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STRATEGIES FOR REGIONAL INNOVATION SYSTEMS:

Learning Transfer and Applications

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Abstract

The paper explains the concept of regional innovation systems. It argues that global economic forces have raised the profile of regions and regional governance not least because of the rise to prominence of regional and local business clusters as vehicles for global and national economic competitiveness. Key definitions are given and distinctions drawn. Then, by reference to a number of important dimensions characterizing innovation such as education, knowledge transfer, linkage and communications, four regions from Asia, Europe and Latin America are contrasted. It is shown that regional innovation systems can be underdeveloped by being too dependent on public support, but equally, an over-emphasis on private infrastructures needs to be guarded against except at the most advanced developmental level. A combination of public and private governance at regional level to promote systemic innovation is advocated.

Regional innovation systems

The concept of regional innovation systems is relatively new at the level of policy (though it has been discussed and written about since the early 1990s).[1] Lundvall, one of the first authors to promote thinking about systems of innovation, mentioned regionalization in relation to globalization and referred to regional networks, but did not believe a regional perspective on innovation could be as useful as national systems, even in respect of such geographically contingent processes as tacit knowledge exchange.[2] He suggested that transnational innovation interactions were likely to gain in importance over national ones, but that regional processes were unlikely to. When this view was being developed, the European Commission was developing and implementing, *inter alia,* Regional Technology Plans and Regional Innovation Strategies precisely because of the weaknesses of national innovation systems in the European Union (EU) over producing rates of innovation competitive with those of the United States of America.[3]

By contrast, Porter showed that the United States' competitive lead in innovation was predicated on the existence of regional and local innovation systems based on clusters.[4] This has been shown to be particularly true in new-economy sectors like biotechnology and information and communication technologies (ICT) in states like Massachusetts and California, or new media in big city districts like Hollywood, Los Angeles and "Silicon Alley" in New York.[5]

By the turn of the millennium, governments practically everywhere in the advanced economies were promoting regional innovation and cluster-building policies as ways of boosting national competitiveness. One of the clearest cases of this approach was in Germany in 1995, when the government announced the BioRegio contest which sought applications from regional bodies for funding support to build innovative, regional biotechnology clusters and help to improve Germany's poor competitive position in biotechnology commercialization. The winning regions were Munich in Bavaria, Cologne-Düsseldorf in North Rhine-Westphalia and Heidelberg in Baden-Württemberg.[6] In the United Kingdom, government industrial policy since 1998 has been to build a knowledge-driven economy by strengthening regional development bodies and co-funding growth of innovation through supporting regional cluster-building strategies. Much of this thinking was influenced by reports on enhancing the global competitiveness of United Kingdom biotechnology.[7]

These examples illustrate that regional innovation systems are now recognized as having an important role to play in economic development policy. This paper presents some of the conceptual thought behind the idea of

[1] Cooke (1992).
[2] Lundvall (1992).
[3] CEC (1995).
[4] Porter (1990, 1998).
[5] Cooke (2001).
[6] Dohse (2000).
[7] DTI (1999a, 1999b).

regional innovation systems and clusters as specific sub-systems operating within regional innovation system settings. Reference is made both to the support systems for innovation, from the private actions of the market to the interventions of governments, and to the ways in which well-functioning systems and clusters may have their own formal or informal governance. There is discussion of strategies adopted by development authorities to support cluster and innovation enhancement, with examples from less favoured regions as far as possible.

Regional innovation systems under intensified competition

The increasing globalization of markets has drastically changed the competitive environment for most companies. Not only on foreign markets but also on their home market they are confronted with intensive price, time and quality competition. To stay competitive they have to restructure their business organization, including their innovation activities and consumer and supplier relationships. Obviously companies are much more successful in regaining and retaining global competitiveness if they benefit from the specific advantage of their environment. Companies that have reacted specifically to different environments have been more successful than those who believed in "one best way" of organizing business.[8] Because of the intensive global competition they face, companies are forced to look for the most supportive environment worldwide. Their restructuring process is therefore directed by the concept of product specialization. Economists notice this when their statistical analyses show the importance of intra-industry trade, that is the trade in different qualities of the same product, say, cars or in different parts of the value chain in electronic or ICT components.[9] Of course, developing countries are deeply involved in intra-industry trade through offshore sourcing by advanced-economy multinationals. This is not only true for multinational companies but also for medium-sized firms. Companies organize their production and innovation processes on a global scale, taking advantage of the specific resources of different territories. New transport and information technologies facilitate the organization of companies' global production networks and innovation processes.[10]

The region as a supportive environment for innovation

As production becomes more science-based, advantages such as developed research infrastructure, a highly qualified workforce and an innovative culture are becoming more important than natural resources, which means that a supportive environment for innovative companies can deliberately be created. To become attractive for companies, territories can set up specific institutions to support their innovation strategies. In an increasingly borderless world the nation-state, logically, loses some strategic economic capabilities, despite Lundvall's arguing in favor of it for innovation, for as we have seen the region is now the more natural economic zone.[11] Regions, especially when they have developed clusters and appropriate administrative machinery for supporting innovative enterprise, represent more meaningful communities of economic interest, define genuine flows of economic activities and can take advantage of true linkages and synergies among economic actors. Regions have to seek competitive advantage from mobilizing all their assets including institutional and governmental ones where these exist, or press for them where they do not. As regions become more specialized and pull the institutional support structure along, so foreign

[8] Kern and Schumann (1984).
[9] E.g. Krugman (1991).
[10] Gereffi (1996).
[11] Lundvall (1992).

direct investment (FDI) seeks out such centres of expertise by following domestic investment as part of global location strategy.[12] Thus it is important to show how the process of adjustment among companies, markets, public authorities, research institutes, training institutions and social partners is transforming each, while creating the elements of an innovative framework that may encompass and stabilize them all. To understand regional innovation systems it is important to analyse three concepts: region, innovation and system. These concepts will be discussed in more detail in the following material.

The concept of region

Although it has been realized that regional economies are becoming more important, there is still no general understanding of how to define a region.[13] A region is, after all, an intellectual concept. It exists only in terms of the criteria by which it is defined, of which four are the most commonly used:

a. it must not have a determinate size;

b. it is homogeneous in terms of specific criteria;

c. it can be distinguished from bordering areas by a particular kind of association of related features;

d. it possesses some kind of internal cohesion.

The boundaries of regions are not fixed once for all; regions can change, new regions can emerge and old ones can perish. Therefore to analyse a region, criteria must be found that define a functioning unit within a specific time.

To define a region from an economic perspective, the concept of industrial cluster is sometimes used.[14] Clusters can be characterized as a dense network of economic actors, who work together very closely and who have intensive exchange relationships. All economic actors who directly contribute to the dominant production process of a region are partners in this network, including manufacturing companies as well as supply and marketing companies, financial institutions, research institutes and technology transfer agencies, economic associations and unions, training institutions, the regional government and even informal associations. The cluster concept can be distinguished from traditional, industry-specific analysis, as it concentrates on industry, which has overlapping cooperation with the governance system. Of course regions may contain more than one economic cluster: Silicon Valley is a large complex including ICT and biotechnology clusters, if we define it economically. The Ruhr region in Germany, likewise, is an economic region with long-established coal, steel and engineering clusters.[15] The political

[12] Cooke et al. (2000).
[13] Harvie (1994).
[14] Porter (1998).
[15] Rehfeld (1995).

region of Tuscany in Italy has many clusters or industrial districts in clothing, furniture manufacture and so on.[16]

We cannot expect to find well-established industrial clusters in all regions. Regions may differ in the closeness of cooperation and in some regions the administration or public governance system may be rather weak while in others there may not be a well-established supportive institutional set-up. In the last case national institutions may be more important than regional ones, if those exist at all. However, in the current state of regionalization it is most useful to think of regions as political governance systems below the national but above the local level of public administration. Federal states or provinces are appropriate vehicles, as are autonomous communities as in Spain. These have the administrative legitimacy and capability to develop policies for supporting enterprise, especially small and medium-sized enterprises (SMEs). Among these might be such instruments as cluster or regional innovation system-building policies. Where the private sector organizes itself regionally it can become part of the regional governance structure for industrial development purposes. Therefore it is important to distinguish between different types of regions and to find out how they function and how well they are doing (see Tables 1-3). It is also important to analyse how national and regional innovation systems are related.

