledge spillovers” are mostly intensive case studies of specific areas. For example, Saxenian’s (1994) study on Silicon Valley and Route 128, Hippel’s (1988) study on the U.S. steel industry, and Dahl and Pederson’s (2004) study among wireless engineers in Scandinavia, all of them based on interviews and surveys, confirmed that ideas flow freely in each of these clusters (Cortright, 2006, p.21). Saxenian’s intensive case study compared Silicon Valley and Route 128 in the Boston region and asked, “Why has Silicon Valley adapted successfully to changing patterns of international competition while Route 128 appears to be losing its competitive advantage?”

She concluded that:

Silicon Valley has a regional network-based industrial system that promotes collective learning and flexible adjustment among specialist producers of a complex of related technologies. The region’s dense social networks and open labor markets encourage experimentation and entrepreneurship. Companies compete intensely while at the same time learning from one another about changing markets and technologies through informal communications and collaborative practices... The Route 128 region, in contrast, is dominated by a small number of relatively integrated corporations. Its industrial system is based on independent firms that internalize a wide range of productive activities. Practices of secrecy and corporate loyalty govern relations between firms and their customers, suppliers, and competitors. (p. 2-3)

Newlands (2003) reviews several case studies of flexible specialization in central and northern Italy and comes to much the same conclusion: “The sources of flexibility lay in collaborative networks...[that] permitted the establishment of trust between actors, a crucial argument within most contemporary approaches to clusters” (p. 523).

Others studies have analyzed these issue quantitatively. For example, Jaffe, Trajtenberg and Henderson (1993) (as cited in Cortright, 2006, p.21) “found that new patents were more likely to cite previous patents in the same metropolitan area or state than to cite more distant patents”, concluding that knowledge is relatively localized.

---

<sup>15</sup> See Kosarko and Weissbourd, “Enhancing Regional Innovation, prepared for Surdna Workshop on Implementing Regionalism.

Black & Henderson (1999) utilize econometric methods to test whether city growth rates (in population size) are closely tied to growth rates in educational attainment and inferred human capital spillovers. They found that cities grew with human capital accumulation and knowledge spillovers and concluded, “Overall, the evidence supports strongly the theoretical result that individual city size growth rates are related to individual local human capital growth rates” (p.271).

The most directly relevant research consists of studies that focus directly on the concept of clusters rather than on proxies for agglomeration. O'Huallachain (1992) identified 18 geographic clusters consisting of related 2-digit industries and examined the relationship between the strength of each of these clusters and regional employment and income growth for the 150 largest metropolitan areas in the U.S. He found that five of the 18 clusters studied had a positive effect on both employment and per capita income growth. The five clusters were: high-order services, high-tech manufacturing, state and local government, textiles and construction, and insurance. The retail trade and recreation service clusters were notable among the clusters that were positively related to metro employment growth but did not have any relationship with income growth.

Feser, Renski, and Goldstein (2008) attempted to assess the effect of clusters by analyzing technology clusters in the Appalachian Regional Commission region from 1998-2002. They identified several different technology clusters and their locations in each of the 406 counties in the region. They then divided the counties into high employment growth and low employment growth counties over the 1998-2002 period and analyzed whether the high growth ones had a greater presence of technology-based clusters in 1998 than did the low-growth ones. They concluded that “We found little evidence that technology industries in spatial clusters in Appalachia created more jobs than the same industries in noncluster locations” (p. 343). They are extremely cautious in placing the findings as being specific to a particular place over a particular time period.

To what extent does the empirical literature separate out the effects on regional economic outcomes of the very diverse processes that lie behind agglomeration economies and which we discussed above? Rosenthal and Strange (2004, p. 2146) ask what do studies on productivity have to say about the various micro foundations of agglomeration economies and answer “not much.” Hanson (2000) echoes this: “We have relatively little understanding of the precise type of externalities that contribute to agglomeration... Individual studies find evidence consistent with human capital spillovers across workers, localized knowledge spillovers in the innovation process, and regional cost and demand linkages between firms” (p. 489). There is little work that attempts to estimate the relative impact of these different effects.

The problem, Rosenthal and Strange observe (2004), is that “agglomeration economies whose sources are knowledge spillovers, labor market pooling, or input sharing all manifest themselves in pretty much the same way” (p. 2146). As Gordon and McCann note “a variety of mechanisms by which the external economies are achieved... operate simultaneously, often indirectly and cumulatively, so that individual sources of the agglomeration process cannot be isolated or individually identified... The only observable manifestation of their existence may thus be the realized efforts on productivity, growth and local factor prices” (p. 517). Finding reasonable measures of each of these as a means of sorting out the effects while controlling for the others is very difficult.

After reviewing the research literature, Glaeser and Gottlieb (2009) conclude:

We focused on three different types of agglomeration economies. There is abundant evidence that manufacturing firms choose location to reduce transport costs, but this does not seem to be an important part of urban competitive advantage today. Today, the urban role in reducing transport costs seems to be more important for service firms. Numerous researchers have argued that dense agglomerations provide labor market pooling so that workers can move from less productive to more productive firms, yet the empirical evidence supporting this claim is still modest. The largest body of evidence supports the view that cities succeed by spurring the transfer of information. Skilled industries are more likely to locate in urban areas and skills predict urban success. Workers have steeper age-earnings profiles in cities and city-level human capital strongly predicts income. It is possible that these effects will be reduced by ongoing improvements in information technology, but that is not certain and has not happened yet. (p. 1023)

However, their conclusion that information transfer or knowledge spillover is the “process” behind the findings they review is indirect evidence of their effects at best. Indeed, as Cumber and MacKinnon (2004) write, “The importance of locally specific forms of knowledge circulating through the labour market has been identified as a key feature of successful agglomerations such as Silicon Valley (Saxenian, 1994). Yet few detailed studies have sought to test this proposition empirically” (p. 964).

#### **6. What systems are important drivers of clusters? Processes that drive the appearance of clusters (What do we know about how clusters actually form?)**

Porter argues that industry clusters are the product of four factors: “the diamond of competitive advantage”: Factor conditions (factors of production like labor force, specialized infrastructure, educational institutions, or demand for services and products); Demand conditions: presence of sophisticated and demanding local customers; Related and supporting industries (suppliers and competitive related industries); firm strategy, structure and rivalry (competition between firms drives competitiveness). Unfortunately, these are a listing of categories; they yield little or nothing about the causes of cluster formation or the processes driving it.

