Regional Innovation Systems, Clusters, and the Knowledge Economy

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This paper presents a systematic account of the idea and content of regional innovation systems following discoveries made by regional scientists, economic geographers and innovation analysts. It considers the conditions and criteria for empirical recognition and judgement as to whether scientifically analysed, concrete cases of innovation activity warrant the designation of regional innovation system. The paper concludes by claiming that the source for Europe's innovation gap with the United States rests on excess reliance on public intervention, which signifies major market failure. The future will require widespread evolution of public innovation support systems along with stronger institutional and organizational support from the private sector.

1. *Introduction*

In this paper, a systematic account of the idea and content of regional innovation systems is presented. This depends intellectually on discoveries made by regional scientists, economic geographers and national systems of innovation analysts who observed several features of actual innovation processes by firms and among firms and researchers that put in question received wisdom. The received wisdom was often influenced by a philosophy and sociology of science that uncritically internalized autobiographical accounts by famous scientists. They stressed the logical progression of discovery from theory to experiment, confirmation to validation and science to technology, but left many puzzles, not least how change occurred. This is noted in the first main section of this paper as a prelude to a brief but highly illustrative account of the precise mechanisms operating in a specific bio-technology innovation system centred in Massachusetts. Although single cases should merely be heuristic rather than scientifically definitive, one alone

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is sufficient to refute conventional wisdom, rather as Karl Popper noted when a *black* swan was discovered in Australia.

The paper then moves into an analysis of conditions and criteria for empirical recognition and judgement as to whether scientifically analysed, concrete cases of innovation activity warrant the designation of 'regional innovation system' or not, something not always done theoretically or empirically in the national systems of innovation literature, although Malerba (1993) is a notable exception. This section is programmatic but reasonably comprehensive. A critic will say that, like some of the analysis in the fifth section which acts as an empirically informed auto-critique and analysis of weaknesses with dominant expressions of the existential nature of regional innovation systems, it is merely dichotomous. This is unavoidable in the formation of a new field of study. Thus, conceptually a system is either a system or it is not. In realist terms a system can be more or less systemic. Such a critique confuses conceptual with real analysis. At the conceptual level it is only a certain subspecies of economist for whom 'the real world is only a special case' who would trouble to model other conceptual universes. For our purposes it is sufficient to delimit polarities conceptually, then deploy the resulting framework to characterize particular empirical cases in terms of combinations of systems indicators. Though space does not allow that here, it is done in Braczyk *et al*. (1998) and the interested reader is referred there for detail.

As noted, the fifth section is devoted to a further, original dichotomization. This notes that much European work, on which the research field of regional innovation systems presently relies, places undue attention upon the role of the public sector in supplying the soft infrastructure of innovation support for enterprises as a consequence of policy. Often this policy has been orchestrated supranationally by the European Commission, although to varying degrees national governments have pursued such policies too, though until recently less obviously at regional level. It is a key hypothesis of the paper that herein lies the source of Europe's innovation gap with the United States, for such reliance on public intervention signifies major market failure of the simplest kind. Even though economists seek more sophisticated understandings than 'market failure' for weakness such as this, it is all too easy to fall into a culturally reductionist trap on the one side or a regulatory one on the other, if it is not simply recognized that markets for innovation services have yet to be widely recognized by European entrepreneurs, in stark contrast to their US counterparts. Whether this is 'failure' or a species of 'nobility' matters little to citizens denied the opportunity of employment in modern industry. The future is seen as requiring the widespread evolution of public innovation support systems and their complementation by stronger institutional and

organizational support from the private sector. Dichotomous analysis has the virtue of setting a conceptual research framework within which useful empirical analysis, learning and possible policy-adaptation can occur.

2. *Lineaments of Regional Systems—Thinking about Innovation*

Thomas Kuhn (1962) was largely responsible for seriously questioning the functionalist, conventional wisdom account of scientific progress, especially as promulgated by the likes of Robert Merton (1962). Kuhn earned his reputation by pointing out that science proceeded not in a rational, value-free manner but through the micro-politics of innovation. He was especially perceptive in revealing the systemic and socio-cultural nature of dominant scientific knowledge, along with the difficult barriers and obstacles to overturning it:

> The man who embraces a new paradigm at an early stage must often do so in defiance of the evidence provided by problem solving. He must, that is, have faith that the new paradigm will succeed with the many large problems that confront it, knowing only that the older paradigm has failed with a few. (Kuhn, 1962, p. 157)

This refers, of course, to scientific revolutions such as that currently under way in the field of functional genomics, and proteomics, in biotechnology. From this new paradigm it is expected that many new therapeutic treatments will be capable of curing diseases not amenable to treatment under the synthetic chemistry paradigm of drug development. But it is no longer expected that such radical innovations will cascade from laboratory to patient embodied as Plato envisaged as a perfect human form that the sculptor releases from the rough-hewn marble.

Rather, other crucial actors will intervene and may well initiate the innovation process. Consider the following. The US biotechnology firm Genzyme developed a drug to help combat the most debilitating effects of Gaucher's disease. This disease wholly undermines the physical capability of the sufferer by rendering bones brittle, but unlike osteoporosis affects also the blood, spleen and liver, so that the patient requires full hospitalization on a permanent basis. Mental faculties are not affected by the disease, hence the discovery of a drug that could manage or ideally, of course, cure the disease would return a fully functioning human being to a normal productive life. *Cerezyme*, the company's recombinant DNA technology, halts progression of the disease, thus enabling patients to return to a normal life provided they

receive annual top-up treatment by injection of the drug. There are only some 5000 persons genetically predisposed to developing this disease in the Americas, and perhaps 10 000 worldwide. Each annual treatment cost some $300 000–400 000 in 1999, but for each US patient, hospitalization for one year cost double that amount. Healthcare insurance companies could therefore be said to be the drivers of specific innovations because of the clear cost advantages successful ones bring. Absence of equivalent drivers in Europe, e.g. the UK, can easily be seen to have the opposite effect. Indeed recently in that country, drug cost to the publicly funded health service has been the excuse for not providing innovative treatment for influenza.

To continue for a moment with the benign effects only of such a 'selection mechanism', Genzyme, which is based in Cambridge and other Massachusetts locations, works closely with Senator Edward Kennedy, a local representative influential on federal government health committees. Its origins lie in Boston's Tufts University and the New England Enzyme Centre. It is a founding member of the Partners Healthcare System with Brigham and Young, Women's Hospital, and the Massachusetts General Hospital, supported with $400 million in National Institutes of Health research funding and giving access to a large patient base for research and clinical trials. Ten senior Harvard faculty are on the Partners Advisory Committee. Local interaction with the Food & Drug Administration (FDA) office in Boston is fruitful, but without the biotechnology industry lobbying through the regional industry association, the Massachusetts Biotechnology Council, the local FDA office would not exist.