The concept of innovation

The concept of innovation is used in connection with the analysis of processes of technological change. Traditionally the process of technological change was viewed as consisting of three different stages: invention, innovation and diffusion. Invention is the stage of the production of new knowledge, innovation is the stage of the first application of the existing knowledge within production, and diffusion in this model means the broad use of new technologies. The model can be characterized as a trickle-down or cascade model; it is assumed that the amount of fundamental research substantially influences the opportunities for technological innovation within a territory, which in turn determines the growth rate of its output. It is assumed that an adequate level of the distribution of resources fundamental scientific research makes it possible to initiate a process of economic growth. However, this cascade model has often been criticized as being based on a functionalist argument. Technological change does not take place according to the linear logic of this model; on the contrary, technological change must be conceptualized as a process whose outcome is not determined but is rather open; it is impossible to discover a sequence of clearly delimited stages that have to be passed one after the other.[17] Instead we have to be aware of the fact that particular innovative activities can both be cause and result, consequence and prerequisite. Therefore a broader definition of innovation is nowadays typically used, which includes all activities of the process of technological change: problems of awareness and definition, the development of new ideas and new solutions for existing problems, the realization of new solutions and technological options, as well as the broader diffusion of new technologies.

[16] Dei Ottati (1994).
[17] Lundvall (1992).

Innovation is ubiquitous

It is also important to bear in mind that innovations are not exceptional phenomena; on the contrary, they can take place at any time in all areas of the economy. They therefore have to be seen as ubiquitous phenomena.[18] If we use such a concept, then there is no need to associate innovations only with major changes, incremental changes are also included in the concept of innovation. Using such a broad definition, it is useful to focus on the process of learning through which knowledge and new technologies are created, distributed and used in specific areas. Learning is defined as a collective process shaped by the existing structure of production, by organizations and by institutions. It is assumed that the characteristics of such a learning system are central to questions of growth, employment and competition. In this context it is useful to distinguish between different processes of learning. First is learning in a more narrow sense, by doing and by using. Learning in this sense takes place within the production process; therefore it might be called learning by producing, indicating that its basic components may be thought of as learning by doing, by using and by interacting in relation to normal production activities.[19]

Second, searching and discovering are complex learning processes, including activities of problem definition and problem solution, which take place in specific institutions. Searching means a process of deliberately choosing and recombining existing knowledge to develop new products and processes. Searching therefore takes place within specific technology paradigms.[20] But exploring means the production of new knowledge for newly defined problems; this learning process does not produce knowledge that can be transformed directly into new technologies. Based on such a broad concept of innovation, it is possible to identify science-intensive high-technology regions and those lagging behind. An important question is to what extent regions learn from each other to become more competitive.

The concept of system

In the literature on innovation the meaning of the term system is not analysed in great detail. Some general definitions of a system of innovation exist; for example, Lundvall defines a system of innovation as being constituted of a number of elements and by the relationship between these elements.[21] It follows that a system of innovation is constituted of elements and relationships that interact in the production, diffusion and use of new and economically useful knowledge.[22] It becomes quite clear that an innovation system is a social system, which means that innovations are the result of social interaction between economic actors. And it is an open system, which interacts with its environment. Here the feedback mechanism is of importance, which means that by producing new knowledge and new technologies the innovation system has an influence not only on its environment but also on the external conditions of its own functioning.

[18] Lundvall (1992).
[19] Johnson (1992).
[20] Dosi (1982).
[21] Nelson and Winter (1982), Lundvall (1992), Edquist (1997).
[22] Lundvall (1992).

Still there is a need to distinguish between operational and conceptual systems. When we talk about an operational system we are referring to a real phenomenon; a conceptual system, however, represents a logical abstraction, a theoretical construct that consists of principles or laws that explain relationships between and among variables. In the latter meaning the term "system" is related to a specific methodological approach and is an analytical framework. Using the systems or systemic approach we construct entities but they do not represent the totality of a real phenomenon. The scientific approach is to look for the constituent elements and their specific characteristics, the relationships between these elements, the boundaries of this system and the interaction with its environment. Defining the systems concept as an analytical tool, we do not need to assume that innovation systems always consist of tight linked actors and that they have clear-cut boundaries. We also do not need to expect that all innovation systems consist of the same actors performing the same function. On the contrary, such an understanding of a system approach is open to flexible interpretation.

In using the systems approach it might be possible to overcome the weaknesses of case studies, because a common and analytical framework is deployed. Its advantage is that it allows for a systematic comparison of innovation activities in various regions. At the same time we are able to compare the existing structure of production, organization and institutions of different regional innovation systems in relation to criteria of efficiency such as growth, employment and economic competitiveness. Doing these comparative studies, one might also find some functional equivalents for specific problems within the innovation process.

Theoretical approaches

The systems approach, as has been said earlier, only provides an analytical framework, and is not itself a substantive theory. Therefore to analyse regional innovation systems it is also important to integrate those substantive theories. For this, evolutionary economic theory, regional science, the industrial district concept, the theorizing of rationalization strategies and the governance concept are important substantive theoretical elements. The theory of an evolutionary economy consists of very different approaches. However, the idea of distinguishing between basic techno-economic paradigms on the one hand, and specific trajectories on the other seems to be important.[23] Depending on the particular kind of social embeddedness, a techno-economic paradigm can lead to different development paths.[24] The Fordist paradigm, for example, led to different national production models shaped by the specific institutional environment.

Perez emphasized the importance of the connection between techno-economic process and societal change for economic growth and international competitiveness in specific territories.[25] Before a new technological paradigm can lead to any substantial rise in productivity, it is argued, a crisis of structural adaptation must be overcome. A mismatch occurs between new

[23] Dosi (1982).
[24] Granovetter (1985).
[25] Perez (1987).

technologies and the old social model of production. As old institutions and cultural patterns correspond to the requirements of the outdated technological system, they have to change if the new paradigm's productivity potential is to be fully exploited. Institutional change refers to work, organization and management practices, as well as to the education system, the financial system, the industrial relation system, etc.

The problem of an institutional gap is also taken up by the concept of lock-in: it is argued that path dependence may lead to political, structural and cognitive, ideas (lock-ins), which then become a hindrance in the search for a new technological paradigm.[26] In an economic crisis, however, there are opportunities to carry out major changes, as it becomes obvious that overcoming the crisis in the traditional development path will not be possible. The distinction between adaptive and innovative learning is also important in this context.[27] In the case of adaptive learning only a better exploitation of the options of a specific techno-economic development path is possible, while innovative learning leads to fundamental changes caused by a new techno-economic paradigm.

