KNOWLEDGE AND REGIONAL COMPETITIVENESS

With 7 tables

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Zusammenfassung: Wissen und regionale Wettbewerbsfähigkeit

Wissen ist zu einem der wichtigsten Aspekte geworden, welche den wirtschaftlichen Erfolg von Regionen beeinflussen. Trotz umfangreicher Forschungen in Nachbardisziplinen weiß man noch sehr wenig darüber, wie Wissen definiert, geschaffen und vermittelt wird. Aus der Perspektive der regionalen Wettbewerbsfähigkeit spielt jenes Wissen die größte Rolle, das in Firmen geschaffen, von diesen kontrolliert und weitergegeben wird. Regionales Wissen setzt sich sowohl aus dem Wissen zusammen, über das die in einer Region angesiedelten Firmen verfügen, als auch aus der Art und Weise, wie die regionale Kultur dazu beiträgt, das bestehende Wissen qualitativ und quantitativ zu verbessern. Dies geschieht am besten über Netzwerke mit anderen Firmen und Organisationen, die entweder einen benachbarten oder einen virtuellen Standort haben. Das Messen von Wissen auf der regionalen Ebene ist besonders schwierig; jüngste Versuche, die "new economy" in den USA zu erfassen, haben jedoch einige Indikatoren zur Messung von Wissen zur Verfügung gestellt. Internationale Vergleiche sind leichter verfügbar, unterscheiden sich aber stark in dem, was sie messen.

Summary: Knowledge has emerged as one of the most important aspects influencing regional economic success. Despite considerable research in other fields, much remains unknown about how knowledge is defined, created and shared. From the perspective of regional competitiveness, it is the knowledge that firms create, control and share that matters most. Regional knowledge is comprised of both what firms within the region have and how the culture of the region helps to improve knowledge both quantitatively and qualitatively. This is best done via networks with other firms and organizations, both those located nearby and in other, nonlocal places. Measuring knowledge at the regional level is especially difficult, because of data problems; recent attempts to track the "new economy" in the USA provide some indicators. International comparisons that incorporate knowledge are more readily available, but they differ greatly in what they measure.

1 Introduction

The competitiveness of places – localities, regions and nations – refers to the ability of the local economy and society to provide an increasing standard of living for its inhabitants. Rarely is this possible by relying upon external investment such as branch plants, whose principal orientation and organizational links are external to the region. The strength of an economy is dependent on the degree to which knowledge is created, used and shared. Places are better off when they promote shared or public knowledge from which many firms and other organizations can benefit. *Indeed, knowledge created and shared forms the basis of successful regions, including high-tech regions.* To create sufficient knowledge that it can serve as a basis for local competitiveness is difficult, and to sustain it is even more difficult as competitor regions continue to emerge.

Not only local entrepreneurs use knowledge in a place; large nonlocal firms also try to utilize local knowledge. The principal motivation for this is to attempt to serve customers in new and untapped market niches, for which unique specializations of suppliers and producers in particular places offer unique possibilities. However, to tap this local knowledge and to have access to it requires that firms have a presence in the specialized places. A second, related motivation is to exploit a local market that contains sophisticated buyers whose knowledge also may offer competitive advantages. The spatial variation in knowledge, and the mobility of some knowledge and immobility of other knowledge, comprise the mosaic that is the economic geography of our world.

This paper examines several dimensions of the culture of technology as a knowledge system that creates and sustains technology-based economic development. The paper begins by defining knowledge and identifying the various forms that knowledge takes in the economic geography of places. Next, knowledge as an input to economic growth and the transfer of knowledge are discussed, including a consideration of how local knowledge has become central to understanding firms. The focus of the paper then shifts to the culture

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Table 1: Levels of knowledge-related concepts
Ebenen von wissensbasierten Konzepten

Concept	Characteristics
Wisdom or nirvana	Complete knowledge
Creativity	Creativity presumes a capacity to order and reorder information with the aid of a knowledge system.
Competence	Embodied knowledge. There are at least three types: (1) instrument-oriented competence, (2) sector-specific competence, and (3) regional-specific competence.
Knowledge	Structurally ordered information. Includes reflection, synthesis, and context. Information laden with experience, truth, judgment, intuition and values. Concepts, ideas and patterns are subsets of knowledge. Often tacit, hard to transfer.
Information	Data endowed with relevance and purpose.
Data	Simple observations of states of the world; easily structured, easily captured on machines, easily transferred.

Source: Adapted from ANDERSSON (1985, 13), BOHN (1994), TÖRNQVIST (1983), DAVENPORT (1997) and HUSEMAN a. GOODMAN (1999)

of knowledge, which is not only localized, but also able to form networks with other places where key knowledge is located.

2 Defining knowledge

Knowledge is best understood as the third step in a hierarchical ordering that progresses from *data* as the lowest-order unit and progresses to *wisdom* or nirvana as the highest-order capability (Tab. 1). ANDERSSON (1985, 13) suggests that "one can view information as variables, whereas knowledge is a set of equations containing these variables". The concepts in Table 1 reflect a refinement and application as we move higher in the table. For example, competence and creativity are important steps on the path to wisdom. HUSEMAN and GOODMAN (1999) skip these steps, saying that "wisdom arises from the processing of knowledge" (p. 211). Yet another way of understanding the levels is DAVENPORT's (1999) sequence of data – information – intelligence – information capital. Finally, there is benefit in QUINN, ANDERSON and FINKELSTEIN's (1997) four types of intellect:

- cognitive (know-what)
- advanced skill (know-how)
- systems knowledge (know-why)
- motivated creativity (care-why).

At a less abstract level, knowledge can be considered to include the skills of workers, the experience of managers and owners, and the "pulse" of customers' needs and demands. The accumulation of skills and knowledge in particular places, long recognized as a phenomenon in the location of economic activity, arguably has increased in importance in recent years. This phenomenon includes two dimensions. First, firms and industries depend on localized knowledge. Second, knowledge is not limited to a few high-technology or knowledge-based sectors; the innovative or knowledge activities of all sectors can be called knowledge-based.

3 The creative region: applying knowledge

At the risk of focusing on a single dimension of a multidimensional phenomenon, let us look at regions or places as creative (AMIN a. GRAHAM 1997). ANDERSSON (1985) has suggested that *regional creativity* develops in regions characterized by five criteria:

1. high levels of competence (and its embodiment of knowledge),
2. many fields of academic and cultural activity (diversity),
3. excellent possibilities for internal *and* external communication,
4. widely shared perceptions of unsatisfied needs, and
5. a general situation of *structural instability* facilitating a synergetic development (Andersson 1985, 19, emphasis in original).

