Chapter 14

Conclusion

The dilemmas of regional innovation systems

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Regional innovation systems were initially defined as 'interacting knowledge generation and exploitation sub-systems linked to global, national and other regional systems for commercialising new knowledge'. In the preceding chapters, authors from all over the world have analysed thirteen European, Asian and American regions in order to put flesh on the notion of knowledge-generating and exploiting sub-systems. Our central thesis in this concluding chapter is that knowledge-generation in regional innovation systems is always faced with various different types of dilemmas and that the strength of regional innovation systems does not depend on a specific set of institutions, technologies, and firms, but on the ability to face the numerous dilemmas connected to territorially bounded production and innovation processes. These problems reflect the fundamental dilemma of innovations: satisficing (even if not optimal) results can be obtained with previous routines, products, technologies, and institutions, while new routines, products, technologies, and institutions require extraordinary investments and the outcomes remain uncertain.

To summarize some of the lessons we can extract from our case studies, we will first condense the basic features of the thirteen regions previously described. We will then reconstruct four dilemmas territorially bounded innovations are confronted with. Then, on the basis of the initially introduced three concepts of regional governance (grassroots, networks and *dirigiste* RIS), we will distinguish different ways of dealing with these dilemmas.

Basic characteristics of institutional regional innovation systems

In the introduction two different types of regional innovation systems were distinguished: entrepreneurial and institutional regional innovation systems. These concepts reflect the distinction between entrepreneurial and institutionalised technological regimes proposed by Winter (1984) and Audretsch (1994). Most of the regions previously analysed can be classified as institutional regional innovation systems (IRIS) – with the partial exception of the Tuscany, Denmark and Singapore. Industrialized regions like Ontario, Wales, Baden-Württemberg,

North Rhine-Westphalia, Tohoku, Brabant, Catalonia, Tampere/Pirkanmaa, Gyeonggi and Slovenia are characterised by the following features (see also the Appendix):

- an industrial structure with a strong position of low and medium technology, in general, quite developed production-related services, but only a small share of high-tech production;
- a governance structure which is dominated by formal, in general public institutions (especially in the fields of research, technology transfer, education and training, marketing in foreign markets). These institutions are in general integrated in the political and administrative context of the national innovation system – even if they are in a legal and operational sense autonomous from the national level.
- a business structure characterised by the important role of multinational companies which are in different ways and to a varying extent integrated into regional production networks.

These regions are often the industrial core regions of their respective countries; this is especially true for Ontario, Gyeonggi, North Brabant, Baden-Württemberg, North Rhine-Westphalia, Catalonia and Tampere.

This type of national or European industrial core region differs from the industrial or service-oriented business districts dominated by small and medium-sized enterprises (SME) in Denmark or Tuscany. Other types of economic regions not represented in our sample are the destroyed industrial regions (for example, in Eastern Germany) and the metropolitan design, research, communication and culture-based service regions which have been described as global or regional cities (Sassen, 2000; Simmie *et al.*, 2002). Most of the regions previously analysed cannot hope to develop a value chain which is predominantly based on services (public relations, finance, advertising, controlling, consulting, mass media). Production is an essential feature of their economic model, which provides an explanation for the relative stability and even inertia of these regions. Huge investments in production facilities and the mastery of specific technologies hamper radical innovations as these innovations would destroy most of the former investments and qualifications. Perhaps Stuttgart, Cardiff, Eindhoven and Barcelona may have the possibility to specialise mainly in advanced services – but Baden-Württemberg, Wales, Southeast North Brabant or Catalonia will not become a new Silicon Valley, a financial district like the City of London or a global media city such as Paris or Munich. Most of the regions we have analysed are bound to their industrial heritage – and they have to face the challenges of a globalised, innovation-centred knowledge economy on this basis, with their specific limitations and opportunities:

- A crucial problem of all the IRIS regions is the systematic discrepancy between research and innovation. This has explicitly been reported in the chapters on the RIS in Ontario, Catalonia, Baden-Württemberg. Only in Baden-Württemberg, where R&D expenditures are extremely high (1999: 3.9 per cent of the GDP, more than the double the European level), was it possible to employ 17.8 per cent of the employees in the production of high and medium-high technologies. In the other European regions this percentage is below 10 per cent (see Appendix).
- Only a minority of regions (especially Singapore, Denmark and Wales) has a strong position in knowledge-intensive services (telecommunication, financial services, education, health, culture). This also points to the legacy of a successful industrial past.
- The potential vulnerability of the regions is a direct consequence of the dependency of large firms which are the entrepreneurial backbone in many of the regional innovation systems analysed in the preceding chapters (Philips, NedCar, DAF, ASML, Océ and Rank Xerox in Southeast Brabant, DaimlerChrysler and Bosch in Baden-Württemberg, Bayer, RWE, Bertelsmann or Thyssen-Krupp in North Rhine-Westphalia, the US, Japanese and European automotive companies in Ontario and Wales, Nokia in the Tampere region). These multinational companies have in principle the opportunity to choose their production sites world-wide with the best mix of production costs, subsidies, and qualifications – possibly leading to delocalisation decisions (see the examples of Tohoku and Wales). And even if the central firms in general do not decide to relocate their production (Dunning, 2000), the regional employment level is directly influenced both by the negative or positive development of these firms and by changing supply strategies (see, for example, the case studies on Brabant and Baden-Württemberg).
- The high mobility of firms, plants, and supplier relations is not matched by a similar flexibility in regional capabilities. The capabilities of a region are anchored in its organisational capabilities (in its firms, its industrial structure, and its patterns of specialisation) and in its governance structure (Crouch *et al.*, 2001). These governance structures are the institutional 'memory' of a region, the result of path-dependent experiences of co-operation and conflict (North, 1990; Crouch and Farrell, 2002). They have been described as *conventions* (Storper, 1997). The relative stability of these conventions and their path-dependent development was comprehensively described in the first edition of this book (Braczyk and Heidenreich, 1998).

The regions described in the preceding chapters are, therefore, trapped in a dilemma which reflects their specific position in a globalised, innovation-centred

knowledge economy: on the one hand, they are often the most innovative regions of their respective nations. They are characterised by good or excellent research and development facilities and a qualified labour force. On the other hand, even a high, in general public engagement in the production of regional 'collective competition goods' (Le Galès and Voelzkow, 2001) is no guarantee for a uncontested position in the global economy. Investments in education and training, research and development, technology transfer and marketing will not automatically 'produce' innovations. They are not entrepreneurial regions as they are lacking a sufficient number of SMEs and creative entrepreneurs in new technological fields. The uncertainties and fragility of the chosen paths of specialisation appear in the form of relocation decisions of firms, mergers, plant closures, external sourcing, and corresponding reductions at the employment level. These risks have become much clearer since the first edition of this book. The promises of a new economy where IT, multimedia, biotechnology, and advanced services could guarantee a similarly uncontested competitive position similar to the post-war period of predominantly national capitalisms have largely been disappointed.