Regional science

The concept of regional science is important because it explains the ways regional economic processes operate to produce agglomeration, urbanization and industrialization. Economists have recently rediscovered the crucial importance of this field and labelled the discovery "new economic geography".[28] The related sub-field of industrial districts describes the characteristic patterns of successful regions by pointing to the following elements: the existence of a strong SME sector; intensive horizontal cooperation between companies; a highly qualified workforce and flexible work structure; a dense infrastructure of supportive institutions and organizations; an innovative regional culture; and, an active regional government.[29] The concept, however, also distinguishes between high- and low-road regional strategies, which means that economic actors can create an innovative system deliberately.[30]

In regional science and industrial innovation studies the focus has traditionally been on new rationalization strategies within companies. It was argued that because of the rigidities and inflexibility of the Fordist production model, new rationalization strategies, making use of the full productive and innovative potential of human beings, were needed. Those new production models were characterized by the following concepts: post-Fordism, new production models, flexible specialization and lean production.[31] [32] [33] [34] More human relations-focused work also stressed the importance of systemic rationalization, which means that the whole value-added process, including supplier and customer relationships, becomes the object of rationalization strategies.[35] More recently, though, the model of Japanese industrial organization that underplayed these concepts has itself been brought into

[26] Grabher (1993).
[27] Nystrom and Starbuck (1984).
[28] Krugman (1991).
[29] Zeitlin (1992), Pyke and Sengenberger (1992).
[30] Pyke and Sengenberger (1992), Cooke (1995).
[31] Piore and Sabel (1984).
[32] Kern and Schumann (1984).
[33] Hirst and Zeitlin (1991).
[34] Womack et al. (1990).
[35] Altmann et al. (1992).

question.[36] It is argued that Japan suffers from the legacy of learning from the West and has made too little public investment in the basic scientific research that enabled the Internet and the human genome to be such paradigmatic innovations. Japan has an innovative hidden economy of small-firm clusters, but its traditional sectors dominated by large firms are no longer competitive, these authors argue.

Governance

The analysis of governance regimes developed, at least in some measure, from economic network analysis.[37] Economic network analysis is a key part of innovation systems analysis. Governance includes the organizational forms and processes through which economic activities in a specific field are coordinated and controlled. Hierarchy, markets, networks and culture are seen as the most important types of governance. The governance concept is applied to companies as well as to their economic environment. Both, public- and private-sector governance structures are very much intertwined with each other. Therefore the economic success of companies not only depends on the intra-organizational mechanisms of coordination and control but also on the fit between them and the regional governance structure. It becomes quite clear that, to analyse regional innovation systems and their transformation, besides the general analytical framework provided by the systems concept, substantive theories are also needed. However, so far there is no single scientific discipline that covers the whole topic. Therefore an interdisciplinary approach is needed to link the different system dimensions.

Policy issues

There is a growing awareness among regional authorities that the economic growth and competitiveness of their regions depend largely on the capacity of indigenous firms to innovate. Offering the appropriate support to indigenous firms to become more competitive through innovation is a rising star on the regional policy agenda. Policy-makers at local and regional levels are formulating regional technology strategy, which sometimes is embedded in their economic development policies, and sometimes is separate from other policy domains. There is a clear need for support in the design of regional innovation policies, both from an analytical perspective and based on experiences and best practices in regions around the world.

There are several issues at stake.

a. Regional authorities do not have access to the full-scale innovation policy instruments available on the national or supranational (e.g. EU) levels, because of limited budgets and responsibilities.

b. It is only a recent phenomenon that regional policy-makers are developing strategic technology plans, and so they have not been able to gain much experience or establish best practice yet. Many regional initiatives are individual projects, without a coherent policy back-up.

[36] Porter et al. (2000).

[37] Lindberg et al.(1991), Hakanson and Johanson (1993), Hooghe (1996), Marks et al. (1996), Cooke et al. (2000).

c. Very often the innovation needs of the firms in the region have not been systematically assessed. This results in an insufficient interaction between industry and the innovation support system. The effectiveness of the innovation support system, in terms of its economic contribution to growth, may be improved when this mismatch is overcome.

One of the assumptions of the regional innovation systems approach is that many innovative firms operate within regional networks, cooperating and interacting not only with other firms such as suppliers, clients and competitors, but also with research and technology resource organizations, innovation support agencies, venture capital funds, and local and regional government bodies. Innovation is a learning process that benefits from the proximity of organizations that can trigger this process. Regional authorities have an important role to play to support this learning process by offering services and other mechanisms that augment the interlinkages between all these actors. The diffusion of knowledge, information and technologies is for a large part transferred through regional channels, alongside national and international channels. The character of these networks and their geographic scale differ between industrial sectors and between regions. They are not static but adapt to the strategic needs of the firms and can expand or contract. This makes for a good understanding of the changing environment of the global economy in which the regional firms operate.

There are three key policy areas where public authorities perceive a need for policy development towards regional innovation systems. First, the concept of a regional system of innovation helps public authorities to focus on their present industrial strengths and to develop a strategy for the future based on those strengths. In addition to studying traditional indicators for innovativeness, such as the research and development (R&D) intensity of the firms, the amount and character of R&D expenditures, the presence of new technology-based firms and so on, the systemic approach looks at the linkages between firms and between firms and the science and technology (S&T) infrastructure. It thus distinguishes clusters of innovative activity, in industrial sectors that are not necessarily known as high-tech but which have good competitive potential. The study of potentially strong inter-firm clusters within the region offers the public authorities a framework to focus their support efforts, alongside generic support actions.

Second, a systemic and integrated analysis of both the firm side (i.e. global competition challenges and innovation needs) and the supply side (i.e. innovation support in its widest sense) contributes to the design of a coherent public innovation strategy. Since the experience with regional innovation policy is relatively young in many regions, present efforts are often a collection of one-off initiatives. Furthermore, in the last decade the insights from evolutionary economics and innovation policy literature have shown that innovation policy involves much more than R&D funding alone. Particularly for SMEs, the support needs include technological assistance, innovation management, access to risk capital, access to R&D results, short-term access to tacit knowledge, and information on patents and licences, to name a few key aspects of the innovation process. For each region the appropriate mix of public and private support agencies that can offer assistance in these areas is different. An analysis of what type of support is available for regional firms reveals whether the region should extend its package of innovation support in areas that have been disregarded up to now.

Third, the concept of a system also helps to clarify what type of support is to be set up at which policy level (local/regional/national/transnational) and what the possibilities for inter-regional cooperation are. Each type of industry has different support needs and different geographical scopes for their production networks and for their links with the innovation support system. Firms operating on an international scale will easily find access to R&D on the national or even international level. For the regional authorities it is important to have a clear view of the geographical level at which the firms in their regions operate. In times of increased global economic integration and tighter public budgets, it seems ineffective for regions to aim to duplicate small-scale national innovation systems within their own boundaries. Again a closer look at the character of the innovation needs and competitive challenges at the company level, combined with the geographical scope of the clusters in the region, provides arguments about what regional authorities should offer themselves, and what could be done in cooperation with other regions or be left to the market or some higher authority. In addition, cross-border regional cooperation could be a good option for those regions where firms are closely interlinked with suppliers or customers just outside the country's borders.

