Economic Competitiveness, Clusters, and Cluster-Based Development

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Cluster theory: Cluster theory and its application, cluster-based economic development policy, have been in the forefront of regional economic development theory and practice during the past decade. Regional clusters im1ply 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 effective clusters will be more competitive, a2nd regions with effective clusters will experience greater growth.

Clusters and regional economic competitiveness: A region's economic competitiveness reflects its competitive advantage. Starting with the premise that a firm will locate in a region where the cost of producing and bringing to market is lower there than elsewhere, a region's competitive advantage consists of its locational attributes with respect to specific types of activities; for instance, a region may have a

competitive advantage for routine manufacturing activities, but not for high-level professional services or for producing some kinds of economic outputs but not others. The major attributes of a region that are important (all relative to other regions) in determining its competitive advantage include labor (availability, quality, and cost); location and transportation costs with respect to suppliers and consumer markets; land (availability, cost, and quality); public infrastructure quality; energy and utility cost; state and local public services, taxes, and regulatory environment; presence of research universities, and so forth. The relative importance of these factors varies with kind of economic activity and good or service produced.   Having effective clusters that produce external benefits to firms that choose to locate in the region becomes one, among many, facets of a region's competitive advantage

What is a cluster?   The above discussion begs the question to some extent: what, exactly, is a cluster?   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 that it has, in many respects, become a 'chaotic concept'."   They list (2003, p. 12) ten different definitions of cluster that they found in their review of the literature.   In an attempt to capture the broad meaning of the term and drawing upon the various definitions in the literature, I define clusters as follows:

A cluster consists 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.

3What are the implications of this 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, pp. 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 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 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 the social network 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 relations and trust and are said to embody social capital that is embedded in them.

Given the overlap between social networks and MAR externalities the overlap between "clusters" and what are traditionally thought of as agglomeration economies appears quite substantial. 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 high regional economic growth is likely to be small, no matter what other institutions are connected to it. It is possible that a better organization of the cluster would result in improved economic performance for the region, but not high economic performance.

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 (Glasmeir, 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.

For example, certain kinds of highly embedded social networks may actually retard innovation and growth.   Porter   notes (2000b, 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.

Cluster processes and economic growth: What are the processes through which we would expect clusters to generate economic growth?   The first cluster form, agglomeration economies, are external benefits that occur 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. As Phelps notes (2004, pp.972-3) 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 ("localization economies") and those that result from the co-location of a large number of firms, even if they are diverse ("urbanization economies," or, if the focus is on their diversity, "Jacobs economies" after writings of Jane Jacobs). The most common conceptual definitions of clusters focus attention more on localization economies, although many of the processes incorporate both and consequently, we will examine both.

Below we discuss the various cluster processes and 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),

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).

4Second, the ability to replace an inferior worker with another more productive one available in the area, or to "match" a worker with the skills needed on the job is a

productivity gain that results to a firm through agglomeration. As Duranton and Puga (2004, pp. 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.). T5he 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, advertizing

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.

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 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).

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.

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 conceive of interventions that would enhance these processes. For example, public provisions to provide land or transportation infrastructure may encourage suppliers to locate in greater proximity to each other; workforce development programs may increase the skill levels needed

for the cluster; labor force intermediary institutions may help to provide more efficient worker-job matching processes.

Knowledge spillovers: Knowledge spillovers or MAR externalities 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 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 it 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.

Cumbers and MacKinnon (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.

Porter (2000b), 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 important (p.264)."

However, despite these claims by Porter and others, Martin and Sunley (p. 16) 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."

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 suggests that clusters can be composed of very different components. As Porter (2003, p. 562) 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."

The most common approach by researchers is to engage in intensive 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, p. 209), '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."

Practitioners, often assisted by local researchers or consultants apply much the same approach. Reid et al (2008, p. 346) note that these qualitative case studies usually rely upon "expert opinions or key informants to isolate clusters. 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.