Most of what we know about cluster formation results from research on agglomeration economies. With respect to agglomerations, Krugman (2000, p. 53) argues (see also Duranton and Puga (2004)) increasing returns to scale are the rationale for agglomerations; industries locate in proximity to each other in order to take advantage of the reduced marginal costs that occur as production increases in the area as a whole. Co-location occurs naturally and without coordination through independent decisions of firms operating in their own interests.

Some of the literature on cluster formation is concerned with why clusters of a particular kind locate and thrive in particular places. While natural features may account for the location of, for example, natural resource clusters, many argue that initial location is a matter of idiosyncratic circumstances or simply luck, followed by processes of “path dependence” and “lock-in”. Economic development is to some degree path –dependent: the set of opportunities



for any particular place will be shaped by the economic activities it has already established, so chance events are important, and there is a propensity for the market to “lock-in” in certain patterns of activities. Product and profit cycle theories (see Markusen, 1985) suggests, however, that lock-in does not last forever, and when a product reaches mass production stage it may move to lower cost production sites.

Returning to our earlier discussion of cluster/agglomeration processes, clusters form through the following systems:

- i. Production process: activities for which the area has a competitive advantage will form clusters (localization economies) and produce scale economies that result in lower costs for firms’ inputs, more productive firms producing their output.
- ii. Labor Market: labor market pooling; firms benefit from larger pool of workers with the required skills, workers benefit from a great variety/quantity of possible employers. In addition clusters will form around skills that are present in the regional labor market. This in turn interacts with the production process: regions specializing in the production of products requiring specific types of skills will attract labor with those types of skills and regions that have specialized skills will attract firms (or expansion of existing firms) that require those types of skills).
- iii. “Market for goods” customers demand certain products, press for innovation, and firms benefit from larger market for their products.
- iv. Social/Institutional/cultural: clusters form through historical accidents, spin-offs from existing clusters, individual entrepreneurs and are then expand in place as a result of lock-in, path dependence, and cultures that are conducive to shared trust through social interactions, face-to-face communication, social networks, etc.

These processes and their results occur naturally as a result of individual firms operating in their own interests through markets and/or as a result of human social interactions. To what extent can they be encouraged, affected, or made more effective through conscious and explicit effort?

## **7. Clusters and Regional Economic Development: What Is Cluster-Based Economic Development Policy?**

Cluster initiatives have become the leading edge of regional economic development policy over the past decade. The Global Cluster Initiative survey (GCIS) identified over 500 cluster initiatives in North America, Europe, Australia and New Zealand as of 2003 (Mills, Reynolds, Reamer, 2008). Cumbers and MacKinnon (2004, p. 959) state that “Cluster-based policies have been adopted by a range of organizations operating at different geographical scales, including regional development agencies within a number of European and North American states... Such policies require the identification of specialist clusters which can then be targeted for support, typically in the form of R&D assistance, bespoke training, venture capital initiatives which attempt to inculcate a culture of innovation and learning, and efforts to build and reinforce a sense of cluster identity among constituent firms and organizations.”

The rationale for cluster-based economic development policies is provided by Michael Porter, who has been the most persistent and effective proponent of such policies:

Since clusters involve powerful externalities across firms in a location, and associated public goods, there is a strong rationale for public policies. In the presence of positive externalities market failure will lead to underinvestment in specialized skills, scientific knowledge, and specialized infrastructure that benefits the entire cluster and increases competition by lowering the barriers to entry of new firms. Public policy that provides rules, mechanisms, and incentives for capturing external economies will improve productivity and, with it, job, wage, and innovation growth.

However, what does “cluster theory” suggest in terms of actual economic development strategies and policies that might be applied? Motoyama (2008) notes:

A limitation of the theory is its feasibility and whether and how government can effectively fill-in the missing components of the cluster. For example, if a specific element in a cluster is missing, such as the suppliers, a logical policy consequence would be for the government to provide grants to attract or nurture them. However, in reality, there is hardly such a case unless the government plans to form a cluster from scratch. The private sector is not blind and has usually looked for business opportunities. Even if there is a gap, how and how well government can promote the missing components is questionable. The more difficult part is to promote the interconnectedness of a cluster. If firms in a cluster do not have sufficient spillover or synergistic effects, what can government do: the current cluster theory may point out that government should do something about it but does not explain how. (p. 360)

Bartik (2008) is skeptical as well, particularly with respect to cluster-targeting strategies:

If clustering boosts productivity in a knowable and predictable way, this has extremely strong implications for policy. If we know that some firms expanding in the cluster would boost productivity at other firms, we should provide subsidies to help those firms expand... However, the problem is that no one knows how large such agglomeration economies are, and at what scale of industry or urban activity these agglomeration economies are most important... Therefore, it is difficult to use such cluster findings as a strong rationale for subsidizing one set of industries rather than another. (p. 15)

Duranton (2009, p. 38) argues that research clearly shows that cluster benefits are real, but they are also quite small. Instead he urges economic development policy makers to focus on “the cost curve” attempting to reduce costs associated with place through more traditional public sector policies related to land use planning, urban transport, and provision of local public goods. He also notes that the various mechanisms that produce clustering benefits (e.g., labor pooling, knowledge transfer through networks, etc.) are difficult to identify empirically and call for very different policy approaches.

Despite what some see as the lack of straightforward implications of “cluster theory” or the cluster framework for public policy, others have suggested clear policy implications. Martin and Sunley (2003, p. 23-24), write that the cluster framework suggests a focus on strengthening existing clusters by helping to promote the supply of local and regional public goods that are

absent due to market failure. These include 1) creating cooperative networks and encouraging dialogue between firms and other agencies, 2) collective marketing of a region's cluster specialties, 3) provision of local services to firms such as financial advice, marketing, and design services, and 4) identification of weaknesses in existing cluster value chains and attracting investors and businesses to fill those gaps.

Porter (2007) argues that:

Public policy at the cluster level should begin with the collection of information that identifies the existence of clusters... Government has an important role in assembling information about cluster composition, membership, employment and performance.... Another potential role for government in cluster development is to *convene* cluster participants if private sector institutions have not already arisen to do so. Once clusters are organized through trade associations or other means, government agencies need to become active participants in dialogs with cluster participants to understand local constraints to productivity and identify gaps and weaknesses in public policy. Another dimension of cluster policy is *incentives* to spur collective investment by cluster participants in assets that benefit many cluster participants, such as university research centers, community colleges curricula, or testing facilities. In some cases, public investment in assets involving cluster externalities is also justified. (p. 5)

Waits (2000, p. 39) suggests that the implications of cluster theory as popularized by Porter and others, are that it directs economic development practitioners to focus on clusters as an analytical tool to better understand the economy, as an organizational tool "to engage industry leaders in a regional strategy and to foster communication, networking, and improvement among the companies within and across clusters," and as a service delivery tool to direct services to key industries in high-value clusters.