Regional innovation strategies, policies and programmes: governance and experimentation

In some development contexts, centralized control of innovation infrastructures may mean that systemic linkages do not develop sufficiently because other economic priorities such as exchange-rate policy or macro-economic policy suffer fluctuations which make regularizing systemic relationships of embeddedness difficult. In other cases, where take-off has been achieved, the same kinds of pressures can inhibit central government from promoting innovation. Regional innovation, in contexts where regional governance exists, may come to be seen as a key source of policy experimentation, along lines argued in the "laboratories of democracy" theme of Osborne[38] and Osborne and Gaebler.[39] Detailed analyses of emergent regional innovation systems in the Republic of Korea by Hassink reveal a political perception that regional experimentation should be stimulated to correct atrophy in innovation at the centre. [40] Part of the Porter et al. analysis points to the importance of federalizing the administrative mind, something adumbrated in a study of regional innovation in Japan's Tohoku region. [41] [42]

A strong, regionalized innovation system is one with systemic linkages between external as well as internal sources of knowledge production (universities, research institutions, and other intermediary organizations and institutions providing government and private innovation services) and firms, both large and small. Most regions do not have these systemic innovation characteristics. Also, some small countries have equivalent weaknesses in

[38] Osborne (1988).
[39] Osborne and Gaebler (1992).
[40] Hassink (1999, 2000).
[41] Porter et al. (2000).
[42] Abe (1998).

their national systems. Broadly speaking, the key dimensions of a regionalized innovation system are: first, the processes and policies supporting education and knowledge transfer; second, arrangements for the governance of innovation; third, the level of investment, especially in R&D; fourth, the type of firms and their degree of linkage and communication, in terms of networking, subcontracting, presence or absence of supply chains and degree of co-makership between customers and suppliers. These dimensions of regional innovation systems analyses will be deployed in the empirical studies provided below (and Tables 1-3). Essentially, and with significantly less control and more complications, a functioning regional innovation system replicates the organizational capability internalized in the large corporation in the externalized relationships of supply chains, horizontal networks, university-industry relationships and the host of marketized and public intermediaries that sell or supply innovation-relevant services. However, the focus on innovation, rather than the panoply of functions involved in industrial organization more generally, means that it is possible to have regional innovation strategies that build towards more systemic regional innovation.

Regional administrations vary in the nature and degree of their autonomy, especially in DCs where they are often weak. The strongest in developed-country settings, such as states in the United States or Australia, for example, or the *länder* of Austria and Germany, are associated with rich, regionalized intermediaries like chambers of commerce, trade associations, regionalized union branches, banks, etc. They also tend to have active innovation policies. Elsewhere regions are weakly developed or, as in Italy, democratically controlled but with limited innovation support capacity and, in most cases, a passive stance towards it. Most small countries are weakly regionalized, and may well have a government science and technology policy, but linkage with industry may be weak or focused on traditionally leading sectors dominated by large firms. This is especially so in mission- rather than diffusion-oriented systems.[43] A mission-oriented system is highly focused on innovation in a specific technology-set, such as aerospace, and a particular goal such as making a moon landing, or building supersonic commercial aircraft. A diffusion-oriented system is more geared to generic process innovation that can spread into many sectors.

National innovation trajectories

Regional economies vary in their typical structure for size of company: some are overwhelmingly dependent on SMEs, others have a mix of large firms and SMEs. Inter-firm interaction, too, varies from the tight small-firm networks typical of industrial districts to arm's-length exchange relationships commonly found in *laisser-faire* settings. Where a reasonable number of larger companies is present there may be strong vertical supply-chain relationships such as those associated with *keiretsu* in Japan and *chaebols* in the Republic of Korea, or there may be few large-firm interactions with indigenous SMEs, as typically has been the case in branch-plant regional enclaves of routine assembly factories owned by multinationals

[43] Ergas (1987).

headquartered elsewhere. In Table 1, an attempt is made to categorize some key innovation system indicators, highlighting diverging degrees of interaction for innovation at the national innovation system level. The Republic of Korea and Brazil are selected as examples of economies with distinctive innovation trajectories in the 1980s and these are provided primarily for illustrative purposes. The key policy and interactive practices acted as conditions for the different innovation and competitiveness trajectories at that time. Thereafter, changes occurred, with both economies severely caught up in the financial meltdown of 1998, out of which, especially in the case of the Republic of Korea, a regional innovation systems perspective emerged more strongly, although in Brazil too, more cooperative forms of competition are now evident.[44]

Table 1. Divergence in national systems of innovation, 1980s

Innovation system indicators	*Republic of Korea*	*Brazil*
Education	Expanding universal system, high tertiary and engineering graduate output	Deteriorating education system with low output of engineers
Knowledge transfer	High imports with local integration and rising firm R&D	High imports from United States but weak local integration and firm-level R&D
Business R&D	Rising to >50 per cent of all R&D	Remains below 25 per cent of all R&D
Linkages	Strong S&T infrastructure linked to R&D	Weakening S&T infrastructure and poor company linkages
Investment	High and supplemented by Japanese inward FDI. High learning from Japan	Decline of United States investment, low internal investment and low learning from abroad
Communications	High investment in advanced telecommunications infrastructure. High growth in electronics, high exports and user-feedback.	Slow development of modern telecommunications. Weak electronics, low exports, low learning

Source: Adopted from Freeman (1995).

The narrative here is clear in that a large part of the explanation for divergence between these economies (and this can be extended to East Asia/Latin American economic performance contrasts, more generally) is assigned to fundamental financial and property-ownership reforms in the Republic of Korea, absent in Brazil, that created a larger entrepreneurial class

[44] Schmitz (1999), Altenburg and Meyer-Stamer (1999), Bell and Albu (1999).

and through universal education, thorough structural and technical transformation. This enabled the entrepreneurial class to access the capital to invest in innovation. Of course it has since also become clear how deeply the state in the Republic of Korea was implicated in financing the growth strategy using the *chaebols* as the financial and production vehicle. It is noteworthy that Krugman queried the sustainability of the East Asian growth model, seeing the large investments associated with universal education and consequent corporate innovation as a one-off catch-up mechanism that could not again produce the same rapid rates of productivity increase.[45] Interestingly, from a globalization viewpoint, the strategy of the Republic of Korea had pervasive effects in advanced-economy regions that had targeted Asian inward FDI from Japan and, later, the Republic of Korea (a case in point being Wales, United Kingdom), but it also applied to Catalonia in Spain, another of Europe's hosts to the likes of Sony, etc.

The arrival of Sony and other consumer electronics corporations from Japan, like Hitachi, Aiwa, Panasonic and Matsushita, in Wales in the 1970s, with stimulus from the regional administration and development agency, led to the beginnings of a regional innovation strategy in which embedding the branch plants through assisting sourcing and supply-chain development, thus building global production nets, formed a part. Supplier firms were helped by customers and public intermediaries to reach the exacting new requirements of producers from Japan. Where indigenous firms left gaps, supplier transplants were encouraged in subsequent rounds of inward investment. Panasonic's consumer electronics components arm was one such firm to transplant, supplying both the Panasonic TV assembly plant but also non-Panasonic customers. The exacting interaction between customers and suppliers rested on the quality-cost pressure applied, whereby suppliers like Panasonic would be required constantly to reduce their parts-per-million defects while also offering a 3-4 per cent annual cost reduction. Eventually, Panasonic had to vacate the market for many components and was substituted by suppliers from the Republic of Korea. It was widely understood in the industry that the latter were able to do this at less cost than those from Japan because of massive subsidies from the government of the Republic of Korea. The recovery in regional component prices after the meltdown of the Republic of Korea economy caused Panasonic and Sony drastically to cut their workforces in Wales and seek suppliers and new plant locations in Eastern Europe.[46]

The Republic of Korea and Brazil

We can look into examples of regional system building to enhance innovation and competitiveness of firms by exploring recent accounts of efforts made in the specific regions of Kyongbuk-Taegu in the Republic of Korea and Santa Catarina in Brazil. Subsequently comparative accounts will be drawn to indicate regional innovation system variety from Northern Ireland, part of the United Kingdom that suffers sectarian political conflict and is economically peripheral, and the Féjer region, a successful development region in Hungary

[45] Krugman (1994).
[46] Cooke and Schall (1997), Cooke et al. (2000).

where market processes have been more important than regional public intervention in the transition to systemic innovation capability.

