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Regional Innovation Systems as Public Goods

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Abstract

The paper focuses on the concepts of ideas and knowledge, which are generally considered as public goods. Ideas and knowledge have always been important to production and growth but nowadays their contribution is central to what many refer to as the knowledge economy, where increasing amounts of production are positioned. The sectors in which disruptive and radical innovation frequently occurs are high-technology manufacturing plus knowledge-intensive business services; the former being mainly aerospace, telecommunications, computing and biotechnology, the latter being mainly research, software, media and financial services.

The paper examines the role of support institutions in knowledge production and innovation, focusing on a regional level. These institutions are shown to be crucial in assisting firms to meet knowledge, skills, financial and other needs that markets fail to provide. The building of global-local relations network management skills by successful firms is shown to be particularly important in this process. The paper investigates and gives examples of the ways in which technological and other standard services in support of regional innovation may be provided. It makes policy recommendations based upon good practice shown by the cases discussed. Finally, the paper considers which role is most appropriately discharged by which governance level, from regional to national and global, including international and supranational agencies such as UNIDO.

Contents

1. Introduction

Public goods, in comparison with private goods, are those whose consumption by one person does not preclude consumption of the same good by another person. Such consumption does not result in depletion of the goods or disutility for previous consumers. As Best (2001:5) puts it: "The value of a cooking recipe to the original user does not diminish with its diffusion to new users." The concept of public goods is also important to new growth theory. This is because new growth theory has productivity increases as endogenous to production. While neoclassical growth models assumed diminishing returns to scale, new growth theory assumes increasing returns to scale associated with new knowledge or technology. New growth models tend to explain where knowledge-driven productivity growth comes from. Productivity may be "made" in production processes by, for example, internal (endogenous) innovation or skills upgrading. Or it may be "bought" as, for instance, in the form of knowledge such as R&D purchased from a university. The same supplier of research may simultaneously also produce, external to the firm, other upgraded human capital. This may have more scientific, technological, managerial or creative content and value than its preceding cohorts. Knowledge may also be "imported" as a public good, otherwise known as "localized knowledge spillovers".[1] These ideas about the importance of innovation and talent to productivity are central to new growth theory. They are also central to the "Washington consensus", after Capra (2002) and Kay (2003). This posits that innovation positively affects productivity, which in turn creates growth and ultimately competitiveness.[2] This central dogma underpins the economic policies of virtually all governments and multilateral agencies.

An unproven thesis

One instance of the apparent failure of the central dogma to hold true is provided by the "Swedish paradox" (Edquist and McKelvey, 1997). High rates of innovation and

[1]For developing countries, transfer of such spillovers is secured most effectively by enabling visiting scholars to conduct internships in proximity to such knowledge, either in academic or business settings, preferably both. This has been a common means for knowledge upgrading by developing regions and countries in the EU such as the Basque Country and Portugal (see Fontes, forthcoming).

[2]The question arises as to the relationship between knowledge and innovation; indeed, are they the same thing? If knowledge is thought of in terms of exploration and exploitation, with the former defined in terms of basic research with high tacitness, this type of knowledge is necessary but not sufficient for innovation. Exploitation knowledge is utilized for innovation, but it is more codified, less scientific and closely linked to conventions of entrepreneurship and risk management.

one of the highest levels of expenditure on the key input to innovation, namely R&D, are associated with relative economic decline in Sweden. The same can be said for Japan and Germany. Conversely, countries like Denmark or Italy that do not spend nearly as much on R&D have continued to grow at a healthy pace. Thus between 1991 and 2002 government funding of business R&D in these countries was, at 0.05 per cent and 0.08 per cent of GDP respectively, much lower than the OECD average (0.12 per cent). Equally, average business expenditure on R&D was modest, at 0.6 per cent of GDP for Italy and 1.2 per cent for Denmark, even in the boom period 1998-2000. Nevertheless, Italy had 40 per cent of its manufacturing firms officially defined as innovative and Denmark 52 per cent (OECD, 2004). Meanwhile Denmark's average annual GDP growth rate for 1998-2002 was 2.0 per cent and Italy's 1.7 per cent compared with the OECD weighted average of 2.9 per cent. Many countries growing faster, such as Mexico, Poland, Slovakia, Hungary and Greece, grew from a significantly lower base (OECD, 2005). But Italy, with its dependence on industrial districts that specialize in both medium- and high-quality design-intensive consumer products, now faces fierce competition, most recently from China, but previously from Turkey, and North African and other Asian countries. Thus far, Denmark's design-intensive clusters seem to have avoided Italy's problems, probably because clothing and footwear are less prominent in Denmark's industrial mix. The central dogma seems to hold better, not for coordinated market economies, of which the above are exemplars, but for liberal market economies like the United Kingdom and the United States of America (Hall and Soskice, 2001). This is because the latter are more flexible and capable of absorbing competitiveness shocks, usually by moving production offshore or even relinquishing it and developing as service economies, especially knowledge-intensive business services (KIBS).

This paper explores the role of public goods in relation to economic growth and new growth theory, focusing on the concepts of ideas and knowledge, which are often public goods of precisely the kind mentioned above. Of course, these have always been important to production and growth but nowadays it is the contribution of these as formalized within production that is central to what many refer to as the knowledge economy, where increasing amounts of production are positioned. These sectors—the main areas in which disruptive and radical innovation frequently occurs—are high-technology manufacturing plus KIBS, the former being mainly aerospace, telecommunications, computing and biotechnology, the latter being mainly research, software, media and financial services (Machlup, 1962; OECD, 1999).

The paper examines the role of support institutions for knowledge production and innovation, especially at a regional level. These are shown to be crucial in assisting firms to satisfy knowledge, skills, finance and other needs that markets fail to provide and the building of global-local relations network management skills by successful firms are shown to be important in this. The paper investigates and gives examples of the means by which technological and other standard services in support of regional innovation may be formulated. It makes policy recommendations based upon good practice revealed by the cases discussed. Finally, the paper considers which role is most appropriately discharged by which governance level, from regional to national and global, including international and supranational agencies such as UNIDO.

2. Innovation support institutions

Assistance to firms in satisfying knowledge, skill, finance and other needs, when markets fail to provide, can play a crucial role in their success and global-local relations network management skills are considered of key importance in this. The underlying concept is that of innovation systems, particularly the variant known as regional innovation systems (RIS) (Cooke et al., 2004). It is often held that differences in economic performance between relatively more or less successful regions can be explained by looking at the mix of regional innovation policies and institutions that foster economic dynamism. In section 4 below, it is shown that for developing countries, RIS require policies for aligning institutional missions and facilitating connections between exploration and exploitation knowledge. In the cases discussed, refocusing of institutional priorities towards entrepreneurship and ensuring seed funding and incubation for small firms are among appropriate instruments, as are "softer" actions such as integrating associative and networking capabilities between exploration and exploitation activities. Multilateral agencies have a useful consciousness-raising function but are often less accomplished in nuts-and-bolts policy instrument design.

Policies pursued by regional governments can enhance the economy, culture and identity of regions, including their institutional capacity to attract, animate and construct competitive advantage. Collective entrepreneurship, by promotion of cooperative practices among actors, may give regions distinctive trajectories in regional economic development.