What kinds of public policy have actually been adopted as part of the cluster-based approach for which Porter provides the above rationale? We begin by first examining some economic development *strategies* that have resulted from use of the cluster framework. Many of these are at the state level.

Hill, Samuel and Stewart (2008) analyzed Ohio's advanced manufacturing sector, which is based on the Central Ohio automotive cluster. This sector has been particularly resilient and has managed to do better with global competition. After analyzing elements that characterize the advanced manufacturing sector, they recommended policies to increase its value added: improving the business environment, supporting incumbent manufacturers, improving the workforce and developing thought leadership in global integrated manufacturing production.

Felbinger and Robey (2001) suggest a new strategy for economic development based on regional clusters that flows from a case-study of Cleveland made for the Northeast Ohio Regional Economic Development Strategies Series (NORESDI). The main purpose was to propose proactive policies that allow state and local governments to participate in the global economy and offer opportunities and venues for effective development, mainly based on a case study of Cleveland's economic development experience. The NORESDI first identified six industry clusters that were relatively competitive or had competitive advantage in the region

and then aimed to promote those clusters in the region. After the stage of cluster identification, “this initiative sought to generate a bottom-up, private sector program in which interrelated private firms within an identifiable “cluster” could work together to identify and resolve common needs and concerns” (p.70). Therefore, a series of cluster forums took place that resulted in the identification of six main barriers to retaining regional competitive advantages: workforce/education, technology/R&D, entrepreneurship, regulatory/tax policy, quality of life, and infrastructure. The authors concluded that to be economically competitive, regions have to operate in a global environment, and to do it is very important to implement strategies of regional cluster-based development to maintain or develop competitiveness and prosperity.

Pennsylvania is another state that has implemented cluster-based economic development strategies. A study conducted by Deloitte for the Industrial Resources Center (IRC) of Pennsylvania and the Department of Community and Economic Development of the Commonwealth of Pennsylvania (2004), proposes a regional strategy that builds from current strengths and addresses competitive challenges, particularly in the manufacturing sector. This study analyzes the importance of manufacturing in the Pennsylvania’s economy, studies the forces that will shape its possible futures and identifies actions to help achieve a dynamic and prosperous future for that sector. The findings highlight the importance and the new challenges of the manufacturing sector and identify sixteen driver industries that produce nearly half of the state’s product and that have grown and concentrated in the state in the last decade. These industries together with their associated cluster of in-state suppliers provide a substantial part of the export earnings of manufacturing, and therefore contribute significantly to the wealth of the Pennsylvania area. Even though these industries are considered as a portfolio, they have different needs so they required different strategies from economic developers. Some of the main recommendations of the study are:

Pennsylvania’s economic development strategy must address the distinct needs of firms at all level of growth and competitiveness in the portfolio of driver industries in Pennsylvania’s manufacturing base. State and local intermediaries should support public policies and private investments that can have a positive impact on the cash statement of firms and tailor and create incentives that have a significant impact on the growth of existing firms.

Another example of cluster-based development strategy is detailed in a study of Missouri by Peters (2004). According to Peters, by correctly identifying competitive clusters, economic development strategies can direct public resources towards the most viable parts of the economy, in other words, they can implement policies to develop industry clusters. To that end, Peters utilizes hierarchical cluster analysis, discriminant function analysis, and factor analysis to identify six competitive clusters based on economic specialization relative to the national economy. In terms of economic development planning, this analysis was used to provide a basis for understanding industry clusters centered on supply chains and its linkages within the economy. In terms of economic development policy, it was used by the Missouri Department of Economic Development to provide a conceptual and empirical basis for linking particular public and private entities in Missouri based on supply chain relationships so that policy could be directed towards strengthening those relationships. The analysis is also being used to support the Missouri Automotive Partnership (MAP). MAP uses it “to identify similar competitive industries is the motorized products cluster, to identify the top suppliers of this

cluster and to determine the economic impact of this cluster in the state” (p.18). It also uses it to guide efforts at creating a motorized products supply-chain forum, which would link state agencies, motorized products firms and their supplier firms.

In many cases the brief description of “strategies” described reflect more exhortation and aspiration than strategy. To have an impact, the strategies have to be implemented through specific policies and practices. What are cluster-based development policies?

Rosenfeld (1997) provides the following list of policy lessons that economic development practitioners should derive from the cluster literature:

- (a) Learn how businesses interact and clusters work
- (b) Support clusters based on their economic dominance, strategic importance, or leadership and potential.
- (c) Improve technical support services.
- (d) Invest in social capital and social infrastructure
- (e) Empower and listen to cluster leaders
- (f) Encourage cross-fertilization of ideas across clusters.
- (g) Recruit companies that fill gaps in cluster development
- (h) Develop and organize supply chain associations
- (i) Support employee entrepreneurs.

In another setting, Rosenfeld (2010) argues that there are essentially three types of economic development policies that flow from cluster theory: associational encouragement (i.e., efforts to encourage information exchange and knowledge spillovers); provision of specialized services to identified clusters; and targeted investments, including research and development and recruitment.

Cortright (2006, p. 48) lists the types of policies or approaches that can “work to create or enhance each of the micro-foundations of industry clustering:

- a. Labor market pooling: labor market information, specialized training
- b. Supplier specialization: brokering, recruiting, entrepreneurship, credit
- c. Knowledge-spillovers: networking, public sector research and development support.
- d. Entrepreneurship: assistance for start-ups, spin-offs.
- e. Lock-in: work to extend, refine, and recombine existing distinctive specializations.
- f. Culture: acknowledge and support cluster organization.

- g. Aggregate and strengthen local demand.

Mills et al. (2008) provide a more specific list of cluster-based activities:

- a. Facilitating market development through joint market assessment, marketing and brand-building
- b. Encouraging relationship-building (networking) within the cluster, within the region, and with clusters in other locations
- c. Promoting collaborative innovation – research, product and process development, and commercialization
- d. Aiding... innovation diffusion, the adoption of innovative products, processes, and processes
- e. Supporting the cluster expansion through attracting firms to the area and supporting new business development
- f. Sponsoring education and training activities
- g. Representing cluster interests before external organizations such as regional development partnerships, national trade associations, and local, state, and federal governments.

