The Relevance of Clusters for Innovation Policy in Latin America and the Caribbean

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Abstract

This paper discusses the unique insights that the concept of industry clusters brings to the question of the proper design and implementation of innovation policy in Latin America. The paper begins by characterizing trends in the use of cluster ideas in development policy making in Latin America, the United States, and Europe. While the nominal invocation of clusters by public officials and agencies is proliferating too rapidly to produce an exhaustive inventory of policy applications, some general trends and approaches can be detected, provided a careful distinction is drawn between ideal scenarios as presented in the academic literature and actual implementation on the ground. The paper then compares the notion of cluster policy to conventional public sector development policy and proposes a conceptual framework for characterizing cluster policy options, intended impacts, and proper means of evaluation and monitoring. It is asserted that cluster concepts offer two principle guides to innovation policy. The first is as a strategic framework for motivating and coordinating targeted interventions and investments designed to establish or nurture innovative activities. The second is as a means of improving the implementation of conventional innovation policies. With regard to evaluation, in neither case is the relevant outcome the growth of innovation clusters per se. The paper suggests some guides for policy makers in Latin America and Caribbean region.

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I Introduction

The increasing knowledge-intensity of production and the progressive elimination of barriers to trade have led many to conclude that a strong base of science, technology, and innovation is essential for sustained economic prosperity (Mytelka and Farinelli 2000). Advanced industrialized countries are responding to increasingly open markets by seeking competitive advantage in general knowledge infrastructure: universities and colleges, public and private laboratories, educated workers, advanced physical infrastructure, and comparatively stable social, political, and market institutions.[2] In developing countries, fears of falling further behind as well as optimism borne of widely publicized examples of high technology success provide the principal motivation to designing ways to boost innovation and technology-related activity.

Unsurprisingly, common indicators of knowledge intensity (R&D as a share of GDP, patent rates, relative employment or value-added in knowledge-oriented or high technology industries, and educational attainment) find developing countries lagging far behind in quantitative terms (OECD 2000, Mitchell 1999, D'Costa 1998). Even in nominally technology-intensive sectors and among high tech transnational corporations, studies show that innovation-oriented investments in developing countries are targeted not toward research and product development but rather toward cost reduction, logistics management, and other activities consistent with cost-sensitive branch production in global commodity chains (see, for example,

[1] Special thanks to Marcela Gonzales Rivas and Henry Renski for assistance with assembling information on cluster-related development policies in Latin America and the United States.

[2] Interest in innovation is also heightened by fears of an emerging "two-tiered economy," that two sectors will come to dominate long-term employment growth prospects in industrialized countries: high skilled technology-intensive activities that are dependent on advanced knowledge infrastructure and low-skilled basic consumer services that serve immediate local market needs (Mowery 2001).

Quadros, Furtado *et al.* 2001). It is clear that the differences between developed and developing country innovation systems are as much qualitative as quantitative (Melo 2001b, Conceição, Gibson *et al.* 2001). At the same time, successful cases of technology-led economic growth such as India's Bangalore software industry and Brazil's Campinas telecommunications sector raise hopes that with the right policy interventions and investments, developing countries might leapfrog what was once viewed as a necessary process of gradual transition from agrarian to knowledge-based development (Etzkowitz and Brisolla 1999).[3]

In Latin America and the Caribbean (LAC), views of innovation are influenced by a general debate about industrial policy. In a recent survey of economic policies in the region, Melo (2001a) documents two phases in the reforms that have followed the import substitution era. In the first phase—from roughly the late 1980s to the mid 1990s—LAC countries sought to implement basic structural reforms related to export trade, privatization, domestic market liberalization, and regulation. At the same time, they curtailed explicit (sector targeted) industrial policies. The logic was that government intervention in liberal market economies is necessarily very modest and that industrial policy is generally prone to distortion and corruption. Yet Melo finds that by the mid-1990s many LAC states had already begun to abandon that strictly hands-off philosophy in favor of explicit public sector strategies aimed at enhancing the competitiveness of particular sectors, value chains, and firms. This second phase, which is ongoing and still without definitive results, reflects a view of government intervention that is more nuanced, particularly as it pertains to technology. LAC countries are recognizing that global competitiveness ultimately implies continuous learning and innovation, processes on

[3] For the case of Bangalore, see Stremlau (1996a), Stremlau (1996b), and Patni (1999), and Voyer (1997a). Quandt (1997) discusses the case of Campinas.

which the public sector might exert considerable positive influence through its role as catalyst, source of demand, and supporter of research, basic education, and training.

In this context, of growing interest in Latin America are the phenomena of high technology industry clusters and their potential value as an innovation policy focus. Mainstream economic theory argues that technology-related activity often agglomerates in specific regions because knowledge spillovers are localized (Glaeser 2000). Knowledge spillovers–the primary engine in the most recent theories of long-run economic growth–are the ability of economic agents to utilize a new technology or innovation without fully compensating its original source or owner (Grossman and Helpman 1991).[4] Innovations initially occur in companies, universities, and laboratories located in specific places. The subsequent spread (or diffusion) of such innovations, as well as the spillovers they generate, *may* occur more readily among economic actors located in close proximity, either because the innovation is tacit in nature or because its successful utilization requires an element of hands-on learning-by-doing. Increasing returns to innovation, coupled with a localized diffusion effect, imply that technology-oriented activity and R&D are likely to concentrate geographically. Technology businesses locate near other high tech companies and R&D performers in order to share in the spillovers, further enhancing the attractiveness of the growing cluster for still more high tech enterprises. The cluster may then expand through a process of cumulative advance.[5]

[4] It has long been understood that technological change is the leading contributor to long-run economic growth (Nelson 1996). But it was not until the revision of the neoclassical model of Solow (1956, 1957), following advances by Romer (1986, 1990) and Lucas (1988), that knowledge spillovers took center stage in growth analysis. As a form of knowledge, a new technology is both nonrivalrous and nonexcludable, public good features that give rise to knowledge spillovers. Resources are utilized to create new knowledge, some part of which "spills over to the research community, and thereby facilitates the creation of still more knowledge" (Grossman and Helpman 1991, p. 17). Because spillovers imply that the process of invention exhibits increasing returns to scale, returns to new productivity-enhancing technologies and ideas are always sufficient to maintain the incentive to invest in still more innovation. Thus, one arrives at perpetual long-run growth.

[5] The emergence of new growth theory more or less coincided with Michael Porter's (1990) research on clustering and national competitiveness as well as an exploding literature on industrial districts. Early on, there was

Indeed, stylistic qualitative analyses in highly industrialized economies suggest that a combination of geographically co-located private sector producers of R&D, related manufacturing and services industries, linked or related suppliers and producer services providers, leading research universities and teaching institutions, and government sponsored labs and technology programs can combine to create powerful spatial clusters of technology-related activity that continue to expand through initial market leadership (often called "first-mover effects") and economies of scale (Saxenian 1994; Porter 1990, 1998, 2000; Hertog, Bergman *et al.* 2001b). Well-known examples in the United States are California's Silicon Valley and Boston's Route 128 (in information technology and biotechnology), greater Seattle (in software and aircraft), and North Carolina's Research Triangle region (in electronics, pharmaceuticals, and biotechnology). Such clusters have contributed to substantial increases in the local economic prosperity while also supplying the innovations that drive national and, in some cases, global economic growth. Such clusters are not restricted to the U.S. or other advanced industrialized countries, although they tend to be smaller and have much less depth in less developed countries (e.g., see Hertog, Bergman *et al.* 2001b, Melo 2001a, Chairatana and Vorrakitpokartorn 2001, Voyer 1997b). Recent studies of the LAC region have identified innovation clusters of differing varieties and size in Argentina, Brazil, Costa Rica, Cuba, Peru, and Mexico (Quandt 1997, Voyer 1997a, Altenburg and Meyer-Stamer 1999, Bortagaray and Tiffin 2000).

An important issue is what clusters imply for the design and implementation of innovation policy, particularly in newly industrializing countries and lagging regions in

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comparatively little cross-fertilization of ideas from these perspectives. However, they all emphasized the tendency toward localization of economic activity and the critical role of knowledge spillovers (albeit described differently by each perspective). The concurrent development of the literatures, all offering varying perspectives on a similar story, contributed strongly to the rise of industry clusters as a concept in development policy debates.

developed ones where technology-intensive activity and basic knowledge infrastructure are limited. Innovation policy constitutes strategies designed to build basic and applied research capabilities, raise the rate of advanced technology adoption and product innovation among home country firms, and generally increase the complement of higher wage knowledge- and technology-intensive industries in a country or region.[6] The strategies might include, among others, the provision of R&D subsidies and incentives, the development of university research competencies, the improvement of basic education, the supply of training, the promotion of business development services, the encouragement of firm networks, the provision of industrial extension, the facilitation of technology transfer, and the targeting of public sector procurement (Leyden and Link 1992, Malecki 1997, Gambardella and Malerba 1999, Tidd and Brocklehurst 1999, Conceição, Heitor *et al.* 1998, Geroski 1990).

Many of those same interventions have been described, at one time or another, as industry cluster policies (Jacobs and de Jong 1992, Jacobs and de Man 1996, Rosenfeld 1997, Enright 2001, Rosenfeld 2001). What unique insights, then, does the cluster concept bring to the innovation policy debate? What is its value-added? Is an industry cluster policy merely the application of a conventional development initiative, such as an R&D incentive or procurement strategy, to a geographically concentrated group of firms? Does the process of clustering, as opposed to the phenomena of clusters, imply a specific and unique kind of policy intervention? Are there risks associated with attempts to build clusters through targeted public sector investments? Conversely, are there opportunity costs to not building them? Is there an

[6]Temple (1998) identifies five determinants of technological change that may be the focus of innovation policy: the generation of new knowledge; the translation of new or existing knowledge into products and processes; the diffusion of innovation; the exchange of knowledge-intensive goods and services; and the absorption of knowledge or learning. All of the processes are subject to market failure. Therefore, the more knowledge-intensive an economy becomes, the more important institutional (i.e., policy) mechanisms for resolving failures will be.

alternative model of intervention that utilizes findings from research on clusters but does not force governments to pick favorite sectors, research concentrations, or regions? Those fundamental questions are raised from the explosion of literature on clustering and closely related sister concepts and perspectives such as learning regions, innovation systems, networks, districts, and innovative milieux.