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) for each industry in the various metropolitan areas in the study – see, for example, Glaeser, 1992; Ohuallachain, 1992, Cortright & Mayer, 2001, and Hill & Brennan, 2000), sectoral specialization weighted by sector size (OECD, 2008), and a Herfindahl index (Henderson et al (1995), which is a measure sectoral diversity for a region's industries). A few studies employ elaborate methods such as input-output analysis (Hill and Brennan, 2000; Feser et al., 2008) and/or 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 (Hill and Brennan, 2000). However even these methods at their core build upon the industrial composition of the regional economy.

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 structures may be captured in many different industrial classifications.

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) o6r 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.

Empirical evidence on the relationship of clusters to growth: 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 et al.) 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). The empirical literature consists of two quite different strands: econometric studies where growth = a + b(measure of clusters) + c(other control variables) and intensive case studies of clusters in one or two locations.

The former literature consists mainly of studies where the growth in aggregate output, personal income, wages, or employment, is regressed against different variables that the theory and the empirical literature have identified as determinants of growth, for example, variables that measure 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.

Many of the studies use some measure of industrial concentration (e.g., location quotients or7 a Herfindahl index). 8 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. 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 (see, for example, Rosenthal and Strange, 2004; OECD, 2008; and Glaeser and Gottlieb, 2009), and there is broad agreement that evidence supports the positive effect of agglomeration on various measures of regional economic performance.

Another set of studies examines whether localization economies of agglomeration or urbanization economies of agglomeration 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 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 is less sympathetic to the argument that clusters are important drivers of growth.

Rosenthal and Strange (2004, pp. 2132-36), Feldman (2000, p. 303) and Cortright (2006, pp. 39-42) review these studies and find mixed results. Rosenthal and Strange, (2004, pp. 2135-36) observe that in many of the studies specialization (proxied 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.

The studies that attempt to focus more directly on "knowledge spillovers" are mostly intensive case studies of specific areas. For example, Saxenian's (1994) 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 (pp. 2-3), "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."

The most relevant research consists of studies that focus directly on the concept of clusters rather than on proxies for agglomeration. Ohuallachain (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.

Feser et al. (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 (pp. 343-3) that "We found little evidence that technology industries in spatial clusters in Appalachia created more jobs than the same industries in noncluster locations." 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, p. 489) 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.   There is little work that attempts to estimate the relative impact of these different effects.

The problem, Rosenthal and Strange observe (2004, p. 2146), is that "agglomeration economies whose sources are knowledge spillovers, labor market pooling, or input sharing all manifest themselves in pretty much the same way."   As Gordon and McCann (p. 517) 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."   Finding reasonable measures of each of these as a means of sorting out the effects while controlling for the others is very difficult.

Clusters and Regional Economic Development: What are the Implications for 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 et al., 2008).   Cumbers and MacKinnon (Urban Studies, 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 policy that might be applied?   Motoyama (2008, p. 360) notes that

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.

Martin and Sunley (2003, pp. 23-24), argue that the cluster focus suggests that policy should 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.

What kinds of public policy have actually been adopted as part of the cluster-based approach for which Porter provides the above rationale?   Cortright (2006, p. 48; see also Mills, 2008) 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.

Unfortunately, many of these are very fuzzy or merely aspirations of the nice work if you could do it variety. Just how, for example, can a region aggregate and strengthen local demand?

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.

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 (pp. 343-3) that "We found little evidence that technology industries

in spatial clusters in Appalachia created more jobs than the same industries in noncluster locations."

Instead, several authors point to benefits not related to specific policies but more to processes. For example, Cumbers and MacKinnon (Urban Studies, 2004, p. 962) 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." Observing Arizona's cluster strategy, Waits (2002, p. 39) 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."

What are the Implications of Cluster Theory and Research for Regional Economic Development Practice? Cluster "theory" is not a theory in the sense that theory provides explanation. Instead, cluster theory provides 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. There is now substantial agreement that it is 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. Should policy be directed at 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.

In short, "cluster theory" does not appear to provide ready-made public policy "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, p. 48), "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 industry cluster in a particular place."

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?

To think about this question we return to the individual processes through which clusters (agglomeration economies and networks) operate that we reviewed in section?

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. It is possible that matching efficiency 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. 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).

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 with 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 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 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.

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 then a "silver bullet" for generating economic growth.

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