MALECKI (1987) combines ANDERSSON's five conditions for regional creativity into three more familiar policy variables: (1) the presence of professional and technical labor (representing competence), (2) urban agglomeration, or a threshold size of place, where cultural activity and communication will be heightened, and (3) conditions that promote synergy or instability.

The first two of these are relatively easy to analyze and data are readily available. The third element is more difficult to identify, even when it is present, but it is related to the local environment or entrepreneurial climate of a place, as seen in its degree of networking, the presence of venture capital, and local supporting institutions (MALECKI 1997b).

In many ways the model creative region, Silicon Valley has been analyzed more than most places. In a review titled "Future Perfect?" MICKLETHWAIT (1997, 7) summarizes his conclusion: "that culture, irritatingly vague though it may sound, is more important to Silicon Valley's success than economic or technological factors". He concludes, following SAXENIAN (1994), that the following characteristics – perhaps best described as local conventions – are present to a greater degree there than perhaps anywhere else in the world:

- tolerance of failure;
- tolerance of treachery;
- risk-seeking;
- reinvestment in the community;
- enthusiasm for change and rapid response to technological change;
- promotion on merit and openness to immigrants and women;
- obsession with the product and the state-of-the-art "cool idea" in technology;
- collaboration;
- variety of firms in size and specialization;
- easy entry.

Several of the items in this list are cultural and/or difficult to transplant to other places. But let us examine a few of them in the context of *regional knowledge*.

One of the more traditional components discussed in the context of high-tech regions is venture capital, which MICKLETHWAIT includes as "reinvestment in the community." Venture capital – funds invested in new businesses – can be considered almost solely as a knowledge-based phenomenon. In the USA, venture capital investment has long concentrated in Silicon Valley, with as much as one-half of the country's stock of venture capital supporting new firms in that region alone. Although some of this money comes from investors outside California, much of it is profits of previous entrepreneurs reinvested in the locality. Informal venture capital, provided by "angels," is difficult to track but appears to be widespread, and certainly plays a major part in the success of any creative or high-tech region. Perhaps what is most significant is the extremely local nature of investment both by "angels" and by formal venture capitalists: they are very concentrated within a small (80 km) radius (MASON a. HARRISON 1995; SAPIENZA 1992). SAXENIAN (1994) attributes Silicon Valley's success, vis-à-vis that of the Boston area, largely to the culture of sharing information. KENNEY and VON BURG (1999) suggest it was more a case of Silicon Valley investors and entrepreneurs focusing on taking advantage of new opportunities in microcomputers, which did not happen in Boston. Perhaps a similar focus of investment is taking place presently, focused on Internet ventures in California (ANDERS a. SWISHER 1999).

Two other cultural aspects of Silicon Valley stand out. First, as a unique environment for technologically advanced entrepreneurship, the Valley provides a large number of entrepreneurial role models as well as a source of venture capital. This environment comprises an "ecosystem" within which firms form and re-form through continual entrepreneurship. Networks of interpersonal relationships support entrepreneurship, links among enterprises (large and small alike), and innovative activity (BAHRAMI a. EVANS 1995; SAXENIAN 1994). Networks provide the "soft" bonds that link the "hard" qualities of Silicon Valley, which take the form primarily of high levels of state-of-the-art R&D but also include several of the characteristics of business clusters: proximity of suppliers, capital availability, access to specialized services, and machine and tool builders (ROSENFELD 1997). Imitation of the "hardware" of Silicon Valley through the creation of science or research parks, has not been effective in most places. Despite geographical proximity, interaction does not necessarily take place (MASSEY, QUINTAS a. WIELD 1992; JOHANNISSON et al. 1994). Something else is needed. This "something else" often is described simply as "synergy" (CASTELLS a. HALL 1994; STÖHR 1986), the fifth of ANDERSSON's characteristics of creative regions. Synergy can be thought of as the "software" of a region: the presence of social structures of sociability, trust, and an industrial structure that demands interaction among firms (e.g. highly linked industries making flexibly changing products). Synergy typically fails to develop in "created" – rather than spontaneous – research parks. Silicon Valley stands out as unique in so many respects that it perhaps is unfair to use such examples.

The second cultural aspect, found in Silicon Valley and in a few other places, is the set of institutional or collective factors that influence the production of synergy in regional clusters or milieus. Many of these also are "soft" factors (such as entrepreneurial energy, innovation and links to innovative networks elsewhere, and shared vision and leadership) which amplify the "hard" factors associated with the local economy. The degree of local interaction of firms with their environment (including various sorts of support institutions and other firms) is critical. Firms must cooperate, share information and resources, and tackle problems jointly (ROSENFELD 1997, 15). In ideal settings, firms are supported by strong local government and non-governmental institutions and the provision of a wide range of social services (PERROW 1992). Interaction that takes place in trust-based relationships provides information that can be put to use in enterprises and results in successful market and non-market transactions.

Perhaps the premier European examples of positive "soft" regional development, based on institutions, conventions, and culture, are Baden-Württemberg and Emilia-Romagna (COOKE a. MORGAN 1998). The German region is presented as a model region, one which has cooperation at the core of a comprehensive and multi-layered "enterprise and innovation support system" (COOKE a. MORGAN 1998, 94). The system has proven able to adapt to the recession of the mid–1990s and the twin pressure of lower-cost but nearly equal-quality competitors. Although not all firms are collaborative, the regional innovation system works to benefit a wider group within the region than is typical elsewhere. Emilia-Romagna is another model of associationalism, centered around regional service centers and other intermediaries that support the networks of small firms in Italy's industrial districts. COOKE and MORGAN conclude that "co-operative yet still competitive systems such as that in Emilia-Romagna will learn, adjust, and evolve" to globalized markets and production, a more uncertain prospect than that for Baden-Württemberg.

By contrast, Wales and the Basque Country can be seen as peripheral regions, places where restructuring away from old industries has taken place in a setting of greater regional and corporate autonomy than elsewhere in the UK or Spain. Branch plants have been treated as a source of innovation in Wales because there is little alternative, and several associative experiments, with the Welsh Development Agency acting as an *animateur*, attempt to push innovation and inter-firm learning in the region. HUGGINS (2000) has found that the best network support revolves around brokers who are able to mix and overlap the "hard" business aspects and "softer" social interests of participants. Formal groups are the most potent form of inter-firm network, but they are best facilitated through an initially informal structure. COOKE and MORGAN (1998) conclude that successful regional economies are *associational economies*. The associational model is a "third way," between state-led and market-led development, demanding a more social and collaborative mode of operation. Social and economic success, then, seems to be based to a considerable degree on regional capability in trust-based relationships, learning, and network competence.