Therefore, the preceding chapters focus much stronger than in the first edition on the risks of the chosen specialisation: Gertler and Wolfe conclude that 'the strong tradition of foreign ownership and reliance on imported technology has meant that Ontario's innovative capacity remains underdeveloped'. Boekholt and de Jager mention 'overlaps and fragmentations of efforts' in the case of Southeast Brabant; Koschatzky 'points to a fragmentation of the Slovenian innovation system, since all of the innovation agents are not equally integrated in information and knowledge exchange'; Cooke demonstrates that the innovation capability of Wales could not been upgraded because the links between the mainly public innovation infrastructure and the new, foreign industrial basis has proved to be too weak; Heidenreich and Krauss refer to the fragile bases of the automotive boom of the 1990s which in a short-term perspective helped to overcome the crisis at the beginning of the 1990s, but which once again intensifies the specialisation on the car industry; Bacaria, Borràs and Fernàndez-Ribas point to a 'gap between scientific research done at universities and public research units, on the one hand, and technological innovation at firms, on the other'; Hilbert *et al.* point to the necessity of encouraging existing firms in North Rhine-Westphalia to shift to new businesses.

These diagnoses illustrate major challenges institutional regional innovation systems are facing: the bridging of the gap between R&D and innovation, between global and local knowledge, between established industrial strengths and new technological trajectories, between successful global companies and a diversified industrial structure of innovative SME. In the following, these challenges will be analysed on a slightly more general basis.

Regional innovation processes between opening and closure

Regional innovation systems are 'places where close inter-firm communication, socio-cultural structures and institutional environment may stimulate socially and territorially embedded collective learning and continuous innovation (Asheim and Isaksen, 2002: 83). Similar to the notion of a conservative innovator or a learning organisation, this concept is an oxymoron expressing two antithetical processes (Weick and Westley, 1996). While the system concept stresses the role of stable regional orders, the concept of innovation emphasises the process of creative destruction (J. Schumpeter). The corresponding dilemma is not specificity of regional innovation systems but reflects the uncertainty, the openness, and the risks of innovation processes.

The concept of innovation refers to 'the transformation of an idea into a marketable product or service, a new or improved manufacturing or distribution process, or a new method of social service' (European Commission, 1995: 4). Innovations in this sense always have to be pushed through against resistance, for example, the inertia or the opposition of the successful businesses. This has already been emphasised by Schumpeter, who defined the enforcement of innovations to be the central function of a charismatic entrepreneur. The achievement of an entrepreneur does not consist in the invention or the development of a new technology but in the enforcement of a new production function. The entrepreneur succeeds in overcoming insecurity and resistances. He/she is not necessarily a successful researcher or an inventor but 'the revolutionary of the economy – and the involuntary pioneer of social and political revolution' (Schumpeter, 1935: 130).

This general positive appraisal of innovations ignores the dilemmas each innovator is confronted with. On the one hand, innovations are risky, with mostly high costs, results remain uncertain. On the other, previous investments, competences, habits, and qualifications are devaluated by innovations. The benefits of innovations and the risks of omitted innovations, therefore, always have to be balanced against the costs of successful innovations and the benefits of omitted innovations. Hence, from an individualistic and short-term perspective, resistance against innovations may often be quite rational. This dilemma can also be formulated as a dilemma between redundancy ('slack') and specialisation/efficiency (Crouch and Farrell, 2002: 20–21).

Additionally, successful innovations are often a barrier to further innovations: not only is the better the enemy of the good. This also holds true vice versa. Stabilisation of successful innovations is a necessary prerequisite for each innovation process. In evolutionary theories of innovation (Nelson and Winter, 1982; David, 1985; Dosi 1988), the contradictory unity of innovation and institutionalisation is taken into account by the distinction of variation and stabilisation phases. Tushman and Rosenberg (1992), for example, distinguish four different phases

of technological innovations: technological discontinuities, eras of ferment, dominant designs, and eras of incremental change. In opposition to this temporal differentiation, innovation system approaches distinguish between learning and knowledge, on the one hand, and institutions on the other without being able to precisely specify the connection between institutions and innovations:[1] How can relatively stable regional orders contribute to innovations? What are the crucial features of the relationship between variety and redundancy in the case of regional innovation systems?

The described dilemmas are familiar to innovation theories (cf. for example for the organisational level, Zaltman *et al.*, 1973; Rammert, 1988; Hage and Hollingsworth, 2000: 978). Also, in the debate on national and regional innovation systems several of these dilemmas have been mentioned: On the one hand, it has been emphasised that networks can be a central prerequisite for innovations. On the other, it has been observed that corporations have the power to block innovations due to lock-in-effects (cf. Grabher, 1993; Fritsch, 2001). Also, emphasis has been put on the importance of regional processes of closure; but contrariwise, it has been stressed that the performance of regional innovation systems essentially depends on a global exploitation of new opportunities (Amin and Thrift, 1994). On the one hand, industrial districts have been defined by their local communities; on the other, Piore and Sabel (1984) have stressed that they are based on competition between co-operating businesses. Very often, however, these dilemmas of innovation and innovation systems have also been ignored. There were attempts to identify a suitable bundle of factors representing the necessary and sufficient conditions for the success of regional innovation systems. Strong regional identities, collective goods, network moderators, a transaction-cost saving networks, and an adequate design of the innovation-supporting infrastructure should do the trick.

Controversially, in the following we will develop an opposing idea. *We suppose that the capability of regional innovation systems is to be sought in the ability to deal with the contradictory challenges and dilemmas of regionally concentrated innovation processes.* There is no universally applicable set of innovation-conducive institutions or a magic formula for regional competitiveness but only the ability to handle the contradictions and conflicting goals of regional innovation processes. In order to develop this thesis, we will now discuss four dilemmas of regionally concentrated innovation processes. These dilemmas refer to the spatial, social, material, and temporal dimension of these processes; they specify the initially mentioned tension between innovations and institutionalisation, or, put in more broadly terms, the dilemma between opening and closure. In this respect, the concept of 'opening' refers to spatial, cognitive, and institutional boundary-spanning processes in science, economy, technology, and organisations; processes of social closure, on the other hand, describe new spatial, cognitive, and institutional forms of regulation and limitation.

Regional economic structures between regionalisation and globalisation

In the spatial dimension, the dilemma of opening and closure is represented by the tension between globalisation and regionalisation. On the one hand, the knowledge society is characterised by the disembedding of social relationships from their local context of interaction (Giddens, 1990). For the regionally embedded company this can result into the need to have to look for suppliers outside its home region. Concerning the regional market, this development can lead to a loss of its role as pilot market as well as to increased competition with companies from all over the world. The exodus of important suppliers, customers, and competitors can result into the destruction of regional networks:

> Globalisation can thus be defined as the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa … Local transformation is as much a part of globalisation as the lateral extension of social connections across time and space … what happens in a local neighbourhood is likely to be influenced by factors – such as world money and commodity markets – operating at an indefinite distance away from that neighbourhood itself.
>
> (Giddens, 1990: 64)

Consequently, the success of regional networks increasingly depends on their ability to become a nodal point in national and supranational information, communication, investment, and production flows. The relatively closed industrial districts described by A. Marshall belong to the past (Amin and Thrift, 1992).