This paper does not attempt a general discussion of the wide range of definitions, views, and theories of industry clusters. Such generalized reviews are already numerous.[7] Instead, it draws selectively on the extant literature to argue that the concept of the industry cluster has two unique implications for Latin America and other industrializing regions. The first is as a model that argues for the concentration of technology-related human, physical, and financial resources in specialized geographic agglomerations in order to generate innovation activity of sufficient scale, depth, and diversity to compete on an international level. The policy implication is to strategically apply a range of strategies—those that are both innovation and non-innovation oriented—to foster a critical mass of high-tech and related innovation activities in specific sectors and locations. The justification for this "cluster building" perspective is based heavily on notions of externalities and economies of scale enjoyed by co-located industries. In general, the perspective suggests that nations and regions within them are better off specializing in highly localized technology-related industries and scientific competencies than implementing broad-based science and technology (S&T) strategies that are essentially sector- and location-neutral. It gains traction from the many stylized examples of successful clusters, from Silicon Valley to Bangalore. Problems with the perspective include the temptation to rely too heavily on ideal

[7] The most relevant theoretical literatures include endogenous growth theory, new industrial districts, technology districts and technopoles, innovative milieux, industrial location and agglomeration economies, strategic management and industrial organization, and innovation systems. See McCann (1995), Feser (1998b), Bergman and Feser (1999), and Moulaert and Sekia (1999), and Gordon and McCann (2000).

types drawn from the developed country experience, evidence that public sector attempts to build clusters will meet with limited success, the difficulty of identifying promising high tech specializations, and the very real risk of unmet expectations given the limited S&T base in less developed countries. Nevertheless, used carefully, cluster concepts have the capability of significantly informing strategic S&T investments in LDCs, most of which must be carefully targeted given limited resources.

The strategy of building clusters as an approach to innovation policy is easy to understand, if difficult to implement. But the theoretical and empirical literatures on clustering also offer insights on how conventional innovation policies (and other development policies, for that matter) might be administered so as to improve their reach and impact. To wit, the second major implication of the industry cluster concept relates to what it says about the implementation of development interventions in general, even if they do not aim to build discrete clusters. This "leveraging" perspective implies that the public sector should utilize, promote, and exploit *synergies*—the various traded and untraded, localized and nonlocalized, interdependencies between economic actors—to more effectively foster innovation and learning. The advantage of the leveraging view is that it seeks to reorient development policy in a way that acknowledges—and indeed, utilizes—the competitiveness-enhancing features of industrial interdependence without the risks of the cluster building approach. A drawback, however, is that it may overstate the capacity of the public sector to design and implement complex interventions, particularly in developing economies where institutional capacity is weak.

The paper is laid out as follows. Section II begins with a discussion of the utilization of cluster concepts in economic development policy making in Latin America, the United States, and Europe, at least as could be determined with a review of secondary sources, government

documents, and expert opinion. Section III then suggests a conceptual framework for situating cluster policy against industrial policy in general and innovation policy in particular. It presents and contrasts the cluster building and leveraging perspectives in detail and considers related empirical work. The last section derives some general lessons for policy action, measurement, and evaluation.

Ultimately, the paper argues that the fact that industries and/or innovations cluster—either in abstract space as described by DeBresson (1989) or in geographic space as in Porter (1990)—is a weak guide for policy in and of itself. Moreover, attempts to build technology clusters as a means to promote innovation are likely to meet with very limited success in most developing country contexts. The case for exploiting interdependencies to leverage innovation policy is stronger, and clusters may very well emerge naturally as a result. Policy makers in the LAC region would be advised to view clustering as a flexible means of implementation rather than as a discrete model of development.[8]

II Industry Clusters and Development Policy Making

One way to gain some insight on what the industry cluster concept means for innovation policy is to examine how governments around the world are actually invoking it in economic development planning and policy making. But that is no easy task. The active or at least nominal use of cluster ideas in policy making at all levels—local, regional, national, and international—continues to grow. Clusters have been debated at the national and regional levels in the U.S., Canada, Australia, New Zealand and most of the European Union since the mid 1990s (Roelandt and Hertog 1999; Hertog, Bergman *et al.* 2001b). Enright (2001) claims that

cluster initiatives have been pursued in ten countries in Latin America, as well as in Malaysia, Singapore, Morocco, South Africa and Senegal. The OECD, the World Bank, UNIDO and UNCTAD are all engaged in considering, developing, funding, and/or evaluating cluster or networking policies of one form or another.[9] Claas van der Linde and Michael Porter have assembled a collection of over 350 studies that examine some 700 clusters in roughly fifty countries. The majority of those studies have been conducted or commissioned by public agencies interested in applying clusters to policy. A simple Internet search on the phrase "industry clusters" turned up 9,150 references at the time of this writing.[10] Few would dispute that this is a topic that warrants careful consideration.

A major problem with efforts to describe "cluster policy" is that many types of development interventions are targeted to specific sectors, regions, or both, and thus could be loosely interpreted as cluster-oriented strategies. For example, the establishment of research parks and technopoles could be considered cluster strategies, even though many such efforts around the world preceded the modern cluster literature. In the United States, North Carolina's development of Research Triangle Park in the 1950s, which subsequently became the anchor of substantial information technology and bioscience clusters, is sometimes viewed (and cited

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[8] Feser and Luger (2002) argue that cluster analysis should be viewed as a "flexible mode of inquiry," a view of *methodology* that is consistent with the cluster as a "means of implementation" view of *policy*.

[9] The OECD, the World Bank, UNIDO, and UNCTAD have all been major players in the evaluation, dissemination, and utilization of cluster ideas. For example, the World Bank organized a workshop of cluster practitioners in Chihuahua, Mexico in November 1997, which helped inspire the founding of The Competitiveness Institute (www.competitiveness.org), a non-profit international association of practitioners that aims to disseminate best practices via a website, newsletter and annual conference. The OECD has considered clusters as part of its National Innovation Systems (NIS) project since 1996, an effort that has resulted in several international workshops and two edited volumes of best practice (Roelandt and Hertog 1999, Hertog, Bergman *et al.* 2001b). UNIDO considers clusters part of its small and medium-sized enterprises (SME) programs (Ceglie and Dini 1999; Fisher and Reuber 2000; Russo, Clara *et al.* 2000; UNIDO 2001, Nadvi 1995). UNCTAD has also focused on clustering and networking as modes of competition for small firms (UNCTAD 1998).

[10] A huge figure given that the latest estimates of the share of web content that current search engines are capable of tapping is about 15 percent (Reich 2002).

favorably) as a cluster strategy (Rosenfeld 2001), even though it was initially designed as an industry recruitment tool. Melo (2001b), referencing Quandt (1999), describes Brazil's establishment of thirteen innovation centers in 1982, as well as a subsequent science park program in 1984, as among the earliest cluster strategies in Latin America. Business incubators, industrial parks, targeted recruitment, enterprise zones, foreign trade zones, and a large variety of other common economic development interventions could similarly be assessed as cluster policy if they aim to foster growth in specific industries or regions.

As a way of limiting the scope of the analysis, this section focuses strictly on international trends in the *explicit* use of cluster ideas. Only efforts that directly reference the concept of clusters, even if they do so in only a nominal way, are therefore considered.[11] The aim is to gain an empirical sense of how public officials are drawing on the notion of clusters. Given the highly malleable nature of the concept, it is to be expected that the utilization of clusters in policy making tends to reflect industry characteristics and mix, views of economic development, prevailing institutional frameworks, and political and economic constraints in the jurisdiction at hand. More specifically, it appears the most common use of cluster ideas is as a way to organize and undertake strategic planning exercises that yield a flexible set of policy options, a clear target group of beneficiaries, and a logical set of private sector partners to planned interventions.

Clusters and Economic Policy in Latin America

Early interest in clusters and clustering focused overwhelmingly on advanced industrialized countries. That is no longer the case. Clusters, districts, and networks are now being systematically studied all over the developing world. Latin America, in particular, has

[11]The assessment is based on existing literature, Internet searches, and personal communication with experts and policy makers. While it is invariably non-exhaustive, hopefully it is representative.

been the subject of considerable research, with Brazil and Mexico receiving most of the attention. Among the clusters (or districts) studied in the former are leather shoe producers in the Sinos Valley (Nadvi 1995; Schmitz 1995a, 1995b, 1999), various high technology sectors in Campinas (Quandt 1997), the wood furniture industry of Ceará (Tendler and Amorim 1996), and the textiles and clothing, metal engineering and electromechanical, and ceramic tiles clusters in Santa Catarina (Meyer-Stamer 1998). Rabellotti (1999) analyzes the footwear sector in Guadalajara, Mexico and Visser (1999) describes the results of a case-control study of clustered and dispersed garment producers in Lima, Peru. None of the aforementioned studies are focused specifically on innovation or technology. In contrast, Bortagaray and Tiffin (2000) attempt a systematic identification of innovation clusters across the region, concluding that while firms in clusters seem to grow faster and generate more profits than those outside of clusters, no Latin American innovation clusters can be reasonably described as mature in the sense of a Silicon Valley. The authors do identify a number of significant developing and potential innovation clusters, including two in Argentina, twenty-seven in Brazil, two in Costa Rica (both in San Jose), one in Cuba (biotechnology), six in Mexico, and one in Uruguay (wine). Unsurprisingly, most of the clusters are in heavily urbanized areas. A lack of investment capital, weak inter-firm and inter-institutional networking, and an absence of adequate business development services are cited as the primary impediments to the further development of innovation clusters in the region.