If necessary, specialist legal and financial services are available in the metropolitan area, as are specialist biotechnology incubation and technology park facilities. There are some 280 other biotechnology firms in the area and the business environment is both scientific and entrepreneurial. Scientific and business collaboration and contracting are pronounced. This is one of the leading clustered, regional, sectoral innovation systems in the world. Of course, it could be considered malign that a firm like Genzyme and others are incentivized to search out minority diseases with a relatively accessible genetic code that carry a very high premium, rather than more common ones with more complex genetic disorders. But given the massive research costs of biotechnology, it is hard to see a market model of innovation selecting a different course. The alternative would involve unlimited and long-term public funding that might not produce desired results, something that could be said to denote the 'crusade against cancer'.

What is striking about the Boston biotechnology case is how important are localized, metropolitan and 'regional' in the sense of Massachusetts-wide

institutional and organizational interactions across a wide range of partnership settings. But non-regional, 'national' or federal interactions are crucial too. Public research funding for the Boston biotechnology cluster was running at nearly $1 billion per year around the turn of the millennium, and most of that was federal in origin, ranging from National Institutes of Health to Small Business Innovation Research (SBIR) grants. Moreover, the regulatory powers of the federal FDA are crucial, even if they can be more easily accessed locally through the opening of a regional office. Finally, the vast power of the US healthcare market and the healthcare insurance industry cannot be underestimated.

Then there are the global linkages between the regional cluster and innovation partners elsewhere, from California to Europe, not least in the case of Genzyme with a Dutch CEO, and two enzyme-production plants in the UK plus other European branch operations. It constitutes for firms like Biogen, Genetics Institute, Quintiles, LeukoSite, Millennium and the many others, a multi-level innovation and, to some extent, governance and regulatory system. This is the advantage of taking a *regional* innovation system (RIS) approach. The rich picture of interactions in the cluster can be set on the canvas of wider, global innovation interactions. In what follows, the paper will first explore the most relevant literature that argues for the relevance and importance, intellectually and in policy terms, of this approach. The following part of this section then explores certain public sector underpinnings and possible multi-level interactions to RISs related to the national approach of Lundvall (1992), Nelson (1993) and later Edquist (1997). Finally, it offers a critique of that kind of public sector focused work by reference to the still-poor European innovation rate and the impressive, market-led innovation systems of the United States, especially those involving so-called 'new economy' industries.

Because innovation systems analysts have been wedded to sentiments of 'national' economies, the concept of a RIS is a relatively new one, its first usage dating from a paper published by the present author (Cooke, 1992) and reviewed similarly in the first collection of papers on the subject (Braczyk *et al*., 1998; Cooke, 1998). The development path of the concept was almost entirely from regional science and economic geography. Indeed, authors like Lundvall (1992) were strangely hostile to the concept, again being strongly wedded to a Listian 'national' economy notion that seems increasingly questionable nowadays. There had been a lengthy tradition of published research on technical change and regional development in the UK by, for example, Oakey (1979) and in the US by Rees (1979), although one of the earliest papers on the subject was that of Thomas (1975). Curiously, Thomas,

Rees and Cooke are from Wales and it is certain from the present author's conversations that Rees was influenced in his research, as were a large number of regional scientists worldwide, by the work of the late Morgan D. Thomas. He, in turn, had made a major contribution to research on growth poles, after Perroux (1955). The linkage to innovation research is completed at this point since, as is pointed out by Cooke (2002), following Anderson (1994), Perroux developed the growth pole concept after reading Schumpeter's (1975) work on disruptive economic change and the swarming effects of radical innovation upon growth processes. Perroux's contribution was to highlight the economic geography of what Dahmén (1950) called 'development blocks' or what are also known nowadays as clusters (Porter, 1998).

In the case of Rees (1979) and Cooke (1992), the moves towards studying regional innovation evolved differently. We have noted that Thomas's (1975) work influenced the former, but of greater direct significance was that of Vernon (1966) on the product life cycle, something Porter (1980) also worked with when analysing corporate strategy. Rees extended the notion of the product lifecycle to that of the regional life cycle, stressing the importance of intensive technology regions to innovation and the negative effects of low technological intensities upon regions that become branded as mature technology 'branch plant' regions. This was also the aspect of innovation and the problems caused by industry restructuring in contexts of low innovativeness that stimulated the present author's interest (see, for example, Cooke, 1980, 1985). The fact that Wales was precisely one of those regions at the end of a product lifecycle, although it had once been a globally significant innovator in metallurgical and mining industries, is undoubtedly connected to the intellectual interests of the three authors originating there. In the Cooke (1985) paper there is a detailed analysis of the then fairly novel idea and practice of regional innovation policy, set in the context of government policies seeking to respond to the rise of Silicon Valley and the early information technology (IT) industry, but drawing on the 'technopole' policy in France and exposing it to critique. The problem observed was the lack of systemic network development around decentralized government research laboratories. Rather these stood like cathedrals in the desert, often in agglomeration but not clustering and not creating synergies through spin-off and subcontracting activities. This, it was concluded, was not the model to imitate in regions such as Wales and the learning value was principally of the developmental weaknesses of linear, centralized and hierarchical growth pole and technopole thinking.

The alternative had to be non-linear, decentralized and heterarchical, something that this author had found in what was coming to be called 'Third

Italy' (Bagnasco, 1977). Working with a Portuguese colleague on the industrial districts of Portugal and Emilia-Romagna, and analysing their contrasts in entrepreneurship and innovativeness with Wales, Cooke and da Rosa Pires (1985) discovered for themselves the value of interfirm networking and regional policies responsive to small firm needs, particularly in Italy. This occurred at approximately the time that the ground-breaking book by Piore and Sabel (1984) on the same subject had been published. Other regional scientists—most notably Saxenian (1981, 1994) and subsequently Scott (1986)—also began writing about network relations of this kind in new technology regions, particularly in Silicon Valley. But, of course both the Third Italy and Silicon Valley were easily seen to be unique and untranslatable, despite the multitude of efforts to do precisely that by consultants and technology policymakers nearly everywhere. Most regions then had relatively weak administrations, little experience or competence in innovation support, little or no high-technology industry, and few, if any, industrial districts. But the question that now had to be answered was whether, underlying these diverse cases of regional economic success there was a generic and generalizable model. To test this out Cooke and Morgan (1990, 1993, 1994a) secured a project to investigate regional innovation networking in Wales and Baden-Württemberg. The latter region was chosen because it had a comparable, though larger-scale, industry structure to that of Wales, dominated by automotive and electronics engineering as well as a mix of large and smaller firms in supply chains. Yet there the resemblance ended since the German region remains the far more prosperous and innovative. So the research question could be summarized as: What's the special ingredient? Both regions could be shown to have industry clusters as defined by Porter:

> Geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions . . . in particular fields that compete but also co-operate. (Porter, 1998, p. 197)

These were stronger in the automotive industry, linked also to machine-tools in the German case, while in Wales it was electronics that had the stronger cluster-like character, even though this had evolved around foreign direct investment (FDI), something Porter erroneously considered impossible until he reconsidered (see Porter, 1998). But while the electronics cluster in Wales could be considered 'competitive', the German automotive one was considerably more endogenously 'generative' and this innovative capability was an important clue to understanding differences in performance.