4 Knowledge, competence and the spatial division of labor

Let us return briefly to the first of ANDERSSON's criteria for regional creativity: *competence*. The importance of skilled workers – and their localization or concentration – benefits both workers and employers. High-technology (or high value-added) industries are notable for their geographical concentration, which is due in large part to labor market considerations (MALECKI a. BRADBURY 1992). In this respect as well, Silicon Valley may be somewhat unique. ALMEIDA and KOGUT (1999), examining in detail the mobility of engineers in the semiconductor industry, find that Silicon Valley has an unusually high degree of interfirm mobility, which affects technology transfer between firms. Knowledge-based manufacturing sectors today include those with high research and development (R&D) intensity: aerospace, pharmaceuticals, computers and office equipment, communications equipment and semiconductors, scientific instruments, and electrical machinery (OECD 1995); these industries are commonly concentrated within all countries where they are found.

In addition to high-tech manufacturing sectors, a large number of producer services – those services for whom firms are the principal customers – are knowledge- and information-intensive, such as financial and legal services, marketing, and R&D (LEE a. HAS 1997; MARSHALL et al. 1988). The concentration of *symbolic analysts* in these jobs, whose work includes problem-solving, problem-identifying, and strategic-brokering activities, require face-to-face contact and collaboration as they customize their service to specific clients (REICH 1991; VON GLINOW 1988). The symbiosis between producer services and manufacturing suggests that the former will not replace the latter, despite productivity gains that have reduced employment in manufacturing (O'CONNOR 1996; ROMO a. SCHWARTZ 1993; KARAOMERLIOGLU a. CARLSSON 1999). Knowledge-intensive economic activities of three types – units of large corporations, firms specialized in technical or business services, and public and non-profit organizations – are located disproportionately in the largest cities (DANIELS 1993; KNOX a. TAYLOR 1995; MOULAERT a. TÖDTLING 1995).

The agglomeration of knowledge allows firms both to minimize transaction costs and to specialize within a social division of labor (STORPER 1998). More importantly, the basis of traditional, static agglomeration economies, traded interdependencies, do not explain agglomeration entirely. *Untraded interdependencies* are the basis of dynamic agglomeration economies, which enhance opportunities for technological learning, as opposed to simply reductions in the unit costs of production with a given technology (MARTIN a. SUNLEY 1996; STORPER 1995, 1998). FOSS (1996) and LAWSON (1999) use this framework to propose that *regional competence* – that shared by a group of firms and based on their interaction – produce a regional system of higher-order capabilities that are distinct from the capabilities of individual firms. There is "a new entry to the list of currently important location factors influencing the geographic location of industry: the knowledge assets of particular local, regional or national milieus" (MASKELL et al. 1998, 24).

These knowledge assets include not merely the credentials or qualifications of workers. They also include the ability, knowledge, skills, talent, behavior, and effort put forth by workers. While workers' knowledge is difficult to capture in simple indices, both workers and their employers can invest in their human capital (DAVENPORT 1999). A wide variety of skills are mentioned in recent research – some of them more related to personal traits, such as enthusiasm, and others more technical; for a summary, see MALECKI (1997a, 317–320).

5 *Knowledge and competence in the firm*

For firms, knowledge is both a product or output and a factor of production. As a product, knowledge is embodied in new products and services. As an input to production, knowledge also is embodied in people and in organizational routines. The resultant knowledge is greater than the sum of the individual knowledge possessed by the firm's employees (NAHAPIET a. GHOSHAL 1998). Knowledge and competence are more than inputs to production; they are "strategic assets" (WINTER 1987). None of these aspects is well-understood and none (especially knowledge within the firm) is captured adequately in economic models, including the highly-touted endogenous growth theory (HOWITT 1997, 12).

The *competence theory of the firm* is a distinct alternative to both neoclassical economics and transaction-cost economics. In the competence perspective, the firm is a repository of skill, experience and knowledge, rather than merely a set of responses to information or transaction costs (CARLSSON a. ELIASSON 1994; HODGSON 1998b; KNUDSEN 1996; LANGLOIS a. ROBERTSON 1995).

Learning is recognized as the highest-level capability, which allows a firm to adapt to changed circumstances in its competitive environment. Learning received little attention within the study of the firm until NELSON and WINTER's (1982) work, and was given new significance by the work of COHEN and LEVINTHAL (1989), who expanded the conventional concept of R&D to include its "two faces": innovation and learning. More influential was their proposed of the concept of "absorptive capacity" for learning: a firm's ability to evaluate potential knowledge, assimilate it, and apply it (COHEN a. LEVINTHAL 1990) . Further refinement proposed that "the prepared firm" is one that does R&D as much to accumulate related knowledge as to accomplish a specific technological objective (COHEN a. LEVINTHAL 1994). It has proven difficult to measure absorptive capacity, since learning is specific to firm-firm dyads and determined by their relative characteristics, especially the relationship between their knowledge-processing systems (LANE a. LUBATKIN 1998).

5.1 *How knowledge is transferred*

One firm's knowledge can be purchased or it can be acquired through interpersonal contacts, which are most easily accomplished in geographic proximity. It is easier to transfer *codified* knowledge – that which is tangible in some way, usually in printed form, as in books, patent applications, and scientific papers. Privately-held knowledge and shared expertise, on the other hand, are tacit in nature, as are new or emergent technologies. Eventually, however, technology and knowledge become ubiquitous and of little competitive advantage (MASKELL 1999).

Tacit knowledge generally is embodied in people, rather than in written form or in objects, and can be acquired through hiring, R&D, and interpersonal networking (FAULKNER, SENKER a. VELHO 1995; NONAKA a. TAKEUCHI 1995). However, it is rarely easy to transfer complex knowledge from one person to another. On-the-job training, on-site engineering, and other means of learning technologies have been central to the process of technology transfer, but few attempts have been made to translate these mechanisms to more general situations. In an important contribution, NONAKA and KONNO (1998) propose the Japanese concept of *ba*, or shared space, as the key to the relationships of knowledge creation. Knowledge is created through a spiraling process of interactions between explicit (or codified) and tacit knowledge: *socialization* (sharing tacit knowledge), *externalization* (expression of tacit knowledge to transmit to others), *combination* (conversion of explicit knowledge into more complex explicit knowledge), and *internalization* (conversion of newly created knowledge into the organization's tacit knowledge). There are four types of shared space or *ba*, including face-to-face, peer-to-peer, group-to-group, and on-site. The need to shift from *individual knowledge* to *group knowledge* understood by a larger group, and *vice*

Table 2: Where to find tacit and explicit knowledge
Wo man „stilles, schwer auszudrückendes Wissen" und wo „offenes, kodierbares Wissen" findet

Types of knowledge	Individual	Group
Explicit	Job skills	Best practices
	Design rules	Stories
	Procedures	Work processes
Tacit	Intuition	Rules of thumb
	Know-how	Traditions
	Common sense	Sources of information
	Judgment	Requirements for survival

Source: DAVENPORT (1999, 149)

versa, seems to be the central feature the *ba* concept and the spiraling process. Group and individual knowledge generally are distinct in accounts of tacit knowledge (Tab. 2).