A review of government documents and web sites gives a sense of how cluster ideas are either informing or being incorporated into economic policy in the region (see Table 1). Immediately noticeable is the breadth of interventions that LAC governments themselves describe as cluster policy. They range from marketing and business networking to targeted export assistance, infrastructure development, and training. Overall, public agencies in the

region tend to be invoking or actively applying cluster concepts mainly in three broad policy areas: export promotion and attraction of inward investment, value chain integration, and networking/SME policy. Those emphases reflect views of what is appropriate given the current industrial structure and stage of development in much of LAC, including the continued dependence on the location of the manufacturing concerns of large multinational companies, a desire to diversify existing industry by filling out supply chains, and a predominance of uncompetitive small and medium-sized producers (particularly in peripheral and lagging areas). Notable is the lack of many innovation programs based on cluster concepts. That does not mean that LAC governments are not targeting S&T investments to specific sectors, research competencies, and/or regions, but rather that there is only modest evidence that cluster ideas are being used explicitly to guide such initiatives. Current cluster interventions in the region seem to be focused on traditional sectors for the most part.

So exactly what value-added are clusters bringing to economic policy making in the LAC region? The answer appears to have less to do with the identification of specific interventions than with the defense of general approaches and setting of strategic priorities. First, as mentioned above, many LAC governments are attempting to identify the right balance between the implementation of free market structural policy and activist (often local and regional) strategies designed to promote the competitiveness of strategic sectors and potential strengths in science and innovation. The region's move to open its markets to international competition while dismantling the protection of inefficient domestic industries has not yielded the gains initially anticipated (Melo 2001). The result is a search for interventions that will address the shortfall while also meeting the approval of multinational lending institutions, key trading partners such as the United States and Canada, and international investors. Industry clusters are

widely viewed by both public and corporate officials in the developed world as a key feature of international competitiveness, i.e., cluster promotion efforts have attained a level of legitimacy as market-friendly industrial policy that other (differently labeled but sometimes quite similar) perspectives have not. Thus while clusters may hold out the promise of a substantive route toward a more activist competitiveness strategy that does not threaten the LAC region's continued shift toward free markets, it is also significant that they are viewed favorably from a symbolic perspective.

Second, the cluster concept is persuading some LAC governments to place more emphasis on the diagnosis of problems and prescription of interventions for existing industries, and to avoid focusing exclusively on the attraction of inward investment. Knorringa and Meyer-Stamer (1998) note that industrial diversification continues to dominate economic development thinking in many developed countries, often to the detriment of existing businesses. They argue that ". . .it is unrealistic to expect local and regional policy-makers to embark enthusiastically on a cluster strengthening policy" (p. 18). They believe that governments are more inclined to try to attract major foreign assemblers in new sectors, even if the probability of success is low, in order to avoid locking into a narrow set of specializations. The result is neglect of the concerns of local businesses and the potential to expand the existing industrial base. Balanced attention to the needs of existing industry is especially valuable even aside from the growth prospects of that industry because it often exposes policy reforms and legitimate investments in infrastructure, education, and other basic factors that could improve the general business climate. The evidence suggests that industry cluster concepts are providing a framework for LAC governments to think about how to address weaknesses and threats to the competitiveness of existing industry and to encourage corporate interests to participate—and even drive—the process. This utilization of

clusters as a strategic planning and organizing device in Latin America parallels the experience in many developed countries.

Clusters and Economic Policy in the United States and Europe

As in Latin America, the utilization of cluster concepts in economic policy making in the United States and Europe reflects local economic conditions as well as views of appropriate industrial policy. In the U.S., since there is no explicit domestic economic development strategy at the federal level, industry cluster strategies have chiefly been a concern of states, regions, and metropolitan areas. Four different trends can be detected in U.S. cluster practice, some of which are represented in the selected illustrative examples in Table 2. First, economic development at the state level in the U.S. remains dominated by business recruitment strategies coupled with the provision of location incentives in the form of direct grants, tax credits, and loans. Many states have therefore used industry clusters primarily as a means of promotion and marketing, often of highly desired technology-oriented sectors such as information technology, electronics and biotechnology, but also of advanced manufacturing sectors that promise substantial wage increases. For example, in the U.S. south, Mississippi, Alabama, and South Carolina have invoked clusters as a rubric for identifying and recruiting vehicle industry suppliers. In many states, the term cluster is synonymous with "industry" and economic development practice is little different in any substantive way.

Second, as is the case in some LAC countries, clusters are commonly used as an organizational and analytical device for implementing a model of collaborative strategic planning and public-private engagement. Arizona's cluster initiatives are the earliest example of this trend (Ffowcs-Williams 2000). In the early 1990s, the state used basic descriptive techniques to identify nine clusters around which it set up advisory groups, working groups, and

town meetings to develop growth strategies (Rosenfeld 2001). Private sector "buy-in" is a major feature of the state's approach, in contrast to the usual top-down implementation model characteristic of most states' development efforts.[12] At the same time, Arizona has tended to apply a standard set of policy interventions to the clusters, some of which lack a strong central logic.[13] The value for the state seems to be the way cluster concepts are used to motivate the coordinated effort of multiple public agencies and private sector stakeholders and not as a means to design unique policy interventions. The utilization of cluster concepts in California and North Carolina provide similar examples (Feser and Luger 2002).[14] Much of the power of clusters as a strategic planning device derives from the traction the concept has in the corporate sector. Thus economic policy makers are able to gain more legitimacy with business leaders when using the language and logic of clusters than with more conventional sector-based approaches and esoteric development theories.

Third, the most recent trend in the United States is the utilization of clusters for the implementation of workforce development strategies. Again, the chief motivator is not extant theories of clustering, but rather pressing public policy issues coupled with the general flexibility of the cluster concept. Welfare reform, the Workforce Investment Act of 1998 (WIA), and the recent recession (resulting in considerable worker displacements and associated re-training needs) have forced state and local agencies to seek ways to better target training, both

[12] Which also coincides nicely with the increasingly pro-market politics in the United States in the wake of the Reagan revolution and the pro-trade, centrist policies of the Clinton Administration.

[13] An example is the "senior living" cluster.

[14] A recent survey of California economic development practitioners by that state's Trade and Commerce Agency found that the cluster concept is being used mainly as part of a broader effort toward comprehensive economic development planning, interagency collaboration, and public-private partnership building: "a systems change is underway in how people conceive of and perceive economic development. To stay competitive in this "global" information economy, better economic information is needed. The fast pace of change and global competition make timely, accurate information critical. The industry cluster analytical process, regional outlook and regional collaboration are tools assisting in this knowledge gain process" (Kawahara, Kelly *et al.* 2000, p. 8).

geographically and by sector. WIA requires states to streamline workforce development programs by better coordinating the delivery of different kinds of services (e.g., job search and training). In most cases, cluster analysis serves as an analytical tool for detecting the occupational and training requirements of projected growth industries (based on a labor pooling argument), though it may also provide a general framework for strategic planning as noted above. The application of clusters to workforce development issues also reflects an increase in the use of cluster concepts by non-traditional economic development organizations, such as universities and community colleges.

Finally, many states and many larger regions are using applied cluster analysis to identify localized concentrations of technology-related industry and research activity, so-called innovation or technology clusters. Such efforts usually motivate the design of innovation policy, although examples of sizable investments in detected clusters are few. One of the reasons for that is that in many states, high tech activity remains modest (at least compared to major concentrations such as Silicon Valley, Austin, and Boston). Therefore, the findings of cluster analyses are often too ambiguous to justify ambitious cluster building efforts. Moreover, the competing interests of various sectors and constituencies in the U.S. (as in most other countries) almost always mean that development resources must be spread relatively thinly across sectors and regions. The result is that clusters again become more of a strategic planning device, helping to reveal strengths and weaknesses facing local businesses and potential interventions that could improve the general business climate, than a rigid guide or model of development.

In Europe, the experience with clusters reflects the much stronger historical role of national governments in development policy than in the U.S., continuing realignment of national policies in the face of European integration, and the heavy influence of research on famous small

firm clusters/districts in Europe itself. More centralized development policy—at least in smaller countries such as the Netherlands, Austria, Denmark, and Finland—has produced cluster initiatives that been more sustained and of somewhat greater sophistication than in the U.S. Integration is forcing European governments to reorient conventional macro policy. Increasingly, the jurisdictional expansion of the EU and the influence of broader global economic forces are harmonizing the general factors that influence a nation's relative business climate (what are often called "framework conditions," such as inflation, regulation, and product standards). Both national and local/regional governments are therefore focusing on local factors that remain under their control, including research competencies and institutions, educational institutions, financing institutions (e.g., venture capital organizations), and general infrastructure (Dalsgaard 2001).[15] In some countries, clusters and cluster analysis (or "cluster mapping") has become a means of achieving that policy reorientation.

Unsurprisingly, the literature on industrial districts and flexible specialization has been more influential in Europe than elsewhere. In the 1990s, several European countries undertook substantial experiments in the use of business networking schemes as a mechanism for encouraging collaborative competition and learning economies among small firms (Helmsing 2001, UNCTAD 2002). That experience has subsequently influenced the programs of multinational organizations such as UNIDO and the World Bank, which now are active in many LDCs, including in Latin America. (Indeed, most networking schemes in the LAC region were initially pushed by international agencies and not national or regional governments.) The findings of subsequent evaluations of business networking initiatives in Europe have been disappointing, with the chief problem being that few firms opt to remain in formalized networks

[15]See Viesti (2002) for a discussion of the complexity of coordinating local, regional, national and international (e.g., EU) development policies, particularly those aimed at promoting local externalities.

after initial public sector incentives are exhausted (Hallberg 1999, Lagendijk 1999a, Lagendijk 1999b).

General Trends in Cluster Policy

So what can be said by way of summary? First, there seems to be no dominant type of policy intervention being used to establish or expand industry clusters. From the perspective of public officials, what appears to make a policy a "cluster policy" is not the economic behavior the initiative is trying to influence but rather the target of the intervention as a loosely identified set of related companies and institutions. From this perspective, deregulation and workforce training may be just as much "cluster policies" as establishing business networks or other schemes to boost interfirm cooperation. In LDCs, traditional sectors are easily the most common target of interest, while both high tech and traditional industries have received attention in the developed world. There is also some bias toward focusing on SMEs.