It is important to bear in mind the fact that regional innovation systems are unusual in the sense of not being present in many countries, and that where they exist or have at least some key characteristics of systemic interaction focused on innovation, they are diverse in nature.[47] They may be dominated by a major industry, such as aerospace in Midi-Pyrénées, France, with its strong regional supplier linkages and connections to public or private research laboratories and higher education. Alternatively, as with many industrial district regions, there may be few direct links to research laboratories but many to various intermediaries and service providers, including regional and local public providers. In such distinct circumstances the collective order or governance of the system may be animated by a large corporation or group of larger firms, or by mainly private chambers of commerce and business associations, as in the "white" politically right-wing or conservative regions of Italy, like Veneto, or, alternatively, more collective, associational partnership arrangements between firms, governments and intermediaries as in "red", politically left-wing Emilia.[48]

Kyongbuk-Taegu: government-led

Kyongbuk-Taegu is located in the heavily industrialized southeastern part of the Republic of Korea. The region is dominated by two industrial complexes, led by *chaebol*, in electronics and textiles in one location (Kumi) and steel in the other (Pohang). The former consists of numerous branch plants and the latter has a large steelworks and numerous steel-consuming customers clustered around it. National government policies of supporting large corporations were mostly responsible for the region's development profile. It had lower than average unemployment, at 6.3 per cent compared with 7.4 per cent, in 1998, but lower R&D personnel and university expenditures. However, the regional public expenditure on S&T is close to the average of 2.6 per cent, at 2.5 per cent of budget. Hassink distinguishes three stages of innovation support: general information, technological advice and joint R&D projects.[49] The first two are met, to a large extent, by the Small & Medium Business Administration (SMBA) set up by the government's Ministry of Trade and Industry in 1996. The network of 11 regional offices runs support initiatives and coordinates SME policies from other ministries, such as the Ministry of Science and Technology. Another agency concentrating on the support and information function is the Small & Medium Industry Promotion Corporation, (SMIPC), a not-for-profit agency also of the Ministry of Trade and Industry, dating from 1979. It now is subordinate to SMBA but firms use its services more, notably for technical assistance.

Third-stage, joint R&D, services are supplied by three regional research centres (RRCs), in high-quality automated electronic parts, high-sensitivity polyester products development and automotive parts technology – the Ministry of Science & Technology established these. They aim to upgrade research facilities at universities, encouraging them to partner SMEs in research projects. Hence, the RRCs are rather more visionary in providing an innovation infrastructure supply ahead of demand, whereas the earlier-stage support and information agencies are meeting a pre-existing demand. Other Ministry of Trade and Industry measures applying to this region include the

[47] Cooke (1998).
[48] Cossentino et al. (1996).
[49] Hassink (2000).

SMBA-managed Industry-University-Government Research Institute Consortium, which encourages the use of university and other laboratories by SMEs, and two techno parks to add to the existing science town at Taejon in the region. Municipalities help fund two specialist industrial research institutes, in textile dyeing and textile development.

It can easily be seen that this is regional innovation architecture with systemic linkages within specific industry agglomerations that is almost wholly dependent upon central government's *dirigisme*. The role of the market is limited except in so far as other firms supply most technical assistance for innovation, mainly through the supply chain. This is an interesting indication of the regionalization of public services to assist innovation upgrading in SMEs in contexts where hitherto relatively closed *chaebol* were the main initiators and carriers of innovation. Even in successful newly industrialized countries such as the Republic of Korea, the market does not recognize or take early steps to create a demand for innovation services. Hence the central state is forced to play the role of the ideal collective capitalist, something that was hotly debated in Italian regions when the Berlusconi government of the early 1990s began questioning the existence of public innovation support systems in politically left-wing regions, supported by the national business association Confindustria. This was rejected, notably in "red Emilia", as pure political opportunism from an entrepreneurial class that had failed to anticipate the growing importance of knowledge-intensive services to business. Nevertheless, to offset possible legislative intervention from the centre, auditing and competitive tendering for service centre status was introduced along with other efficiencies. The Republic of Korea generally, and Kyongbuk-Taegu in particular, have somewhat different industrial structures from those of Italy, but it is nevertheless notable that public innovation-service provision has taken precedence over market processes in both cases. This is unlike high-technology districts like Silicon Valley or Cambridge (United Kingdom), where venture capital is abundant and private services thrive even though risks are high.[50] Hassink says that in the Republic of Korea generally, heavy centralization has meant SME networks are remarkably weak. [51]

Santa Catarina: market-led

Regional innovation in Brazil depends on the presence of industry clusters, especially those in contact with foreign markets. The case of textiles and garments and other clusters in Santa Catarina is taken as an exemplar by Altenburg and Meyer-Stamer.[52] In 1997 many firms were experiencing acute competitive pressures and massive losses were being incurred in a business community that had hitherto shown no strong interest in systemically interactive innovation practices, but rather had succeeded by individualistic competitive means. The crisis caused the state industry federation to engage the Swiss Institute for Management Development (IMD) to assist in the generic organizational innovation of international benchmarking. This showed that the best seven firms were at the same level as Europe's laggards in the equivalent industry. Innovations were envisioned by such firms but often not successfully implemented. One reason for this was insufficient attention to the value of collective compared to individualistic action. Unlike in the example of the Republic of Korea, the regional industry federation initiated support and intervention. An international trade centre supplied

[50] Keeble and Wilkinson (1999).
[51] Hassink (2000).
[52] Altenburg and Meyer-Stamer (1999).

technological information and advice. In also supplying international trade statistics, the centre monitored and advised on those technical norms, such as ISO14000, that regulated environmental standards.

There are in firms frequently suffer skills deficiencies that cannot satisfactorily be overcome by individual firms acting alone. This problem faced the electro-mechanical engineering cluster in Santa Catarina. In this case the local chamber of industry and commerce deployed good network linkages with the training infrastructure to encourage a federal polytechnic to establish specialist courses to tackle areas of skills deficiency. With regard to upgrading innovation capability, the ceramics cluster and the regional industry federation established, in cooperation with the Federal University of Santa Catarina, a Centre for Ceramics Technology modelled on that set up by the Valencia Regional Administration in Castellon, Spain, itself modelled on that in Sassuolo's ceramics district in Emilia-Romagna, Italy. The university relocated a laboratory to the centre, intended to provide testing and certification services, but it will eventually be fully engaged in technology development.

Table 2. Regional innovation policies and actions in the Republic of Korea and Brazil, 1998

Indicator	*Kyongbuk-Taegu*	*Santa Catarina*
Education	Universal system, lower than average tertiary-level expenditure	Skills inadequacies needing collective action and response
Knowledge transfer	*Chaebol* branch plants, but public funding for SME innovation infrastructures	Openness to international learning, advice and exemplars
Business R&D	Private lower than national R&D expenditure, public S&T expenditure average	Low and dependent on collective public provision of research facilities
Linkages	Public S&T infrastructure linked to cluster specialisms	Crisis of competitiveness producing more collective output and inter-firm associativeness
Investment	Central state "guided capitalism" moving to regional support for innovation in SMEs	Industry losses reduced investment but led to search for cooperative investment infrastructure
Communications	Electronic networks installed but socio-economic networks weak among SMEs	Industry federation well-linked to global advice and information, and advising SMEs accordingly

Sources: Based on Hassink (2000), Altenburg and Meyer-Stamer (1999).