The significance of NONAKA and KONNO's spiraling process of interactions is twofold. First, it explicitly recognizes knowledge creation and learning as continual, ongoing processes in Japanese companies (MALECKI 2000a). Moreover, there is no one-way path from tacit to explicit knowledge; instead, explicit knowledge is internalized and used to develop new tacit knowledge. Second, several different "shared spaces" are involved in knowledge creation. Some of these are internal to the firm; others are external. Some can be local; others rely on organizational rather than geographic proximity (RALLET a. TORRE 1998). CONSTANT, SPROULL and KIESLER (1996) report on the advantages of organizational weak ties as the basis for useful information obtained electronically from (unknown) others within a global firm. Whether based on geographic or organizational proximity, time, space and infrastructure must be available for seeking, generating and exchanging knowledge (PRUSAK a. COHEN 1998). Often, this is best done by urban institutions that can provide the shared space for many different groups (CREVOISIER 1999; MAILLAT 1998). Third, the more that tacit knowledge is diffused and shared, the harder is imitation (LEONARD a. SENSIPER 1998, 121).

If firms are to be "learning organizations" then the firm's employees must be able to learn to "gain knowledge" from many sources (LEONARD-BARTON 1995; NEVIS, DI BELLA a. GOULD 1995). The experience of multinational firms suggests that in order to exploit geographically-dispersed knowledge, a firm must become a "local" in several locales simultaneously and to integrate the knowledge from various sources (BLANC a. SIERRA 1999; COHENDET et al. 1999; GASSMANN a. VON ZEDTWITZ 1999). No single organizational form stands out as clearly best, because it is not the structure of the firm that is critical, but the set of connections the firm has to external knowledge, both tacit and codified (ANTONELLI 1999; CHESBROUGH a. TEECE 1996; TEECE 1998). Because tacit and idiosyncratic knowledge are decentralized, co-location is required at several locations, and the necessary knowledge cannot be centralized in a single point (GRANT 1996).

Summarizing these tendencies, AMIN and COHENDET (1998) suggest five competencies as critical for globalized firms:

1. integrate the firm internally,
2. exploit advantages of proximity at many locations,
3. integrate fragmented pieces of localized learning,
4. ongoing investment in access to knowledge, and
5. focus on a small number of core competencies.

More generally, there are three aspects to the "information age" organization's structure: (1) decentralization, (2) information practices that promote both an awareness of external information and information-sharing within the organization, and (3) a network structure for the out-sourcing of non-core activities (MENDELSON a. PILLAI 1999). Note that these considerations will not "work" for all companies. A significant distinction exists between the traditional, bulk-material manufacturing and system-based or knowledge-based sectors (ARTHUR 1996; KUSUNOKI, NONAKA a. NAGATA 1998).

The importance of "being there," not just being linked remotely, has become recognized as critical (PORTER 1998b; GERTLER 1995, 1997; MASKELL a. MALMBERG 1999). It has become apparent that telecommunications provides access to knowledge but does not facilitate its understanding and implementation. The reason is that tacit knowledge, on which localized capabilities are based, is "sticky" and difficult to transfer within or between organizations (BROWN a. DUGUID 1998; LEONARD a. SENSIPER 1998; TEECE 1998; VON HIPPEL 1994). In essence, as firms attempt to become closer to their customers in a world of short product cycles and mass customization, the locus of problem-solving tends toward users because of sticky local information that must be transferred a number of times (VON HIPPEL 1998). These transfers of knowledge represent the externalization or transformation of tacit knowledge into codified knowledge to transmit it elsewhere within the firm. This externalization complements local knowledge but does not replace it (COHENDET et al. 1999).

User-producer interaction is a key mechanism for how outside knowledge and technologies are obtained, understood, and incorporated. In addition, it is essential that the recipient has sufficient absorptive capacity for knowledge transfer to occur, even between units within a firm (SZULANSKI 1996). Technology transfer requires technical competence – absorptive capacity – in *both* the provider and the recipient. In general, then, "the knowledge required to make and sell any firm's products resides in the structure of direct and indirect capabilities within that firm, supplemented by the structure of indirect capabilities that connect it with other firms" (LOASBY 1998, 154). Most of these connections represent *relation-specific skills* that are unique to each relationship (PATCHELL a. HAYTER 1995). In most cases, producer-user links fall with the concept of *technological systems* which are distinct from national or regional innovation systems (CARLSSON a. STANKIEWICZ 1991). The presence of regional, national, and global innovation systems – collectively *spatial innovative systems* – ties technological systems to spatial linkages (MALECKI a. OINAS 1999). They coincide in *regional clusters*, which are more like filières than standard sectors for which data allow easy identification (PORTER 1998a).

6 *Regional knowledge*

Both connections with other firms and local or regional forces are the basis of the distinctive competence of a region. A region only begins to be competitive through the presence of localized knowledge. It requires, secondly, the sharing of that knowledge – and, thirdly, its comparison against benchmarks elsewhere. Finally, it requires continuous improvement based on awareness of local and global competitors and complementary partners. A distinctive regional competence is likely to be based at first on advanced factors, including knowledge resources (represented by highly educated personnel and university research institutes) and infrastructure, which go beyond the neoclassical or basic factors of production: physical, capital, and human resources (PORTER 1990). Sharing knowledge, like many transactions, is "highly sensitive to geographical distance by virtue of their substantive complexity, uncertainty and recurrence over time" (STORPER a. SCOTT 1995, 507–508). The spectrum of complementary assets, which encompasses a range of capabilities that support and sustain the development and enhancement of technology, also makes some places better in many ways for knowledge-based efforts. Some systems of interaction are better than others, whether for exchanging internal knowledge or accessing external knowledge. A region with "thick" or "deep" competences can compensate for – or add to – relatively thin competences in a firm (LAWSON 1999; MALMBERG, SÖLVELL a. ZANDER 1996).