Second, it is hard to find examples of governments in either developed or developing countries making substantial investments in specific clusters to the exclusion of other local businesses and industries. As argued below, a major policy implication of the concept of clusters is that higher rates of innovation and growth can be achieved by actively nurturing localized concentrations of linked businesses in promising industries rather than seeking a more diversified sectoral and spatial distribution of economic activity. Whether targeted development of this nature is a good idea is an empirical question that has received comparatively little attention in the cluster literature to date. It is also a strategy that has distinct distributional consequences that have to be evaluated as much on ethical as efficiency grounds. In any case, it seems that few governments are actively buying into the specialization strategy, at least at present.

Third, applied cluster analysis—the detection of the presence of clusters and/or the strengths, weaknesses, and opportunities facing clustered enterprises—probably accounts for most of current the policy effort associated with cluster concepts. In most instances, governments are not following up cluster analyses with major cluster building or expansion initiatives. Rather, they are using the analyses to identify various problems facing current local or future businesses that could be addressed by interventions of relatively limited scope. The findings of cluster analyses are also occasionally being used to motivate support for general shifts in strategy, such as improvements in education or the provision of advanced infrastructure, that are increasingly viewed as key preconditions for the competitive success of industry in general (not just clusters). At the same time, in other cases the pursuit of clusters may be distracting policy attention from more basic needs.

Finally, the cluster concept is being used heavily by public officials to identify and motivate the participation of key "partners" in the policy process. In developed countries, a focus on clusters is being used to secure corporate support and assistance with policy design (and thus to facilitate a general move toward policy making via public-private partnerships). The modern notion of clusters has its genesis in strategic management theory (e.g., Porter 1990), a body of concepts that many business people find much more understandable and compelling than academic theories of the firm or the development process. In developing countries, industrial policy as cluster policy finds sanction with key trading partners and lending agencies concerned with promoting a shift toward free markets. Given a world in which industrial policy carries the taint of the protectionist strategies of the past, it appears to be easier to make the case that cluster policy is about competitiveness.

III Conceptualizing Clusters and Innovation Policy

Informed by a positive understanding of most common uses of clusters in policy making, we now turn to a consideration of the normative, namely what clusters imply for innovation policy given received theory and available empirical work. It is *de rigueur* for academics to claim that there is substantial lack of agreement about the policy implications of cluster concepts. In a paper summarizing theories of clusters and clustering drafted in 1997, I asserted that there was, at that time, "little consensus about the precise meaning of an industry cluster, the dynamics that underlie cluster growth and development, and the policy initiatives that would best build and strengthen clusters" (Feser 1998b, p. 18). Rosenfeld (2001) borrows one of former U.S. Labor Secretary Robert Reich's favorite quips to draw a parallel between clusters and the concept of competitiveness—"rarely has a term in public discourse gone so directly from obscurity to meaninglessness without an intervening period of coherence."[16] Similar sentiments are expressed to greater or lesser degree by Held (1996), Boekholt and Thuriaux (1997), Enright (2000), and Xie and Stough (2002). Referring to industrial policy in general, Geroski (1990, p. 214) writes that "as much creative energy is typically expended in trying to decide what to argue about as is actually expended in arguing about anything in particular." Could the same be said for clusters? Is there nothing in the cluster concept that is not already considered by other theories and conceptual frameworks?

Indeed, there is substantial writing on innovation and technology policy, most of which pre-dates the modern fascination with clusters. The work is chiefly concerned with evaluating a wide range of interventions designed to boost basic and applied innovation and ultimately growth in incomes. The influence on the rate of business innovation of regulation, standards

setting, infrastructure investments, research subsidies, risk financing, technology transfer, and public sector procurement have all been subject to considerable research (Justman and Teubal 1986, Markusen 1993, Simons 1993, Malecki 1997, Shapira, Klein *et al.* 2001). More recently, innovation policy discussions, particularly the concept of National Innovation Systems (NIS), have come to be dominated by perspectives in neo-Schumpeterian evolutionary economics.[17] NIS emphasizes the non-linear process of innovation, including feedback effects between stages of innovation and various innovation actors, as well as between the public policies and noncommercial institutions that constitute the framework in which innovation and learning occur. The Regional Innovation Systems (RIS) concept, or "reduced-NIS" as described by Hertog, Bergman *et al.* (2001a), asserts that a decentralized regional approach to innovation policy is likely to be more effective than a centralized national model (Asheim and Isaksen 1997; Cooke, Uranga *et al.* 1997; Moulaert and Sekia 1999).

What unique insights does the concept of industry clusters bring to the already rich innovation debate? There are two. The first is that related businesses in concentrated high-tech agglomerations are likely to innovate more and grow faster than firms in peripheral locations. Therefore, governments should actively concentrate S&T investments both sectorally and geographically where possible (a "cluster building" view). The second is that businesses compete not as isolated units but rather within complex webs of interdependence, a keen understanding of which is essential to the proper design and implementation of innovation policy (a "synergy leveraging" view). Both insights are essentially hypotheses that have received

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[16] Actually, Reich has applied the turn of phrase to a variety of terms, including "fiscal responsibility," "globalization," and "labor market flexibility," as a quick Internet search will attest.

[17] According to Moulaert and Sekia (1999, p. 8), in the NIS/RIS view, ". . .innovation is a creative process, with the following features: the interaction between agents of the process (built on feed-back), the cumulative aspect and increasing returns to the innovative process and the 'problem-solving' orientation, showing thus the specific nature

varying degrees of attention in the empirical literature. Occasionally they yield contradictory policy advice, such as when efforts to boost interfirm synergies and collective learning can be best achieved by strengthening linkages with distant partners rather than local firms. Such contradictions may be more common in developing economies than highly developed ones.

The Allure of the Archtypical Cluster

Before considering the cluster building and leveraging perspectives in detail, it is instructive to first review the evolution in modern thinking on clusters. Although the study of the relationship between business interdependence and geographic concentration is at least as old as Marshall (1961), Michael Porter's *Competitive Advantage of Nations*, subsequent related writings (Porter 1998, 2000), and prolific international consulting practice have by far exerted the greatest influence on the application of clusters to development policy. There are two ways that Porter's work might be interpreted: first, as a treatise on *clusters* as geographically localized concentrations of industrial activity; and, second, as an explanation of *clustering* (Clancy *et al.* 2001). While Porter's most useful contributions in the *Competitive Advantage of Nations* relate to hypotheses about business interdependence (or clustering irrespective of geography), particularly the roles of cooperative competition and non-market institutions (Cooke, Uranga *et al.* 1997), his empirical approach initially encouraged an excessive focus on localized clusters as geographic phenomena. Building clusters according to ideal-types—the process of singling out for special policy attention those localized groups of industries in a country or region that appear to conform to pre-set criteria—has become a multi-million dollar consulting business.

Porter (1990) sought to explain, *ex post*, the source of competitiveness of leading export-oriented industries in selected industrialized countries. Failed industries were not part of the

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of the innovation. Moreover, innovation is not only a technological process, it is organisational. *And it is this organisational part which is paramount and determines the technological innovation itself*" [emphasis added].

study. The methodology therefore offered no serious evaluation of competing hypotheses. But more fundamentally, the inductively derived "diamond model of competitiveness" is static. What works for an industry today may not be what accounted for its initial rise. That the present sources of competitiveness of Silicon Valley's information technology industry conform to the diamond framework does not constitute sufficient evidence of the adequacy of the model as an explanation of how Silicon Valley got to be the way it is. Yet for many policy makers, the most compelling message in the *Competitive Advantage of Nations* is that one can use the diamond (or some other similar descriptive model) to devise ways to replicate the current conditions of globally competitive complexes in advanced industrial countries. Unfortunately, the Porter diamond offers few realistic policy handles for less developed nations and lagging regions in developed ones.[18] How exactly does a government build sophisticated home demand or a culture of competition that exemplifies just the right balance of rivalry and cooperation in a place with limited economic activity to begin with?

It is important to stress that the problem is not the messenger but the method. The new industrial districts and related literature on flexible specialization also spawned a considerable amount of reasoning and policy prescription by ideal-type (the ideal Italianate district), probably not the intention of Piore and Sabel (1984) and other early contributors such as Brusco (1982) and Bellandi (1989).[19] Arguments about what is and is not truly a cluster, as well as the proliferation of typologies of clusters and industrial districts (e.g. Courlet and Pecqueur 1991,

[18]Porter (1990, pp. 675-76) does offer some guidance for developing nations: "To progress, the developing nation faces the daunting task of upgrading all four parts of the national 'diamond' sufficiently to reach the threshold necessary to compete in advanced countries." He suggests the first step is to improve education, information, technology, and modern infrastructure. But he remains confident that clusters are the key: "As a starting point, a nation must identify those industries where its factor advantages today provide some competitive advantage but where *other* determinants of national advantage are also actually, or potentially, present" (p. 677, emphasis in original).

[19]Goglio (2002) discusses the rigid application of the industrial district concept to theorizing and policy making.

Markusen 1996, Capello 1999, Rosenfeld 1997, McCormick 1999, and Enright 2000), reflect efforts by subsequent researchers to acknowledge the variety of territorial production systems that operate quite competitively. Note that the fundamental thesis that business interdependence is an important element of competitiveness is not disputed by these typologies. Rather, what is at issue is the form—both functional and spatial—that that interdependence takes at a given point in an industry's life cycle and a region's development trajectory.

Unresolved even as differing types of "Porterian" and "Italianate" clusters are identified and documented are the more fundamental questions related to direction of causality, the relative significance of various competitiveness factors, and the feasibility of alternative policy interventions. Reliance on ideal-types limits serious consideration of such issues and as a result may generate lessons that are not grounded in a careful analysis of the history of leading clusters, even if that is the basic intention. For instance, UNIDO's Cluster Development Program aims to draw lessons "from the experience of successful clusters and [implement] them through technical cooperation projects in various developing countries" (Russo, Clara *et al.* 2000, p. 2). One specific aim is to help cluster actors "develop a consensus-based vision of the cluster as a whole" (p. 6). But lest anyone actually believe that such a consensus was instrumental in establishing the semiconductors business in Silicon Valley in the late 1950s, consider the view of Intel co-founder Gordon Moore:

> What 'works' right now in this dynamic, regional, high-technology economy tells us little of how precisely Silicon Valley came to be just such a place, or how any such place comes into being. The potential disaster lies in the fact that these static, descriptive efforts culminate in policy recommendations that resemble recipes or magic potions (Moore and Davis 2001, p. 3).