Simultaneously, the globalisation of economic exchanges does not imply that geographic proximity looses its importance. On the contrary: regional, location-specific factors become even more important in the context of world-wide competition on costs and innovativeness. This is proved by an increasingly regional differentiation of production and technological capabilities (Archibugi *et al.*, 1999). While technological and scientific knowledge is produced on a world-wide basis, increasingly implicit, applied knowledge and experience in particular play a role in the most innovative regions of the world. While by means of world-wide information, communication, and transportation facilities spatial distances are increasingly losing their importance, nevertheless, the economic success of industrial and metropolitan business districts points to the key role of spatial proximity and personal communication. While even SMEs more frequently use world-wide development, production, and distribution structures, the core competences of businesses as well as the strategic suppliers and customers are nevertheless

still concentrated in a region (Archibugi and Michie, 1995; Patel and Pavitt, 1998). Regional capabilities build precisely on the regional use of world-wide information, innovation, and market chances. '[I]ndustrial districts or innovative milieus are compelled to integrate extra-regional contributions as an essential component of the regional innovation process itself (Gordon, 1995: 195).

The dilemma of regionalisation and globalisation determines the relationship between dominant, globally oriented groups and smaller companies oriented towards regional and national markets. The insertion of regional economies into world-wide information, trade, and investment flows is effected by multinational, in general, bigger companies. Despite decreasing communication, co-ordination and transportation costs, the degree of internationalisation is still linked to the size of an organisation. This becomes problematic if the entire technological knowledge of a region is concentrated in these focal companies while the innovativeness of other regional companies remains extremely limited. Also vertical co-operation networks, i.e. predominantly supplier relationships, can become an obstacle to learning and innovation as the economic fate of a region is closely linked to a specific technology, a specific product or even to a specific company, such as the case in Wales and Tohoku. Also in Brabant, Baden-Württemberg and Ontario the economic structure of the region is dominated by a few focal companies and their plants and suppliers. A more diversified business structure with horizontal networks, such as in Tuscany, Denmark and Catalonia, is also favourable for the focal firms. This especially holds true if these are engaged in the development and production of complex products bringing about a dependency on close development and production networks with smaller firms.

Regional networks between fragility, regional learning and lock-in-effects

In the social dimension, the dilemma of opening and closure shapes regional co-operation networks. Due to interorganisational mobility of employees, different forms of 'network moderators', and intensive social and professional contacts regional co-operation relationships can facilitate the exchange of information between potential competitors (Powell *et al.*, 1996). The learning and innovation opportunities connected to spatial proximity represent a crucial condition for the advancement of the basis of regional competence.

However, the contribution of co-operation networks to regional innovativeness is put at risk by lock-in-effects of established networks, on the one hand, and, on the other, by individualistic business strategies. In this respect, for instance Chesbrough and Teece (1996: 68) stress that the stability of interorganisational forms of co-operation is always endangered by changing and potentially diverging interests of companies:

> Each company wants the other to do more, while each is also looking for ways to realize the most gain from the innovation. Information sharing can be reduced or biased, as each seeks to get the most at the other's expense. In most cases, the open exchange of information that fuels systemic innovation will be easier and safer within a company than across company boundaries. The inevitable conflicts and choices that arise as a systemic innovation develops can best be resolved by an integrated company's internal management processes.

Interorganisational networks, therefore, always have to be stabilised by *regional orders*. These orders can be defined as ensemble of institutionalised expectations, routines, and methods which shape the organisational, economic, technical, scientific, and political relationships in a region (cf. for a similar concept, the concept of 'worlds of production' Salais and Storper, 1993). These patterns encompass both formalised expectations (rules, laws) and informal habits, methods, and cultural frames and perceptions (Scott, 1998: 107–114; Crouch and Trigilia, 2001: 224–229). These informal patterns have additionally been defined by Storper (1997: 38) as conventions, as 'taken-for-granted mutually coherent expectations, routines, and practices'.

Regional orders can contribute to the capability of regional innovation systems in two different ways: they can reduce the uncertainties, risks, and ambiguities always linked to innovations. Regional unions and associations, regional schools and training facilities, informal contacts and networks each contribute to the production of certainties. This cognitive function of regional networks has already been stressed by the so-called Californian school of new regional economics (cf. Storper, 1997: 9–14) – even if here the reduction of uncertainties was analysed exclusively under the perspective of reducing transaction cost:

> Culture formation depends on (though is certainly not fully explained by) a structure of transactions … the greater the substantive complexity, irregularity, uncertainty, unpredictability and uncodifiability of transactions, the greater their sensitivity to geographical distance. In all these circumstances, the cost of covering distance will rise dramatically.
>
> (Storper and Scott, 1995: 506)

However, the availability of information on new technologies and markets, qualifications as well as subventions is not only a problem of costs. Innovative companies are facing considerable uncertainties concerning their future strategies – these uncertainties may be reduced by close and intensive contacts with other regional companies as well as by the production for regional pilot clients. This cognitive function of regional orders – the creation of subjective certainties in

order to facilitate action – is equivalent to *trust* (Lane and Bachman, 1998). The (perceived) risks of innovations are reduced by the use of regional experiences, information, methods, and certainties. Simultaneously, however, such cognitive lock-in-processes are always risky: they not only facilitate collective rules of interpretation and appropriateness innovations, they also enable the continuation of previous paths and the blindness to new challenges.

On the other hand, by means of providing 'local collective competition goods' (Crouch *et al.*, 2001), regional orders can also help to overcome the problems of collective action and interorganisational co-operation as regional institutions provide necessary resources required for innovation (public research and development facilities, technology transfer, education and training). By establishing collective rules of interpretation and behaviour and by providing collective resources, regional orders make an essential contribution to the innovative potential of regional companies.

Such processes of cognitive and political closure can facilitate the co-operation between regional actors, the link between different cognitive arenas (Hage and Hollingsworth, 2000) as well as the discovery of new paths of action. However, regional networks can also contribute to the blindness to new challenges and opportunities. In addition, collective resources (for example, subsidies) can delay adaptation. In order to prevent a devaluation of previous competences and investments accumulated experiences and knowledge can impede the search for new strategies (see Grabher, 1993). The dilemma of social opening and closure is, therefore, translated into the tension between fragility of interorganisational patterns of co-operation, regional learning, and regional lock-in-effects.

Regional research, development and technology transfer institutions between learning and institutionalisation

In the substantial dimension, the tension between closure and opening is materialised in the tension between normatively stylised, and knowledge-based innovation systems. These two types of innovation systems are characterised by different forms of structural coupling among social subsystems. In the first case – which has initially been termed Institutional Regional Innovation System (IRIS) – knowledge-based subsystems are closely coupled with social systems favouring stable, predictable paths of innovation. In the second case – introduced as Entrepreneurial Regional Innovation System (ERIS) –closely coupled knowledge-based subsystems favour science- or technology-driven innovations.