Cases where economic governance gave global identities to artificial (not previously geographically or in any other way coherent) regions include those of Emilia-Romagna in Italy and Baden-Württemberg in Germany respectively.[3] To become attractive for companies, specific institutions to support innovation strategies of territories can be set up. Regions that have constructed advantage by supporting innovative enterprise can act as meaningful communities of economic interest, can define genuine flows of economic activities and can take advantage of true linkages and synergies among economic actors. Regions need to seek competitive advantage by 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 direct investment (FDI) seeks out such centres of expertise by

[3]On this, see in particular Cooke and Morgan (1998).

following domestic investment as part of a global location strategy. This is something predicted for countries like China and India, leaving Western economies and regions pondering a future in which that stage of innovation system-building is now over (Cooke et al., 2000).

The lesson of the 1990s

What was learned in the 1990s is that assisting in the formation of network relationships among firms and establishing the broader institutional setting supports firms' innovative activities is not sufficiently powerful to embed them structurally, especially when global conditions no longer favour such strategies. RIS are a useful framework for studying economic and innovative performance; they are also functional tools to enhance the innovation processes of firms. They do this by knitting together knowledge flows and the systems on which they rely, building trust and confidence in institutional reliability; and above all, they do it by generating institutional self-knowledge and a certain kind of collective dissatisfaction with the status quo. RIS comprise a set of institutions, both public and private, which produce pervasive and systemic effects that encourage firms in the region to adopt common norms, expectations, values, attitudes and practices, where a culture of innovation is nurtured and knowledge-transfer processes are enhanced. A national system of innovation (NIS) cannot adequately do this; time economies, as well as distance and decay effects, militate against thoroughgoing cognitive penetration.[4]

A dimension that seems almost completely missing in the way most national innovation systems function is the capability to manage media communication about innovation in other than a dogmatic way. This can be inimical to furthering innovation strategies, since labour supply and demand mismatches arise as market failures owing to the absence of even virtual knowledge spillovers. Governments in most developed regions and many developing countries make injunctions to their businesses to innovate, but this is seldom analysed or popularized in ways that assist non-innovators to gain the necessary knowledge to effect change. A contributory factor is that innovation is seldom communicated in digestible ways to the media. This issue has been at the forefront of concern in the ongoing activities of The Competitiveness Institute (TCI), one of whose members, the Swedish Innovation Agency (VINNOVA), houses the only known dedicated innovation media specialist.

Contrariwise, regional innovation interaction among firms and other innovation organizations has been regarded as playing an important role in fostering regional innovation potential. Labour demand and supply are increasingly influenced by innovation, growth potential and linkages among firms within a defined location. The portability of information and communication technology (ICT) skills is an example of how

[4]Metcalfe (1997) defines a NIS as "a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technology." This is both much broader in institutional scale, thus remote from specific regional industrial mixes, and narrower because of its "new technology" emphasis than the definition of a RIS, which is as follows: "a regional innovation system consists of interacting knowledge generation and exploitation sub-systems linked to global, national and other regional systems for commercialising new knowledge" (Cooke, 2004).

knowledge of labour market opportunities filters through to appropriately qualified talent. It follows from this that the functioning of a system of innovation influences the labour market dynamic and the ability of localities to generate, attract and retain the highly skilled workers that are essential for establishing and growing innovative companies, as argued in Florida (2002). The presence of research capabilities in numerous universities and of entrepreneurs, financiers and artistic cultures is crucial to talent-led growth.

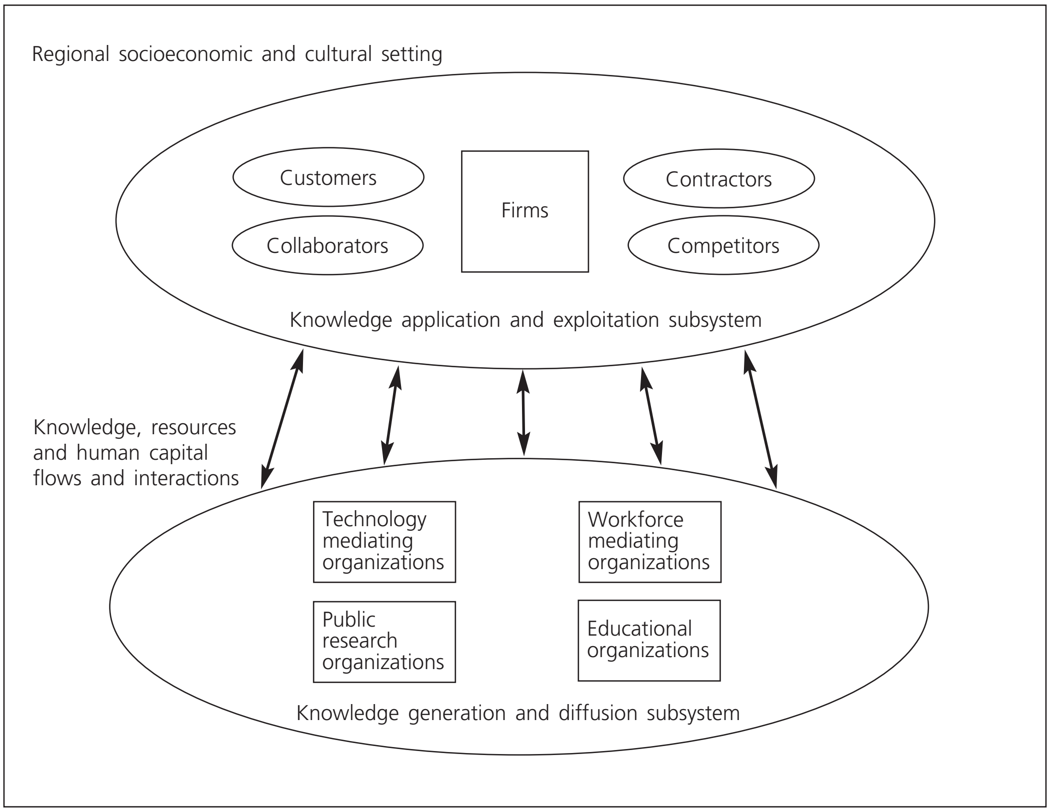
Innovation systems: supply and demand

Previous work has identified two sides of an innovation system: a supply side and a demand side (Braczyk et al., 1998). The former consists of the institutional sources of knowledge creation as well as the institutions responsible for training and the preparation of highly qualified labour power. The demand side subsumes productive systems, firms and organizations that develop and apply the scientific and technological output of the supply side in the creation and marketing of innovative products and processes.[5] Bridging the gap between the two is a wide range of innovation support organizations that play a role in the acquisition and diffusion of technological ideas, solutions and know-how throughout the innovation system. These may include: skills agencies, technology centres, technology brokers, business innovation centres, organizations in the higher education sector and mechanisms for financing innovation such as venture capital systems. One of the assumptions of the RIS approach is that many innovative firms operate in 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 process that frequently benefits from the proximity of organizations that can trigger this process. Furthermore, regional authorities have an important role to play to support innovation processes by offering services and other mechanisms that augment the interlinkages between all these actors.

RIS as portrayed in figure 1 show that the main connectivity vectors at regional level are horizontal, while those at national level are primarily vertical. Moreover, although it is difficult to be precise, it can be suggested that at least half the key connectivity at national level is outwards to the global level. This applies to larger firms and to the activities of innovation ministers at numerous meetings on science and technology policy, technical standards and the design of international innovation programmes, which can include both multilateral economic assistance organizations (MEAOs) and bilateral collaborations. In some countries, such ministries and their functionaries are fully engaged in devising schemes to protect “national champions” or to promote their industries to global markets. In most cases, nation states are engaged in science and technology strategy building. It is difficult to avoid the inference that national innovation systems have lost salience considerably as a result of, on the one hand, global

[5] This may also involve new knowledge creation, albeit more in synthetic (e.g. engineering) or even symbolic (e.g. design) than analytical (scientific) knowledge.