One might argue that working to establish a collective vision among firms and related institutions in a set of industries cannot hurt, *ceterus paribus*. But in the world of development

policy, *ceterus paribus* never applies. Every intervention exacts an opportunity cost in human, financial, and political capital.

But the larger point is that Porter's descriptive theory of the determinants of competitiveness came to be misinterpreted as a narrow model of how to build localized clusters in specific regions. In fact, a careful reading shows that Porter set up a number of intriguing hypotheses that stand apart from the question of geography: namely, the links between sectoral economic growth on the one hand and sophisticated home demand, rivalrous yet cooperative competition, and the presence of related and supporting industries on the other. Porter suggested that many of the industries characterized by such features tend to be localized in specific regions. He did not offer a systematic explanation of causes of localization, grounded in any theory of industry location or externalities, but essentially an empirical *observation* of a tendency toward spatial co-location of competitive firms. This point is important because merely the observation was sufficient to set in motion a conviction among policy makers and many analysts that building regional clusters—as opposed to raising productivity, boosting innovation, redressing market failures, or other more conventional objectives—is an appropriate goal of development policy. Indeed, in the cluster building view, innovation, productivity, and growth are an assumed indirect outcome of the expansion of the cluster.

On Building versus Leveraging

With respect to innovation policy, the cluster building view holds that an important route to raising rates of innovation is to nurture the expansion of discrete spatial agglomerations of technology-related activity, including formally and informally linked businesses, university research competencies, government laboratories, colleges and technology training institutes, and

private sector contract R&D houses.[20] To accomplish this will likely require the application of broad portfolio of policy interventions, some of which aim to build the science base, some of which enhance the general framework conditions in which firms operate, and some of which seek to expand the tech sector directly (e.g., via recruitment or entrepreneurship programs). Examples of such interventions are listed in Table 3, which was derived from several papers offering practical guidance to policy makers. The process usually involves conducting an analysis to identify strengths and weaknesses among a set of related businesses (industry cluster analysis), the results from which drive the flexible prescription of relevant solutions. The perspective differs from the "synergy leveraging" view in that its explicit aim is to develop a discrete technology-based specialization that can capture increasing returns to scale and foster collective learning and innovation. Conversely, the perspective asserts that a broad-based S&T strategy (e.g., one that is largely sector-, technology-, or location-neutral) will generate less net innovation overall than one that is focused on building specific, localized S&T competencies. Its most persuasive logic derives not from the history of tech clusters but rather from theories of spatial externalities and knowledge spillovers, the basic principles of which are documented elsewhere and need not be recounted here.

The leveraging view, in contrast, holds that conventional innovation policy should aim to nurture and exploit innovative synergies between interdependent firms and institutions, regardless of whether a discrete spatial cluster emerges as a result. The difference in perspectives therefore hinges largely on the nature of the policy objective: in the building view, it is the cluster itself; in the leveraging view, it is the synergies that presumably drive clustering. Existing theory and empirical research on clusters emphasizes that businesses operate not in

[20] According to Porter 2002 (p. ix): "Strong and competitive clusters are a critical component of a good business environment and are the *driving force* behind regional innovation and rising productivity" [emphasis added].

isolation, as postulated by the standard neoclassical model of competition, but rather as part of larger formal and informal networks (Best 1990). Those networks jointly constrain and offer opportunities to enhance businesses' competitive positions. They also influence processes of joint learning and innovation. The process of clustering, whether viewed from the perspective of strategic management (Porter), industrial districts (Marshall), new growth theory, or NIS/RIS, suggests industrial policy can be made more effective by exploiting network synergies. With regard to technology policy, this implies that cluster linkages—whether they are regional, national, or global in scope—are the conduits through which innovative impulses flow.

As an example of what is meant by leveraging synergies, consider a typical innovation strategy: attempts by government to increase the rate of advanced technology adoption among small firms. One possible mechanism for increasing adoption rates is the provision of publicly subsidized industrial extension programs targeted toward small and medium sized enterprises (Shapira 2001). Alternatively, a cluster-based approach to industrial extension would attempt to exploit pressures within extended buyer-supplier chains to maximize limited program resources. Technology surveys indicate that among the most important influences on firm adoption behavior are the production systems of end-market customers that require close integration with supplier systems (Bergman and Feser 2001). Thus industrial extension programs might begin by encouraging or aiding the adoption of best-practice technologies among major buyers within extended supply chains (many of which will be large firms), coupled with assistance to local supplier SMEs as pressures for upgrading build. Ultimately, the issue is the *means* by which the same basic strategy—industrial extension—is implemented. Tendler and Amorim (1996) describe a similar approach with respect to regional government procurement in Brazil, where a key feature of the program was not just the injection of demand, but also the establishment of

appropriate incentives for the local business support agency so that the right kind of assistance to local producers would be supplied (that is, *the way* that demand was injected). In the case of leveraging, the focus shifts from the cluster itself to the proper design of institutions and strategies of policy implementation given a model of interdependent competition.

Empirical Evidence

The strategies of building clusters and leveraging synergies are not necessarily mutually exclusive, though they may occasionally contradict one another in certain respects. It is possible to imagine both approaches informing innovation policy in significant ways. However, there may be empirical and conceptual arguments that suggest that one approach or the other is likely to be more efficacious in the long run, particularly in developing economies. We will consider the question of empirical work first, focusing on research relevant to the innovation question.

First, there have been a number of attempts to explain the causes of localized clustering itself (Dumais, Ellison *et al.* 1997; Ellison 1997; Sweeney and Feser 1998; Feser and Sweeney 2000). If knowledge spillovers explain why enterprises seek proximate locations, that would lend some support to the cluster building view as well as verify an important consequence of firm interdependence. The challenge for any empirical work on co-location, however, is that most economic activity is localized given the generally concentrated pattern of human settlement. Spillovers are only one reason that businesses might cluster. Others include access to markets, labor, infrastructure, suppliers, natural resources, historical lock-in, and even chance. In developing countries, businesses often concentrate near administrative centers because the public sector accounts for a high share of demand and because government bureaucracies often heavily influence the mix and distribution of business opportunities. Existing studies are hampered by very weak measures of spillovers (e.g., patents), a dearth of appropriate

methodologies for controlling for competing location factors, and a lack of suitable time series for addressing questions of causality. It is fair to say that the empirical study of the co-location of innovative businesses is still fairly rudimentary.

Second, there is a body of work that finds some evidence that innovations, as opposed to firms, tend to cluster geographically and that knowledge spillovers are often localized (Jaffe 1986; Griliches 1992; Jaffe, Trajtenberg *et al.* 1993; Feldman 1994; Adams and Jaffe 1996; Audretsch and Feldman 1996; Breschi 1999; Feldman 1999; Wallsten 2001; Koo 2002). While findings vary, collectively the research offers modest evidence of the spatial clustering of innovations, at least as measured mainly by patents and patent citations. We might therefore draw the tentative conclusion that an active strategy of developing high tech specializations in particular regions would yield higher rates of innovation. However, we cannot be sure because few of the studies consider whether the specific *mix* of S&T resources, industrial activity, and other basic factors (e.g., infrastructure and basic education) are critical to the result. It is also important to note that all of the research on knowledge spillovers is confined to the developed country context and much of it considers innovation trends in a fairly narrow group of sectors. A related literature finds that rates of innovation and productivity tend to be higher among businesses that are proximate to research universities (Jaffe 1989; Acs, Audretsch *et al.* 1992; Acs, Audretsch *et al.* 1994; Anselin, Varga *et al.* 1997). Aside from firms, the role of universities in technology clusters has received the most attention. But again, analysis of the developing country context is limited.

Third, there is a small but expanding literature that examines the relationship between clusters and economic performance using quasi-experimental rather than case study methods.[21]

[21]Here I ignore the large empirical literature on agglomeration economies since most of it explores the relationships between geography, linkages, and productivity using only very crude measures of clustering (urban and city size

For example, Baptista and Swann (1998) use a database of innovations in the UK to examine whether companies proximate to other enterprises in the same line of business tend to innovate at higher rates. They find modest evidence that they do and conclude that knowledge spillovers are localized.[22] In related work, Baptista (2001) finds that technology adoption rates are higher in clusters, mainly because proximity helps to reduce the uncertainty of technology upgrading as well as increases information about the availability and utility of new technologies (a conventional diffusion effect).[23] Porter (2002) conducted a six-city analysis in the U.S. that claims to demonstrate, among other things, that clusters of technology-related activity generate higher rates of innovation, entrepreneurship, and growth. However, since the study considers only successful technology agglomerations, it cannot evaluate the relative advantages of clustered versus unclustered industrial development.

Finally, there is an enormous case study literature, the review of which could easily consume another paper or two.[24] The richest of such studies investigate clustering dynamics using industrial districts and flexible specialization concepts. In a recent review of the literature

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as proxies for urbanization and localization economies). Similarly, Glaeser, Kallal *et al.* (1992) and Glaeser, Scheinkman *et al.* (1995) use only aggregate measures of concentration to study the links between localization, specialization, and urban growth. Feser (1998a) provides a review.

[22]"Using regional employment as a measure of a cluster's strength, it was found that a firm is more likely to innovate if located in a region where the presence of firms in its own industry is strong. The effects of the proximity of firms in other industries do not appear to be significant. . ." (Baptista and Swann 1998, p. 538).

[23]"Interpersonal connections and networking play an important role in knowledge transfer, and supply-side factors are often significant in determining diffusion paths. This leads to the need for policy to consider the role of supplier-user relationships, professional and trade associations, academic and public-funded R&D, and organisations manufacturing complementary assets and technologies. The significance of these institutional relationships becomes larger as their geographical scope becomes smaller" (Baptista 2001, p. 44). Other studies have also found evidence of a relationship between agglomeration (either co-location of similar businesses or location in a highly urbanized area) and technology adoption. Examples are Harrison, Kelley *et al.* 1996b; Harrison, Kelley *et al.* 1996a; Kelley and Helper 1999. The pattern of causality is unclear in many technology adoption studies, however, due to the heavy use of cross-sectional rather than time series data.