In both cases, a systematic, permanent irritation between science, technology, economy, politics, and the public has been institutionalised. The different social systems (science, technology, economy, politics) do not follow only their own logic as assumed in an ideal-typical model of a modern, functionally differentiated

society: Science is not only engaged in the falsification of propositions, economy not only in the reproduction of liquidity, technology not only in the construction of working artefacts, politics not only in the production of collectively binding rules because these systems also take into account their different perspectives and logics. Innovation systems require the closer coupling of economic, technological, scientific, and political perspectives; innovations are facilitated by relatively stable interactions between scientific, economic, technical, and political perspectives. Based on the work of the system theoretician Niklas Luhmann, two forms of such a structural coupling can be distinguished, namely, knowledge-based and normatively based forms. Luhmann (1994) defines knowledge as cognitive expectations which are ready to be disappointed and revised if disproved by contradicting evidence. Knowledge is, therefore, characterised by a cognitive style; the social systems represented by these expectations are prepared to learn. Normatively based expectations, however, are not revised even if they are disappointed. While the economy and science are characterised primarily through knowledge-based forms of expectations, politics, administration, and jurisdiction are dominated by normatively stylised expectations (Luhmann, 1975).

Both in knowledge-based and normatively stylised innovation systems, innovative individuals, organisations and networks are coupled with social institutions. In normatively coupled innovation systems, calculability and stability are much more important than the revision of disappointed expectations. This refers to a dominance of normatively stylised subsystems. Scientific discoveries and technical inventions can be converted into economically relevant innovations only when political, legal, social, and cultural points of view are taken into consideration, for example, in the context of a 'co-ordinated market economy' (Hall and Soskice, 2001). Innovative companies are closely coupled with other social spheres, especially with research, technology transfer, unions, business associations, schools, banks, the labour law, and politics. This facilitates the design and incremental improvement of complex technical system, for example, cars, machinery, chemistry, and other investment goods. The requests of the environment are interpreted as requests for reliable, calculable, long-term oriented decisions; the long-term accumulation of organisational and technical knowledge is more important than the short-term maximisation of the shareholder-value. Such innovation systems are characterised by path dependency and inertia.

Instead, in knowledge-based innovation systems, established interests and regulation structures have to be less considered (Cooke, 2002). The readiness to learn is more important than calculability. The innovation strategies of firms are restricted less by legal, political, ethical, and social considerations; they are more closely coupled with economic, scientific, and technical perspectives.

This *dilemma between fragmented, knowledge-based and normatively regulated innovation systems* also shapes the tension between the publicly financed research,

development, and technology transfer infrastructure and technological innovations. While explicit knowledge is in general crucial for the advancement of sciences, technological knowledge is to a great extent implicit; it is applied knowledge (see Faulkner, 1994): 'A significant amount of innovations and improvements are originated through "learning-by-doing" and "learning-by-using"' (Dosi, 1988: 223). The knowledge required for the development, construction, and implementation of new technologies cannot be reduced to scientific discoveries: 'Technological knowledge is much less well articulated than is scientific knowledge; much of it is not written down and is implicit in "experience", skills, etc.' (Dosi, 1982: 153). Without rules of thumb, practical experiences, proved design, and construction principles technologies can hardly be developed. Additionally, the development of new technologies and procedures requires the recombination of specific knowledge from different sources, consumers and clients, technology and science, and law and politics. In this respect, technological innovations are considerably facilitated by the structural coupling of technical, economic, scientific, political, and cultural subsystems.

Regional research, development, and technology transfer institutions can, therefore, be distinguished according to the different forms of structural coupling. In knowledge-based orders this coupling increases the learning capacities of the involved subsystems; in normatively stylised orders the coherence and calculability of regional innovation processes are more important.

The regional economic policy between previous strengths and new technological fields

In the temporal dimension, regional innovation systems are characterised by the tension between previous strengths and new technological fields. The success of an RIS depends both on the development of previous strengths and technological trajectories and on the opening for new developments and chances. In this respect, regions face the dilemma of being especially successful in a short-term perspective if the innovation supporting institutional infrastructure (education and research, bank systems, technology transfer, industrial policy) is optimally adjusted to the dominant industrial clusters (cf. the example of Baden-Württemberg). This, however, may impede the positioning in new technological fields (information and communication technologies, biotechnology, new materials) and the recombination of previous knowledge (micro system technology, nanotechnology, optoelectronics, mechatronics). While the existing technological and organisational patterns of specialisation must be supported by regional institutions, new technological fields can only be reached if the region and its firms and institutions open up to new perspectives, co-operation partners, and technologies. This, however, is equivalent to a suboptimal adaptation to existing core sectors.

This dilemma of redundancy and variety arises from the cumulative character and the path-dependency of regional and technological developments (Dosi, 1982; Edquist, 1997; Braczyk and Heidenreich, 1998). Regional and technological learning are cumulative processes. The experiences and the practical knowledge accumulated in the course of the development and utilization of a technology also outline the further development of a region. Such technological path-dependencies cannot be easily broken up by industrial policies. Singapore, for example, was only able to gain its top position as South-east Asia's service and logistics centre after the development of industrial competences in the petrochemical, electrical engineering and electronics industry. Regional trajectories, therefore, refer to the competences, methods, problem definitions, and technologies found in a region. These regional knowledge assets deeply rooted in the rules and routines of regional employees and firms are transmitted and further developed in regional networks. It is therefore difficult to establish a new Silicon Valley if there is already a successful and innovative one.

The dilemma between previous strengths and new technological paths also shapes the regional economic policy. One the one hand, regional policies can focus on previous and present strengths. The competences and networks developed in the course of decades of industrial experiences are the strengths of a region. Additionally, new economic strengths like production-related services can be developed on the basis of already existing competences. This can be done by cluster policies which stimulate and support the emergence of 'networks of production of strongly interdependent firms (including specialised suppliers), knowledge producing agents (universities, research institutes, engineering companies), bridging institutions (brokers, consultants), and customers linked to each other in a value-adding production chain' (Boekholt and Thuriaux, 1999: 381). Simultaneously, however, the development of the regional competences requires a diversification of regional competences by supporting newly founded firms and SMEs outside the established networks as well as lines of technological specialisation.

In conclusion: innovation processes are always accompanied by dilemmas due to the liability of newness and the advantages of omitted innovations. They are shaped by the tension between the advantageous exploitation of previous technologies and products and the preservation of sunk investments as well as the uncertainties of new technologies, product specialisations, institutions, markets, and procedures. In the case of regional innovation systems, this dilemma brings about a tension between spatial, social, substantial and temporal dimensions of processes of opening and closure. In the spatial dimension, it refers to the tension between globalisation and regionalisation. The social dimension is characterized by the tension between the openness of global developments and relations and the stabilising lock-in-effects of regional networks. Concerning the substantial

dimension, this is illustrated by the tension between knowledge-based and normative forms of structural coupling. Finally, referring to the temporal dimension, this dilemma emerges in the tension between the continuation of previous technological development paths and the assertion in new technological fields. These four dilemmas shape the regional economic structures, the regional patterns of co-operation, the innovation-supporting infrastructure (research, development, and technology transfer) as well as economic policies.