Figure 1. The regional innovation system: a schematic illustration



innovation impulses—most notably from the United States—and, on the other, the more embedded approach, feasible only at regional level but by no means generically present in all regions.

Where there is a rich innovation infrastructure, ranging from specialist research institutes, to universities, colleges and technology-transfer agencies, and institutional learning is routine, firms have considerable opportunities to access or test knowledge, whether internally or externally generated to the region. 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.

Two dimensions of innovation systems

Following Braczyk et al. (1998), different innovation systems can be measured and identified along the two following dimensions.

- First is the governance dimension, which comprises public policy, institutions and knowledge infrastructure; also known as the soft infrastructure of enterprise innovation support. Here, reference is made to a networking propensity whereby key regional governance mechanisms, notably the regional administrative bodies, are interactive and inclusive with respect to other bodies of consequence to regional innovation. This may lead to an organizational setting in which the regional administration animates or facilitates associativeness among representative bodies inside or outside public governance.

- Second is the business innovation dimension, namely the industrial base characterized in terms of productive culture and systemic innovation. This refers to the level of investment, especially in R&D; the type of firms and their degree of linkage and communication, in terms of networking, subcontracting, presence or absence of supply and value chains and degree of co-makership between customers and suppliers.

Three types of RIS

Following these two dimensions, Braczyk et al. (1998) suggested a taxonomy of RIS, as represented in figure 2. Firms can range from possessing global to merely local reach. Three different types of RIS emerge: the localist one is not dominated by large indigenous firms and the business innovation culture is one in which the research reach of firms is not very great, although there may be local research organizations capable of combining with industry clusters within the region. A localist set-up will probably have few major public innovation or R&D resources, but may have smaller private ones. Finally, there will be a reasonably high degree of associativeness among entrepreneurs and between them and local or regional policymakers. An interactive RIS is one in which there is a balance between large and small firms. The reach of this combination will vary between numerous instances of access to regional research resources and to foreign innovation sourcing as and when required. The mix of public and private research institutes and laboratories in the interactive RIS is balanced, reflecting the presence of larger firms with regional headquarters and a regional government keen to

Figure 2. Regional innovation systems: a taxonomy

	Grassroots	**Network**	**Dirigiste**
Localist	Tuscany	Denmark	Tohoku
Interactive	Catalonia	Baden-Württemburg	Gyeonggi (Republic of Korea)
Globalized	Ontario	North Rhine-Westphalia	Wales

Business innovation

Governance of enterprise/innovation support

Source: Cooke et al., 2004.

promote the innovation base of the economy. In the third type of RIS, the globalized one, the innovation system is dominated by global corporations, often supported by clustered supply chains of rather dependent small and medium-sized enterprises (SMEs). The research reach is largely internal and private in nature rather than public, although a more public innovation structure aimed at helping SMEs may have developed.

Three forms of RIS governance

Following Cooke et al. (2004), the governance dimension can generate three different RIS forms: grassroots, network and *dirigiste*. Grassroots is where the innovation system is generated and organized locally, at town or district level. Financial support and research competences are diffused locally, with a very low amount of supra-local or national coordination. Local development agencies and local institutional actors play a predominant role. A network RIS is more likely to occur when the institutional support encompasses local, regional, federal and supranational levels, and funding is often guided by agreements among banks, government agencies and firms.

Table 1. Typology of regional innovation systems and key action impulses

RIS characteristics	*Grassroots*	*Network*	*Dirigiste*
Initiation	Local	Multilevel	Central
Funding	Diffused	Guided	Determined
Research	Applied	Mixed	Basic
Coordination	Low	High	High
Specialization	Weak	Flexible	Strong

Source: Cooke, 1992.

The research competence is likely to be mixed, with both pure and applied, blue-skies (exploration) and near-market (exploitation) activities geared to the needs of large and small firms. A *dirigiste* system is animated mainly from outside and above the region itself. Innovation often occurs as a product of central government policies. Funding is centrally determined, with decentralized units located in the region and with research competences often linked to the needs of larger, state-owned firms in or beyond the region. It is important to note that in each RIS system public intervention is variable but public good knowledge for innovation circulates relatively freely beyond the institutions that originate ideas, whether firms or other bodies.

Grassroots

The grassroots system is driven by local initiation. Funding may come from family, community and local credit agencies, research is highly applied and practical rather than scientific, coordination of interactions is based on social capital rather than formal organizations, and industry specialization may be diverse, as in the case of regions with numerous distinctive clusters. Italy is the exemplar, where, for example, the regions of Tuscany or Marche have at least 10 distinctive clusters (see box 1).

Box 1. Origins of the grassroots innovation concept

When first researched (around 1989 or 1990) the drivers of the work on the grassroots innovation concept were the concepts of innovation, which replaced a much narrower discourse about technology and networks emerging to challenge market and state as the key coordination modes for complex institutional action and industrial order. An influence highlighting these concerns was the then new book by Best (1990) on new forms of competition. There were accounts of the superiority of certain networked forms of innovation governance over markets. Powerful instances of this were the distinctive trajectories of the Italian design-intensive and UK scale-intensive furniture industries. The former succeeded while the latter atrophied. The industrial district RIS model was the genesis for the stylized grassroots category since it was clearly a market-driven model but one in which neither scale nor science was particularly pronounced. Nevertheless, local, weak ties coupling or coordination were clearly present, as were diffuse—we would now say social capital-based—funding mechanisms and a regionally diversified grouping of distinctive industrial districts. It could be said that communicative linkages in the grassroots model were locally intense but mediated nationally and globally by looser entrepreneurial intermediation.

Network

The network system is rather more formalized and integrated at different levels: local, regional and national. Funding for innovation is more likely to engage public goods programmes with research of an applied but formalized nature being utilized. Some more scientific inputs may be accessed from industrial research institutes or universities. In such systems coordination is rather high, with membership systems and effective knowledge circulation through seminars, workshops and associational networks. Specialization by economic activity is more flexible than in grassroots systems (box 2). A scale above the grassroots model but still by no means governed or coordinated either fully by market relations arising from corporate power or state planning modes of intervention, this is basically a partnership model of networking in which power relations nevertheless also accompany symmetry in the innovation interactions among stakeholders. The network paradigm enabling the model to be envisaged arising from varieties of engineering excellence, from automotive to tooling and printing machinery, was Baden-Württemberg's industrial system. This was a regionally associative form of the Germanic coordinated type of industrial order in which constructed advantage (Foray and Freeman, 1993) had arisen historically because the region was once so poor and suffering from major out-migration. The constructed nature of intervention in this historic case concerns the establishment by Ferdinand von Steinbeis of the vocational training works in locomotive technology (see box 2), which provided skills in the advanced technology of the day, railway locomotive engineering, that farm labourers and woodcutters would not otherwise derive locally. In turn this boosted regional engineering skills more broadly by establishing training curricula, contributing to the region's global engineering advantage that persists to this day in the form of businesses built by regional entrepreneurs as Porsche, Daimler-Benz and Bosch.