The region or territory has an internalness to it as well. In effect, the local culture of some regions operates as "internal" and facilitates knowledge creation and widespread learning. Learned skills become partially embedded in habits, which grow into routines or customs – or conventions – and become a common part of a social culture (STORPER 1998). Institutions, in turn, are durable and integrated complexes of routines and customs. Thus, habits, conventions, and routines preserve knowledge, particularly tacit knowledge in relation to skills, and institutions "act through time as their transmission belt" (HODGSON 1998a, 180). This is especially true of collective knowledge, which is embedded in a social setting and comprises largely tacit (or implicit) knowledge (SPENDER 1996). CAPELLO (1999) sees within some regions – high technology milieux – a continuity over time that allows the accumulation of knowledge. A rhythm of innovation and pace of learning and stable interfirm and interorganizational linkages provide this continuity and facilitate transfer of knowledge through labor mobility within the milieu, intense innovation linkages, and spin-off.

Collective learning is a public, social, or "club good" that is not an outcome of proximity. Collective learning also is not common in most local production systems, even industrial districts. It is a characteristic of the type known as *innovative milieux*. Milieux have been the subject of a series of studies both by GREMI (Groupe de Recherche Européen sur les Milieux Innovateurs) and others (BRAMANTI a. RATTI 1997). Learning is identified as only one of a group of conditions that remain through structural changes. The others are the interlinked industrial production system, governance structures, and "support space" relationships between enterprises and local institutions. These are seen as crucial to the creation of a proper mix of, on the one hand, connections internal to the milieu and its internal synergy and, on the other hand, external networks and openness to outside knowledge (BRAMANTI a. RATTI

1997; BRAMANTI a. SENN 1997). An innovative milieu combines learning (from both local and nonlocal sources of knowledge) and interaction, or cooperation with respect to innovation (CAMAGNI 1995; MAILLAT 1995). PINCH and HENRY's (1999) account of Britain's Motor Sport Valley includes close connections between the region's aerospace and automotive industries. Such an environment, which may not be restricted to innovative milieux, "promotes entrepreneurship and innovations and the development of dynamic learning externalities and technological spill-over" (MASKELL et al. 1998, 183). In other words, firms become – and remain – competitive by conceiving and implementing strategies that utilize – directly or indirectly – the valuable traits of their location. These traits enable those firms to earn a profit despite otherwise similar competitors located in other places (MASKELL et al. 1998, 51).

The local context provides "the values, the knowledge, the institutions and the physical environment necessary for its continuance" (BECATTINI a. RULLANI 1996, 161). LAWSON and LORENZ (1999) add technical consultancies to the list of people with overlapping technical knowledge who are available to combine knowledge into new combinations that contribute to regional collective learning. These business service firms serve as knowledge brokers for manufacturers and other service firms (BRYSON 1997). KEEBLE et al. (1999) see high-tech regions like Silicon Valley and Cambridge as successful because of their global and local networks and linkages. The need for local and global networks is a recurring, but not yet standard, theme in research on networks (AMIN a. THRIFT 1992; BELUSSI a. ARCANGELI 1998). It is here that findings on multinational firms becomes pertinent. While firms in such environments can be competitive by relying on non-local networks, the stronger local environment for firms is one in which *both* local links are abundant and flows of knowledge to and from other places are common.

6.1 The culture of regional knowledge

The tacit nature of new or innovative knowledge and the localness of much tacit knowledge make knowledge difficult to tap from a distance or to transfer to other places. The "stickiness" of regional knowledge is a result not only of learning (organizational as well as collective) and its support systems, discussed above. Stickiness also is a result of trust and mutual understanding, which reinforce local interfirm cooperation that is embedded in the business culture of an area, making it even more difficult for outsiders to imitate. The development of specialized skill depends on accumulated experience and a variety of experience found in a local area, but that variety can only be encompassed within a network of connections (LOASBY 1998).

The collective nature of a territory can be seen in the presence of its *collective entrepreneurs*: not only firms, but also inter-firm associations, worker organizations, financial institutions, and governmental agencies (BEST 1990; LORENZ 1992). They represent the social capital that firms are able to build and draw upon through their ties within the regional institutional environment (LEVINTHAL 1994). In addition, *vertical links* to other regions and the presence of gatekeepers are significant (CROMIE, BIRLEY a. CALLAGHAN 1993; FLORA a. FLORA 1993; FLORA et al. 1997). Flows and linkages to the outside need to be balanced: to include not only flows (such as exports) out but also receptivity to new ideas coming from other places. External connections do not "just happen"; they rely on intermediaries, especially wholesalers, who buy and sell outside the region, bringing new information and competing products back to the region (MEYER 1998). Other key individuals in wholesaling, producer services, and financial services act as bridges that cross industry lines, serving as community entrepreneurs (CROMIE, BIRLEY a. CALLAGHAN 1993; MEYER 1998).

Some places are able to create, attract, and keep economic activity – to maintain their competitiveness in a world of increasingly global competition. They do so because people in those places "make connections" with other places, retaining close network links with other local systems and with global knowledge (AMIN a. THRIFT 1992; BECATTINI a. RULLANI 1996; MALECKI a. OINAS 1999). Such an innovative milieu is the seat of permanent processes of adjustments and transformations to external changes, such as competition and technological discontinuities. These adjustments are able to take place when interaction and cooperation are the social norm, and where learning and innovation are able to respond to and incorporate new knowledge. These are externalities of proximity, variety and accessibility that are usually found in larger cities (MAILLAT 1998, 127).

In order to be competitive, firms need a web of interactions and information flows within and into the region, including high-tech knowledge translated to be applicable to the industry. A focus on learning removes the artificial distinction that has been placed in the literature between high-tech and low-tech sectors and between innovative and non-innovative firms (MASKELL et al. 1998; OINAS a. VIRKKALA 1997). R&D by firms still is important, however, because it represents an "active" outlook, an absorptive capacity, a level of

Table 3: Interaction between firm personality and regional characteristics on firm performance

Wechselbeziehungen zwischen der "Persönlichkeit" einer Firma und regionalen Besonderheiten der ökonomischen Leistung von Firmen

		Firm personality	
		Introverted	*Extroverted*
Regional characteristics	*Sparse environment*	Few local or nonlocal links	Firms make many nonlocal links
	Innovative milieu	Many local links	Both local and nonlocal links are numerous

technological progressiveness, and an "open mind", reaching out for new information and being receptive to it. Technically progressive firms take part in information exchange, they continually search for information, and they maintain internal communication (SWEENEY 1987). Small firms (SMEs) have great difficulty to be progressive, but we must not think of small firms as homogeneous. SMEs vary greatly in their information-seeking and learning behavior (CULLEN 1998; MALECKI a. POEHLING 1999).