Facing the dilemmas of regional innovation systems

In this section, we will discuss how the former-mentioned spatial, social, substantial, and temporal dimensions of the innovation dilemma shape the innovation systems in the 13 regions previously analysed. We concentrate on the question how these four dilemmas shape the regional economic structure, the patterns of co-operation, the regional research, development, and technology transfer infrastructure, as well as the regional economic policy. Referring to the three types of structure of regional governance Cooke has initially distinguished (grassroots, network and *dirigiste* RIS), we will reconstruct the different forms these dilemmas assume in the following. The results of this analysis are summarised in Table 14.1. The supporting statistical indicators to the analysis are put together in the Appendix tables.

The dilemmas of informal and market-driven forms of co-ordination

Grassroots RISs are characterised by flexible interorganisational networks between mostly SMEs, which are connected to the global market by a number of major global companies. An example of this pattern is provided by California, where the economic structure is marked by a multiplicity of local economic districts – for example in the area of jewellery, furniture, automobile design, entertainment, computers, biotechnology, and multimedia – and some world-wide successful companies.

On the contrary, the industrial districts in the Tuscany region have chosen a different, very particular way of dealing with the dilemma of regionalisation and globalisation. Unlike California and most other regions of the world these districts are not dominated by large focal companies connecting the regional economic structure with the world market. Additionally, the generally very small companies in the Tuscany are not bought by external bigger competitors. The 'more conscious and planned form of integration' usually associated with bigger businesses is replaced by a more or less strongly formalised co-operation networks ('enterprise groups'). The integration into global markets, therefore, does not require the abolition of essential features of the Italian industrial districts.

Table 14.1 Dilemmas of regional innovation systems

Regional innovation dilemmas	Regions	Regional economic structures between regionalisation and globalisation	Regional networks between fragmentation, regional learning and lock-in effects	Regional research, development and technology transfer institutions between learning and institutionalisation	Regional Economic policy between previous strengths and new technological fields
Regional governance					
Grassroots	Tuscany, Ontario, Brabant, Catalonia	Between focal companies (global players) and regional diversity	Between flexibility ('fierce individualism') and institutionally stabilised co-operation	Between applied development and systematic research activities	Between previous strengths and new technological fields
Network	Tampere, Denmark Baden-Württemberg, North Rhine-Westphalia, Wales	Successful global companies and innovative SMEs. Two partially contradicting conditions for regional competitiveness	Danger of institutional lock-in-effects	Marginal returns of high R&D expenditures in established technological fields	Between the general public support of a knowledge infrastructure and differentiated (cluster) policies
Diregiste	Slovenia, Tohoku, Gyeonggi. Singapore	Between publicly subsidised new plants and the internal development of regional competences	Fragmentation; low impact of inter-organisational networks	Decoupling of national R&D agencies and private companies	Between an unified national industrial policy and first steps to decentralisation

The Canadian way of dealing with the dilemma of globalisation and regionalisation is much more widely spread than the Tuscan way. According to Gertler and Wolfe, the economic structure of Ontario is heavily shaped by US and Japanese automobile companies. The most important conditions for the settlement of these plants were the proximity to an attractive market, relatively low labour costs, as well as different forms of political support. Concisely, it was possible to integrate the foreign plants into the network of regional suppliers. Nevertheless, the development of an autonomous regional basis for innovations only succeeded partially as the research and development capacities are still mainly concentrated in the home country of the foreign groups.

In this respect, in this region the dilemma of globalisation and regionalisation emerges in a latent threat to the regional economic structure: Either the focal companies are no longer able to face the pressures of the international competition or – due to an increasing attractiveness of other regions – they decide to relocate their production, their supplier contracts or their research facilities to other locations. This risk is being reduced by the strong position of the smaller companies which seems to be a characteristic feature of grassroots regions.

The second dilemma refers to the question which collective goods are produced by regional co-operation networks and how these networks can be stabilised. The 'enterprise groups' described by Dei Ottati in Tuscany are an impressive example for such co-operation structures. Design, marketing, product innovation, and production are distributed among different firms of the groups which are mainly integrated by personal ties, supplier relationships or capital links. However, also this model of a decentralised, self-organised co-operation reaches its limits. More strongly institutionalised forms of co-operation are required. Dei Ottati emphasises:

> Effective collective action is required for the accelerated renewal and upgrading of localized knowledge … the increased speed and variety of innovations call for the injection and wide diffusion of new, partially heterogeneous, skills; but such a need, especially in a system of small and medium-sized firms, can be met only by some form of collective provision.

In Ontario, multipurpose centres exist in two subregions, namely in Ottawa and in Waterloo (cf. the descriptions of the Ottawa Centre for Research and Innovation (OCRI) and Communitech Chapter 4). But even in Ontario the existence of institutionally stabilised patterns of co-operation are rather an exception than the rule. In general, the interorganisational patterns of co-operation are shaped by 'fierce individualism and entrepreneurialism'.

In grassroots regions, therefore, especially the dynamic, mostly SMEs operate in a field of tension between individual initiatives and institutionally stabilised forms of co-operation. Their success is based on their initiative and their entre-

preneurial commitment. In an innovation-centred economy, however, the exploitation of new possibilities increasingly depends on the co-operation and exchange of information with other firms in order to develop new products and to open up new, especially foreign markets. Such arenas of interorganisational learning can be stabilised only to a certain extent by personal relationships and hierarchies of reputation. Often public institutions are required in order to put intercompany relationships on a permanent basis (see, for example, the detailed analysis of owners' organisations, clubs und Chambers of Commerce in the Catalonian example). The co-operation dilemma of grassroots regions can, hence, be characterised as tension between individualised entrepreneurialism and institutionalised learning.

The tension between applied, highly specific development activities and more broadly oriented and systematic research refers to a third dilemma of grassroots regions. In this respect, Bacaria *et al*. illustrate the important role of applied research in the Catalonian innovation system. At the same time, this orientation is accompanied by a 'lack of relational linkages between Catalan innovators in some pro-patenting sectors'. In particular, the flexible SME of this region can hardly profit from public research activities. Considerable innovation activities such as their 'learning capacity' in new technological fields prove to be too weak. As a result, the strong role of applied research reveals itself to be a barrier to the link with more systematic research and development activities.

A fourth dilemma is the consequence of the path-dependency of regional trajectories (Braczyk and Heidenreich, 1998). The regions previously described bear considerable strengths in their traditional technological fields: Catalonia in the field of textile, metal working, and food, Ontario and Brabant in the automotive industry, in electrical, and electronic products, Tuscany in textiles, clothing, and furniture. However, it is precisely the previous success with these mature industries which impede the development of strengths in new technological fields as the available resources and manpower are already invested in the established technological trajectories. This dilemma between previous strengths and new fields can partially be reduced by funds for risk capital. In general, however, the required radical innovations cannot be financed internally. This is true even for California (Castells and Hall, 1994; Leslie, 2000): a considerable extent of the success of this region has been enabled by military research. Without an adequate industrial policy, the rise of new industries is in general not possible. In this respect, Gertler and Wolfe emphasise the role of the state for the central business of the Canadian telecommunication industry. The state can promote new technological trajectories both by direct public subsidies and orders and by funding research facilities and academic education.