[24]Among the better case studies, many of them focused on the developing country context, are Schmitz (1995b), Meyer-Stamer (1998), Tewari (1998), Ivarsson (1999), Kathuria (1999), Kennedy (1999), Knorringa (1999), Musik (1999), Nadvi (1999), Rabellotti (1999), Schmitz (1999), Tewari (1999), Visser (1999), Weijland (1999), Athreye (2001), Casanueva (2001), Hendry, Brown *et al.* (2001), and Richards (2001).

pertaining to Latin America, Altenburg and Meyer-Stamer (1999) drew the following conclusions: 1) while clustering is widespread in Latin America, clusters in the region are rarely propelled by competitive small and medium sized firms (SMEs), as is common in Europe; 2) addressing the weakness of SMEs must therefore be a major focus of LAC cluster strategies, particularly the establishment of connections between transnational corporations and small firms; 3) because most clusters in Latin America are centered on the production of standardized commodities, innovation policy will have most success by encouraging the diffusion of technologies from TNCs to local firms, rather than attempting to grow an indigenous R&D presence; 4) because there is a decided lack of cooperation among firms in LAC clusters, the promotion of networking via the use of brokers and other incentives is critical to encouraging interfirm synergies.

Some of these conclusions echo the findings of Schmitz and Musyck (1994), who review the general industrial district literature in Europe to derive lessons for developing countries. They argue that the European experience shows the value of an industrial policy that is decentralized to the local and regional level and is implemented by both governmental and non-governmental units.[25] They also conclude that the "emergence of the industrial districts does not result from consciously pursued local or regional industrial strategy" (p. 904). Indeed, in the cases they reviewed, they found that growth first occurred spontaneously and then was enhanced by local institutional support structures (including development policy). An important trend in the industrial districts literature is a shift from a focus on purely local connections between businesses to a more sophisticated consideration of interfirm innovation dynamics within global commodity chains (Schmitz 2000, Humphrey and Schimitz 2000). The shift is motivated by

[25]"We would suggest that regional and local institutions offer two advantages over central institutions: less ideology and more accountability" (Schmitz and Musyck 1994, p. 904).

recognition that full-scale clusters of the Italianate or Porterian variety are rarely found in developing countries and that external linkages are often more important to the competitiveness of developing country firms than internal ones.

One recent piece of case study work deserves special mention. Swann, Prevezer *et al.* (1998) attempt to identify the specific conditions—in terms of size, diversity, linkages between agents, and so forth—under which biotechnology and information technology clusters begin to attract new entrants and generate increasing returns and spillovers. They also focus on clustering over time, finding that the "forces that influence the growth and entry of firms in clusters are not simply related to the stage of each technology: they depend also on the stage of the cluster in its own life cycle" (p. 2). Clusters eventually become "congested" and cease growing. They may even fail to regenerate themselves as their underlying technology strengths wane. This theme of cluster sustainability has received little attention in the literature (though see Bergman 2002 and Pouder and St. John 1996), largely because so many definitions of clusters are normative in character (e.g., "a cluster is a concentrated agglomeration of highly competitive firms"). In the view of Swann, Prevezer *et al.* (1998, p. 306), policy makers should "consider the creation of powerful and visible magnets for industrial location." They find that universities and laboratories are among the most important institutions driving the success of innovation clusters. Thus government should promote "promising points of intersection" between technology industries and university research competencies as a way to boost innovation rates. Swann (1999) finds that clusters are competitive only when they have a high level of internal sectoral diversity, a serious implication for the more narrow and underdeveloped innovation clusters in Latin America and the rest of the developing world.

Assessment

Given the empirical literature, what can be said about the relative value of clusters as an innovation policy focus, whether from the point of view of building clusters or leveraging innovative synergies? Clearly S&T agglomerations are common in highly industrialized countries, there is mounting evidence that knowledge spillovers tend to be localized and are therefore a source of regional scale economies, and a deep case study literature argues that there are significant innovation effects derived from formal and informal networking among local firms and support agents (labs, universities, government agencies, business development services). The literature on the relationship between presence in a cluster and economic performance is relatively weak, but based on what we know now, LAC governments should clearly consider the role of clusters and clustering in the design of innovation policy. Moreover, given extremely limited resources in developing economies, governments are seeking to target S&T investments to existing or promising technology specializations anyway. Clusters would appear to offer a coherent way to pursue that targeting effort.

But what is the right approach: to aggressively attempt to build specific innovation clusters or to adopt the more conservative strategy of using clusters as a way to rethink conventional innovation policy? Or, put differently, is aiming to build innovation clusters as a strategic policy objective the best way to harness the benefits of clustering? There are several reasons to suggest that it may not be, especially in developing economies.

First, it is widely accepted in the literature that the public sector's capacity to build innovation clusters from scratch (or even "catalyze" them, to employ a common euphemism) is severely limited, even in highly industrialized economies. Obviously the problem is of particular significance in the developing country context, where innovation activity is often modest to

nonexistent. There is a striking paradox in the literature of detailed recipes for cluster promotion alongside pronouncements that innovation clusters cannot be created from nothing and that policy accounts for only a small part of most competitive clusters' success. Making "policy flexibility" an ingredient in the recipe is the usual tack for finessing the contradiction. But the real problem is in making the notion of a spatial cluster—rather than innovation, income, growth or other direct economic outcome—the relevant objective.

Second, researchers have shown convincingly that there is no single model of a competitive localized cluster. This implies not that more typologies of innovation clusters with attendant "guides for growth" need to be developed, but rather that the objective of strategically growing a full-scale regional cluster with a host of coordinated interventions is probably too broad to be useful. Clusters are groups of businesses (and related support institutions such as universities, colleges, government laboratories, and development agencies) linked *in various ways* and at *various levels of geography* (local, regional, national, international, global, or combinations thereof).[26] The linkage, which may be formal or informal (traded or untraded), might derive from buyer-supplier ties, shared labor pools, codified transfer of knowledge or technologies, tacit transfer of knowledge, shared social and cultural norms, and the like. Theoretically, there are a great many dimensions on which businesses might be related, and each dimension may manifest itself at different spatial scales (e.g., labor pools at the regional level, shared knowledge at the global level, etc.). A single firm may be a member of one cluster defined as an industrial district and another cluster defined as a global trading network or value

[26]Some authors have argued for additional dimensions. In suggesting how one might select a methodology for analyzing concentrated industries, Feser *et al.* (2001) add stage of development (or the time dimension) to the mix. Enright (2001) outlines a total of eleven dimensions, two of which relate to geography. Others are density, breadth, depth, activity base, strength of competitive position, stage of development, technological activities, innovative capacity, and ownership structures. In any case, there is no single best typology of clusters.

chain. Focusing policy on only the local or regional dimension of business linkages necessarily leaves out key dimensions of interdependence that have real implications for competitiveness.[27]

Third, cluster building is full of political risks. It may overstate the public sector's capacity to develop coordinated, multifaceted development strategies, given the size of the challenge in developing countries as well as political and ethical pressures to diffuse resources across sectors, institutions, and regions. Publicly laying out a goal to nurture a regional biotechnology, information technology, automotive or other cluster is also a highly visible act that will be judged, several years hence, at its face value: that is, did the professed innovation cluster materialize? There is a high risk of unmet expectations that have real costs in terms of garnering political, financial, and leadership capital for subsequent development initiatives. Few would dispute that that risk is inversely related to the existing size of the S&T base at the start of the intervention.

Fourth, cluster building often focuses attention away from basic needs and toward interventions that promise immediate impacts on the size and scope of the innovation cluster itself. Those include investments in research competencies in the universities, the development and placement of government laboratories, the supply of venture capital financing, the provision of R&D and other incentives to existing firms, and the recruitment of high technology enterprises. Such strategies may make sense in developed economies where the advanced infrastructure and institutional capacity are already in place. However, in developing countries, including much of Latin America aside from Mexico and Brazil, many basic needs remain to be fulfilled. Most of those, including roads, airports, public transportation, schools, basic

[27]The full range of literature directly and indirectly related to clusters could be interpreted as a multidisciplinary "fleshing out" of Francois Perroux's (Perroux 1950; Perroux 1988) theory of industrial linkages in abstract economic space. Perroux, of course, strenuously objected to the excessive consideration of geography in the analysis of economic growth.

telecommunications, and accountable and efficient government, benefit multiple sectors, not just those in target clusters.

Finally, highly specialized "cluster building" initiatives can unintentionally help lock a region into an industrial specialization or innovation competency that will eventually face decline. As Pouder and St. John (1996) note, "Once a super nova for state-of-the-art innovation, the hot spot quickly becomes an industry black hole." Analysts typically caution against "picking winners," but that concern usually references the possibility of targeting a low growth or declining sector in the short run. The bigger problem may be that as active cluster building efforts reorient economic policy from the basic approach of providing and maintaining a level playing field to tailoring institutional structures to particular industrial specializations, the public sector's ability to adapt to changing economic circumstances declines. The very process of carrying out the objectives of funding *selected* research competencies (rather than meritorious research in general), encouraging *specialized* venture capital sources, building *dedicated* rather than general incubators, developing *targeted* business incentives, and so on, specializes government competencies just as it aims to specialize the industrial base. An economic policy regime with a narrow set of competencies is less nimble when economic and technological conditions change, as they inevitably do.