Vertical links to other regions as well as horizontal ones within the region are the essence of the "munificent environments" identified by DUBINI (1989). Put briefly, access to other entrepreneurs, to consultants, and to sources of information are far more readily available in munificent settings than in "sparse environments". The characteristics of a successful place depend on the ability of firms to assemble critical sets of factors (such as talent, technology, capital, and know-how) – mainly from the local environment (MALECKI 1997). The environment for a firm or a community involves a host of industrial, technological, and economic linkages, many of which are public resource endowments in the locale or region.

Even within sparse regions, firms are not identical: some are more competitive than others. A central finding from several years of research in North Florida is that small firms differ in their general outlook toward external networking and contacts. MALECKI a. POEHLING (1999) have identified extroverts and introverts, distinct types of firm "personality" that determine to a large degree whether outside expertise is sought when competitive or other issues arise. This finding complements that on firms in munificent environments that seemingly fail to take advantage of their regional surroundings and its institutional thickness. GROTZ and BRAUN (1997), for example, have shown that there is little use by SMEs in Baden-Württemberg of the institutions within the region. Most contacts are "low-profile" (quick information, general consultation, or a literature inquiry); there are few inter-firm relationships. Thus, Table 3 suggests that there are two dimensions at work: firm personality and regional characteristics.

The identification of horizontal and vertical (local and nonlocal) links is no easy task. In fact, it is a task that is commonly by-passed in favor of the easier filtering of input-output relationships. PORTER (1998a) stresses, for example that clusters – the latest fad in regional development policy – cannot be identified in this way. What is needed is a meticulous identification of links and relationships that are critical to an industry and its technologies. *These links and relationships are the intangible essence of the competitive firm and the competitive region.* Some of these links and networks are within the local agglomeration while others exhibit awareness of, and close ties to, centers of excellence in other places.

Where does this take us beyond "(neo)Marshallian nodes in global networks"? In that work, AMIN and THRIFT (1992) stressed the local: that local places need a critical mass of know-how, skills and finance; a thick socio-cultural and institutional infrastructure; and entrepreneurial traditions. However, their view of global networks as dominated by large firms demands some enhancement to account for smaller firms – not the smallest, which are likely always to be disadvantaged vis-à-vis global firms, but an increasingly competitive group of medium-size to large firms. These large but not global firms are able to muster the competence to compete in niches that are too small to be attractive to giant firms (HAYTER, PATCHELL a. REES 1999; PATCHELL, HAYTER a. REES 1999).

PORTER (1998a) suggests some specific possibilities for government include: creating specialized education and training programs, enhancing specialized transportation and communications infrastructure, and acting perceptively to respond to cluster needs for testing and other cluster-specific services. He emphasizes that government policy alone will be unable to be influential; both the local private sector and trade associations and other collective bodies must work together – constructing what COOKE and MORGAN (1998) call an associational economy.

A second generalization from recent research is the importance of regional economic diversity. This conforms to the hypothesis that urbanization and inter-industry spillovers are more important than localization (intra-industry) spillovers. This proves to be the case in several studies (FELDMAN a. AUDRETSCH 1999; HARRISON, KELLEY a. Gant 1996; KELLEY a. HELPER 1999), and reinforces the notion of untraded interdependencies as the principal benefit from geographic proximity (PINCH a. HENRY 1999; STORPER 1998).

Can telecommunications serve as an "equalizer" for firms in remote regions or places without the ingredients or culture of a milieu? As pointed out earlier, telecommunications allows firms to gain access to distant or global knowledge, particularly within the context of organizational proximity, but understanding and implementation of that knowledge often requires geographical proximity. While telecommunications is the best way to be plugged into the external world, the most useful information is only available within the local milieu (CREVOISIER 1996; MASKELL et al. 1998; PORTER 1998a, 236). Telecommunications is less necessary locally, because the dynamics of informal, face-to-face communication dominate. However, both locally and globally, electronic communications permits the rapid response and quick turnaround demanded by Internet time.

7 Measuring knowledge across space

The manifestations of knowledge in innovativeness, technological capability and the ultimate goal of these processes, development, have given rise to many measures – indicating the multiple dimensions of knowledge. (The multidimensionality of knowledge may be the counterpart to GARDNER's (1993) theory of multiple intelligences in people.) However, measuring the geography of knowledge has never been an easy task. International data are notoriously scarce and spotty; the World Bank's (1998) *World Development Report 1998/99: Knowledge for Development* includes in an Appendix of International Statistics on Knowledge tertiary enrollments in only four fields of study: natural sciences, mathematics and computer science, engineering, and transport and communications. Common indicators included in this report and in others are R&D spending per capita and school enrollment rates. A relatively unusual one is teledensity (telephone density), indicating the ability to access knowledge. Output measures include high technology goods as a share of exports, and development effects, such as productivity and GNP per capita. The *World Development Reports* have drawn criticism for their single-minded growth orientation (UL HAQ 1995). An alternative *Human Development Index* includes an education index and a combined educational-level enrollment ratio among other indicators, such as life expectancy and adult literacy rate to highlight the difference between GDP and human development (UNDP 1999).

It normally is even more difficult to measure knowledge at the regional level within countries. The problems are manifold: administrative boundaries do not encompass or reflect economic regions, data are not collected regularly and uniformly on proper indicators, and politicians prefer output measures and quantifiable indicators over qualitative attributes that matter more. Despite these problems, groups such as the Corporation for Enterprise Development (1998) and Ameri Trust/SRI (1986) have stressed for over a decade that regions (e.g. states within the USA) with the best sets of human, technology, and financial resources and infrastructure were the ones most likely to have high-performing economies five years later. The annual *Report Cards* of the Corporation for Enterprise Development show the link between knowledge and capital: neither alone is adequate. A rich region must invest in its future – an uncertain future for which knowledge and innovation are the best bets. A "smart but poor" region suffers from the inability to stay smart without adequate capital to invest in maintaining its education and innovation infrastructure.

The link between R&D as a two-pronged activity – for innovation and for learning – has long led to its use as an indicator. Lack of data on just where companies conduct R&D (and how much) has been a prominent gap which proxies and estimates have had to fill. In the USA, the National Science Foundation (1998) has begun to close this gap at the state scale with its *Science and Engineering State Profiles*, which include indicators on scientists and engineers (S&E), R&D spending, and patents issued. These indicators, along with business services, comprise what FELDMAN and FLORIDA (1994) suggest as the *technological infrastructure* of a region.