In conclusion: on the one hand, grassroots RIS is distinguished by 'fierce individualism' and rather weak public governance structures. This endangers the stability of the institutional order in the region. However, the regional economic

structure is also shaped by dynamic SMEs which provide the innovative performance to considerably increase interorganisational networks. The capability of the grassroots regions is, therefore, shaped by the tension between fragile governance structures and innovation-centred economic structures.

The dilemmas of network-like governances

In networked innovation systems (Tampere, Denmark, Baden-Württemberg, North Rhine-Westphalia, Wales), the established technological paths are stabilised both by innovation-supporting institutions, especially by research, technology transfer and education facilities, and by interorganisational networks.

A first dilemma of these regions results from the dependence on a relatively small number of global players: Nokia in the Tampere Region, Daimler-Chrysler and Bosch in Baden-Württemberg, Philips and DAF in North Brabant, Thyssen-Krupp, Bayer, RWE and the WestLB in North Rhine-Westphalia dominate the regional economic structure. With the exception of Wales, these companies are only partially embedded into the regional networks of innovative regional suppliers. In Baden-Württemberg and in Denmark, however, the competencies of the smaller, regionally anchored firms seem to be much more extended and diversified. A diversified structure of innovative SMEs, however, is a crucial asset for the regional embedding of the focal companies into a region. This is demonstrated, for example, by the relocation and downsizing decisions of a limited number of foreign companies in Wales. Even if the foreign plants could be embedded into regional networks of competence, an upgrading to more research and development intensive activities would fail. The regional capability of a region, therefore, depends on the global competitive position of focal companies as well as on a diversified population of innovative, internationally oriented businesses. These two pillars of regional competitiveness do not automatically stabilise each other. Larger companies will rather contribute to focus regional capabilities on their specific technological fields than to a regional variety. This tension between variety and short-term economic efficiency can be called a 'global player dilemma' of regional innovation systems.

Second, the regional patterns of co-operation in network regions are institutionalised in a much more stable way than in the grassroots regions. While the institutional basis for co-operative arrangements are very fragile in Ontario and Tuscany, interorganisational patterns of co-operation are effectively stabilised by institutions such as the Steinbeis Foundation in Baden-Württemberg, the North Rhine-Westphalian SME politics, the German Chambers of Commerce, the Danish Technology Institute, the Welsh Development Agency or the national Technology Agency in Finland. These are institutionalised 'knowledge bridges' bringing together different partners from economy, science, politics, and the public and represent a crucial asset for each economic region.

Both the strengths and the limits of these institutions can be illustrated referring to the example of Wales: After the decline of the regional steel and mining industry, in the 1970s and 1980s Wales became a preferred location for Japanese, American and German automobile and electronics plants. In the first edition of this book Cooke wrote: 'Wales had become one of the key centres of high-quality, high-skill automotive engine and components production in Europe.' The 'Welsh Development Agency' tried to integrate the newly created industrial plants into the institutional and industrial infrastructure of the regions, by means of technology transfer centres, science and technology parks, supplier groups, common research projects, as well as by means of education and training facilities. As a result, the foreign production plants were meant to be used as industrial kernels for the construction of new production clusters. With the revaluation of the British pound and the availability of Central European production locations, however, this FDI-driven reindustrialisation model reached its limits (cf. the analysis by Cooke). Albeit network activities in Wales are still stronger than the national average, the regional embedding of the newly established plants did not prove to be sufficient for the durable upgrading of the regions innovative capabilities.

In comparison to Wales, co-operation relationships are considerable more intensive in Baden-Württemberg. Cooke reported: Of all firms surveyed, the mean was 44 per cent of firms having innovation partnership with regional customers, 35 per cent suppliers and 24 per cent universities. In Baden-Württemberg the figures were 89 per cent, 80 per cent and 25 per cent respectively, while in Wales they were 28 per cent, 22 per cent and 25 per cent.' However, most of the co-operation relationships in Baden-Württemberg are of a vertical nature. Horizontal forms of co-operation, meaning relations between potential competitors, play a relatively subordinate role. This points to the limits of regional institutions: the internationalisation of production, distribution and development, common research and development activities, as well as consultancy on business management cannot be provided adequately by the established institutions. Heidenreich and Krauss conclude:

> Established production structures and close-knit regional supply and service networks make it harder to tap into new market opportunities. These highly institutionalized structures and networks show a remarkable stability and continuity … New companies play a relatively insignificant role and start-ups are encouraged to adapt their innovation strategies and behaviour as far as possible to the established technology paths, in order to increase their chances of success or, inversely, to reduce their risk of failure.

Additionally, the North Rhine-Westphalian economy is profiled by the path-dependent nature of established co-operation networks. This is illustrated by

Hilbert *et al*. in in Chapter 9 in the example of the regional environmental industry in NRW. While the region has succeeded in specialising in this new field after the decline of the coal and steel industry, the accumulated technological competences favour environment protection concepts which are primarily less innovative 'end-of-pipe solutions'. New concepts of environmental protection aimed at the reorganisation of the production and consumption processes, however, are not supported by the 'long-standing roots in mechanical engineering' of the region.

Third, in comparison to grassroots regions, network regions increasingly invest in research and development. Research expenditures, however, are no guarantee for innovations – especially if they are continuously concentrated on the established technologies. In particular the patent specialisation illustrates that the regions are mainly continuing their successful specialisation of the past: Baden-Württemberg exhibits distinctive strengths in the field of transportation technologies and mechanical engineering; North Rhine-Westphalia in the field of the performing operation, chemistry and metallurgy; the Tampere Region (that belongs to the Etelä-Suomi region) in the field of electricity and physics, and Denmark in the area of human necessities (food).

Apart from these limitations, in comparison to other regions, the regions assigned by Cooke to the type of networked innovation systems nevertheless succeeded best in leaving the previous trajectories and in placing themselves in new technological and economic domains (see Appendix Table A.3).

- Denmark and Wales have chosen a service-oriented path of development: Denmark traditionally has a higher share of employment in the service sector. Also in the knowledge-intensive services, Denmark – closely following the European service metropoles (London, Stockholm, Paris, Brussels, Helsinki) – shows one of the highest regional employment shares in Europe. Wales joined this path *volens nolens* after the end of its 'industrial renaissance', i.e. after the retreat of foreign production plants. The high share of knowledge-based services (1999: 37.5 per cent in comparison to the European average of 32 per cent) points to the role of the public service (cf. Chapter 8 by Cooke).
- The Tampere Region successfully specialised on advanced technologies beyond the established paths. While the Finnish economy was traditionally focused on resource-based industries and their spring-offs (pulp and paper, mechanical engineering and automation), in the 1990s it started a new technological trajectory in the ICT sector and knowledge-intensive services. One-third of the labour force is already employed in knowledge-intensive services (1999). This success is not only based on isolated companies such as Nokia, but is backed by a high share of academically trained people (2001: 32 per cent of the working-age population), high research and development

expenditures (2.4 per cent of the GDP), and a high patent quota (248 per million residents) in the Etelä-Suomi Region, to which Tampere belongs. Additionally, systematically interorganisational networks have been developed (see Chapter 5 by Schienstock *et al.*).