Feser (2008, p. 189-190) provides a longer list of common cluster-building interventions for increasing innovations from technology-related activity, including interventions on the demand side as well as on the supply side. These include:

#### Supply Side

- Creation of cluster industry association to serve as catalyst for cluster interests
- Location incentives for and recruitment of firms that would fill important gaps in the cluster supply chain.
- Establishment of business networks to encourage information sharing and joint problem-solving.
- Investment in university research competencies related to the cluster.
- Provision of business incubators to provide services to cluster members.
- Regulatory assistance that would provide guidance to firms on regulatory compliance
- Provision of technical and business development advice and services to smaller firms through an industrial extension service analogous to the agricultural extension service.
- Skill upgrading of workers in identified cluster firms.
- Making available risk-based financing through creation of venture capital pools.

## Demand Side

- Targeting of public sector procurement to local firms in the cluster.
- Foster purchasing links among members of the cluster in product or value chains through supplier fairs and assistance to suppliers.

What do we know about how well these cluster-based policies work? To what extent have they been evaluated? In some ways, this is a tricky question, since most of the individual policies described above have existed long before there were intentional and explicit “cluster-based” economic development policies. The difference, to the extent a difference exists, is the target of the policy(ies) – i.e., an identified cluster rather than a single industry sector or sectors or individual firms – and the way the policies are combined. They also differ in what they *do not* attempt to do. As Porter (2009) notes, “Cluster-based policies, unlike sectoral or industrial policies should be neutral with regard to industry or type of economic activity... Cluster policy is thus fundamentally different from sectoral or industrial policy, the fatal flaw of which is a tendency to favor particular types of economic activity, pick winners, and tilt the playing field” (However, as Martin and Sunley (2003) observe, in practice this neutrality is frequently violated with practitioners engaging in an effort to identify clusters that are more likely to produce growth on which to focus, a strategy unlike the picking winner strategy common in industry-based economic development policy.).

There are many case studies of specific cluster-based initiatives, most of which focus on the processes through which cluster-based policy is applied or operates. Very few actually undertake systematic evaluation of outcomes. As noted above, Feser et al. (2008) attempted to assess the effect of clusters (not cluster-based policies, although the creation of clusters is presumably the object of such policy) by analyzing technology clusters in the Appalachian Regional Commission region from 1998-2002. They concluded that “We found little evidence that technology industries in spatial clusters in Appalachia created more jobs than the same industries in noncluster locations” (p. 343).

Instead, several authors point to benefits not related to specific policies but more to processes. For example, Cumbers and MacKinnon (2004) observe “In a regional context in particular, a clusters approach seems to provide development agencies with a new and compelling rationale for both identifying a limited number of sectors to support – generally those that are deemed to have the highest growth potential – and defending and justifying this to those interests that are consequently excluded” (p. 962). Observing Arizona’s cluster strategy, Waits (2000) concluded that best practice is the use of cluster working groups to help policy makers better understand an industry, the challenges it faces, and the most valuable assistance government can provide” (p. 39).

Bacheller (2000) in his commentary on state-level economic development using a cluster strategy in New York, concludes that using this strategy “allowed a better understanding of the state’s economy, strengthening the ESD position as a leader in key industry clusters and enhancing competitiveness of industries through the use of interfirm approaches.

## 8. What are the Implications of Cluster Theory and Research for Regional Economic Development Practice?

Clusters provide a conceptual framework through which a regional economy can be analyzed and understood. Conceptual frameworks are not necessarily correct or incorrect; they are ways of looking at the world and their utility lies in the understanding and insights that looking at the world through that framework provides. Indeed, as evidenced by its widespread adoption, the cluster framework has proven to be a very useful framework, one that is clearly superior to seeing the world solely through the frame of industrial sectors, the previous dominant framework.

A cluster framework thus suggests that economic development policy makers and practitioners should focus not solely on individual export sectors, but on the wider set of firms, actors and institutions that form a cluster and help determine the cluster's competitiveness. Surely this provides a better understanding of how regional economic processes work to lead to regional economic performance than does a focus solely on economic sectors. As one example, Cortright (2006) notes that "cluster theory" suggests that regional economic development practitioners should work with groups of firms rather than with individual firms. He also argues that use of a cluster framework "will shift analysis from firm-level rent-seeking (subsidies, tax breaks) to more widely shared competitive problems. So our first recommendation is that is extremely useful for local and regional economic development practitioners to think about economic development through a cluster framework.

What does this suggest for economic development policy and practice?

Here the world begins to look a bit more murky. Use of a cluster framework does not directly lead to answers to the difficult questions for regional economic development.<sup>16</sup> There is widespread agreement that it is not possible to create clusters where there is not an initial base for the cluster to grow on. There is less agreement on whether it is possible to identify "emerging clusters" or whether clusters can only be identified "in the rearview mirror," i.e., after they already exist. Should policy be directed at specific clusters or at concerns that are the foundation of virtually every cluster (e.g., human capital, public infrastructure)? If a cluster-based policy makes sense, should the policy be targeted at specific clusters or, as Porter argues, all sectors? If targeted, towards what kinds of sectors and how selected? And what kinds of specific policies make sense? To none of these does utilizing a clusters framework provide definitive answers.

Cortright writes that most researchers agree that, "No set policy prescription emerges from the cluster literature." In particular, the silver bullet of creating new clusters seems unattainable. As he notes (2006), "The tantalizing paradox of clustering is that it implies that the location of economic activity is not preordained and that, therefore, public policy... can make a difference. Yet at the same time it is virtually impossible to say what it takes to successfully create a new

---

<sup>16</sup> Indeed, Duranton (2009) asks whether cluster-based strategies in the face of limited resources make sense given the small payoff relative to more traditional local policies.



industry cluster in a particular place” (p.48). Summarizing his review of the literature, Cortright (2006, p. 47-48) writes:

There is general agreement that it is difficult or nearly impossible for public policy intentionally to create industry clusters where they do not already exist... Most successful clusters have evolved serendipitously. Although public policies have occasionally been a catalyst to cluster growth, their effects are as likely to be inadvertent as intentional (Rosenfeld, 2002b).