Box 2. Constructing regional advantage by integration of public goods provision

Baden-Württemberg was a Swabian (rather than Asian) "tiger". Under the enlightened Kingdom of Württemberg, Ferdinand von Steinbeis in 1868 established the first industrial training facility in the locomotive works at Esslingen, near Stuttgart. This is thus an early case of endogenous constructed regional advantage, subsequently evolving and spreading its influence throughout a geographically integrated administrative region, so that today there are over 500 Steinbeis knowledge-transfer centres within Baden-Württemberg and neighbouring regions and States (e.g. Switzerland). However, they are structurally embedded in a specific cultural and institutional context. For example, they were designed as "fiefdoms" mainly of *Fachhochschule* (polytechnic) professors in a region with some 40 such institutions set in a national higher education system that privileges chair positions much more than elsewhere. Hence, historically, vocational training and corresponding talent formation in relation to basic technological needs related to railway technology was at the heart of this associative public goods provision, unmet by market forces. It set an example to regional governments in subsequent years. These emulated such principles in a more modern style. The integration of innovation support was secured by providing innovation support to affiliated experts.

Dirigiste

The *dirigiste* system has far more central government intervention and possibly more large-scale business engagement in its operations. Initiation and inspiration are centrally influenced and funding is specifically programme-based (as with the Franco-EU aerospace cluster at Toulouse in Aquitaine, France, which is the exemplary case). Basic scientific research inputs are as important as applied ones, and both coordination and specialization are strong. The science- and technology-rich region of Rhône-Alpes is testimony to the continuation of such a mode of intervention over a long period (box 3). During the 1970s and 1980s, France (and Quebec in Canada) had been at the forefront of innovation policy. Foremost here was the French idea of *technopoles*, evolved from the postwar state-planning model inspired by Francis Perroux and his successful promotion of the growth poles idea. This echoed Schumpeter's idea of swarming by firms seeking to imitate the innovating entrepreneur, leading to the formation of what would now be called a cluster.

Germany's Ruhr Valley was Perroux's inspiration. Large-scale industrial complexes, such as the great steel branches at Dunkirk and Fos-sur-Mer were designed as economic anchors for downstream processing, and the *technopole* idea built on the example of the Ruhr by setting up a more analytical, science-based and advanced technology infrastructure. Science parks and even science cities, as at Lille, were constructed, usually by decentralizing government research laboratories from Paris. This happened at the first such *technopole* with the Meylan-ZIRST science park at Grenoble, opened in the 1950s.

Box 3. Exogenous regional public goods innovation support

In a quest to find the world's oldest cluster, Van der Linde (2003) selected Oyonnax in the Rhône-Alpes region. "Plastics Valley" as it is nowadays known "can trace its history back to the year 630AD when the village was given a monopoly to make combs. Wooden combs were followed by celluloid combs … when combs fell out of fashion in the 1920s and 1930s, the unemployed craftsmen turned to the production of plastic toys and eyewear lenses … a further innovation was the adoption of injection moulding in 1936 … By 1998 600 firms … and a workforce of 12,700 produced 1.8 billion worth of plastic toys and eyewear" (p. 140). At Oyonnax the real take-off of the eyewear business came with the foundation of the Société Confraternelle des Ouvriers Lunetiers in Paris in 1849. This confederation or "house of lens-makers" was the ancestor of today's powerful Essilor group. Taking its inspiration from the collectivist ideas of Saint-Simon, the association was founded by three small industrialists: Duez, Duriez and Muneaux. However, notice the dependence on Paris for this. Nevertheless, the Lycée Technique Victor Bérard was France's first optics school, founded in 1933 in the nearby eyewear district Morez. It is thus clear that the historical embeddedness and path dependence of regional innovation are rooted in and evolve from initial conditions that assist the construction of specific kinds of regional advantage.

By the 1980s, Grenoble and the wider Rhône-Alpes region were leading innovation in energy, high-performance engineering and materials. Populating the regional system by the early 1990s were regional centres for innovation and technology transfer (RCITTs) in composite materials, agro-food, production, electronics and mechanics, biotechnology and biomedical devices, chemistry and energy. There were also nine decentralized offices of the Ministry of Research and Technology (DRRTs) and numerous investments by ANVAR, the national risk-capital fund, in the region. Remarkably, despite the emergence of regional government in France some years previously, all this infrastructure was designed and funded from Paris. The region's comparative advantage in hydroelectric power generation had morphed into a globally significant expertise in nuclear energy production, hence also specialization in materials science, electronics and mechanics. Thus the region had become a technological powerhouse, with the pole itself including colleges, private and public research, large businesses (e.g. Rhône-Poulenc, now Sanofi-Aventis, Caterpillar, Philips), SMEs and financing vehicles, but the whole was, as it were, steered or directed from Paris with relatively little regional or local innovation input.

The global competition imperative

In all the cases discussed above, innovation was seen as essential because of the pressure of global competition. In Emilia-Romagna, EU training programme funding was used to establish real services centres where small textile, clothing and footwear firms could access skills and technologies, to enable them to speed up the fashion manufacturing process to avoid losing markets after emulation of their previous designs by developing-country competitors. In Germany, Steinbeis centres became popular because of innovation threats from external competitors like Japan and the East Asian newly industrialized economies (NIEs) in the engineering and automotive industries. Many of France's comparable industries were similarly threatened. Since then, more firms have learned, helped by access to research and other valuable knowledge in their regional innovation systems, how to collaborate or form alliances with firms in developing countries. This is done often by tapping into developing-country clusters using overseas agents to identify reliable outsourcing targets. The German chamber of industry and commerce established "incubators" in Singapore, Japan and elsewhere to enable branches of medium-sized firms and spinouts from smaller ones to access markets on German industry parks in such countries. Thereafter, there has been production outsourcing and even R&D in developing countries, and complex systems integration of time-to-market scheduling and production logistics has become normal. In Brazil, incubator programmes have been used as a way of identifying small businesses that may contract in such outsourcing opportunities from high-tech firms abroad. Global-local interaction has become a vital part of most manufacturing industries. The key to development is securing the capabilities that enable local firms to engage with global value chains and networks on terms that are as favourable to them as realistically possible. The management and control of innovation to meet constantly changing demands in global markets is an imperative.

3. How public goods innovation support operates

Regional-level public goods interventions have frequently been crucial to the stimulation of economic growth in areas suffering from poverty and technological backwardness. But even though the region or province is an important canvas for economic development policy because of the economic advantages arising from geographies of association and collective entrepreneurship, these are capable of being stimulated by either endogenous forces like clusters or by exogenous forces in the shape of central government. The important developmental lesson is that whichever impulse triggers economic growth, a public goods posture focused at this meso level is important.

The long run

In all cases where a long history of such support for regional innovative capabilities can be traced, the origins came from an entrepreneurial impulse, probably with a regulatory flourish from *noblesse oblige*. This has enabled a specialist tinkering survival strategy to construct advantage that has produced benign path dependence. In Germany, the paradigmatic regulatory environment was that created under the Württemberg royal house and the vocational training innovator von Steinbeis, forerunner of the *Land* minister president, Lothar Späth. Späth quoted von Steinbeis as saying, to paraphrase, ". . . in this region we have only ever had our wits to rely upon" (Spath, 1985).[6]

In Italy, notably in Emilia-Romagna and Tuscany: " . . . the progressive traditions of the dukedoms of Parma and Piacenza ... Modena and Reggio ... exerted a powerful influence on the historical evolution of regional knowledge linkages. The industrial districts of Carpi, Sassuolo and Faenza are among the oldest in Italy ... The economic prosperity of Toscana started in the eleventh century, based on the unique cultural traditions of its communes (Lucca, Pisa, Pistoia, Siena, Arezzo) ... Florence prevailed and absorbed the most positive elements of Toscana's typical pattern of development" (Iammarino, 2005: 510).