- Also Baden-Württemberg and North Rhine-Westphalia hold a strong position in advanced technologies. The number of patents (595 and 260 per million inhabitants) is far above the European average (140). To a large extent, these regions are continuing their paths of specialisation. This is demonstrated by the patent specialisation of these regions and the share of advanced technologies (chemistry, mechanical engineering, transportation and ICT technologies), which is far above the European average (see Appendix Table A.2). An indicator of the limits of this 'path-preserving' model, however, is represented by the share of R&D expenditures and the share of academically trained employee in North Rhine-Westphalia, which is below the European average.

Network regions, therefore, are characterised by efficient research and development structures focusing on their particular profile of regional specialisation. The Tampere Region has been the most successful in establishing new technological trajectories, but this is less so for Wales and North Rhine-Westphalia.

Fourth, the mostly successful development of networked innovation systems can additionally be attributed to a successful balance between both a general and a differentiated economic policy. The case studies illustrate the difficulties of a balance. In the two German federal states analysed in this volume, which are bigger than most European states with 10 and 18 million inhabitants, only basic attempts are made in supporting innovative clusters. A reason for this restraint is that cluster politics imply the selective support of single subregions and, hence, counteract the politically desired homogeneity of living conditions. As well as this political risk, the economic risks of cluster policy are also a considerable factor. An alleged future technology can prove to be a stalemate. As a result, most regions and countries – especially the German ones – support mainly the general 'knowledge infrastructure' of a region (research and development, education). Additionally, Denmark and Tampere have developed a 'differentiated industrial policy' (see, for example, the Regional Centres of Expertise Programme in Finland, the network of local technological information centres in Denmark or the publicly financed 'real services' – marketing, technological advice, quality assurance, organisation consulting, information on markets and standards – in other regions). Hence, a regionalised economic policy has to face the tension between a differentiated and a general support of the economic development.

In conclusion, the networked RIS have developed effective and sound innovation-supporting institutions. Their economic structure is shaped by global players as well as by networked SMEs. The risks of these regions arise above all from their success: the established technological, organisational, and institutional structures can become a barrier for further innovations.

The dilemmas of dirigiste*, state-dominated innovation systems*

Finally, there is a *dirigiste* type of regional innovation systems to which in the Introduction Slovenia, Tohoku, Gyeonggi and Singapore were ascribed. In these regions, in opposition to regional protagonists the state holds a relatively dominant position. Accordingly, these regions are shaped by the tension between an active, largely centralised state and regional actors translating (in a more or less sufficient way) public incentives and new results drawn from research and development into innovations. Against the background of these linear patterns of innovation, networked patterns are only slowly becoming more important.

The first dilemma referring to this regional economic structure can be illustrated by the example of Singapore. The institutional prerequisite for its industrial development was a strong government consistently subordinating the interests of domestic entrepreneurs to the interests of foreign businesses. Initially in the 1960s, refineries and labour-intensive textile and clothing plants were built. In the 1970s, with the help of foreign direct investment (FDI) a capital-intensive electronics industry was generated. Since the 1980s, Singapore has developed into a highly qualified finance and logistics centre for the South-East Asia. As a result, the dependency of the region on investment decisions from foreign companies remains high. According to Hing Ai Yun in Chapter 11, the strong state may even become the Achilles' heel of the further development in Singapore. Correspondingly, there is a dilemma referring to the tension between a state-induced and FDI-based industrialisation and the development of its own, independent research, and competence basis.

Tohoku is an extreme example of the vulnerability of a region favouring external, state-induced investments. According to Shiro Abe in Chapter 10, who describes the 'hollowing out' of Tohoku, the labour cost-intensive mass production of electronic products which was the basis of the regional economic success in the 1980s has progressively been transferred to other Asian countries since the end of the 1980s.

The example of the South Korean region of Gyeonggi additionally demonstrates the strengths of regional variety in the context of a *dirigiste* innovation system. Also this region was strongly hit by the Asian crisis in 1998. However, according to Robert Hassink in Chapter 12, 'the Gyeonggi economy has quickly recovered … firms in Gyeonggi are increasingly internationally active, foreign

direct investment has been strongly increasing after the economic crisis at the end of the 1990s and even if their customers relocate to other regions, they tend to stay in Gyeonggi due to agglomeration advantages'.

In conclusion, a strong state can contribute to the industrialisation of a region especially by means of public subsidies or other types of support for globally active companies. If the development of an endogenous qualification, research, and competence basis fails and if the newly established factories cannot be embedded in regional networks, these factories remain 'cathedrals in the desert'. In this case, the region can easily be hit by relocation decisions and economic crises.

Regional co-operation networks can hardly be promoted by a strong state; at least, in our case studies we found only little supportive indications to this argument. The *dirigiste* counterpart to the support of networks seems to be the state-sponsored foundation of technology parks and science cities. The 'technopoleis', technology-intensive cities described by Shiro Abe, are an example of this public role. Like the Welsh Development Agency, the powerful Japanese Ministry of International Trade and Industry (MITI) has succeeded in transferring production plants into the rural region of Tohoku. However, not even the technopolis-initiative was able to strengthen regional networks: 'Local linkages within the technopolis area still appear weak, and most branch subsidiaries retain strong vertical links with their headquarters, rather than opening up new production spaces for local firms.'

Korea also shows a similar point of departure. According to Robert Hassink, the level of regional networking is very low in Gyeonggi. The regional companies are part of a national production system (especially in the automobile production). The main task of the public innovation support infrastructure is to improve contacts with public research facilities and to inform them about public funding programmes. The support of regional networks is not part of its remit. Such a centralist innovation support structure increasingly reaches its limits: with the transition from an investment- to an innovation-driven stage of industrial development, the requests for stronger regional networks intensify. Nationally homogeneous agencies increasingly cannot tackle the more diversified regional requests: 'Gyeonggi, therefore, seems to move from a *dirigiste* to a network kind of regional innovation support system.'

For such a transition, Slovenia provides excellent conditions. Even if its innovation system has to be characterised as *dirigiste* and fragmented (due to the socialist legacies), Knut Koschatzky in Chapter 13 describes extraordinarily intensive interorganisational patterns of co-operation: 93 per cent of the questioned companies 'confirmed that their co-operation with at least one partner surpassed normal business relationships in the case of innovation relevant activities'. However, these are mainly vertical relationships, namely relations to business-related service

companies, to customers, and suppliers. Contacts with competitors or with the public research and development infrastructure are considerably more fragile.

In conclusion, the *dirigiste* innovation systems are mainly characterised by a national supportive infrastructure. Up to now, regional co-operation networks have had a minor role in the current development concepts. Slovenia, Gyeonggi, Singapore, and Tohoku are, therefore, not characterised by fully developed regional innovation systems. However, with the increasing importance of more complex, non-linear innovation processes, regional networks are increasingly growing in importance in order to face the uncertainties of systemic, recursive innovation strategies. First indicators for such a shift towards network-based innovation concepts can be observed in all five regions –in Tohoku, in particular, they are already supported by regional institutions.