In the late 1980s, the first fruits of the research and theorization of national innovation systems (Freeman, 1987) became widely available, and the present author invited this key figure to Cardiff to address his masters class in regional development. Shortly after, a chapter by Lundvall on 'Innovation as an Interactive Process' was published in the collection of Dosi *et al*. (1988). While the ideas of both, notably Freeman's on networks and Lundvall's on interactive learning, were ones we understood and found useful in conducting the comparative research, the relative generality of their concepts of national innovation systems and their blind spot about regions were obvious weaknesses in what was nevertheless path-breaking work. What was becoming clear was that there was a distinct need for new and detailed empirical research inside firms and innovation support organizations to get a better understanding of the nature of and extent to which co-operation and partnership operated in a market context, and to determine the extent to which they contributed to greater innovativeness and competitiveness. What the national innovation systems research had never done was to schematize systems typologically but rather, presented everywhere studied as rather unique. This was something we also considered a weakness and a long-term aim to correct this was fulfilled in the publication of Braczyk *et al*. (1998) but prefigured in Cooke (1992) and Cooke and Morgan (1994b).

So what is the relationship between a national system of innovation (NSI) and an RIS? This is, of course, a large question, that requires another article. However, some thought was given to this in Cooke *et al*. (2000). There, it was suggested, lies a powerful, persisting role for NSIs to set scientific priorities, and fund basic research and university-level training. RISs may influence or even disburse certain allocations, but without major tax-raising and tax-retaining powers, which few if any real systems have, there is an NSI monopoly. But this is a functional division based on historic path-dependence. In evolutionary terms, things can change. Thus, what is presently, following Arrovian theorems, justified in terms of market failure (of investment in basic research) may evolve into something else, such as market non-failure consequent on radical privatization and incentivization of basic research investment, probably through private foundations. Or regions may wrest more taxation control from central government and amass budgets sufficient to set and fund their own, democratically achieved, basic research priorities. In relational terms, regional lobbies make a difference, as in the US pork-barrel system of defence-science allocations that disproportionately favoured certain regions. In Germany and the UK expensive decisions to build new synchrotrons have similarly been lobbied to Berlin and Oxford as biotechnology rises up the political agenda at the expense of nuclear research. Finally,

as advanced industry inclines more to the cluster than the corporate model of industrial organization, specialized RISs will necessarily develop intimate relationships with centres of major scientific policy and funding within the NSI, of the kind currently enjoyed by corporate heads. RIS governance thus becomes a litmus-test of industry capability, and in many cases, new actors, such as university rectors, may take their place, as in Austin, TX with Sematech and MRC or Sheffield, UK where advanced titanium research has caused Boeing to make a first R&D move off-shore (Cooke, 2001).

3. *The Conceptual System and the Real System*

There is confusion among many economists, and others, tutored in neoclassical economics, about the distinction between a conceptual and a real system. The former may include such obvious idealisations as 'perfect competition', 'equilibrium', 'the real world is just a special case' and so on. The latter will describe an actually existing system, with all its flaws and complexities. Iteration between conceptual and real systems is normally conducted by drawing on dichotomous thinking, aimed at covering polarities, in relation to which real cases are then measured. In the research process described earlier, empirical research was, as usual, also necessary to assist delineation of conceptual systems. Thus, at this point, the research approach contained five key, linked concepts. The first was *region*, by which was meant a meso-level political unit set between the national or federal and local levels of government that might have some cultural or historical homogeneity but which at least had some statutory powers to intervene and support economic development, particularly innovation. The second was *innovation*, where the broad notion promulgated by the neo-Schumpeterian school, of which Freeman and Lundvall were leading exponents, as commercialization of new knowledge in respect of products, processes and organization was a good starting point, but one that needed to be tested by detailed empirical research in firms. Third was the concept of *network*, which was conceived of as a set of reciprocal, reputational or customary trust and co-operation-based linkages among actors that coalesces to enable its members to pursue common interests, in this case in respect of innovation, after which it may continue with new projects, evolve with changed members or disappear. Fourth, the concept of *learning* was prominent, particularly that related to 'institutional learning' where new levels and kinds of knowledge, skills and capabilities could be embedded in the routines and conventions of firms and innovation support organizations, and old ones discarded or forgotten as Johnson (1992) usefully put it. Finally, *interaction* was key, in the sense of regular means of

formal and informal meetings or communication focused on innovation such that firms and relevant network organizations and members could *associate* to learn, critique or pursue specific project ideas or practices of collective and individual economic, commercial or communal relevance.

In conducting the comparative European research, initially in two very differently performing regions from the innovation viewpoint, and analysing the results of interviews with senior managers of firms, government and intermediary 'governance' organizations, it became possible to speak of RISs the strengths and weaknesses of which could be measured along the five axes. Indeed 'systemness', which is a conceptual as well as a real construct, where the ideal and real are much closer together in something like a central heating system than they are in respect of regional innovation, can be shown to be present or not in part or the whole of these dimensions. Hence whether or not a region has an innovation system can be determined, as can the nature of whatever systemic innovation interaction, networking and learning capacity it does, in fact, possess. Analysing these dimensions against, on the one hand, interactive governance, meaning good knowledge flows among intermediaries and with firms, and on the other hand, interfirm interaction, networking, learning and so on, enabled a judgement about the nature and extent of systemness to be made.

Thus Baden-Württemberg could be shown to be a clear instance of a *heterarchical* RIS because research results showed that firms had many vertical and horizontal, market and non-market, trustful and sceptical relations with each other. More than this, they had comparable relationships with intermediaries and government departments, who themselves worked through networks. Of course, in both dimensions, there were power relations; thus Daimler-Benz was able to animate and influence networks at the highest possible level inside and beyond the region. Equally, as the authoritative institution, the *Land* government was more influential than any other public body operating in the region. But that did not mean that actions important for innovation were only initiated by them, nor that those that were always succeeded. A fine instance of the latter was the *Land*-initiated policy for Baden-Württemberg to become the first region in Germany or elsewhere in interactive television. A large budget was earmarked and leading large firms in telecoms, computing and TV were organized into a policy network. Small and medium-sized firms were not highlighted in this process despite critics' arguments that 'content is king', the technology is not, and the innovative new media firms were in the *Mittelstand.* Predictably telecoms firms (Deutsche Telekom) found it impossible to agree standards or much else with computing firms (IBM, Hewlett-Packard) and the TV company could not work with

either. Hence the attempt to 'create' a new media network among global players in the region was a failure.