[6] Späth (1985).

Entrepreneurship and constructed advantage

Being entrepreneurial can be seen in terms of Orlikowski's (2002) "sense of knowing" about how, in this case, to "do business". This is evident in Iammarino's historical analysis of regional innovation systems in the *longue durée*. She describes " . . . communes, all fierce competitors for market share, product variety, trade intensity, cultural creativity and social dynamism". In other words, these are traditions of collective entrepreneurship, familial, communal and social but also competitive and confident of being able to rely on others in the network to provide finance, to assist in planning and production, and to speak well of the key artisan seeking a contract in a system of production that was often in those early days for some kind of luxury consumption—a painting, a clock, or an ornate comb.

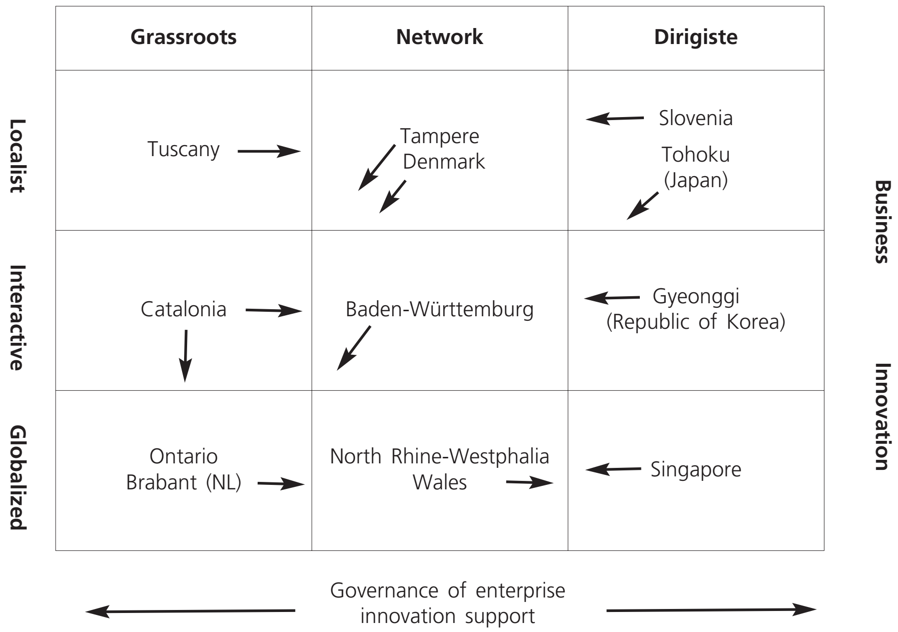
Constructed advantage took distinctive forms within a framework set by comparable but by no means identical cultural and institutional conditions (Geertz, 1973). In this case, distinctiveness evolves as part of a more open, innovative, modestly liberal governance regime in which entrepreneurship of a collective kind and innovation in meeting competitive market demand are able to flourish. Iammarino compares the more innovative Italian regions in the late middle ages with those, like Marche, Umbria and Lazio of the papal states, stifled under institutional dogmatism and adapting only slowly. Innovation and entrepreneurship require talent and crucially the means for producing talent. Moreover, in more adventurous settings institutions for the formation of talent thrived, whether at Esslingen or in the creative apprentice workshops of Florence.

Evolutionary dynamics

The completion of research reported in Cooke et al. (2004) made it possible for the first time to trace the evolution of types of RIS since data on the position of regions studied were available for two time points 10 years apart. Detailed accounts of these regional trajectories may be found in Cooke et al. (2004) but in brief, three things may be said about both the general classification and the dynamic element portrayed.

First is that the concept "regional" is somewhat extended to encompass at least three small nation-States like Denmark, Singapore and Slovenia. It might be useful for MEAOs to recognize this since scale differences mean small countries may not need to consider regional interventions except to seek to ensure that regional disparities are reduced and interventions appropriately orchestrated at central-government level, as in Singapore or Slovenia. Such States clearly have in principle greater power to implement innovation support initiatives than do most regions of larger States. They can pursue sovereign policies that also autonomously favour firms in their jurisdiction. It is of interest that, despite differing levels of autonomy, the direction of innovation system trajectories shows some convergence over time. For example, there is a tendency for business and government to move towards the centre, demonstrating a higher networking propensity. A few regions go against this trend by remaining relatively unchanged in their business innovation character and their governance of innovation support. In the case of Wales, despite devolution of some powers from the central government to the Welsh Assembly in the 1990s, the new devolved government has centralized all innovation administration to itself.

Figure 3. Regional innovation systems: typology and evolution



Source: Cooke *et al.*, 2004.

Interpretation of these trajectories suggests that the concept of utilizing innovation for business competitiveness and regional constructed advantage has strengthened over the 10 years encompassed in the regions researched. Even Baden-Württemberg, which already had a highly evolved innovation framework, experienced new associative policy input from its Commission of Inquiry, published in 2000. Policies to stimulate diversification of innovation across a range of industries like biotechnology, photonics and new media are a pronounced feature of the policy landscape. This is consequent upon a recognition that the regional economy had become undesirably monocultural around automotives.

A common desire for knowledge-intensive industries

The desire of regional and smaller state innovation policy-makers for a biotechnology presence is marked in the evolution of their innovation focus. It is present from Singapore's Biopolis to Denmark's Medicon Valley now linking Copenhagen to the Swedish side of the Øresund bridge. Catalonia, Tampere and Wales are among regions extending or building bioparks and gene parks. With these developments goes a heightened sense of the importance of talent and entrepreneurship within innovation systems. This is because it is not multinational companies that carry this development impulse but spinout firms from university research centres of excellence. Attracting, recruiting and retaining research talent, on the one hand, and assisting in the formation of entrepreneurs to transform exploration knowledge into exploited commercial innovations, on the other, have become greater imperatives in the past 10 years.

Regionally constructed advantage is now being focused on industries at the heart of the new knowledge economy because the constructed advantage of only a decade ago is swiftly vanishing. Tuscany, Brabant and Wales are paradigmatic cases. Tuscany has numerous, distinctive clusters, more traditionally referred to as industrial districts, in its regional setting, ranging from textiles to leather and furniture. Each of these traditional sectors is facing competition from cheaper goods from, particularly, China. In Prato, the heart of Tuscany's woollen fabric industry, the cluster is evolving into a clothing manufacturing centre. The skills needed to, for example, stitch, sew on buttons and make clothing accessories, were not traditional to Prato and, in any case, Italian wages would render such products prohibitively expensive. Remarkably, during the 10 years covered by these regional innovation system case studies, at least 23,000 Chinese workers and entrepreneurs moved to Prato to supply these missing elements in the local division of labour. Numerous other Asian and North African ethnic minority workforces have joined them. One of the Netherlands' greatest firms, Philips, was headquartered in Eindhoven in the region of Brabant. Philips owes its existence to a decision by the Dutch government in the nineteenth century to suspend international patenting protocols as a means of constructing advantage for what was perceived to be a lagging economy at the time. The Edison light bulb was simply pirated as a consequence. Philips grew to be an almost classic M-form (hierarchically managed) corporation. Nowadays however, recognizing inefficiencies in that standalone corporate structure, it has adopted open innovation, outsourcing R&D to entrepreneurial firms and research institutes within and beyond its region. In this way, knowledge entrepreneurship has been externalized with all the network management skills that are thereby implied being evolved.