Cumber and MacKinnon (2004, p. 965), summarizing the conclusions of Wolfe and Gertler (same issue) observe that their results “do not provide easy answers for policy-makers as they conclude that cluster development is often due to a set of unique and path-dependent circumstances which are not easily replicable elsewhere and in any case can take several decades to nurture.”

And Newlands (2003), when analyzing theoretical approaches used in cluster theory, concludes that “cluster theories do not necessarily provide much detailed or specific guidance in the construction of economic development strategies” (p.528). But while it may be the case that clusters not be created where they previously have not existed (or were very weak), can *existing or emerging* clusters be built on and made more effective? Given that the literature we have reviewed indicates that clusters develop naturally through market processes and individual actions of firms, workers, and residents (consumers), is it possible for direct and intentional human intervention to improve cluster operations, and, if so, through what kinds of policies or practices?

At a broad level, the question of which clusters to focus on reduces to the same kinds of questions economic development policy makers have developed answers to through more traditional frameworks and the policy implications are also similar.

- Focus on clusters for which the region has existing assets, as evidence by some existing concentration.
- Focus on clusters for which the region has a competitive advantage relative to other regions. Focus on clusters that are growing nationally.
- Focus on clusters for which an intervention strategy is possible and for which intervention will make a difference in terms of affecting economic development objectives.
- Focus on cluster whose impacts or externalities particularly serve public purposes (e.g. employ more entry level labor or promote energy efficiency).

As Duranton (2009) and others have noted, appropriate cluster policies are likely to vary depending on the specific mechanisms and processes that produce cluster benefits. Thus, to consider specific policy and practice interventions we return to the individual processes through which clusters (agglomeration economies and networks) operate that we reviewed in section 3.

*Labor market pooling* results from a large supply of labor with a variety of different skills and occupational specialties resulting in agglomeration economies through more efficient matching, better quality of the match, and the ready availability of specialist skills. While all of these occur naturally through agglomerations, it is certainly possible to think of interventions that might make a difference. The efficiency of the matching process, for example could be improved through labor market intermediaries at the regional and sub-regional level that help match employers and potential employees. The quality of the match and specialist skills could be improved through customized training provided by community colleges and workforce development institutions and programs. While labor markets are region-wide, travel across space is not frictionless, and the ability to provide efficient and higher quality matches could be improved through improvements in a region's transportation system that would allow easier access of worker to job throughout the region. More generally the presence of specific kinds of area amenities, including publicly provided ones, might serve to attract worker in-migrants of skill levels in demand (although presumably higher wages offered by employers for workers in skill-demanded occupations would serve as the primary attraction). According to Duranton and Puga (2009), local industry agglomeration clusters speed "sharing, matching and learning" when it comes to workers, business relationships and knowledge transmission.

The cautionary note here, however, is *could*. The existence of a regional labor market exchange process seems a reasonable idea, but it does not *guarantee* that the job matching process will become more efficient. Workforce development programs abound, but most of the evaluation research literature suggests that they have little effect. The real question is how can these rather traditional economic and workforce development programs, programs that are consistent with a cluster approach, be structured and operated so that they are effective. A cluster framework as an organizing lens suggests that these institutions and programs be developed along cluster rather than industrial lines.

*Input sharing/supplier specialization* is another process that provides agglomeration economies through the co-location of suppliers and producers throughout the value-chain. To the extent that agglomeration economies produced through these processes increase with greater proximity (e.g., through reduced transportation costs) land use and zoning policy, including possibly the provision of industrial parks or districts might play a role.

*Knowledge spillovers* result from the concentration of many people working on problems in a similar or related set of industries, occupations, production processes, etc. that produces a widely shared understanding and the transmission of information. As we noted earlier, the propensity for knowledge spillovers may be a function of history and culture as well as simply agglomeration. However, the literature indicates that much knowledge sharing occurs through informal and quasi-formal networks of relationships. Can such networks be strengthened through intervention or through creation of formal networks? This is a particularly important question from a cluster perspective, since cluster members do not necessarily perceive themselves as being joint participants in a common endeavor. Trade associations are a private sector response to formalization of knowledge-spillover networks. A cluster-oriented public sector response would focus on creating networks that connect the various cluster members across institutions. Indeed, this is a common feature of cluster-based development strategies.

Indeed, some interventions feature designated “cluster brokers” to serve as facilitators of interaction and information exchange.

However, creating a formal network doesn’t necessarily result in substantial knowledge spillovers. First, as Saxenian emphasizes in her comparative case study of Silicon Valley and Route 128, regional history and culture differ, leaving firms in some regions interested in collaboration and networked learning, while firms in other regions suspicious and concerned about local competitors gaining an advantage over them. Second, a substantial amount of research suggests that most learning takes place in informal peer networks, and particularly so when trust is embedded in the local history and culture. In these cases formal networks may be a *result* of effective informal networks. There is a substantial literature on organizational and institutional learning and learning networks that needs to be explored for implications on how cluster-based networks can be strengthened and/or developed to improve regional economies.

Many of the possible interventions that flow from the above discussion of cluster operations – as well as the various lists described in the previous section – are activities and programs that have long been a part of the local and regional economic development arsenal. The argument is that they will be more effectively applied if they are focused on clusters rather than on industrial sectors.

This brings us back to what cluster-based strategies should look like on a broader scale. As noted above, it is widely agreed that it is difficult if not impossible to consciously *create* a new cluster or to strengthen a very weak one. But what about existing clusters? Porter suggests (2003, p. 564) that public policy should be concerned with upgrading all clusters that exist in a region. Others argue that economic development policy should focus resources on a small number of most promising clusters (although Martin and Sunley, 2003, p. 24, argue that if policy is too focused “it starts to look like old industrial policy and too close to the discredited notion of ‘picking winners.’”).

While all regions have clusters, it makes little sense, despite Porter’s injunction, for regional economic development policy to focus on clusters for which export demand is declining or clusters that produce primarily low-skill, low-wage jobs. Moreover, regional economic development policy should take into account that regions exist in a competitive environment and the same cluster specialty cannot be competitive everywhere. Despite the fact that a very high proportion of regional cluster-based development plans focus on a bio-technology cluster, life sciences and/or information technology clusters, it is just not possible for every region to have such a cluster. Some regions are simply better positioned to be competitive in a cluster than are other regions.