However, an alternative narrative can be provided where the networks already exist and a member highlights an innovation issue. The case concerns the early 1990s impact on the possible future industrial fabric by the advent of Toyota's new luxury car, the Lexus. Keep in mind the *Land* is home to Mercedes and Porsche and also had Audi in the region. Mercedes expressed its fears that it would be uncompetitive both to its industry association and the government. The reason was that Mercedes still designed and even produced far more parts and components in-house than the industry average in Germany. One way of reducing costs was to subcontract responsibility for innovation to the supply-chain. This idea was discussed with the automotive trade association and the regional industry minister's office. The ministry, on the advice of the association, commissioned US consultants to explore the capability of regional *Mittelstand* firms to take on an extra R&D burden. It transpired that most were used to receiving designs from the customer and producing to order, also few had R&D offices or staff. So to stimulate greater integration of innovation in the external system of production, the ministry agreed to subsidize model projects in which suppliers would learn to innovate by interaction. Suppliers expressed fears that they would lose precious know-how to competitors, so agreement was reached that sensitive knowledge needed to innovate would be held by the Fraunhofer Institute, which would act as a trusted third-party member of the project networks. The outcome was a more systemic regional innovation process and one that has contributed to the strengthening of Mercedes's global competitive position.

The key point here is that such interaction could take place rapidly because a variety of key players were present in proximity and accordingly were familiar with each others' reputations and capabilities. Thus as well as large customer firms and extended supply chains, there were numerous research institutes such as the Fraunhofer Society, well-equipped in applied automotive research, the Max Planck Institutes if more fundamental research knowledge was needed, the regional branch of the German automotive industry association, the technology centres of the Steinbeis Foundation scattered throughout the higher education system of the *Land,* and numerous engineering and other technical consultancies. The systemic nature of these nodes in the network could relatively easily be exploited given a challenge such as the one described.

In a different setting such as that of Wales, where industry restructuring was more comparable to that occurring in Germany's older industries in the Ruhr, the role of the state is much stronger because of market failure in the

declining sectors. Unlike Baden-Württemberg, Wales had pressed for a powerful economic development agency to manage the transition to new industries. Modelling itself on the Irish Development Authority, the Welsh Development Agency went full-speed for a FDI strategy. The ingenuity of this rather basic approach was to target Japan rather than the United States, as the Irish and, later, Scottish development agencies had done. Relatively few European regional development agencies either existed or pursued such strategies so the competitive field was not as strong as it subsequently became. Around 60 Japanese and other south-east Asian companies were attracted from 1975 onwards. The challenge that evolved as this rebuilding process developed also concerned supply chains and innovation, neither of which were strong in automotive and electronic engineering. Gradually, through discussion, a 'sourcing' policy was adapted to become a supplier development programme and an innovative forum of candidate and approved suppliers aimed at establishing standards, quality criteria and innovation with customers was formed by the development agency. Where gaps in the supply chain were found, the agency persuaded FDI supply firms to locate in what were becoming automotive and electronics clusters. Later small R&D divisions were established by some of the FDI firms and contract research was placed in universities. Skills problems were tackled by involving training colleges and intermediaries in the forums. A regional innovation strategy, part-funded as a pilot by the European Commission, was produced with full industry involvement.

But state agencies were co-ordinating all these policies and the systemic promotion of innovation was somewhat *hierarchical* as a consequence. Market failure had meant that, despite attempts to build up the innovation capability of the regional economy, most FDI firms were at the mature end of the product and hence regional life cycle. By the beginning of the new millennium the problems of devoting a great deal of attention to FDI in mature sectors like automotive components, televisions and telecom equipment, and failing to create a good environment for entrepreneurship in innovative 'new economy' sectors, were revealed. Wales scores low on new economy businesses and its FDI firms like Sony and Panasonic are beginning to downsize and shift mature production to Poland, Slovakia and the Czech Republic. Unlike Ireland and Scotland, where the pursuit of high technology has eventually led to secondary and indigenous business growth in, for example, business and leisure software, not least because skills development in high technology creates knowledge that is also suitable for entrepreneurship in new economy fields where barriers to entry are low, in Wales the government is belatedly trying to lead an entrepreneurship crusade. The key problem remains a

dearth of growing mid-size businesses either producing or investing in future-oriented business sectors, and while public consciousness of the importance of innovation may have risen, for example as inputs to the production of regional technology plans and innovation strategies, for the moment the outputs remain rather disappointing.

There are many more regions in Europe and elsewhere with a story similar to that of Wales than Baden-Württemberg. In a further research study (Cooke *et al.*, 2000) funded by the TSER programme of the European Commission, 11 regions in the EU and in Eastern and Central Europe were examined with a common research methodology to establish the extent to which RISs existed. Of these, only four were good candidates. Two are those already discussed above; the others are the Basque country in Spain, with a state-led structure very much like that of Wales, and a still rather weak innovation performance (see also Cooke and Morgan, 1998), and Styria in Austria where there is also a strong public innovation support infrastructure but much of it devoted to university spin-out and cluster formation. Elsewhere, in regions like Friuli in Italy or Wallonia in Belgium, where there were signs of growth these seemed almost to be occurring despite rather than because of government actions. In Brabant in Holland SME innovation was evident but there was no regional administration, and the same applies to Tampere region in Finland where, like Styria, university spin-offs supplying Nokia are doing well with stimulus from the national innovation system promotion of incubation and science parks. The Centro region in Portugal has market-based, low-technology industrial districts which are rather vulnerable to export trading conditions, but cannot be said to have the character of a RIS. There are networks but they are somewhat clientelistic and opportunities for upgrading through learning from university research are scarce. Lower Silesia in Poland has potential, based on its universities, but has little regional systemic innovation capability, unlike Féjer region in Hungary which has a burgeoning regional supply chain culture developing around US FDI in automotive and electronics engineering but no regional government or strong research base. It is notable that automotive and electronics FDI had a limited propulsive effect in restructuring older industrial regions in Western Europe and is now increasingly performing that mature product lifecycle function in the East while gradually attenuating its presence in its previous host regions. The best lesson the East can learn from the West is to seek to develop RISs that promote endogenous development in immature sectors that may nevertheless benefit from certain kinds of skills development and knowledge transfer from advanced users and producers of, say computers, pharmaceuticals and telecommunications. For the moment it is those learner regions that adapt

rather than imitate or simply act as production platforms that develop the most, as happened to some degree in Ireland and the Asian 'tigers'.

4. *Conditions and Criteria for Regional Innovation Systems*

Taking the latter observation further, and bearing in mind the finding that there are few fully functioning RISs and even fewer where the economic performance of such regions is outstanding, at least in Europe where most of the research has been focused, what, it may nevertheless legitimately be asked, is an appropriate model to which regions in the throes of major restructuring might aspire? The point here is that economically high performing regions have innovation systems of great sophistication but they are market-led. These are not locations characterized by market failure. But most regions across the world and many in the advanced economies suffer market weakness if not failure to varying degrees. In distilling results from a great deal of research on and considering the prospects for regional systems of innovation, Cooke *et al*. (1997) explored theoretically the key organizational and institutional dimensions providing for strong and weak RIS potential. This was a pioneering attempt to specify desirable criteria upon which systemic innovation at the regional level might occur. These can be divided into infrastructural and superstructural characteristics. These terms are used for reasons of familiarity and logic. Terms like 'innovation infrastructure', 'soft infrastructure' and 'network infrastructure' are widely used to denote the enterprise support subsystem for innovation. The corollary of infrastructure is superstructure.