Given these problems, the more conservative approach of viewing cluster concepts as a tool for leveraging innovative synergies among businesses (ultimately to improve the implementation of innovation policy) has distinct advantages. First and foremost, the leveraging view shifts attention away from generalized "cluster building," an impractical strategy where the existing S&T base is modest. Second, it is agnostic with respect to the level of geography in which business linkages manifest themselves. Rather, it allows that key formal and informal

linkages occur at all spatial scales and between different kinds firms (large and small, branch manufacturers and headquarters, buyers and suppliers, etc.). The goal is to look for ways to strengthen and use those linkages to increase innovation and growth rates. Third, it can help inform a wide range of interventions which themselves can be legitimated using conventional policy analytic tools (such as concepts of public goods and market failure). Fourth, it places emphasis on the most important insights of the cluster literature—the notions of cooperative competition and collective efficiency—without biasing policy away from strategies that are not aimed at immediate growth and expansion of a selected group of industries. Fifth, it reduces the burden on applied cluster analysis, which due to a variety of data and methodological limitations, can realistically offer only a general impression of overlapping science, technology, and industry strengths in most regions (Feser and Luger 2002). Finally, it probably most closely matches current policy practice in Latin America and other developing economies, where clusters are being used to inform existing policies rather than as separately conceived development strategies implemented with substantial targeted investments.

IV Summary and Policy Guides

The tendency of economic activity in general—and innovative and knowledge-intensive activity in particular—to concentrate functionally and geographically suggests to policy makers that an effective S&T strategy might be to target groups of related high tech sectors in specific regions for development attention. The goal is to replicate elements of successful innovation clusters from around the world. As a result of that interest, various typologies of clusters and associated guides for how to expand them have been developed. The implication is a model of policy design, implementation, and evaluation that looks like the following: 1) identify or "map"

groups of sectors that qualify, by some definition, as clusters (whether Porterian, Italianate, etc.); 2) assess strengths and weaknesses (or impediments to growth) in said clusters; 3) prescribe and implement policies to rectify weaknesses, maximize strengths, and spur growth; and 4) evaluate policies for overall impact on cluster expansion and performance. The view has led naturally to the question: what policies are most effective for generating and sustaining innovation clusters?

Section III argued that such a perspective is unlikely to meet with substantial success in Latin America and other developing regions, while Section II showed that actual development practice around the world has not seriously embraced it for a combination of logical and political reasons. Instead, it was argued that LAC governments should mainly use cluster concepts and cluster analysis to improve the design and implementation of conventional innovation policies. This shifts the policy objective from building clusters *per se* to increasing rates of innovation by implementing innovation strategies in ways that leverage interfirm synergies and connections to nonmarket institutions (e.g., universities, labs, network brokers, etc.), even when firms are not part of concentrated regional agglomerations. The following are a series of policy guides that follow from this view.

National, regional, and local development agencies in LAC should still include applied cluster analysis in their suite of analytical tools. To acknowledge the limited prospects of a government-led "cluster building" effort in developing economies is not an argument against the value of applied regional cluster analysis. Cluster analysis is the process of systematically analyzing strengths, weaknesses, opportunities, and threats facing a set of interrelated existing or potential regional industries (Bergman and Feser 1999). It aims to document key linkages to non-market institutions such as universities and laboratories, identify areas of joint research and industrial strength where possible, and solicit corporate views of need for various policy

interventions. In developed economies, it relies heavily on extensive secondary data on industry linkages (e.g., input-output), innovation (e.g., OECD innovation surveys and matrices), employment, and output. In developed economies where timely secondary data are much more limited, particularly at the subnational level, cluster analysis must utilize primary data collection techniques to a much greater extent. Recently, the collection of data via surveys and focus groups has become more common and a number of model survey instruments and focus group protocols are available.[28] In general, cluster analysis has substantially improved the richness of applied economic studies.

Applied cluster analyses must be flexible in approach and avoid methods based on "ideal types" that reinforce a rigid "cluster finding" mentality. The way that most agencies are using the results of cluster analyses indicates that the *general* capability of cluster analysis for exposing co-dependencies among businesses, local support agencies, universities and colleges, and so forth is more useful than its potential for selecting a *specific* set of specializations for development policy focus. Analyses are most flexible when they utilize a variety of cluster definitions, data sources, and analytical methods and result in indicators and data series that are updated and consulted over time. Cluster analysis should be viewed not as a one-time exercise but as an ongoing tool for exploring a wide variety of economic questions that formerly were explored using a sector-based logic.

Cluster analyses should be part of broader strategic planning processes that incorporate substantial private sector involvement and public opinion. Section II noted that another very common use of cluster analysis is as a means of motivating and facilitating public-private discussions about development challenges and goals, both for existing firms as well as potential

[28]Input-output tables in Latin America are generally too aggregated and out-of-date to serve as the primary data source for applied cluster analysis.

growth industries. Cluster analysis methods should be designed to maximize corporate and public involvement in the generation and interpretation of results. The formation of corporate steering groups, the organization of public meetings to review and discuss findings, and the utilization of focus groups to collect qualitative information on strengths and weaknesses in the local business environment all help lay the groundwork for subsequent policy initiatives by including the views and motivating the support of the eventual stakeholders of those policies.

S&T policy should remain as sector-, technology-, and location-neutral as is reasonable, letting market imperatives and research competencies drive resources flows. In the LAC region and other developing countries, interest in clusters should not derail efforts to improve the necessary basic framework conditions for innovation and entrepreneurship. Those conditions are largely sector- and location-neutral and reward scientific and innovative activity on their merits rather than their fit with pre-determined industrial specializations. Issues such as support for basic university research, technical training and education, intellectual property protections, and anti-trust law are more critical in many developing countries than clusters or clustering.

Any efforts to target specific technology sectors or S&T competencies for growth (cluster building) should be demand-driven and modest in extent, at least initially. Most research indicates that the public sector has played a very modest role in influencing the establishment of the leading innovation clusters around the world and only a slightly stronger one in their subsequent competitive success. In developing economies where the incidence of market failure is greater, government might be expected to successfully exert greater influence on cluster formation and growth. However, cluster building can exact a significant opportunity cost in that it often diverts resources from other general policy initiatives such as the provision of infrastructure and improved basic education. The low risk, low cost approach to cluster building

puts local businesses in the driver's seat by organizing a forum for firms to express joint concerns, engage in collective problem-solving on issues of common concern, and make collective requests for services or policy changes. Porter 2002 (p. xvi) argues that major anchor companies in local clusters play a key role in organizing neighboring firms for joint action. Above all, development agencies should avoid pursuing unrealistic objectives, such as creating entirely new industrial or research strengths in the current "fashion" industries (e.g., biotechnology). In the LAC region, the clustering of innovation is likely to be tied to more traditional industries such as automobiles, chemicals, and furniture.

S&T investments should be measured for impact on overall innovation rates, not innovation in targeted clusters. Perhaps the largest pitfall in economic policy making related to clusters is confusion over means and ends. Clusters and clustering are a means to competitive success, not an end in themselves. Ulimately, attempts to build and support clusters or to leverage synergies within them are only a route to boosting overall rates of innovation and growth. If a cluster strategy results in a rapid rate of expansion of a narrow segment of industries but overall net decline in innovation and growth at the macro level (either the nation or region, depending on the level of intervention), it must be regarded as a failure. It is still unclear whether cluster strategies will have an appreciable net positive impact on overall innovation and growth rates in developing countries. Indeed, the relationship between overall innovation rates and clustering is still uncertain in developed countries.

Policy evaluations should be undertaken that compare the impact of cluster-based interventions with the impact of conventional policies. Important proof of the value of the cluster concept is in whether conventional policies designed to exploit cluster dynamics are actually more effective than those that essentially ignore such dynamics. Conventional policy

prescriptions implemented based on a model of clustering must therefore be evaluated against non-cluster-based implementations of the same policy. For example, a number of states in the U.S. have sought to make a very common development strategy—the attraction of inward investment through marketing and incentives—more effective by targeting potential supplier firms to existing local end-market producers. Suppliers and end-market producers are identified via analyses of business linkages (a kind of cluster analysis). What makes marketing and recruitment cluster strategies in this case are not the initiatives themselves, but rather the way those initiatives are implemented. It follows that we should evaluate whether the level of inward investment generated by cluster-targeted programs is higher than the level for broad-based or untargeted programs. That is a question that is rarely asked. Instead, the focus is typically on whether cluster-targeted recruitment programs have demonstrated success in filling out local supply chains, an outcome that can occur just as easily with an untargeted strategy as a targeted one. Without comparing approaches to implementation, it is impossible to gauge if acknowledging this particular version of interdependence—the co-location of firms in value chains—really improved development policy efficacy.

The private sector must play an active role. Firms view regional clusters as signals of the characteristics and advantages of production in given locations. Silicon Valley continues to grow in part because dynamic technology companies and small entrepreneurs, faced with selecting a location with limited information, observe other similar companies thriving in the region and conclude that the right mix of locational advantages must be in place. But once in place, firms also depend heavily on infrastructure, externalities, and competitive milieu of regional clusters. Porter (2002, p. xix) argues that businesses, not just policy makers, must

recognize the ongoing relationship between location and competitive position, to “see their cluster as a competitive asset.”

TABLE 1. LATIN AMERICA: EXAMPLES OF CLUSTER POLICY INITIATIVES BY COUNTRY

Country	*Source*	*Policy Type*	*Example*
MEXICO	On line information and document (SE, matrix by State)	Promotion of business associations	Creation of the Mexican Council of Cotton Production (Durango).
		Export promotion	Establishment of the Export Development Center (Chiapas).
		Infrastructure development	Construction of a fire station (Hidalgo).
		Direct investment	Development of a Silver processing/refinement plant (Guerrero).
		Training	Training workshop for lime producers (Colima).
		Marketing	Trade shows, promotion, marketing, etc.
	Altenburg and Meyer-Stamer (1999)	Networking	Empresas Integradoras Program: private corporations owned by groups of small firms that provide demand aggregation, purchasing, and marketing services. Firms are lured to participate with tax deductions, loans, and training programs.
	Melo (2001a), Altenburg and Meyer-Stamer (1999)	Production chain integration	Eight broad sectors targeted: high-tech industries, automobiles, light manufacturing, petrochemicals, mining, agribusiness, forestry, and public sector. Aims to coordinate private-sector efforts with the following aims: formation of clusters; rationalization of internal corridors; identify supplier opportunities and customer technical requirements (through compilation of information sources such as directories and organization of supplier and export promotion conventions; subcontracting exchange schemes or SES).
PARAGUAY	On line document (STP)	Export promotion	Establishment of international production standards (e.g., animal feed processing (supporting grains cluster in Itapua y Alto Parana).
		Promotion of business association	Establishment of food production committee (grains cluster in Itapua y Alto Parana).
		Investment catalyst	Promotion of public-private partnerships for the production of vegetables.
		Support for suppliers/producers	Support existing agriculture cooperatives through credit (Caaguazu Department).