An economic development policy informed by cluster theory would proceed by first identifying clusters in the region that produce goods and services for export, are competitive or have a competitive advantage in doing so, and have some existing concentration in the region – i.e., the region already has assets in the cluster that it can build upon. It would then further focus on those clusters for which external demand is increasing or expected to increase. In many cases the broad clusters are readily apparent. The next step is to identify the cluster components, the cluster driver(s), and the interaction between the driver(s) and other components. Not all cluster components are created equal. The cluster driver in the Detroit region, for example, is the automobile industry. The cluster includes the headquarters function,

engineering, research and development, and production plants, although these have a diminishing presence. Efficient supply chains in the region make the industry and the region more competitive; however, the supply chains without the industry are unlikely to be able to sustain a cluster.

The purpose of the above exercises is to search for gaps, inefficiencies, and market failures among the relationships of these components to one another that might be improved through direct intervention and then to fashion interventions (programs, structures, activities) addressed to these. In this regard cluster-based economic development places particular emphasis on determining whether and how information exchange among cluster members, beyond that which already occurs through knowledge spillovers, can be improved.

Muro and Katz (2010) review what they call “general principles for productive pro-cluster activity (p. 18):

- Don’t try to create clusters. Clusters initiative should only be attempted where clusters already exist. Clusters cannot be created out of nothing.
- Clusters strategies or policy interventions should use data and analysis to target interventions, drive design and track performance.
- Focus clusters initiatives on clusters where there is objectively measured evidence of under-capacity.
- Maximize impact by leveraging cluster-relevant preexisting approaches, programs and initiatives.
- Align efforts “vertically” (coordination up and down the different levels of government) as well as horizontally (coordination between policy offering of any one level of government).
- Let the private sector lead on cluster strategy.

The above discussion simply moves us back to the beginning of this section: cluster-based policy is more a framework for viewing and analyzing regional economies than a “silver bullet” for generating economic growth.

## **9. What we don’t yet know about clusters: An agenda for future research.**

Our review of the cluster concept and cluster-based economic development suggests a variety of avenues both for future research to improve our understanding of how clusters work and for future product development to assist policy makers and practitioners in designing and implementing regional economic development policy.

As our review suggests, we know a good deal about how clusters operate, but much less about how they are formed and, in particular, the extent to which they can be assisted either in their

formation or in operation through public policy. This, of course is the critical question for public policy makers. There is widespread agreement that it is unlikely that completely new clusters can be created where some foundation and elements of the cluster do not already exist. But can “emerging clusters” be identified and encouraged to develop through public policy? Since efforts to identify emerging sectors are occurring increasingly frequently in economic development plans, one obvious research project would involve a simple assessment of their effectiveness: to what extent have clusters that have been identified as “emerging” actually emerged? Can public policies be identified which, when used, were more likely to lead to the successful emergence of clusters?

This leads to an even broader question: how can clusters be identified? As we have seen, existing methods, particularly the quantitative ones, have conceptual shortcomings, while the more qualitative ones are time consuming and sometimes yield self-interested results. Research and product development are needed to methods for identifying clusters – including, if possible, emerging clusters – and for evaluating which clusters have the most potential, are most amenable to interventions, will have particular desired development impacts and externalities, and so forth (as further discussed below). How, for example, can the identification of clusters through initial quantitative analysis be improved, in particular through using measures that more closely capture the conceptual meaning of “cluster?” Can clusters that cut across NAICS codes be identified through means other than input-output analysis, a technique that is powerful but largely unavailable to economic development policy makers in most regions? How can networks that signal the existence of clusters be identified? Is social network analysis a realistic possibility?

There are a range of research and development questions that relate directly to public policy. Since clusters result from natural processes – private sector, organic, market driven activity – can public policy improve the functioning of clusters and through what means? Cluster-based economic development policy has many advocates, but even they acknowledge that there is a dearth of evidence about how cluster-based economic development policies, activities, practices have actually performed. Systematic objective evaluation research on cluster-based economic development policy outcomes is badly needed.

It is possible, indeed likely, that clusters differ by type, by place, and by stage of development and that these differences have important implications for policy and practice. Some types may be more susceptible to successful policy intervention than others and different types may require different kinds of interventions. While, as we noted in our paper, there are some efforts to develop cluster “typologies,” none of the existing ones are very helpful to policy makers. This suggests another important area for research and development: how can clusters be best characterized (i.e., sorted into relevant classifications through typologies) so that they provide relevant information to economic development practitioners such as:

- What kinds of clusters work best for different types of regional economies?
- What are the kinds of interventions most appropriate for different kinds of clusters?

In addition, the types are shifting towards functions (e.g., headquarters, production facilities specializations) from industry groupings. Understanding how to identify functional clusters and design appropriate interventions to support them is particularly critical.

Knowledge spillovers through informal networks are a critical benefit of the existence of clusters, leading to increases in regional productivity and output. While the processes through which knowledge spillovers occur are not well understood, such spillovers provide scope for policy intervention through assisting network formation and operations. Reid et al.'s (2008) suggestion that social network analysis be employed as a research technique to better understand the many different types of networks and how each operates is a very promising approach. In addition, there is a substantial literature on organizational and institutional learning and learning networks that needs to be explored for implications on how cluster-based networks can be strengthened and/or developed to improve regional economies.

The key for economic development policymakers is whether and how knowledge spillovers can be encouraged through efforts to make networks more effective. Research is needed on what kinds of policy efforts can accomplish this. Can, for example, "cluster brokers" bring about more effective network operations? Is providing government financial assistance for network operations, organizing more formal networks, or providing venues such as conferences around issues relevant to a network encourage knowledge spillover.

## Appendix. Measures of cluster/spatial agglomeration

- i. Regional population or regional employment (in total or in a specific sector) with larger sizes implying greater agglomerations.

Glaeser and Goettlieb (2009) regress income on city size (population). Agglomeration economies happen when productivity rises with population, so this regression can capture the presence of agglomeration economies. They also use historical population as an instrument for current population. The authors use a standard spatial equilibrium model to understand the connection between density and income in the US: according to urban economists, the large concentrations of people in high-income areas with no exogenous sources of productivity heterogeneity, suggests there are important agglomeration economies.

- ii. Regional population density or regional employment density (in total or in a specific sector) Density is population or employment divided by area, e.g., square miles.

- iii. Concentration indices

Glaeser et al. (1992): share of city employment in industry / share of U.S. employment in industry.

Henderson et al. (1995): Herfindahl index across industries. Industry concentration measure (total city employment in 5 largest industries).

Ohuallachain (1992): employment shares in each industry across metro areas.

Waldhorn, Egan & Park (1998): relative employment concentration or location quotients.