4.1 Infrastructural Issues

The first infrastructural issue concerns the degree to which, as was discussed in Section 2, there is regional financial competence. This includes private and public finance. Where there is a regional stock exchange, firms, especially SMEs, may find opportunity in a local capital market. Where regional governments have jurisdiction and competence, a regional credit-based system in which the regional administration can be involved in co-financing or provision of loan guarantees will be of considerable value—something extremely important in the German approach where the private sector strongly avoids high risk. Hence, secured 'proximity capital' can clearly be of great importance, especially as lender–borrower interaction and open communication are seen to be increasingly important features in modern theories of finance. Hence, regional governance for innovation entails the facilitation

of interaction between parties, including, where appropriate and available, the competences of member-state and EU resources. This can help build up capability, reputation, trust and reliability amongst regional partners.

However, regional *public* budgets are also important for mobilizing regional innovation potential. We may consider three kinds of budgetary competence for those situations where at least some kind of regional administration exists. First, regions may have competence to administer *decentralized spending*. This is where the region is the channel through which central government expenditure flows for certain items. Much Italian, Spanish and French regional expenditure is of this kind although there are exceptions, such as the Italian Special Statute regions and for some Spanish regions. A second category applies to cases where regions have *autonomous spending* competence. This occurs where regions determine how to spend a centrally allocated block-grant (as in Scotland and Wales in the UK) or where, as in federal systems, they are able to negotiate their expenditure priorities with their central state and, where appropriate, the EU. The third category is where regions have *taxation authority* as well as autonomous spending competence since this allows them extra capacity to design special policies to support, for example, regional innovation. The Basque country in Spain has this competence, as does Scotland. Clearly, the strongest base for the promotion of regional innovation is found where regions have regionalized credit facilities and administrations with autonomous spending and/or taxation authority.

A further infrastructural issue concerns the competence regional authorities have for controlling or influencing investments in hard infrastructures such as transport and telecommunications and softer, knowledge infrastructures such as universities, research institutes, science parks and technology transfer centres. Most regions lack the budgetary capacity for the most strategic of these, but many have competences to design and construct many of them or, if not, to influence decisions ultimately made elsewhere in respect of them. The range of possibilities is enormous in this respect, so we classify broadly into types of infrastructure over which regions may have more or less managerial or influence capacity. If we think of our three cases, then the federal systems in Germany and the United States have most influence over infrastructural decisions, including roads and even airport policies; in Germany basic research funding frequently has a regional (*Land*) component, and in the US, too, management and funding of public universities is devolved. In the UK case, regions in England (but not Northern Ireland, Scotland and Wales) have only had regional development agencies since April 1999. So the infrastructural autonomy enjoyed in the federal system is absent except for the construction, mainly privately, of science and technology parks,

whose location is regulated by local government, but can be strongly influenced by UK government decisions, as the long drawn-out case of refusal of planning permission for the Wellcome Trust to build a biotechnology science park in the countryside near Cambridge by the UK Minister of the Environment, Transport and the Regions testifies.

4.2 Superstructural Issues

Three broad categories of conditions and criteria can be advanced in respect of superstructural issues. These refer, in general, to mentalities amongst regional actors or the 'culture' of the region and can be divided into the *institutional level*, the *organizational level for firms* and the *organizational level for governance*. Together, these help to define the degree of *embeddedness* of the region, its institutions and organizations. Embeddedness is here defined in terms of the extent to which a social community operates in terms of shared norms of co-operation, trustful interaction and 'untraded interdependencies' (Dosi, 1988) as distinct from competitive, individualistic, 'arm's length exchange' and hierarchical norms. The contention here is that the former set of characteristics is more appropriate to systemic innovation through network or partnership relationships. It is widely thought that American entrepreneurship involves a strong individualist characteristic, but in biotechnology, as in other cases of high technology, there is co-operation as well as competition. It should also be noted that the work of Saxenian (1994) points strongly to the conclusion that a key reason for Silicon Valley's better long-term innovation performance than that of Route 128 in Boston was that Silicon Valley was the region with the greater embeddedness. But the resurgence of the latter is linked to Massachusetts's adoption of a cluster policy from which biotechnology and biomedical instruments, for example, have benefited (Porter, 1998; Best, 1999).

Therefore, if we look, first, at the institutional level, the 'atmosphere' of a co-operative culture, associative disposition, learning orientation and quest for consensus would be expected to be stronger in a region displaying characteristics of systemic innovation, whereas a competitive culture, individualism, a 'not invented here' mentality and dissension would be typical of non-systemic, weakly interactive innovation at regional level. Moving to the organizational level of the firm, those with stronger systemic innovation potential will display trustful labour relations, shopfloor co-operation and a worker welfare orientation with emphasis upon helping workers improve through a mentoring system, and an openness to externalizing transactions and knowledge exchange with other firms and organizations with respect to

TABLE 1. Conditions for Higher and Lower Regional Innovation Systems Potential

Higher RSI potential	Lower RSI potential
Infrastructural level	
Autonomous taxing and spending	Decentralized spending
Regional private finance	National financial organization
Policy influence on infrastructure	Limited influence on infrastructure
Regional university–industry strategy	Piecemeal innovation projects
Superstructural level	
Institutional dimension	
Co-operative culture	Competitive culture
Interactive learning	Individualistic
Associative-consensus	Institutional dissension
Organizational dimension (firms)	
Harmonious labour relations	Antagonistic labour relations
Worker mentoring	Self-acquired skills
Externalization	Internalization
Interactive innovation	Stand alone R&D
Organizational dimension (policy)	
Inclusive	Exclusive
Monitoring	Reacting
Consultative	Authoritative
Networking	Hierarchical

innovation. The weakly systemic firm characteristics would include antagonistic labour relations, workplace division, 'sweating' and a 'teach yourself' attitude to worker improvement. Internalization of business functions would be strongly pronounced and innovativeness might be limited to adaptation. Regarding the organization of governance, the embedded region will display inclusivity, monitoring, consultation, delegation and networking propensities among its policymakers while the disembedded region will have organizations that tend to be exclusive, reactive, authoritarian and hierarchical. In outline these characteristics are summarized in Table 1.

Clearly, both sets of conditions are ideal-types. But, it is likely that there are tendencies by regions towards one or other pole. Perhaps overlaying this nowadays is an element of convergence influenced either by globalization processes, or the policy effects of state governments or European Union programmes.

5. *Problems with Public Regional Innovation Systems*

We can say that RISs are both rare and newly discovered. In Europe, where

research has been concentrated, they are dependent on public institutions to a significant degree. This is true even in accomplished regional economies such as Baden-Württemberg, but normal in many cases where industrial change is pronounced, and there are many cases where it is hard to discern systemic regional innovation. It is seldom the case in the European setting that weakly developed regional administration (in the sense denoted in Table 1) is accompanied by strongly innovative economic performance, but it is likely to evolve in some places if experiences of the emergence of 'new economy' sectors in the United States are repeated there. Some limited evidence that this is so is observable in innovative 'hot spots' in the south-east of England, and maybe (though this is based on unstructured discourse with some 'new economy' players) also the Amsterdam–Utrecht corridor in the Netherlands and Stockholm–Uppsala in Sweden; where dot-com, biotechnology and ICT start-up activity is pronounced, there are strong private or marketised RISs. Vence (2001), using EU data, has recently shown how such regions performed best in the EU 1980–95 in relation to productivity and employment growth. These 'new economy' sectors of ICT, biotechnology and media have in common proximity to as well as some presence inside large cities. This intra-city presence is particularly true for new media and leisure software (computer games) firms, as it is also in New York and Los Angeles as described in Braczyk *et al.* (1999). For ICT and biotechnology, especially the latter, location in satellites closer to leading-edge university research is most important. Hence, Cambridge and Oxford, at about 50 miles from London, have ICT or biotechnology clusters, as do Uppsala and Amsterdam–Utrecht in relation to their capitals (Ernst & Young, 1999).