The most recent scorecard of regional (state-level) knowledge indicators is *The State New Economy Index* (ATKINSON, COURT a. WARD 1999). Although anticipated by the work of a decade earlier, the *New Economy Index* focuses on the distinction between the *old economy* and the *new economy* across four dimensions: economy-wide characteristics, industry, workforce, and government (ATKINSON a. COURT 1998). The state index

Table 4: Indicators in the New Economy Index
Indikatoren, die im „Index der Neuen Wirtschaft" verwendet werden

Dimension	Indicator
Knowledge jobs	Jobs in offices (% of total jobs) Jobs held by managers, professionals and technicians (% of total workforce) Workforce education level (weighted measure of advanced degrees, bachelor's degrees, associate's degrees, and some college coursework)
Globalization	Export focus of manufacturing (% of jobs dependent on exports) Foreign direct investment (% employed by foreign companies)
Economic dynamism	"Gazelle" jobs (% of jobs in fast-growing companies – those with sales revenue that has grown 20% or more for 4 straight years) Job churning (business start-ups and failures as % of all firms) Initial Public Offerings (IPOs) (value of IPOs as % of gross state product)
Transformation to a digital economy	Online population (% of adults with Internet access) Commercial Internet domains (number per firm) Education technology (weighted measure of % of classrooms wired for the Internet, teachers with technology training, and schools with more than 50% of teachers with school-based e-mail accounts) Digital government (a measure of digital technologies in state governments)
Technological innovation capacity	Number of high-tech jobs (jobs in electronics, software and computer-related services, and telecommunications as % of total employment) Number of scientists and engineers (% of workforce) Number of patents issued (per 1,000 workers) Industry investment in research and development (% of GSP) Venture capital (% of GSP)

Source: ATKINSON, COURT a. WARD (1999)

encompasses 17 indicators in five categories suggesting, as its precursors did, that several dimensions are needed to encompass state or regional preparedness for economic transformation (Tab. 4).

ATKINSON, COURT and WARD (1999) also suggest five key policy strategies. (1) Government and industry should co-invest in the skills of the workforce and (2) they should co-invest in an infrastructure for innovation. The public sector has three additional responsibilities: to promote innovation- and customer-oriented government, to foster the transformation to a digital economy, and to foster civic collaboration.

Although its measurement is even more difficult at the local scale, the importance of knowledge at the local level can be seen in the case of the Boston area. Boston is a city whose firms have been criticized for their lack of flexibility in this age of flexibility, resulting in a less entrepreneurial culture, especially in comparison to Silicon Valley (SAXENIAN 1994). The high-tech cluster of computer and electronics firms along Route 128 surrounding Boston attracted a great deal of attention in the 1960s and 1970s as a model of a high tech and inspiring imitators elsewhere – one of only a handful of regions that attained the status of a "self-sustaining cluster", able to muster an infrastructure and agglomeration economies to facilitate business formation (MILLER a. COTÉ 1987). SAXENIAN's (1994) comparison of the computer industries in the Boston area and Silicon Valley concluded that the Boston area's conservative, large-firm culture was unable to respond to change in high-technology industries. This critique has had tremendous influence, but it may not accurately portray the region and its competitiveness (MALECKI 2000b). The resilience of the area and its local culture maintains the region's ability to sustain competitiveness through knowledge.

Despite the decline of the minicomputer industry and in defense-related sectors in the 1980s, Boston remained competitive by shifting to new industries. Its networks of computer firms were weak in comparison to those in Silicon Valley (SAXENIAN 1994). However, the Boston area also has "networks and institutions of a 'generic' nature" – especially its universities and their global networks and venture capitalists – that have helped the region to diversify and develop new industries and firms (TÖDTLING 1994). The move to biotechnology, software, telecommunications, and health care rendered the decline of the computer sector and

Table 5: Competitiveness criteria in the World Competitiveness Yearbook (number of variables included in parentheses)
Wettbewerbskriterien im "World Competitiveness Yearbook" (Zahl der Variablen in Klammern)

Factors	Variables used	
Domestic economy (30)	Value added (9)	Economic sectors performance (6)
	Investments (2)	Cost of living (4)
	Savings (2)	Adaptiveness (3)
	Final consumption (4)	
Internationalization (45)	Current account balance (6)	Portfolio investments (2)
	Exports of goods and services (10)	Foreign direct investments (6)
	Imports of goods and services (5)	National protectionism (8)
	Exchange rate (3)	Openness (5)
Government (48)	National debt (8)	State efficiency (11)
	Government expenditure (3)	State involvement (7)
	Fiscal policies (14)	Justice and security (5)
Finance (27)	Cost of capital (3)	Stock markets dynamism (5)
	Availability of capital (8)	Banking sector efficiency (11)
Infrastructure (32)	Basic infrastructure (10)	Energy self-sufficiency (5)
	Technological infrastructure (13)	Environment (4)
Management (36)	Productivity (12)	Management efficiency (9)
	Labor costs (5)	Corporate culture (5)
	Corporate performance (4)	
Science and technology (26)	R&D expenditures (5)	Scientific environment (5)
	R&D personnel (6)	Intellectual property (5)
	Technology management (5)	
People (44)	Population characteristics (5)	Educational structures (11)
	Labor force characteristics (8)	Quality of life (7)
	Employment (6)	Attitudes and values (5)
	Unemployment (2)	

Source: IMD (1999b)

defense spending to mere "bumps" for the local economy to travel over (KANTER 1995). The significance of education in the local culture has helped institutions in Boston to craft educational and training systems outside the context of its famous universities, including Harvard and MIT.

Although Boston has changed since the "Massachusetts miracle" days of the 1980s, the region's firms, institutions and other local actors show an ability to adapt to new conditions. Indeed, the region's "productive culture," centered around firms and other institutions and not government-led, has the systemic qualities of a *regional innovation system* (COOKE, GOMEZ URANGA a. EXTEBARRIA 1997). Massachusetts is ranked no lower than ninth in the USA on any knowledge (R&D or S&E) indicator, and as high as second in postdoctorates and number of federal research awards to small firms, despite ranking only 13th in population and labor force, 12th in total federal expenditures, and 10th in gross state product (National Science Foundation 1998). Perhaps more significant is the fact that Massachusetts ranks first overall on *The State New Economy Index* (ATKINSON, COURT a. WARD 1999).