TABLE 1. LATIN AMERICA: EXAMPLES OF CLUSTER POLICY INITIATIVES BY COUNTRY

Country	*Source*	*Policy Type*	*Example*
		Marketing	Carry on studies to identify potential export products (vegetable cluster).
		Infrastructure development	Development of highways to transport exported products (e.g., oranges in Itapu).
		Applied research, extension	Enhance productivity of the sector by introducing new varieties of cotton.
		Training	Training for metal mechanics sector; promotion of technical specialization, etc.
		Other strategies suggested	Reduce production costs; set up a revitalization program for the restructuring of the sector; establishment of production of a type of wood
	Farinelli and Kluzer (1998)	SME modernization, promotion, networking	EC supported establishment (1993) of small firm consortia for small firms in the furniture, textiles/clothing and leather goods industries; implemented by Ministry of Industry and Trade (Paraguayan Support Centre for Enterprises).
HONDURAS	On line information (UNIDO), Altenburg and Meyer-Stamer (1999)	Promotion of business associations	Establishment of networks of firms with common needs, like joint establishment of shops to sell finished products, sharing large orders of products, etc.
		Support for suppliers/producers	A UNIDO program to provide technical support to help SME obtain credit. Establishment of a cluster promotion center (CERTEC).
		Production chain integration	Promote vertical networks between small and large firms.
		Training	Training for metal workers (Tegucigalpa); training for cluster/network "brokers" to diffuse networks.
NICARAGUA	On line information (UNIDO)	Promotion of business associations	Establishment of networks of firms with common needs, like the handicraft hammock production sector.
		Export promotion	Technical assistance to standardize production and pricing systems among a network of firms in the same industry/sector.
		Training	Training for workers as well as cluster/network "brokers" to diffuse networks.
		Regulation assistance	Technical assistance in legal issues to formalize economic activity.

TABLE 1. LATIN AMERICA: EXAMPLES OF CLUSTER POLICY INITIATIVES BY COUNTRY

Country	*Source*	*Policy Type*	*Example*
		Brokering, catalyst	Coordination between UNIDO and the National Institute for SMEs.
		Production chain integration	Promote firms integration along production chains.
BRAZIL	On line information (SEBRAE)	Training	Via Brazilian Support Service of Micro and Small Enterprises (SEBRAE). Training for cluster promoters.
	Melo (2001a)	SME support	Technological Support Program for Micro- and Small-size Enterprises (PATME): financing of product and process improvements and equipment upgrades; provision of training; assistance with quality control. SEBRAEtec grants for the purchase of business development services from consultants, universities, and technical institutes.
COSTA RICA	Document (CLACDS-INCAE)	Training	Courses offered by the National Institute for Learning according to the needs of firms.
URUGUAY	Document (EU); Farinelli and Kluzer (1998)	Production support and export promotion of SMEs; modernization	EC supported promotion of SME integration in order to share large contracts, as well as manage export activities, etc. (furniture industry); implemented by Comisec
		Promotion of business association, networking	Establish a common strategic vision of the industrial restructuring needed in the textile and clothing industries was agreed among the main trade associations.

TABLE 1. LATIN AMERICA: EXAMPLES OF CLUSTER POLICY INITIATIVES BY COUNTRY

Country	*Source*	*Policy Type*	*Example*
COLOMBIA	On line information (MINDESA); Melo (2001a)	Production chain integration, expansion	Targets existing and potential chains. Existing target chains include exporters facing stiff external competition (textiles/apparel, leather goods/footwear, automotive cars/parts, sugar cane/products, oleaginous seeds/oil/soap, aquaculture, tuna, toiletries and cleaning products, and potatoes) as well as chains with significant internal trade and linkages (petrochemicals, plastics, steel, electronics, among others). Potential include IT, biotech, chemistry, and communications, among others. Provision of specialized and general support infrastructure; preparation of "sector competitiveness agreements; education and training, fostering dialogue between private and public sectors.
VENEZUELA	On line information (MPD)	Production chain integration	
CHILE	On line information (CORFO)	Recruitment, inward investment	Marketing, diffusion of information, financial support for investment studies, etc. (by region)
		Extension	Training for firms on internet usage (on-line).
		Location incentives	Land incentives, wage subsidies; credit support; bonuses for project investment to banks, co-financing of risk studies, etc. (Arica)
		Strategic planning	Comprehensive development plan for the Lota region; includes a wide variety of policies.
	Altenburg and Meyer-Stamer (1999)	Networking	Proyectos de Fomento (PROFOs): Contracts between a small group of small firms public or private agency network brokers that provide resources for market research, industry studies, and participation in trade fairs.

TABLE 2. UNITED STATES: SELECTED EXAMPLES OF CLUSTER POLICY INITIATIVES BY STATE

State	*Background*	*Intervention*	*Source*
Arizona	Development of Arizona Strategic Plan for Economic Development in 1992, resulting in adoption of state cluster strategy. Renamed Governor's Strategic Partnership for Economic Development (GSPED); administered by Arizona Department of Commerce. Public-private partnerships represent each cluster.	Analysis. Strategic planning. Targeted marketing for recruitment, tax policy (incentives).	Waits (1992), Morfessis (1994), Vieh (2002)
Connecticut	In 1998, established Connecticut's Industry Cluster Initiative under the Department of Economic and Community Development. Also established Governor's Council on Economic Competitiveness and Technology to monitor cluster progress.	Strategic planning. Creation of lead organizations. Biotech facilities fund. Workforce training in metalworking.	CDECD (2001)
Iowa	Legislation in December 2000 creates the New Economy Council to develop strategic planning and mobilize public and private resources in three clusters: life sciences, advanced manufacturing, and information solutions.	Analysis. Strategic Planning. Marketing. Workforce development (planned). Telecommunications Infrastructure (planned). Establishment of Plant Sciences center at U. of Iowa.	Iowa Governor's Office
Kentucky	Office of the New Economy established five research area clusters as priorities for development.	Strategic planning. Coordinated effort to obtain federal research dollars. Grants and loans for high tech industries.	KIC (2002)
Massachusetts	Massachusetts Technology Collaborative, an independent organization (organized in present form in 1994), coordinates technology policy for the state. Industry cluster concepts used in ongoing economic analysis and strategic planning.	Strategic planning. Economic analysis (tracking of tech sector growth).	MTC (2001)
Mississippi	In 2000, private sector commissioned study of communications and information technology cluster by Michael Porter. Subsequently, state funded follow-up studies of automotive and plastics/polymers industries. Effort managed by Mississippi Development Authority.	Analysis. Strategic planning. Establishment of cluster organizations. Workforce development planning (in progress).	RTS (2001)

TABLE 3. COMMON "CLUSTER BUILDING" INTERVENTIONS

Supply-side interventions	*Objectives*
Identity	Creation of cluster industry association or similar private sector organization to serve as catalyst and key stakeholder for cluster interests.
Location incentives, recruitment	Attract inward investment by directly reducing business costs through tax and non-tax incentives. Cluster analysis used to identify gaps in supply chains as possible recruitment targets, with objective being to increase business locations per unit of recruitment effort, resources. Cluster analysis may also be used to identify labor skill requirements of related industries in order to "sell" local labor pools to relocating firms.
Business networks	Establishment of forums for information sharing and joint problem solving of firms in selected sectors. Encourage cooperation in areas of marketing, training, sourcing, sales.
Business development services	Identification and articulation of demand of local firms for business development services (development of BDS markets); encouragement of closer alignment between services supplied and firm needs (development of BDS supply). Closely related to provision of industrial extension.
University research competencies	Investment in specific research disciplines that reflect unique strengths of existing faculty or desirable strengths.
Non-university labs, research "catalysts"	Creation or funding of intermediary agencies designed to conduct independent research and/or foster collaboration between university and industry researchers (a brokering or catalyst function); may also seek to leverage national government sources of research funding.
R&D incentives, subsidies, awards	Provision of incentives to increase R&D activity of industry, usually small firms or firms located in peripheral regions.
Regulatory assistance	Guidance with regulatory compliance issues. Designed to free up engineering and research staff in industry to focus on R&D and innovation activities.
Incubators	Development of facilities to provide subsidized space and services to high tech start-ups.
Industrial extension	Provision of technical and business development services to smaller firms, usually through regional network of extension offices and sometimes based in engineering universities and colleges.
Training	Skill upgrading of workers in identified cluster firms by focused training programs, delivered on demand or available through community colleges. Professional certificate programs for industry specializations (e.g., information technology, networking).
Basic education	Improvement of primary and secondary education as long-term labor pool upgrading strategy.

TABLE 3. COMMON "CLUSTER BUILDING" INTERVENTIONS

Supply-side interventions	*Objectives*
Lab space, buildings, parks	Provision of specialized facilities and space (e.g., wet labs in biotechnology) via grants, low cost loans, and other inducements.
Risk-based financing	Attraction of venture capital through creation of venture capital pools (via public sector investing power) and marketing of area firms/industry to traditional venture capital sources.

Demand-side interventions	*Objectives*
Procurement	Targeting of public sector purchasing to local firms or firms in target development regions.
Regulation and regulatory enforcement	Recognition in regulatory design and enforcement of impacts on markets, particularly in sectors such as environmental controls, electronics, information technology, and media.
Supply chain development	Foster purchasing linkages among firms in product or value chains, via supplier fairs and assistance (BDS or extension) to suppliers with meeting technical or standards requirements of customers, usually larger firms. Help with meeting international standards (e.g. ISO).

Basic categories of interventions are from Enright (2001), Rosenfeld (2001) and DeVol (2000).

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