Clearly, there is much more of a ground-up feel to the actions taken to improve different aspects of the business of these three Santa Catarina clusters. The federal and regional states are noticeable by their absence from involvement. Initiative is taken in a grassroots way by representative private-sector bodies, although the federally funded higher-education sector was brought in to help solve at least two of the problems that caused collective action to be explored in contexts where arm's-length exchange was culturally more traditional. Importantly, the small systemic elements focused on clusters were receptive to international experiences; hence this can be considered to be a set of localized industry clusters open to the influences of economic learning and institutional borrowing. It is difficult to argue that Santa Catarina represents a fully functioning regional innovation system, but at sub-system levels centred on clusters it reveals a consciousness of the value, for global competitiveness, of an open disposition towards collective action for systemic innovation. Between them, Kyongbuk-Taegu and Santa Catarina represent virtual polar opposites in respect of the nature of innovation pursued and the governance model by means of which actions may be taken forward. The contrast between top-down and ground-up, public action and private action, large- and small-firm clusters could scarcely be more pronounced.

Northern Ireland: public and private

The material above has alluded to the variation between the administratively decentralized but institutionally highly centralized public mode of innovation governance in the case of the Republic of Korea, and the localized, private and associational mode of innovation governance in Santa Catarina. Northern Ireland is interesting because, although it is a territory of the United Kingdom, a developed country, it has been one of Europe's less developed regions, driven by political strife for many years and recently given devolved powers by the United Kingdom's government in a power-sharing Assembly. Until this occurred, the regional innovation system, to the extent it existed, displayed a strongly pyramidal structure, something that is changing a little with the devolved governance of innovation. This means it remains heavily dependent on public policy, public intervention through grant allocation mechanisms and public agencies determining the actions deemed appropriate for achieving strategic goals. There is consensus for goals of modernization through an emphasis on building clusters in advanced industries like aerospace, ICT software and biomedical engineering.

The Department of Economic Development's "Strategy 2010" document encapsulates the shared aims of government and industry, with most of the former and many of the latter being directly reached by tactical initiatives to implement aspects of it. The Industrial Research and Technology Unit (IRTU) is important because it has innovation as one of its major remits. It is small and at the limits of its capabilities to meet what will soon be a significantly growing demand for its services. It is likely that the IRTU will have a strategic role in a new integrated economic development body for Northern Ireland, because innovation is indeed the golden thread running throughout the future knowledge-driven economy. From innovation come competitiveness, productivity growth and rapid new firm formation, all things

badly needed in the economy. It will require enhanced budgetary and staffing resources to meet the imperatives of the knowledge-driven economy now emerging in Northern Ireland.

The innovation pyramid narrows towards the top because innovation becomes attenuated as the company sector is approached. A large tail of innovation under-achievers occupies a sizeable segment of the industrial structure, but in terms of innovation it is small. Multinationals have a central economic role but not all are innovative, although those that are may be near the global leading edge, but not much of that innovation content is sourced in Northern Ireland yet. One exception is the case of Short's, acquired in the 1990s as a viable commuter aerospace company by Bombardier of Quebec, Canada. Old-economy innovators, especially in clothing and textiles (Northern Ireland was once a major world-leading linen producer), are interesting, but few in number, as are new-economy innovators. A case of innovation in a global supplier network between Northern Ireland and Asia shows how the demands of complex organization require local technical solutions, in this case from engineers at Colombo University, Sri Lanka.[53]

Desmonds is an old-established Northern Ireland family firm dating from 1885, with 16 plants managed from its head office in Derry. Most of the output supplies Marks & Spencer, the United Kingdom retailer. A small portion of output is contracted to the Ralph Lauren and Tommy Hilfiger labels. Some 2,400 are employed in Northern Ireland, 1,750 in overseas joint ventures and a further 1,250 in overseas strategic alliance firms. Overseas partners are predominantly in Sri Lanka, Turkey and Bangladesh, and there are trials under way in South Africa. Desmonds is a registered member of the Ethical Trading Initiative.[54] Northern Ireland's Queen's University incubator firm Kainos innovated a global trading software system for the company with research funding from the IRTU. Accordingly, production turnaround from fabric arrival to garment dispatch was cut from four weeks to four hours. Other product innovations like bonded fleece were developed with the Hong Kong SAR firm Golden Sky, taking the latter's concept to the product development stage. The pace of change means that innovation may be hampered when an overseas affiliate finds it difficult to respond swiftly to market shifts. The firm successfully commissioned Colombo University's textiles engineering department to produce local solutions to the need to increase supply-chain efficiency in response to the new, faster ordering system. This satisfies its aim to remain in Northern Ireland because of all the business re-engineering it has undertaken. This is allied to its embeddedness in the regional innovation support infrastructure involving the IRTU and the universities, along with support from the United Kingdom's government in lobbying the EU to stop discriminating against Sri Lankan production. But the company also highly values established links to the textile production-engineering centre at Colombo University.

Thus Northern Ireland's innovation pyramid's base is both broadly and deeply in government, including governments and markets in foreign locations. Through universities there are growing links between incubators and new-economy innovators.

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[53] Cooke et al. (2001).

[54] An initiative that supports trading in goods and services that are not result of child labour and other morally dubious practices.

These are capable of developing new sectors such as software themselves and they can find solutions to old-economy problems, with innovative implications worldwide. But locally, the capability to compete through innovation also requires the emergence of a new dimension for the public innovation pyramid. This involves university research, spinout firms, incubation facilities and venture capital to fund the growth of new companies. This is in place and is being augmented by the Northern Ireland Science Park Foundation that will help establish growth firms in different parts of Northern Ireland. The private sector is fully engaged in this, led by local venture capitalists, who syndicate with other investors, also with banks if loans are required, and who frequently involve public grant subsidies as part of the investment package. In this way, the traditional public, centralized funding and governance of innovation are being complemented and changed by the demand for more market-oriented innovation support actions to respond to global competition. This is a pointer to a more flexible, responsive and swift-moving model of regional innovation governance, especially in rather *dirigiste* settings like Kyongbuk-Taegu, but also in possibly more receptive private-sector systems such as Santa Catarina.

Hungary's Féjer region: FDI-led

Located south-west of Budapest, this region has been one of Hungary's most successful locations for Western companies seeking production and marketing bases in Central and Eastern Europe. By 1993, foreign direct investments from firms like Ford, Opel, Audi and Keiper-Recaro in automotive engineering, and Philips, Nokia and IBM in electronics was already substantial. Alcoa was also there producing aluminium. The region has a few decentralized offices but could not be said to have a meaningful public base of regional innovation institutions. It has a regional development council, an economic development marketing office and a branch of the national technological development committee, responsible for coordinating research activities and financing innovation in firms and research institutions. Together, though, these governance mechanisms were sufficiently valuable to enable these blue-chip foreign investors to perceive Féjer as a receptive location. One key way in which this occurred was through the elaboration of local supply chains of firms in tune with the exacting requirements of these corporate giants. Though numerous smaller, entrepreneurial firms existed before the arrival of the inward investors, organizational and technical capabilities were rapidly and successfully upgraded. A branch of the Hungarian Development Bank charged with financing targeted sectors such as automotive and electronic engineering SMEs had already begun playing an important role in the upgrading process.