These places are dependent on public research funds for basic scientific investigation, but exploitation and commercialization of scientific findings is looked after by venture capitalists, corporate venturing arms of larger firms, contracts and milestone payments by big pharmaceutical, media or ICT firms, business angels, patent lawyers, specialist corporate lawyers, merchant banks, consultants and accountants. In and near to great cities is found a rich private infrastructure of innovation support whose presence has become particularly visible during the period of emergence and consolidation of what have been identified as the 'new economy' sectors. Although leading corporations involved in the marketing of computing, telecommunications, varieties of software, pharmaceuticals and media products and services exist outside clusters, they also have a presence in many of them, either through establishing localized plants or offices, or even more commonly through acquisition, a contractual relationship or other form of partnership. But, having also outsourced much leading-edge research to smaller technology firms, it is

TABLE 2. New Rules for a New Economy (adapted from Kelly, 1998)

Old economy	New economy
Centralized	Decentralized
Constant returns	Increasing returns
Value scarcity	Value abundance
Rising prices	Falling prices
Maximize firm value	Maximize network value
Incremental innovation	Disruptive innovation
Place proximity	Cyberspace
Machine-focused technology	Human-focused technology

these suppliers that display high levels of clustering to access knowledge spillovers, opportunities for tacit knowledge-exchange and other 'untraded interdependencies', more generally. Such settings create highly innovative milieux and in Europe the support infrastructure is beginning to learn to be as aggressive in pursuit of innovation opportunities capable of being realized as substantially profitable investments as the model that emerged first in California. But they are, as yet, few in number and far behind the originators of what we may refer to as the 'new economy innovation system' actors.

An early discussion of the nature of the new economy was presented in a book by Kelly (1998). This focused on networking and the likely impact of the Internet on business. It concluded with ten rules for the new economy that have wider application. In Table 2 these are contrasted with some rules of the old economy. Subsequently a further comparison with another set of new economy 'conventions' borrowed by Kaplan (1999) is presented in Table 3. In Kelly's summary of the rules there is some actual repetition, so here they are condensed to eight. They relate to the main organizing features or assumptions about rational business practices and expectations. As was argued earlier, dichotomies are helpful ways of differentiating conceptual systems, or in this case conceptual models. Thus what Table 2 does is to characterize emphases in two conceptual models, the full argument for which may be perused in the cited reference (and indeed others, e.g. Norton, 2000; Micklethwait and Wooldridge, 2000). The key distinction is between a model of preferred industry organization in which centralized corporate structures pursued constant returns from scale economies, accompanied by mild (although sometimes raging) inflation, where core technologies were mature and disruptive change unwelcome, and headquarter's decisions could be locked-in to a specific piece of machinery, often the original source of the corporation's existence. Probably the classic example is Xerox, based in

TABLE 3. Old and New Economy Conventions (after Kaplan, 1999)

Old economy	New economy
A skill	Lifelong learning
Industrial relations conflicts	Teams
Environmental conflicts	Growth
Security	Risk-taking
Monopolies	Competition
Plants	Intelligence
Standardization	Customer choice
Litigation	Investment
Status quo	Agility
Hierarchical	Distributed
Wages	Ownership/options

Rochester, NY, exploiting an original copier technology incrementally, maximizing share value but also firm value. Thus:

> Virtually Xerox's entire workforce of 125 000 was focused on selling one type of product; the office copier. They represented decades of corporate investment—hundreds of millions of dollars—in embedded training, technology, and customer service. (Hiltzik, 2000, p. 392)

This is by way of comparison with Apple, itself spawned, circuitously, by Xerox through its investment in the Palo Alto Research Centre or Xerox PARC where the Alto, predecessor of the Macintosh, originated. Xerox PARC was both organized as and ushered in a mode of industry organization that has much in common with both the concept and reality of 'new economy' conventions. That is, first-mover advantage by a small start-up like Apple gave increasing returns, based on Moore's Law of the falling price of micro-processors, in disruptive technologies where knowledge was enacted upon itself to create productivity and enhanced value (Castells, 1996; Cooke, 2002), a definition of the 'knowledge economy' that is at the heart of new economy industry. Although Xerox PARC was set up by the parent firm as an innovative R&D laboratory, few products other than laser printers were successfully marketed by Xerox, but most of PARC's other innovations became mainstays of Silicon Valley and the ICT part of the 'new economy'.

First, socio-technical networks overcome the centralization implicit in classic corporate and governmental bureaucracies. This is something discussed earlier in this paper in relation to the search for a conceptual model of innovation in geographical space that would counteract the policy weaknesses

of technopole thinking. In this sense Kelly's argument has some validity but it is patently clear that the power that has 'swarmed away from the centre' has often been less commanding executive power and more marginal, individual influence. In a few cases and specific industries, traditionally powerful corporations have been supplanted by new, rapidly growing companies, most obviously in IT with the passing of IBM by Intel and Microsoft. Kelly says the new economy overcomes scarcity and yields increasing returns to scale. The latter now has a respectable pedigree following the discoveries of the 'new neoclassicals' led by Krugman (1991, 1995; for comment, see Cooke and Morgan, 1998) and clusters are said to be the means of inducing them to some extent. But clusters thrive on scarcity of entrepreneurial talent, intellectual capital, tacit knowledge exchange and the immobility of such assets. Hence the new economy continues to be based on scarcity, but of knowledge 'capital' more than, for example, financial capital.

So prices of computers and software fall in real terms but not drugs, especially not biotechnologically derived drugs as was shown in the introduction to this paper. Further, it is also clear that modestly rising inflation remains an accompaniment to the new economy overall. Nevertheless, technology-influenced productivity increases have begun to be apparent in some areas of the new economy and parts of the old one integrating with it, such as telecom services, logistics and, in pure cost per item terms, e-commerce. Networks, as we have seen, are an important instrument in competitiveness, and add value under some, but by no means all, circumstances. Place proximity is important for clusters, but the growth of project-based work may supersede them and the 'virtual firm' leads to the question: does cyberspace substitute? It is well known that codified knowledge transcends space easily but not new knowledge that is often created by 'epistemic communities' of distinctively skilled people exploiting spillovers in specific knowledge-intensive places. So, space continues to exert an influence so long as talent remains scarce. Technology facilitates but does not replace proximate social interaction for purposes of innovation. And perhaps through his assertion that technology becomes anthropomorphic in the new economy (think of call-centres) Kelly has missed this point, but not without indicating some possibly important tendencies present in such industries.