Finally, Wales's innovation system was relatively over-governed, but Japanese and other FDI engineering firms stimulated local entrepreneurship and talent formation as they elaborated regional supply chains. However, by 2005 even one of the first, iconic FDI arrivals, Sony, had almost completely shut, following other plant closures by Hitachi, Panasonic and Korea's LG. A totally new entrepreneurship and talent-based innovation approach is now painfully and slowly being attempted (Cooke et al., 2004).

Clearly, regional innovation systems are not islands; they are more like icebergs, swiftly affected by their global environment, immediate external conditions and internal dynamics. Increasingly, where policy consciousness and reflexivity involve recognition of the importance of innovation to economic growth and the connected importance of entrepreneurship and talent to innovation, regional firms and policy governance are engaging new challenges in the knowledge economy. This stretches from the widespread embrace of new, thriving but complex sectors like biotechnology to the equivalent organizational complexities of managing open innovation through R&D outsourcing.

The components of public goods innovation support

In summary, the key means by which public goods innovation support has been achieved can be identified. It is principally by stimulating collective entrepreneurship by utilizing and promoting social capital among diverse actors such as those in the private sector, mainly firms, and those in the public sector, such as talent and knowledge formation organizations like universities and other institutions of higher education. The system is completed when regional and local intermediary innovation agencies are introjected. This may be done less centrally by appointing experts in polytechnics as one-person knowledge transfer agents, as in the Steinbeis Foundation in Germany. Along with these, there are real services units like those in Italian industrial districts to improve skills, plus regional and local business association branches, and provide collective services for firms like payroll and taxation management, common purchasing and networking opportunities. These all assist in promoting collective entrepreneurship. Finally, skills and talent formation services are an important complement, so agencies or experts able to assist intermediation in matching skills needs to capabilities are necessary. The Danish networking programme offered subsidized brokerage terms to appropriate individuals for securing these and other services. The service was a public good, state-subsidized programme, open to all with the appropriate qualifying attributes (e.g. SME, looking to export, seeking support services, etc).

4. Policy recommendations from the successful services

RIS are a powerful instrument for obtaining economic growth. In line with new economic growth theory, they rest fundamentally upon the notion of public goods provision where market failure to support innovation is evident. They involve collective entrepreneurship, exploitation of social capital advantages where these exist and building networks where they do not, specialist, small-scale enterprise and innovation support services (real services or Steinbeis centres), regional financing and investment vehicles and labour market adjustment services. Producing innovation combines a three-way relationship between innovation, entrepreneurship and talent formation interacting systemically over time, evolving as local and global conditions dictate. Underpinning all three there need to be financial resources sufficient to make a difference to the status quo and stimulate a process of change for the better.

Box 4. The South African Innovation Survey

South Africa has adopted an explicit innovation systems policy, but it is national not regional. However, it involves a process of performance benchmarking against countries like Australia, Republic of Korea and Viet Nam. The South African Innovation Survey (SAIS) is modelled upon that of the EU Community Innovation Survey (Rooks & Oerlemans, 2005). The first SAIS showed 44 per cent of firms had innovated new technological products or services in the previous three years, comparable to the EU average; 49 per cent invested in R&D which was considerably more than the EU average (36 per cent), though the magnitude of investment was considerably lower. In Thailand and Viet Nam, for example the ASEAN Agricultural Innovation System policy is being implemented, integrating more tightly the fragmentary innovation arrangements of both countries. (Chairatana & Sinh, 2003).

Innovation support services

Innovation is the commercialization of new knowledge. Unless that knowledge is generated inside a large firm or SME it is likely to be knowledge subject to exploration inside a public goods organization practising open science such as a university or major public research institute. Under the latter circumstances, exploitation of the discovery or invention follows an intensive period of application of examination knowledge such as a patent application to release intellectual property rights (IPR) by licensing, trade sale or formation of a spinout company. These types of knowledge integration are fundamental to an increasing amount of what is nowadays called open innovation and offer opportunities to suitably innovative developing-country firms. Other examination knowledge opportunities arise through clinical trials and patient testing of candidate products like new drugs that may be outsourced to developing countries like India or China with large and varied populations.

For reasons of public goods efficiencies and effectiveness public research institutes are being transformed both in terms of direction of research and proximity to social needs. Under such circumstances, certain key policy instruments become crucial (see box 5).

The success of the Brazilian incubator programme is well-known (Etzkowitz et al., 2005). Incubation is extremely important in nurturing new businesses in technology as in other sectors. As table 2 shows, there are distinctive incubator programmes and types in Brazil. Yet, the technological incubatees are the most numerous. This suggests that the policy of formalizing university or research institute academic entrepreneurship links through students graduating their firm has been a rather useful approach to innovation.

Box 5. Transformation and reinvention of a public goods research institute

The nuclear and energy research institute of Brazil (IPEN) in São Paulo lost its mission in the mid-1990s with a change of government policy. IPEN had to become more market-oriented if its commitments to 1,000 staff and 5,500 students were to survive. Funding from international programmes had to be sought and co-evolution with social needs addressed. This also involved engagement with the metropolitan São Paulo programmes for technology parks and business incubators. IPEN changed the direction of its research from a nuclear to a healthcare focus. Networking and partnership had to be taken on board. Becoming more market facing meant also management retraining, so an ISO 9000 training programme in modern management for nuclear medicinal products was accessed and utilized. This led to failure and a rethink towards learning by following a Brazilian quality management programme with inbuilt monitoring and evaluation standards appropriate for the chosen field. Later, ISO 9000 was resumed successfully. Subsequently, other standards have also been pursued as IPEN changed its face from energy towards improving the quality of life for Brazilian citizens. These include joining a Technology Excellence Research Project run by ABIPTI, the Brazilian Technological Research Association, to improve the management practices of its members. Thus IPEN was seeking to be market-facing but also to raise its standards of research and innovation excellence substantially. The reference is the Brazilian National Quality Award. In 1998, it opened an incubator, CIETEC, thus completing moves through the exploration to exploitation knowledge value chain, and the learning deficit to quality achievement standards using Balanced Score Card (BSC) techniques. Publications dropped by 23 per cent between 2003 and 2004 but technologies increased by 21 per cent, recognition of the shift from "ivory tower" to academic entrepreneurship.

Source: Zouain and De Sousa, 2005.

Table 2. Regional distribution of Brazilian incubators, 2003

Region	*Technological*	*Traditional*	*Mixed*	*Cooperative*	*Private*	*Total*
North	5	1	2	3	–	11
Northeast	13	5	5	5	–	28
Central-West	5	1	2	–	–	8
Southeast	37	17	15	13	5	87
South	47	32	16	8	–	103
Total	**107**	**56**	**40**	**29**	**5**	**237**

Source: Etzkowitz et al., 2005.

Argentina's experience with incubators as instruments for assisting new firm formation based on knowledge entrepreneurship is less successful. Argentina's incubators were first instituted in 1995. International programmes had proposed university incubators even in the early 1990s but they were slow to develop. By 2005, there were 50 incubator projects and 16 functioning incubators with companies operating in them. However, there have been high failure and low graduation rates that have held growth of incubators and incubator firms back considerably, partly because of funding problems. While funding programmes may be influenced at the idea stage by MEAOs (box 6), if there is inadequate follow-up from private or public programmes they are likely to be stillborn. Even when there is a relatively generous national funding programme for building incubators and associated infrastructure, without seed-funding for incubatees such programmes are likely to be ineffective. Thus there should be appropriate multilevel governance of incubator programmes with pump-priming from MEAOs. Infrastructure on a scale beyond the resources of regions should be supplied by national programmes. Seed-funding must be established at regional, municipal and local levels through associative public-private partnership activity. Something like this appears to have happened in Brazil where there has been success, but not in Argentina.