Such is the influence of the multinationals that they are, in effect, the innovation governance institution for the region. Training and consultancy firms of modest scale, in addition to the public bodies discussed, work to meet the requirements of the inward investors. For innovation the multinationals had been typically self-contained, though the global move to outsourcing was beginning to mean they were showing interest in any appropriate national innovation infrastructures by the end of the millennium. However regional resources, whether public centres of technology,

universities or governance bodies, were not of great interest to foreign firms in the late 1990s. The regional vision was one geared largely to having local firms play a development role as partners of large multinationals, assisting them to build a robust base.

To the extent that this involved upgrading local supplier SMEs, there has been some partial innovation system-building, but there is always a risk with such a reliance on transplants (e.g. FDI in routine assembly factories of multinationals with headquarters elsewhere) that if and when they go away, the system so painfully put in place is left high and dry.

Table 3. Regional innovation policies and actions in Northern Ireland and Hungary, 1998

Indicator	*Northern Ireland*	*Féjer region*
Education	Selective system, high-quality elite attracts FDI, leaves long tail of lower skills	Technical skills universal and in demand but for lower-order FDI-led occupations
Knowledge transfer	Through branch plants, but indigenous incubation from university research developing	Entirely founded on branch-plant based limited SME upgrading regionally
Business R&D	Low due to branch plants and under-innovative SMEs. Public-sector R&D reasonably high	Low because of branch-plant economy and lack of demand or supply in university research
Linkages	Public S&T infrastructure linked to firm and cluster specialisms	Vertical through multinational supply chains. No public research linkage
Investment	Public-sector innovation pyramid moderating with spin-outs and venture capital	FDI and limited indigenous development bank finance for SME upgrading
Communications	High-grade, suitable for massive bandwidth usage by optical networking research. Economic networks weak	Outdated but capable of sustaining FDI engineering needs. Economic networks vertical to FDI

Sources: Based on Cooke et al. (2000, 2001).

This absence of connection between regional knowledge centres and leading global firms so often characterizes such externally dependent system building. Here the contrast with Kyongbuk-Taegu, Santa Catarina (Table 2) and Northern Ireland (Table 3) is pronounced. Although pursuing different paths, one more public, one more private, the other in partnership, each was trying to create space for innovation by indigenous businesses to some degree (less in Santa Catarina), independently of old- economy sectors. The opportunity for this in the Féjer region in Hungary was less because of its transitional nature. But attention to the prospects for less dependent upgrading of indigenous businesses could be overdue. Féjer regional colleges perceived that they played a negligible formal role in innovation policy, let alone innovation activity, something definitely untrue in, for example, Santa Catarina.[55] But problems of transition included, *inter alia*, the dominance of

[55] Cooke et al. (2000).

foreign capital, the low technology of the inputs required from indigenous firms by the multinationals, the lack of receptivity of colleges and universities to working with industry and the low value of their research to industry, accordingly. Creating a regional innovation system was also accorded a very low priority by regional authorities in Féjer region. Hence this is a good example of enclave innovation, where global businesses produce reasonably advanced, not necessarily leading-edge, products using lower value-added inputs from a dependent supply chain that has been helped to upgrade by local private- and public-enterprise support services. Links between this sub-system and higher education are extremely weak and demand for such cooperation is as weak as supply. Nevertheless, this region is performing well in its enclave innovation role, although how sustainable the strategy is remains to be seen.

Conclusion

The strategic intellectual and policy concept of regional innovation systems has been introduced, defined and put to work in analytical and action-related terms. It has been shown to be a new concept, postdating that of national systems of innovation, which has been intellectually important, if difficult to apply empirically except in small, regional-scale countries such as in Scandinavia. For some time, possibly because of this, the idea of regional innovation systems was rather neglected, if not resisted. However changes in the macro-economy in the 1990s mean that the idea of national economic sovereignty, if it ever had any real meaning, has certainly lost it with the rise of global competitiveness in a world order of liberal trade and instantaneous financial transactions flows. The new world economic order now tends to privilege the regional as the correlate of global, because of the rise to prominence of globally competitive regional and local industrial clusters. These are often telescoped versions of regional and even national innovation systems, especially where science-based, as with biotechnology and ICT. They have strong vertical and horizontal inter-firm linkages in supply chains or for joint technology development. Such phenomena are quite pronounced in DCs.[56] But as they develop, at least in new-economy hot spots, they draw on a rich infrastructure of consultants, lawyers, management accountants, venture capitalists and other knowledge-intensive business services (KIBS).

In less developed settings such support infrastructures tend to be absent, and the public sector substitutes with less effectiveness, perhaps, with grants, technology centres and business advice. This is because of market failure by KIBS to spot early evidence of demand, especially in clusters; hence the public sector has to be the innovative provider despite lack of experience and expertise. This is even more the case with regional innovation systems, operating at a sufficient scale to cover many clusters and other forms of industrial organization, like agglomerations, company towns and multinational enclaves. In quite accomplished advanced-economy regions, the regional administration, university funding, research funding, technology-transfer services, research institutes and the training system are all heavily dependent on public initiative. It is only the more knowledge-based and high-

[56] Schmitz and Nadvi (1999).

tech of regions, like California, Bavaria, the Thames Valley or Massachusetts, where many services are private. So this is the trajectory. As regions develop and demand for sophisticated services (KIBS) rises, so such services will concentrate nearby. They may arrive later than public services, but they will ultimately rise to prominence over them. So what is sometimes called the "knowledge generation and diffusion" sub-system, which complements the "knowledge application and exploitation" sub-system, becomes more and more a mix of private and public support, while that connected to knowledge application and exploitation becomes ever more marketized.

In applying this analysis to four developing regions in Asia, Europe and Latin America, it was instructive to note how variable specific regional innovation systems may look, even if they may not yet warrant being designated systems but show signs of some kinds of cooperation or limited systemic interaction. There are different routes along the trajectory to regional innovation system status, and maybe different types of trajectory and destination. In brief, by looking at such dimensions as education, knowledge transfer, R&D, linkage, investment and communications, it is possible to detect more strongly public as compared with more marketized system cultures. Thus Kyongbuk-Taegu is at an earlier stage away from the FDI/ multinational dependency trajectory transition to support for indigenous, innovative SMEs than Northern Ireland, which is well short of, let us say, the Thames Valley in the United Kingdom. Equally, Santa Catarina could be said to be more advanced in some ways than the Féjer region in Hungary, because it discovered the virtues of private-led institutional actions to build inter-institutional cooperation as a governance mechanism, whereas Féjer's governance order was happy to develop a kind of handmaiden capacity for leading multinationals for innovation, because of the undoubted economic benefits that accompanied the enclave innovation of the inward investing type. Féjer therefore has some ground to make up on all three of the other regions studied here, in terms of innovation governance. However, it is stronger than most, possibly even than the Korean example, in the nature and newness of the inward investment it has received. By combining the strong points of each case studied, policy-makers could produce an interesting, profitable yet flexible vision of the role regional innovation systems thought can play in their economic destiny.

References

Abe, S., "Regional innovation systems in Japan: the case of Tohoku", in H. Braczyk, P. Cooke and M. Heidenreich (eds) *Regional Innovation Systems* (London, UCL Press, 1998), pp. 286-318.

Altenburg, T. and J. Meyer-Stamer, "How to promote clusters: policy experiences from Latin America", *World Development* 27 (1999), pp. 1693-1714.