This transition from linear to systemic innovation concepts also shapes the third of the four dimensions examined here, namely the relationship between companies and research, development, and technology transfer infrastructures. Up to now, companies and institutions have been largely decoupled. In Slovenia, for example, 'The closest co-operation existed between Slovenian university institutes and the public administration … other, mainly private institutes were clearly more oriented towards industry.' This is correspondingly documented by the structure of R&D expenditures: even if expenditures are quite high (1.5 per cent of GDP), only 54 per cent of these originate from private businesses.

In Japan and Korea, national actors try to overcome the institutional decoupling between research and businesses by founding technology parks and regional research centres. In the extraordinarily research-intensive region Gyeonggi, the regional research centres succeeded in prompting numerous SMEs, however, mostly outside the region. In the Japanese region of Tohoku it was not possible to strengthen the regional research and development capacities in a persistent way. It can, therefore, be concluded that *dirigiste* RIS did not succeed in the regionalisation of national research and development activities and a closer coupling with the enterprise sector.

Fourth, In the past, the strong states dominating the *dirigiste* innovation systems originally did not favour a regionalisation of industrial politics. Gradually this changed in Japan and Korea. In such unitaristic states like Japan, however, it is a very difficult task to pursue diversified industrial policies. The development of the technopolis initiatives clearly demonstrates this argument. Not only did this initiative pursue the objective to promote knowledge-intensive industries: 'In some cases, they could even be considered as a form of social policy in disguise, through implementing measures (via some sort of public investment) to compensate those regions where private business investment was scarce or existing industries were declining.' Without stronger political regions and a different, more networked development model, diversified industrial politics can hardly be

implemented. Simultaneously, disadvantaged regions like Tohoku hardly have the opportunity to profit from such regionalisation.

In Table 14.1 key aspects of the previous argumentation are summarised. As a major result of the discussion it can be concluded that a regional innovation infrastructure is only partially institutionalised in grassroots and *dirigiste* regions. In the case of the first, regional governance structures are the result of a provisional regulation of individual business strategies; in the second case, the regional level is rather weak in comparison to the national level. This points to the fragility of regional governance structures, which is dependent on two conditions: first, regional companies must be able to benefit from the implicit, regionally distributed competences of other businesses. This requires an innovation strategy supported by close co-operation with suppliers and competitors as well as by close contacts with universities and research institutes. This, however, is not the case in regions still dominated by standardised mass production of less complex products where companies are primarily interested in low capital and labour costs or in subsidies, not in the development of regional competences. Partially this seems to be the case in Gyeonggi, Ontario, Wales and Tohoku. Second, the state must be ready to decentralise competences and responsibilities and to accept a diversified regional development. This problem is not only relevant in countries with *dirigiste* innovation systems (France, Slovenia, Japan, Korea, Singapore), but also in Finland (Tampere), Spain (Catalonia) und Germany. Bacaria *et al*., for example, not only described considerable frictions between the national and the regional level, but also the tendency to split the Catalonian innovation system into two separate support structures, into a national and a regional one. Similar problems apply to the two German regions as these are too large for a diversified economic policy.

If both conditions (decentralisation of political competences and innovation-centred business strategies) are met, the essential prerequisites for a fully-fledged regional innovation system – which are basically characterised by a regional order and regional co-operation and innovation networks – are found. Even successful innovation systems of this type, however, are still threatened by the reverse of their success, namely from institutional lock-in-effects and from the specialisation in specific technologies and industries. As a result of their past successes, regional economies erode if new firms, products and technologies are not simultaneously promoted.

Conclusion

In this concluding chapter, central dilemmas of the thirteen regional innovation systems previously analysed have been summarised. The starting point was the dilemma between innovation and institutionalisation: given the enormous risks of innovations it is partially rational for individual entrepreneurs, organisations,

and networks to preserve the previous competences and specialisation profiles and to gradually develop them towards new directions. The risks of omitted innovations, however, are opposed by the risks of failed innovations: successful innovations in one field can devaluate previously accumulated competences, technologies, investments, and plants in other fields. On the one hand, regional actors have to open up to new demands, challenges, and technologies; on the other, a relative regional closure is a precondition for the continuation of previous recipes of success and for the incremental accumulation of competences.

In the case of spatially concentrated innovation processes, this innovation dilemma is translated in four different dilemmas: first, businesses must assert themselves in an increasingly world-wide competition. In the most innovative regions of the world, this is accompanied by the increasing importance of local, experience-based, context-bound knowledge. Second, innovative firms are dependent on distributed knowledge of innovation networks, i.e. on trustbased patterns of co-operation between firms, schools, research institutes, political authorities, and users as these networks facilitate the recombination of technical knowledge and the embeddedness of new technologies. However, these networks may also be accompanied by lock-in-effects. Regional competitiveness, therefore, also depends on a diversification of the regional economic structure and the opening up to new competences, technologies, and businesses. Third, a close coupling of scientific, economic, political, technical, and cultural actors facilitates the reciprocal adjustment of perspectives and actions. This, however, may also hamper radical scientific, economic or technical innovations. Fourth, regional competitiveness is based on the accumulation and path-dependent development of competences. This, however, may also impede new technological trajectories. These four dilemmas shape the regional economic structure ('between regionalisation and globalisation'), the regional co-operation networks ('between fragility, regional learning and lock-in-effects'), the regional development and technology transfer institutions ('between learning and normative regulations'), and the regional economic policies ('between previous strengths and new technological fields').

In the third section of this chapter, it was described how the thirteen regions face these four dilemmas. It was found that the three types of governance structures initially proposed by Philip Cooke are characterised by different patterns. In the case of the grassroots regions, the institutional orders of these regions are highly fragile. They are continuously threatened by 'fierce individualism' among mostly small enterprises and a relative weak position of the local authorities. *Dirigiste* structures, on the other hand, reflect a linear innovation concept, in which basic research, applied research, development, and production can still be decoupled, demonstrated by minimal regional co-operation; regional companies are mainly connected by vertical supplier-customer relationships. The state guarantees the stability of the institutional order; the organisational interests in a decentralised

regional order are still relatively weak. In networked RIS, entrepreneurial interests in the regional support of distributed innovation processes are matched by a regionalisation of research, development, technology transfer, and economic policy. In this case, regional innovation networks and innovation-supporting institutions can develop. However, even these networked innovation systems are always threatened by their previous successes, namely by the inertia of previous technological specializations and institutions. This indicates the challenges, regional innovation systems have to face in a knowledge-based economy.

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Notes

1 Cf. Lundvall (1992), Nelson (1993), Edquist (1997) and Archibugi *et al.* (1999). Metcalfe (1995), for example, defines national systems of innovation as that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.

It remains open in which way the creation, storage and transfer of knowledge is effectuated. There have been attempts to fill this gap with the concept of co-operation or networks which should be able to facilitate innovations (Hage and Hollingsworth, 2000). But Fritsch (2001) has shown that the assumed connection 'between the co-operative behaviour of firms and the performance of the regional innovation system' cannot be proved.