Box 6. Inadequate multilevel management of incubation finance

The idea of developing incubators to stimulate business innovation through exploitation of science and technology fields began with the UNESCO-supported Columbus project organized through the Conference of Rectors of European Universities. Workshops were held in Florianopolis in 1991, then Rio de Janeiro in 1993 and Santa Fe de Bogotá in 1994. Two training models were available for incubator managers in 1992 and 1995. William Bolton, author of *The University Handbook of Enterprise Development*, and other experts advised the few Argentinian universities receptive to the idea. Argentina's first incubator was founded at Zapala under the National University of Comahue in 1995. Its specialization was ceramics; thereafter three more were founded, including one by the National Space Agency in Cordoba. The first public policy in support of incubators was in the Province of Buenos Aires. This was the Programme for Production Technology Incubators sponsored by the Provincial Employment Institute, which was part of the Ministry for Production (later the Ministry of Employment took over and closed the programme). All 11 regional universities participated in the programme, each receiving US$50,000 for infrastructure development. A national programme under FONTAR (the National Technological Fund) using Inter-American

Development Bank funds followed in 1997. From 2001 to 2005, 33 grants of roughly US$700,000 each were funded by FONTAR and 31 incubators came into existence. The occupancy rate of 44 per cent is low, but a surge of new incubators in very recent years explains this. There have been 282 incubatees over this period, of which only 25 (<9%) have graduated. Again, incubatee youthfulness is the main reason. Services offered include physical infrastructure, housing, access to electronic communication, consultancy and entrepreneurship training, but there is a general lack of funds for such incubation. Comparison with the Brazilian experience shows that while MEAOs may be important stimulators of an innovation support idea without localized, regionalized or national funding—meaning public funding since incubators are seldom profitable in themselves—application of that idea may be severely hampered by lack of investment finance for incubatee firms.

Source: Versino and Hoeser, 2005.

Integrating financial support

Support for innovation is fundamentally a public goods activity justified by a general failure of the market to come forward and anticipate a rate of return on capital investment in incubator facilities. There is virtually absolute market failure in provision of necessary finance for incubatee firms in many cases, although Brazil, for example, performed better than Argentina in this respect.

A case, in which innovation advantage was systemically constructed by linking excellent science and technology (talent) to entrepreneurship (incubation) and innovation (financing) in the absence of entrepreneurship and innovation resources, is that of Israel. Moreover, this case shows that public goods may be in advance of market thinking in provision of systemically interacting innovation support, but that public goods may transform into private goods once a profitable return on investment can be envisaged or demonstrated. The introduction of public goods may thus contribute to reducing the asymmetric information uncertainties that caused market failure in the first instance.

Intermediary agencies

Exploration knowledge institutes may adapt to a systemic innovation posture at regional level in part by retraining management and researchers, in part also by engaging in the public goods strategies of sub-national institutions, and by opening and recruiting new businesses for an incubator. It has been shown that a top-down influence focused on a single instrument, building incubators, may enthuse exploration knowledge institutes without them being able to progress swiftly because of weaker systemic linkages at the regional level, specifically financial means of supporting incubatees. Examples of the importance of well-established intermediary organizations in securing better performance from industrial districts come from the ceramics clusters of Castellon in Spain and Sassuolo in Italy (both of which have strong links to the ceramics cluster in Santa Catarina, Brazil).

Box 7. Public goods financing fuels innovative entrepreneurship in Israel

The Israeli model was created with the prospect of global software innovation leadership being endangered by a lack of risk finance. An ambitious and successful incubator programme enabled many thousands of entrepreneurs to emerge from universities and, particularly, research institutes like the Weizmann Institute of Science. The niche technology is indigenous, being in the data security business, otherwise known as Internet firewalls. Israelis pioneered the technology, mainly in the Israel Defence Forces (IDFs) and Mossad, first-mover entrepreneurs being former military personnel made redundant with the scaling back of Israeli defence expenditure. From 1980 to 1990, firms specialized in anti-virus, software protection and encryption technologies (Carmel Software, Iris, BRM and Eliashim were lead firms). At this stage there was no venture capital (VC) in Israel, though the Office of the Chief Scientist's Industrial R&D Fund and a 1984 R&D law that allowed 50 per cent grants benefited software firms. The Weizmann was key as the invention source of what became a world-standard encryption algorithm. Firms like Algorithmic Research and NDS were set up in the embryonic Tel Aviv innovation corridor. Firewall firms then emerged (1990–1996). With the arrival of the Internet in this period, demand for encryption engines mushroomed, and world-leader firms like Checkpoint, Memco and Aladdin were founded. At this time also (1991), the Israeli government set up Yozma, a public VC firm, which triggered the formation of the Israeli VC industry. By the third stage of development, Yozma had been privatized (1997), funds rose in number from 1 to 70, and US$1 billion was available for start-up and Initial Public Offering (IPO) businesses. This was the point at which ties with the United States became pronounced. IPOs listed on Nasdaq and many of the 70 VCs originated in the United States. Some non-IPO firms have been acquired by US companies.

Source: Cooke et al., 2002.

At the institutional level, the Spanish ceramic tile sector has a more fragmented associative character than the Italian. In Italy, there is a clear hegemony of the tile manufacturers" association (Assopiastrelle) and to a lesser degree the manufacturers of machinery and equipment association (ACIMAC). In contrast, the Spanish sector shows a multiplicity of agents of which the principal is the manufacturer's association (ASCER), but also relevant are the frits and glaze manufacturers" association, the manufacturers of equipment and machinery association (ASEBEC), the ceramic technicians association (ATC) and the ceramic and building materials distributors' association (ANDIMAC). This fragmentation limits the industry's voice in representing this leading industrial district as a whole. For example, leadership in international exhibitions lies with the Italian rather than the Spanish ceramics fairs. There are also certain mismatches in the skills requirements for transforming local into global competitiveness in Castellon, while these seem better integrated in Sassuolo (see box 8) (Gabaldón-Estevan et al., 2005).

Box 8. Training and skills mismatches cause weakness in global ceramics markets

Regarding training, Castellon's Jaume 1 University supplies high-quality ceramics chemistry graduates, but supplies of management, commercial and industrial engineering talent are scarce and deficient. The Emilia-Romagna universities only recently offered chemistry specialization, their strength being the supply of business administration and engineering talent. Research activity in ceramics is advanced in Castellon, with the university and two specialist research centres, while in Sassuolo there is only the real services centre, the Centro Ceramico di Bologna (CCB), which has been adequate for research needs thus far. Technical innovation in Castellon comes mainly from the glaze manufacturers, but in Sassuolo it comes from the mechanical and design providers. Castellon is highly dependent for research and training on the Institute of Ceramics Technology (ITC), while in Sassuolo greater training effort is spent on design, management and commercialization. The Italian set-up is far more market-oriented, understanding global tastes, while the Spanish is good at ceramics science but less capable of turning local to global competitive advantage.

Source: Gabaldón-Estevan et al., 2005.