A more sober analysis is offered by Norton (2000) who makes the important, if fairly obvious, point that the new economy is remarkably geographically focused, is highly Schumpeterian in its particular occurrences, and that it shows extremely strong tendencies towards regional imbalance. Norton is clear that the new economy is a real phenomenon and its propulsive power was networked IT, the increasing returns from which are likely to

widen the IT lead between the United States and the rest of the world. This judgement would have to be modified were it to move beyond networked PCs to mobile telephony where, as we know, the US lags several EU member-states. Like Kelly, Norton sees the decline of centralization and hierarchy as accompaniments of the new economy, stresses the importance of free-flowing information, though does not comment on the barriers posed by the value of exploitable knowledge. This means even tacit knowledge exchanges are actually highly circumscribed and project focused (Zucker *et al.*, 1998).

Norton then explores the importance of geographical proximity to the entrepreneurial innovation that is hypothesized to lie at the heart of the new economy. This is where he draws on Micklethwait and Wooldridge's (2000) anatomy of the apparent success of Silicon Valley as an innovative cluster, concluding that tolerance (of failure and treachery), risk-seeking, restlessness, reinvestment in the cluster, meritocracy, collaboration, variety, product-obsession and low entry barriers comprise the culture of this economic community, the capital of the new economy, '*a milieu conducive to spin-offs and start-ups*' (Norton, 2000, p. 239). His conclusion is that Silicon Valley and other, lesser, though also new economy places are characterized by the geographical concatenation of scientists, engineers, entrepreneurs and venture capitalists looking for value from technological discontinuities, the more disruptive, hence rarer, the better. Though recall Krugman's (1995) comment about the disappointing rate of radical innovation from ICT compared to steam and electricity. Nevertheless, Norton goes on to show statistically that places with high digital IPOs (initial public offerings) like San Francisco, San Jose, Denver, Boston and Seattle have high concentrations of the key new economy actors.

This is interesting because it links to the third approach to understanding the new economy. In Kaplan's (1999) account of the rise of firms like Cisco Systems, Netscape, Yahoo! and Oracle, all founded in Silicon Valley, great importance is given to firms like Kleiner, Perkins, Caulfield & Byers and other, lesser venture capital houses such as Sequoia Capital, Sierra Ventures, Technology Venture Investments, New Enterprise Associates and the Mayfield Fund, all clustered in Sand Hill Road, Palo Alto. Kleiner Perkins (KP) investments (230 firms in which equity is retained) have market capitalizations worth $125 billion, 1997 revenues of $61 billion and employ 162 000 people, mostly but not exclusively in Silicon Valley. In brief, the key role in entrepreneurial innovation is now taken by an aggressive scouring of research laboratories by venture capitalists, some of whom, like KP, have, in effect, built their own clusters of start-up firms who are encouraged (Bronson, 1998, says 'coerced') to trade with each other in Japanese *keiretsu* style. This

phenomenon is more advanced in IT, telephony, software and dot-com fields than biotechnology, but since these are co-located and co-funded by the same venture capitalists in Silicon Valley, the model is distinguished mainly by the higher burn rates and slower IPO progress of the latter. Essentially, if a biotechnology business opportunity looks like a winner, the experience is indistinguishable.

An empirical indication of the *keiretsu* approach to proximity in venture capital investment is shown by analysis of the location of the investments of KP, the leading *keiretsu* investor (www.kpcb.com). Of the 230 firms in which the company retains equity, 59% or 134 are located in Silicon Valley, 25 are located elsewhere in California and 71 outside that state. Of those in Silicon Valley, 20 are in Mountain View, 18 in Sunnyvale, 16 in San Jose, 14 each in Palo Alto and San Mateo and seven each in Santa Clara and Redwood City. These locations are easily within an hour's drive of Sand Hill Road where KP has its head office, many are within an hour's walk. Not only is geographical proximity at the heart of this model of industry organization, clustering activity between firms in the *keiretsu* family is the rationale for the performance enhancement of the equity holdings. Thus intertrading and joint marketing, recruiting and technology exchange are conducted. This underline's Zook's (2000) observation about the high positive correlation between Internet firms and venture capitalists in the US, which is that the latter do not like to be more than an hour's drive away from their investments because they are then able to engage in hand's-on management of the firm.

Key elements of new economy conventions are captured in Table 3 (after Kaplan, 1999). Many do not differ significantly from our earlier comparisons, but some elements focus emphasis on peculiarities of business practice, like low litigation, intelligence (distributed), and the widespread use of stock options as compensation. As we have seen, the idea of a 'new economy' can be criticized for overstatements of singular features of some industries as being generic, and flimsy evidence that the knowledge-intensive sectors involved have conquered scarcity and are thus immune from the business cycle. However, there are new features to the innovation system, principally the voraciousness and abundance of investment capital, the rationale for expenditure of which rests on calculated risks that can appear and indeed turn out to be massive and misplaced gambles. To some extent the long lead-times and high cash 'burn-rate' in biotechnology triggered this kind of high up-front cost investment based on a calculated risk that enough returns would accrue when some firms reached the IPO stage to compensate for the losers. Thus innovation is the fundamental source of value, seeking it out is an investment imperative, and systemic search and selection procedures by

venture capitalists is the main means of exploiting gains from public investment in basic research. This is the fundamental feature of the new economy, rather than the conquering of scarcity. It is, in fact, investment based on the apotheosis of scarcity, the 'breakthrough' innovation, the 'magic bullet' cure and the chance to reap riches that yield lifetime security. Knowledge-driven clusters help make this happen. However, inspection of Table 3 begs the question in general of how many of the conventions exclusively assigned to the new economy actually apply in the old, whether currently or, more tellingly, when it was new. Thus a strong emphasis on teamwork, multi-skilling, customization, agility and distributed intelligence could be said to be characteristic of many mature sectors responding to global competitiveness challenges, just as growth and risk-taking were pronounced features of the early automotive or aviation industries. The emphasis on stock options for workers and its apparently higher ranking than wages is novel, and, if true, the rejection of litigation in favour of investing in the newest new thing (Lewis, 2000) is too, although Microsoft must be one of the exceptions that proves the rule. On the other side, the complexity for old economy telecoms giants like AT&T and BT of combining still hierarchical business cultures with the need to keep younger staff who are being lured elsewhere by stock options is sufficiently great for them to be on the verge of splitting apart, thus creating new corporate vehicles for their old and new services. Having made these points, there are some areas of agreement among all three authors on the distinctive aspects of new economy businesses.