8 Knowledge in international competition

The preference for rankings, report cards, and league tables is nowhere more apparent than in the annual rankings of countries. Annual scoreboards include the *World Competitiveness Yearbook* (*WCY*) of the International Institute for Management Development (IMD) and the *Global Competitiveness Report* (*GCR*) of the World Economic Forum (WEF) . The *WCY* includes 288 variables in eight categories (Tab. 5). Some of the variables are "hard data" from secondary sources; others are "soft data" from a 106-item survey of over 4,000 company executives. The hard data contribute two-thirds of a country's overall performance; the survey data the remaining one-third (IMD 1999a). The *WCY* ranks a relatively small set of countries (47); the *GCR* includes 59. The WEF claims that its "rankings are based on a clear definition of competitiveness as the ability of a country to achieve sustained high rates of growth in GDP per capita" (WEF 1999). The WEF provides less information about its methodology and variables, confining the discussion to the eight factors that make up its overall "Competitiveness Index" (Tab. 6). The eight

Table 6: Factors in the World Economic Forum's Global Competitiveness Index (estimated number of variables in each factor in parentheses)
Faktoren im "World Economic Forum's Global Competitiveness Index" (geschätzte Zahl der Variablen jedes Faktors in Klammern)

Factor	Examples of variables
Openness (11)	Average tariff rate Foreign access to capital markets
Government (22)	Tax evasion Government bureaucracy Corporate tax rate
Finance (24)	Financial sector risk rating Sophistication of financial markets
Infrastructure (10)	Telephones and fax machines Cost of domestic air travel
Technology (19)	E-commerce Technology licensing Internet for customer service
Management (9)	Delegation of authority Compensation policies
Labor (17)	Minimum wage regulations Social welfare system
Institutions (22)	Forced contributions Litigation costs

Source: SACHS a. WARNER (1999); WEF (1999b; 1999c).

factors in the *GCR* are simplified yet more into two dimensions: a low-cost business environment and rules and institutions (SACHS a. WARNER 1999). Both of these international competitiveness indicators and the recent *New Economy Index* discussed above give a prominent position to Internet use, adding it to the conventional R&D indicators.

Despite subtle differences between the two sets of rankings – Singapore, the USA and Hong Kong are the top three in the *GCR*; in the *WCY* it is the USA, Singapore, and Finland – both IMD and WEF incorporate surveys of executives (their clients and customers) and as much hard data as possible. The World Economic Forum provides greater analysis of its data and rankings (PORTER 1999; SACHS a. WARNER 1999), and a balance sheet of national assets and liabilities, but fewer details of its data and methodology. The WEF also has developed products for geographic niches with its *Asia Competitiveness Report* and *Africa Competitiveness Report*.

ROESSNER et al. (1996) have developed indicators of high-tech competitiveness, on which they compare 28 nations: the "Big 3" (USA, Japan and Germany), seven other western European economies (UK, France, Netherlands, Switzerland, Italy, Sweden, and Spain), three non-European highly-developed countries (Canada, Australia, New Zealand), two former Eastern Bloc countries (Hungary and Russia), the "Four Tigers" (Hong Kong, Singapore, South Korea, and Taiwan), six Asian "Tiger Cubs" (Malaysia, China, Thailand, Philippines, India, and Indonesia), and three Latin American nations (Brazil, Argentina, and Mexico). Their indicators, like those of the IMD and WEF, rely heavily on a survey: ROESSNER et al. surveyed a group of experts, including academics and policy-makers, most of whom were not business executives. Organized into four categories of inputs or leading indicators of a nation's capacity to compete internationally in high-technology markets (Tab. 7), their results show that the USA, Japan, and Germany (in that order) are well ahead of the other 25 countries in technological infrastructure and productive capacity, but are nearly equal to the Four Tigers and other developed economies in national orientation and socioeconomic infrastructure. In short, it is knowledge and capital that sustain the world's leading economies. The output measures (PORTER et al. 1996) give the lead in *high tech standing* to Japan, followed closely by the USA and (at some distance) Germany. A *high tech emphasis* is highest among Asian countries, led by Singapore, Malaysia, and Japan. The *rate of change of high tech competitiveness* is rated highest for Indonesia, China, New Zealand and the Philippines. Sector-specific rankings show that no country dominates all of high technology.

Each of the indicators of competitiveness (Tab. 4–7) includes knowledge, whether in the form of an educated population or of resources or people committed

Table 7: Indicators of high-tech competitiveness
Indikatoren der HighTech-Wettbewerbsfähigkeit

Input indicators	Variables
National orientation	Investment risk index
	National strategy
	Social influences favoring technological change
	Entrepreneurial spirit
	Attitudes toward technology
Socioeconomic infrastructure	Human skills index (from tertiary and secondary education data)
	Encouragement of foreign investment
	Mobility of capital
Technological infrastructure	Number of scientists and engineers in R&D
	Linkage of R&D to industry
	Output of indigenous academic science and engineering
	Ability to make effective use of technological knowledge
Productive capacity	Value of electronics production
	Supply of skilled labor
	Indigenous component supply
	Industrial management capability

Source: ROESSNER et al. (1996)

to R&D. More recent efforts incorporate Internet technology as a means for access to the abundance of information "out there" that must be found before it can be put to use. The more complex competitiveness indices include government, institutions, and management, all of which comprise the innovation system of a region or nation. Finally, more than the others, ROESSNER et al. (Tab. 7) include measures of linkages, which are central to understanding the role of any place within the global economy.

9 Conclusions

Knowledge has become a central organizing concept for those concerned with regional economic development. This paper has traced the role of knowledge to capabilities and competence of firms, to technology transfer, and local and regional manifestations of knowledge. Going well beyond the concern for high technology of the 1970s and for flexibility of the 1980s, learning has become a means to understand regional competitiveness. Knowledge, rooted in regional and local cultures and its intrinsically human or soft characteristics that resist economic modeling, is fundamental to understanding both agglomeration or clustering of economic activity and the ability of places to develop competitiveness.

It is evident that these conditions for learning do not exist – and probably cannot be created – in all places. Moreover, more than knowledge (and capital) are needed: the growing consensus on competitiveness seems to demand infrastructure, a global outlook, and government and institutions that not only accept but embrace change and disequilibrium. Such an outlook and culture are relatively new outside private companies, and are resisted by most bureaucrats and politicians. Conditions for learning can develop where knowledge takes center-stage in the culture and, consequently, in policies and in the actions of the region's firms and institutions. The challenge for all regions and nations in our competitive times is to incorporate knowledge and learning at the center of a spatial innovation system.

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