Performance in terms of production and export share is better in Italy than Spain, although they have comparable sized industries. However, as table 3 shows, the performance of both the Italian and Spanish clusters (in each case the clusters account for the bulk of national production) is being threatened by the rise of China. Even Brazil is suffering stagnation in its global market share because of China's competitive incursion into the global ceramics market.

In 2003 Italy had 315 ceramics firms to Spain's 294, employment was 30,264 and 25,200 respectively, and mean firm employment was 96 in Italy and 86 in Spain. Nevertheless, Italy remained the global leader in export performance, although it had experienced the sharpest decline because of China, the world's largest producer.

Table 3. Evolution in Shares of Ceramics Production and Exports (per cent of world total)

	Italy		*Spain*		*China*		*Brazil*	
	1998	*2003*	*1998*	*2003*	*1998*	*2003*	*1998*	*2003*
Production Share	13	10	12	10	34	32	8	9
Export Share	41	31	27	25	2	15	4	4

Source: ASCER, 2003.

Better organization of intermediaries seems to be crucial to the development of Italy's global lead from a local cluster and regional economic governance base. But now attention must once again be given to more design-intensive production, since China's cost advantage in production means global market losses are unlikely to be recovered at the lower-quality levels. Hence regional and local coherence, integration and associativeness among intermediaries are essential to mount swift responses to global competitiveness threats in times of market instability. It remains to be seen if Italy can reassert its global market share in this and other sectors, faced with the competitive challenge from China, and whether further public goods actions will assist.

5. Conclusions and recommendations

Exogenous stimuli are sometimes needed

Where evidence that innovation mechanisms are working successfully in neighbouring countries with comparable developmental trajectories is not understood or acted upon, a stimulus from exogenous sources is needed. UNESCO's sponsorship of the incubators concept through the Association of European University Rectors is a case in point. But it is not enough to alert and advise, where resources for achievement of aims are absent. Tighter partnership with national governments is required for implementation. Co-funded pilot projects based on successful experimentation in comparable settings are a means to achieving this where recipient organizations show receptivity to innovative solutions. There is clearly a role for UNIDO to initiate the regional innovation system-building process, perhaps in partnership with UNESCO. This should take the form of raising consciousness through regional conferences, ensuring national stakeholders are receptive and willing to invest in innovation infrastructure (the exploration, examination and exploitation dimensions) then, at national and sub-national levels, ensuring seed-funding and other risk investment capital is available and tailored to local needs and potentials. UNIDO should follow through ideas with committed development co-funding for knowledge centres, partnerships and networks.

National and regional policy priorities

At the national level formulating general policy approaches that suit changing global conditions is a fundamental responsibility. This can be achieved with vigour in the field of science and technology policy, for example, by redirecting traditional "ivory tower" research institute and university practice towards more market-facing academic entrepreneurship. Science policy ministries must interact positively with ministries of industry and employment in recognition of the strains involved in organizational transformation, otherwise wasteful duplication and relearning efforts will follow. The Brazilian experience of initial failure in management retraining later followed by a less ambitious retraining route is an example of successful adaptation.

Moreover, the need for academic entrepreneurship to have an outlet in nursery facilities provided by specific or generic incubators means that such policy transitions and investment redirections could perfectly well be pilot projects co-funded by MEAOs at specific experimental and institutional levels. In general, training for management, entrepreneurship and knowledge exploitation should be mainstreamed in higher education institutions specializing in innovation studies. Practical experience of nuts-and-bolts elements like incubation should be pursued with knowledge transfer through internships. Benchmarking innovation performance against comparator countries and regions must be undertaken. RIS policy fine-tuning must be practised by sub-national development agencies to better integrate system interaction and improved knowledge flows.

While a positive climate for investment in spinout firms, whether from public-good organizations or private companies, is reinforced by government regulatory, taxation and incentivization policies at the level of the nation-State, every region is distinctive economically. Thus, the regional or provincial level becomes an active integrator of multilevel public and private investment pools for seed-funding and subsequent VC opportunities. Israel did this successfully as a small country. Other examples reveal successful and less successful VC vehicles with public status (as in Wales) or privatized though formerly public (as in Scotland). It is also possible to have such vehicles as private sector with a public presence in the investment syndicates (Northern Ireland). The regional system, if well integrated, is the appropriate lead partner, interacting vertically and laterally with key stakeholders in building knowledge entrepreneurship.

Knowledge transfer centres can be public, co-funded, or private

Knowledge transfer centres should be public when estimates of market strength suggest private solutions are inappropriate. But to ensure regional and national commitment instruments like seed capital funds co-funded by public-private partnerships are a suitable way to proceed. Where services are successfully provided and as firms improve profitability, privatization should not be ruled out. Centre managers should have such an aim as a central part of their job description where appropriate. Fundamentally, RIS must be public entities where there is market failure in the supply of innovation services, although the firms that use them in the system are presumed to be private. Thus, systems should be more or less pure public-goods with some joint private element at the outset, if feasible. Thereafter, profitable elements may evolve into jointly funded public-private entities. One well-established alternative for system elements like knowledge-transfer centres is for there to be a membership subscription arrangement, which turns the service into more of an associative or club form of goods. Judgements on a regional and national level with UNIDO analysis and advice should determine which approach is adopted.

Talent formation is crucial

Talent formation in clusters is a crucial factor in innovative competitiveness. Thus the Italian ceramics industry placed a historic emphasis on marketing and design skills which served the industry well in global markets and may well be extremely important in restructuring to face mounting competition from China. Spain's ceramics cluster, by contrast, has deficiencies in this aspect but strengths in the science of ceramics. This suggests that a forum and consensus approach towards change in complex and unstable competitive environments is a constructed advantage of considerable value, in this case in getting the skills mix from the labour market in the correct balance.

The role of business and industry associations

Finally, this draws attention to the important intermediary role played by business and industry associations. They can serve their overall membership better when they are confederated or consolidated with one voice than when they are fragmented. In the case of successful real services units or centres, tailored to meet customers' and members' needs, the absence of basic scientific research in the cluster may not be a problem if it can be bought as needed from elsewhere. These are usually regional- and local-level interactions rather than national or international, although pilot projects to establish such support vehicles in clusters can help the aims of collective entrepreneurship by the supply of common business services, networking opportunities, and representation at overseas trade fairs and exhibitions, to name a few. Thereafter, emulation of good practice is mainly a function for the RIS itself interacting with business cluster associations, municipalities and labour market agencies at the local level.

The creation of RIS disbursing resources of a public-goods nature is desirable in developmental terms. It also fits modern economic growth theory with its stress on global trade, increasing returns to agglomeration and the key role of public goods like ideas and knowledge. Finally, the RIS approach is seen fully to engage with distinctive responsibilities at all economic governance levels. UNIDO and other MEAOs can act as initiators, securers of national support, advisers and co-funders of pilot projects. The national level takes the lead in policy formation and reform. For innovation this means funding and co-funding packages among science, industry and employment ministries to ensure that the transformation of research cultures towards market opportunities is done in a thoughtful and well-planned way. Infrastructural and pump-priming (early-stage stimulation of action by seed-funding to get initiatives going) policy-related funding is also key. Financing for incubation and seed-funding incubatee firms is best conducted at the regional level with local fine-tuning covering talent and skills formation and the building of strong multilevel associative interactions. Regional funding of specific initiatives as regards venture capital, entrepreneurship and skills adaptation is also appropriate, as is co-funding of such activities with the private sector wherever possible

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