Altmann, N., C. Kohler and P. Meil, eds, *Technology and Work in German Industry* (London, Routledge, 1992).

Bell, M. and M. Albu, "Knowledge systems and technological dynamism in industrial clusters in developing countries", *World Development* 27 (1999), pp. 1715-1734.

Commission of the European Communities (CEC), *Green Paper on Innovation* (Brussels, CEC, 1995).

Cooke, P., "Regional innovation systems: competitive regulation in the new Europe", *Geoforum* 23 (1992), pp. 365-382.

Cooke, P., "Introduction: origins of the concept", in H. Braczyk, P. Cooke and M. Heidenreich (eds) *Regional innovation systems* (London, UCL Press, 1998), pp. 2-25.

Cooke, P., *Knowledge Economies: Clusters, Learning and Co-operative Advantage* (London, Routledge, 2002).

Cooke, P., ed., *The Rise of the Rustbelt* (London, UCL Press, 1995).

Cooke, P., P. Boekholt and F. Tödtling, *The Governance of Innovation in Europe: Regional Perspectives on Global Competitiveness* (London, Pinter, 2000).

Cooke, P., S. Roper and P. Wylie, *Regional Innovation Strategy for Northern Ireland* (Belfast, Northern Ireland Economic Council, 2001).

Cooke, P. and N. Schall, *How do Welsh Firms Innovate?*, Regional Industrial Research Report No. 29 (Cardiff, Centre for Advanced Studies, 1997).

Cossentino, F., F. Pyke and W. Sengenberger, eds, *Local and Regional Response to Global Pressure; the Case of Italy and its Industrial Districts* (Geneva, International Institute for Labour Studies, 1996).

Dei Ottati, G., "Prato and its evolution in a European context", in R. Leonardi and R. Nanetti (eds) *Regional Development in a Modern European Economy: the Case of Tuscany* (London, Pinter, 1994).

Department of Trade and Industry (DTI), *Biotechnology Clusters* (London, DTI, 1999a).

Department of Trade and Industry (DTI), *Genome Valley: the Economic Potential and Strategic Performance of Biotechnology in the United Kingdom* (London, DTI, 1999b).

Dohse, D., "Technology policy and the regions: the case of the BioRegio contest", *Research Policy* 29 (2000), pp. 1111-1133.

Dosi, G., "Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technological change", *Research Policy* 11 (1982), pp. 147-162.

Edquist, C., *Systems of Innovation: Technologies, Institutions and Organizations* (London, Pinter, 1997).

Ergas, H., "The importance of technology policy", in P. Dasgupta and P. Stoneman (eds) *Economic Policy and Technological Performance* (Cambridge, Cambridge University Press, 1987).

Freeman, C., "The 'national system of innovation' in historical perspective", *Cambridge Journal of Economics* 19 (1995), pp. 5-24.

Gereffi, G., "Commodity chains and regional divisions of labour in East Asia", *Journal of Asian Business* 12 (1996), pp. 75-112.

Grabher, G., ed., *The Embedded Firm: On the Socioeconomics of Industrial Networks* (London, Routledge, 1993).

Granovetter, Mark, "Economic action and social structure: the problem of embeddedness", *American Journal of Sociology* 91, 3 (1985) pp. 481-510.

Hakanson, H. and J. Johanson, "The network as a governance structure: interfirm cooperation beyond markets and hierarchies", in G. Grabher (ed.) *The Embedded Firm: On the Socioeconomics of Industrial Networks* (London, Routledge, 1993).

Harvie, C., *The Rise of Regional Europe* (London, Routledge, 1994).

Hassink, R., "South Korea's economic miracle and crisis: explanations and regional consequences", *European Planning Studies* 7 (1999), pp. 127-143.

Hassink, R., "Regional innovation support systems in South Korea and Japan compared", *Zeitschrift für Wirtschaftsgeographie*, 44 (2000), pp. 228-245.

Hirst, P. and J. Zeitlin, "Flexible specialisation versus post-Fordism: theory, evidence and policy implications", *Economy and Society* 20 (1991), pp. 1-56.

Hooghe, L., ed., *Cohesion Policy and European Integration: Building Multi-Level Governance* (Oxford, Clarendon Press, 1996).

Johnson, B., "Institutional learning", in B. Lundvall (ed.) *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning* (London, Pinter, 1992), pp. 23-44.

Keeble, D. and F. Wilkinson, "Collective learning and knowledge development in the evolution of regional clusters of high technology SMEs in Europe", *Regional Studies* 33 (1999), pp. 295-303.

Kern, H. and M. Schumann, *Das Ende der Arbeitsteilung?* (Munich, C.H. Beck Verlag, 1984).

Krugman, P., *Geography and Trade* (Cambridge, MA, MIT Press, 1991).

Krugman, P., "The myth of Asia's miracle", *Foreign Affairs* (November-December 1994), pp. 63-75.

Lindberg, L., J. Campbell, L. Hollingsworth and J. Rogers, "Economic governance and the analysis of structural change in the American economy", in J. Campbell, L. Hollingsworth, L. Lindberg, and J. Rogers (eds) *Governance of the American Economy* (Cambridge, MA, MIT Press, 1991).

Lundvall, B., ed., *National Systems of Innovation; Towards a Theory of Innovation and Interactive Learning* (London, Pinter, 1992).

Marks, G., F. Scharpf, W. Schmitter and W. Streeck, *Governance in the European Union* (London, Sage, 1996).

Nelson, R., and S. Winter, *An Evolutionary Theory of Economic Change* (Boston, MA, The Belknap Press of Harvard University, 1982).

Nyström, P. and W. Starbuck, "To avoid organizational crisis unlearn", *Organizational Dynamics* (Spring 1984), pp. 53-65.

Osborne, D., *Laboratories of Democracy* (Boston, MA, Harvard Business School Press, 1988).

Osborne, D. and D. Gaebler, *Reinventing Government* (New York, Addison Wesley, 1992).

Perez, C., "Microelectronics, long waves and world structural change", *World Development* 13 (1987), pp. 441-463.

Piore, M. and C. Sabel, *The Second Industrial Divide: Possibilities for Prosperity* (New York, Basic Books, 1984).

Porter, M., *The Competitive Advantage of Nations* (New York, The Free Press, 1990).

Porter, M., *On Competition* (Boston, MA, Harvard Business School Press,1998).

Porter, M., H. Takeuchi and M. Sakakibara, *Can Japan Compete?* (London, Macmillan, 2000).

Pyke, F. and W. Sengenberger, eds, *Industrial Districts and Local Economic Regeneration* (Geneva, International Institute for Labour Studies, 1992).

Rehfeld, D., "Disintegration and reintegration of production clusters in the Ruhr area", in P. Cooke (ed.) *The Rise of the Rustbelt* (London, UCL Press, 1995), pp 85-102.

Schmitz, H., "Global competition and local cooperation: success and failure in the Sinos valley, Brazil", *World Development* 27 (1999), pp. 1627-1650.

Schmitz, H. and K. Nadvi, "Clustering and industrialization: introduction", *World Development* 27 (1999), pp. 1503-1514.

Womack, J., D. Jones and D. Roos, *The Machine That Changed the World* (New York, Rawson Macmillan, 1990).

Zeitlin, J., "Industrial districts and local economic regeneration: overview and comments", in F. Pyke and W. Sengenberger (eds) *Industrial Districts and Local Economic Regeneration* (Geneva, International Institute for Labour Studies, 1992).