- iv. Localization economies:

Barkley and Henry (1999). Base industry size (to capture the presence of static localization economies). Regional specialization in industry (MAR localization economies). Industry activity in nearby urbanized counties.

Henry, Barkley and Zhang (1997). Level of income in an industry in the initial base year.

- v. Other measures of spatial agglomeration.

Hanson (2005) analyzes the spatial correlation between regional wages and consumer purchasing power to see whether demand linkages contribute to spatial agglomeration. The findings in this paper are consistent with the hypothesis that geographic concentration of economic activity is caused by product demand

linkages between regions: regional variation in wages is associated with proximity to large markets, which suggest strong demand linkages between regions.

- vi. Are there measures of occupational clustering? Presumably there are, utilizing the standard occupational classification. Have we found any yet?
- vii. Hill and Brennan (2000): They use agglomerative hierarchical cluster analysis to group similar industries in terms of their economic characteristics, such as measures of competitiveness, inter-industry linkages, and export measures.

Note: most of the empirical literature focuses on agglomeration rather than clusters as a concept.



## References

- Allen, J. and Potiowsky, T. (2008). Portland's Green Building Cluster: Economic Trends and Impacts. *Economic Development Quarterly*, 22 (4), 303-315.
- Austrian, Z. (2000). Cluster Case Studies: The Marriage of Quantitative and Qualitative Information for Action. *Economic Development Quarterly*, 14 (1), 97-110.
- Bacheller, J. (2000). Commentary on State-Level Economic Development in New York. *Economic Development Quarterly*, 14 (1), 5-10.
- Baptista, R. and Swann, P. (1998). Do firms in clusters innovate more? *Research Policy*, 27, 525-540.
- Barkley, D., and Henry, M. (1999). Industry agglomerations and employment change in non-metropolitan areas. The applied regional science conference (ARSC). Oxford and Malden: Blackwell Publishers.
- Barkley, D., Henry, M. and Nair, S. (2006). Regional Innovation Systems: Implications for Nonmetropolitan Areas and Workers in the South. *Growth and Change*, 37(2), 278-366.
- Bartik, T. (2008). *The Revitalization of Older Industrial Cities: A Review Essay of Retooling for Growth*. Upjohn Institute Working Paper No. 08-143. Kalamazoo, MI. The Upjohn Institute.
- Bergman, E. and Feser, E. (1999). Industrial and Regional clusters: Concepts and Comparative applications. *The Web Book of Regional Science*. Retrieved from <http://www.rri.wvu.edu/WebBook/Bergman-Feser/contents.htm>
- Black, D. and Henderson, V. (1999). A theory of urban growth. *The Journal of Political Economy*, 107 (2), 252-284.
- Cortright, J. (2006). Making sense of clusters: regional competitiveness and economic development. Discussion paper Brookings Institution Metropolitan Policy Program.
- Cortright, J. and Mayer, H. (2001). High-Tech Specialization: A comparison of high technology centers. Center on urban and metropolitan policy. The Brookings Institution. Survey series, January 2001.
- Cumbers, A. and MacKinnon, D. (2004). Introduction: Clusters in Urban and Regional Development. *Urban Studies*, 41 (5/6), 959-969.
- Dahl, M. S., and Pedersen, C.O.R. (2004). Knowledge Flows through Informal Contacts in Industrial Clusters: Myth or Reality?. *Research Policy*, 33 (10), 1673-86.
- Davis, J. and Henderson, J. (2004). The agglomeration of headquarters. Discussion papers. Center for Economic Studies, Bureau of the Census. Washington, DC.

- Deloitte Consulting . (2004). Manufacturing Pennsylvania's Future: Regional Strategies That Build from Current Strengths and Address Competitive Challenges.
- Duranton, G. (2009). *California Dreamin': The Feeble Case for Cluster Policies*. Unpublished paper, Department of Economics, University of Toronto, July 1, 2009.
- Duranton, G. and Puga, D. (2004) Micro-foundations of urban agglomeration economies. In Henderson, J., and Thisse, J. *Handbook of Regional and Urban Economics. Vol. 4. Cities and geography*. The Netherlands: Elsevier B.V.
- Duranton, G. and Puga, D. (2005). From Sectoral to Functional Urban Specialization. *Journal of Urban Economic*, 57 (2), 343-370.
- Enright, M. (2003). Regional Clusters: What we know and what we should know. In Brocker, J. Dohse, D. and Soltwedel, R. (Eds.), *Innovation Clusters and Interregional competition*. Springer. NY: 2003.
- Felbinger, C. and Robey, J. (2001). Globalization's impact on state and local policy: the rise of regional cluster-based economic development strategies. *Policy Studies Review*, 18 (3), 63-79.
- Feldman, M. (2000). Location and Innovation: The New Economic Geography of Innovation, Spillovers, and Agglomeration. In Clark, G., Feldman, M. and Gertler, M. (Eds). *The Oxford handbook of economic geography* (pp. 373-394). Oxford: Oxford University Press.
- Feldman, M. and Audretsch, D. (1999). Innovation in cities: Science based diversity, specialization and localized competition. *European Economic Review*, 43, 409-429.
- Feser, E. (2008). On Building Clusters Versus Leveraging Synergies in the Design of Innovation Policy for Developing Economies. In Uwe Blien and Gunther Maier (Eds.). *The Economics of Regional Clusters: Networks, Technology, and Policy* (pp.185-207). Cheltenham, UK. Edward Elgar.
- Feser, E., Renski, H., and Goldstein, H. (2008). Clusters and Economic Development Outcomes: An Analysis of the Link Between Clustering and Industry Growth. *Economic Development Quarterly*, 22 (4), 324-344.
- Glaeser, E. (2000). The new economics of urban and regional growth. In Clark, G., Feldman, M. and Gertler, M. (Eds). *The Oxford handbook of economic geography* (pp.83-98). Oxford: Oxford University Press.
- Glaeser, E. and Gottlieb, J. (2009). The Wealth of Cities: Agglomeration economies and spatial equilibrium in the United States. *Journal of Economic Literature*, 47(4), 983-1028.
- Glaeser, E., Kallal, H., Scheinkman, J. and Shleifer, A. (1992). Growth in cities. *The Journal of Political Economy*, 100 (6), Centennial Issue, 1126-1152.
- Gordon, I.R. and McCann, P. (2000). Industrial clusters: complexes, agglomeration and/or social networks?. *Urban Studies*, 37(3), 513-532.