First, the idea of decentralization of control of parts of the new economy away from the corporate behemoths of the preceding generation is a fundamental point of agreement. That is, in the newer sectors, based as they are in clusters around universities, in the main, there is less dependence for knowledge exploitation and innovation upon the corporate R&D laboratories from whence most commercial innovations continue to be forthcoming, but less so in new economy sectors. Second, the idea of flows of value, particularly of knowledge or innovation capability, through networks, is fundamental. Indeed so much is this a feature of new economy clustering that in the exemplar of Silicon Valley, the strategy of building 'private clusters', corporate *keiretsus* or EcoNets, as they are also known, is not confined to KP. Intel has a powerful corporate venturing arm, Intel Capital, as do Lucent Technologies, AT&T Ventures and Cisco Systems, the latter internalizing its EcoNet by acquisition. Table 4 gives an indication of the main corporate venturing actors by number of IPOs in 1999 with the 'if-held' value of the equity involved over the year. These and many other venture houses are key drivers of the new economy, and increasingly the structuring of clusters. They—along with the

TABLE 4. Number of IPOs and Value, Top Ten, 1999

Corporate venturer/venture capitalist	IPOs	Value ($b.)
Access Technology Partners	28	73
Intel Capital	23	52
New Enterprise Associates	20	66
Kleiner Perkins	18	78
Comdisco Ventures	17	29
Benchmark Capital	15	113
Goldman Sachs	12	29
Technology Crossover Ventures	12	26
Institutional Venture Partners	11	91

Source: Craven (2000).

technology entrepreneurs—are central in the creation of a new kind of systemic innovation that is the real source of advantage over, for example, European competitors, something to which we return at the end of this section. Finally, there is some measure of agreement about the distinctiveness of innovation around new knowledge, moving rapidly from workbench to generating investment if not sales in the new economy. Such is the power of innovation where serial innovators like Jim Clark of Netscape are concerned that they audition venture capitalists for their next IPO, not the other way round. This is the central feature of the new economy as it has emerged thus far. It is not well developed in Europe, though developments of cluster-based, venture capital-backed new economy activities are beginning to emerge. But if the European Commission, concerned at the innovation gap with the United States (CEC, 1995) seeks an explanation for the slow rate of commercialization of science and technology in the EU, it needs only to consider the abundance and proactivity of the innovation support system in California or Massachusetts compared to that nearer home.

This brings us conveniently to a brief consideration of the new economy innovation system (NEIS) discussed so far, in relation to the kind of RISs that emerged in support of old economy regions, often confronting economic crisis, and have been the subject of much academic and policy interest of late (e.g. Braczyk *et al*., 1998; De la Mothe and Paquet, 1998; Acs, 2000). Table 5 seeks to capture aspects of these distinctions. The key differences are the often public nature of the typical RIS with its technology transfer bodies, science parks, partnership funding, linkage of innovation to hierarchical supply chain relations and strong user-driven, incremental emphasis. This is typical of systemic innovation in Europe (Cooke *et al*., 2000) and in old economy regions of the US (Shapira, 1998). The key differences lie in the attitudes of financier and entrepreneur in new economy settings. The cluster

TABLE 5. Aspects of regional and new economy innovation systems

Regional innovation system (RIS)	New economy innovation system (NEIS)
R&D driven	Venture capital driven
User–producer relations	Serial start-ups
Technology-focused	Market-focused
Incremental innovation	Incremental and disruptive
Bank borrowing	Initial public offerings
External supply-chain networks	Internal EcoNets
Science park	Incubators

is there to be scoured for innovative ideas and potential businesses from the investor's viewpoint and there to enable the innovation entrepreneur to accumulate very large sums of money from his or her point of view. Technology is a means to the latter end, though employee stock-option holders may also be product obsessives as Norton (2000) suggests (on this, see Bronson, 1998). Whatever assists this process, and incubators staffed with managers who can take the pain out of management for technology entrepreneurs are a case in point, is provided as far as possible.

Hence, an assessment and variable perspective on the new economy have been presented. The interim conclusion is that a distinctive mode of induced innovation has been established and that it has proved to be effective at raising the rate of new firm formation around new economy sectors, but really, thus far, only those sectors. This has given the United States, where the model was set in place in Silicon Valley in the 1970s but developed significantly and bravely, some would say recklessly, in the 1990s, a lead that may yet expand further in the first decade of the 21st century, except in mobile, convergent (multimedia) telephony where Europe leads. The NEIS is strongly clustered in virtually every new economy industry and even if the cluster is not yet properly formed, firms still agglomerate around universities or centres of creative knowledge like film studios. Learning is, of course, the central attraction where knowledge capital can have rapidly escalating value. The more knowledge-based clusters thrive, the more imbalanced the economy is likely to become spatially and in distributional terms, and the more important it becomes to seek ways of moderating this without killing the golden goose. This is an important challenge confronting economic policymakers everywhere for the foreseeable future.

6. *Conclusions*

Even though the gloss has gone from many new economy stocks as the

inevitable cyclicality of all markets reasserted itself for dot-coms and mobile telephony firms in the year 2000, something has happened to make systemic innovation a key resource for the venture capital community in the United States and a little of Europe, that helps us understand the innovation gap regularly experienced by the latter in relation to the former. It was shown in the introduction how markets incentivize the quest for exploitation of science and its transformation into commercialized innovations. It was then shown how relatively regionalized such processes are even in the US but that in that economy systemic innovation is endemic and privatized. Of course, big federal budgets fuel the whole process through the funding of basic research. For the moment that will remain the case as large corporations reveal no strong appetite to take those kinds of risks.

Recognition of the importance of systemic innovation at the regional level was shown to be a relatively recent phenomenon in Europe. However, a great deal of detailed research showed that much of the responsibility for supporting it in European regions rested on the not always adequate shoulders of government functionaries at a variety of levels, including, to a growing extent, that of the region. It is not difficult to draw the conclusion that these public innovation systems, where they exist, and that is by no means everywhere, are uncompetitive with the private systems operating in the United States. This is not the fault of personnel but policy, which in Europe seeks to provide what in Italy are called 'real services' because there has been market failure in the provision of private innovation support infrastructures of the 'soft' variety. The obvious policy conclusion to be drawn from this analysis is that policy should stimulate the growth of strong private investing organizations that will have the profit-motive as the incentive to be more proactive than a public system has shown itself to be capable of.

The processes operating with such speed and relative success to induce commercial innovation from research laboratories in places like Silicon Valley and Boston can be reasonably clearly detected. Universities have, in leading cases, highly professional technical liaison offices, backed by experienced exploitation and commercialization personnel. There is abundant investment capital and places to invest it. There are regulatory mechanisms covering things like stock-options which give greater incentives than is the case normally in Europe. It is evident from work conducted by the UK science ministry (Sainsbury, 1999) that smaller, innovative firms in the United States find a support initiative such as Small Business Innovation Research (SBIR), with its research council-like peer-review system, valuable at the early, research or 'proof of principle' stage of innovation. Firms in the UK who know about SBIR have pressed the government to introduce something similar.

Even though SBIR is (early-stage) public investment, it is consistent with the time-economies of new economy firms. This should be contrasted with a European example, recently discovered by the present author, where a bank required an innovative SME to have won a grant as a condition for even considering a loan application. Without seeking simply to imitate the new economy model of systemic innovation, it is clearly desirable that some account is taken of its key elements in redesigning innovation policy in Europe to begin to close the gaps that have once again opened up between the innovation performances of the two competitor economies.

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