- Granovetter, M. (1973). The Strength of Weak Ties. *American Journal of Sociology*, 78, 1360-1380.
- Hanson, G. (2000). Firms, Workers, and the Geographic Concentration of Economic Activity. In Clark, G., Feldman, M. and Gertler, M. (Eds). *The Oxford Handbook of Economic Geography* (pp. 477-494). Oxford: Oxford University Press.
- Hanson, G. (2005). Market potential, increasing returns and geographic concentration. *Journal of International Economics*, 67, 1-24.
- Henderson, V., Kuncoro, A. and Turner, M. (1995). Industrial development in cities. *The Journal of Political Economy*, 103(5), 1067-1090.
- Henry, M., Barkley, D. and Zhang, Y. (1997). Industry clusters in the TVA region: Do they affect development of rural areas. TVA rural studies. Contractor Paper 98-9.
- Hill, E. and Brennan, J.F. (2000). A methodology for identifying the drivers of industrial clusters: the foundation of regional competitive advantage. *Economic Development Quarterly*, 14, 65- 96.
- Hill, E., Samuel, J, Stewart, F. In cooperation with the MPI Group, Inc. (2008). Driving Ohio's prosperity: Central Ohio is the leverage point of a two-job strategy for growing the value of automotive and advanced manufacturing. How to help manufacturers do today's job of meeting customer's demands and tomorrow's job of continuing to innovate and improve. Prepared for Compete Columbus.
- Hippel, E.v. (1988). *The Sources of Innovation*. Oxford: Oxford University Press.
- Iammarino, S. and McCann, P. (2006). The Structure and Evolution of Industrial Clusters: Transactions, Technology and Knowledge Spillovers. *Research Policy*, 35, 1018-1036.
- Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, 99(3), 483-99.
- Krugman, P. (2000). Where in the world is the 'New Economic Geography'? In Clark, G., Feldman, M. and Gertler, M. (Eds). *The Oxford handbook of economic geography* (pp.49-60). Oxford: Oxford University Press.
- Malmberg, A. and Maskell, P. (2006). Localized Learning Revisited. *Growth and Change*, 37 (1), 1-18.
- Markusen, A. (1985). *Profit Cycles, Oligopoly, and Regional Development*. Cambridge, MA. The MIT Press.
- Markusen, A. (1996). Sticky places in slippery space: a typology of industrial districts. *Economic Geography*, 72 (3), 293-313.
- Martin, R. and Sunley, P. (2003). Deconstructing clusters: Chaotic concept or policy panacea? *Journal of Economic Geography*, 3, 5-35.

- Mills, K., Reynolds, E. and Reamer, A. (2008). *Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies*. Washington, DC. Metropolitan Policy Program. Brookings Institution.
- Motoyama, Y. (2008). What Was New About Cluster Theory? What Could It Answer and What Could It Not Answer? *Economic Development Quarterly*, 22(4), 353-363.
- Muro, M. and Katz, B. (2010). The new "cluster moment": How regional innovation clusters can foster the next economy. Metropolitan Policy Program, Brookings Institution.
- Newlands, D. (2003). Competition and Cooperation in Industrial Clusters: the Implications for Public Policy. *European Planning Studies*, 11(5), 521-532.
- OECD (2008). The sources of economic growth in OECD regions: a parametric analysis. Working party on territorial indicators.
- O'Huallachain, B. (1992). Economic structure and growth of metropolitan areas. In Mills, E. and McDonald, J. (Eds). *Sources of Metropolitan Growth*. New Brunswick, NJ: Rutgers University, Center for Urban Policy Research.
- Peters, D. (2004). Revisiting industry cluster theory and method for use in public policy: An example identifying supplier-based cluster in Missouri. Mid-Continent Regional Science Association, 35<sup>th</sup> Annual meeting.
- Phelps, N.A. (2004), Clusters, Dispersion, and the Spaces in Between. *Urban Studies*, 41(5/6), 971-989.
- Porter, M. (1998). *Competitive Advantage. Creating and sustaining superior performance*. New York: Free Press.
- Porter, M. (2000). Locations, clusters and company strategy. In Clark, G., Feldman, M. and Gertler, M. (Eds). *The Oxford handbook of economic geography* (pp.253-274). Oxford: Oxford University Press.
- Porter, M. (2003). The Economic Performance of Regions. *Regional Studies*, 37(6), 545-578.
- Porter, M. (2009). *Clusters and Economic Policy: Aligning Public Policy with the New Economics of Competition*. White Paper, Institute for Strategy and Competitiveness, Harvard Business School.
- Porter, M. (2010). Cluster Mapping Project. Retrieved from <https://secure.hbs.edu/isc/login/login.do?http://data.isc.hbs.edu/isc/>
- Putnam, R. (1993). *Making Democracy Work. Civic tradition in Modern Italy*. Princeton: Princeton University Press.
- Reid, N., Smith, W., and Carroll, M. (2008). Cluster Regions: A Social Network Perspective. *Economic Development Quarterly*, 22 (4), 345-352.
- Rosenfeld, S. (1997). Bringing Business Clusters into the Mainstream of Economic Development. *European Planning Studies*, 5 (1), 3-23.

- Rosenfeld, S. (2000). Community college/Cluster connections: Specialization and Competitiveness in the United States and Europe. *Economic Development Quarterly*, 14 (1), 51-62.
- Rosenfeld, S. (2005). *Industry Clusters: Business Choice, Policy Outcome, or Branding Strategy?* Carrboro, NC. Regional Technology Strategies.
- Rosenfeld, S. (2010). Discussion at *Implementing Clusters Workshop*, Federal Reserve Bank of Chicago, May, 26, 2010.
- Rosenthal, S. and Strange, W. (2004). Evidence of the nature and sources of agglomeration economies. In Henderson, J.V. and Thisse, J.F. (Eds.). *Handbook of regional and urban economics*, Vol. 4.
- Safford, S. (2009). *Why the Garden Club Couldn't Save Youngstown: the Transformation of the Rust Belt*. Cambridge, MA: Harvard University Press.
- Saxenian, A. (1994). *Regional advantage: Culture and competition in Silicon Valley and Route 128*. Cambridge and London: Harvard University Press.
- Strauss-Kahn, V. and Vives, X. (2006). Why and where do headquarters move? Working paper No. 650. IESE Business school, University of Navarra.
- Waits, M. (2000). The added value of the industry-cluster approach to economic analysis, strategy development, and service delivery. *Economic Development Quarterly*, 14 (1), 35-50.