PART IV

Conclusion

9. Conclusion: questions for further research

Frans van Waarden and Steven Casper (with contributions from the other authors)

The overviews in the foregoing chapters of quite a variety of literatures relevant for studying innovation, have presented a lot of research questions which have been studied; concepts, definitions, hypotheses and theories which have been developed; and empirical findings described. These theories and findings have in turn produced new research questions, some of which have been studied, while others point to lacunae in research in the respective fields. Some authors have identified some of them already in their respective chapters.

In this concluding chapter we will try to aggregate, identify and organize some of the open questions. We cannot be anywhere near complete, because the field is too diverse and complex. We will have to restrict ourselves and make some selections, in particular ones that may be relevant for a well-founded and intelligent technology policy.

In ordering research questions we can use the distinction between basic research, applied research and product development, familiar from the innovation literature. This can of course also be usefully applied in social science. An 'innovative' research programme may contain research questions and themes from these different degrees of concreteness of research. Lkewise, in science and technology policy the state can decide to further basic research, applied research or product development in research on innovation. The following is organized according to this distinction.

1 BASIC RESEARCH: ORGANIZATIONS AND INSTITUTIONS

At the level of basic research, we need a better understanding of the determinants of innovation within the idea-innovation chain (see Figure 1.3, Chapter 1). We believe that often 'perhaps the crux of innovation and learning is not so much technology as organization' (Nooteboom, Chapter 5).

Which structures facilitate learning within and between organizations, and hence innovation? Which organizational structures and processes can best solve the contradictory needs of stimulating exploration of new avenues in knowledge and product development (often requiring a more organic organizational form), while still allowing for exploitation of existing knowledge and products (often requiring a more mechanical form). Or: how to solve the paradox of creating enough cognitive distance between organizations to allow for diversity, but also enough cognitive proximity for them to be able to learn from each other? Much is already known about these demands on organizations, and organizations have experimented with various forms to solve these paradoxes, but the problem has not yet been solved.

Organizational structures are important as they provide for different patterns of communication and information exchange as well as for various incentives and disincentives for innovation. How does the institutional environment affect this learning capacity? What are effective and efficient 'interfaces' between institutions, organizations and innovation? How can the various levels of aggregation in the chain best be connected? These are some of the more abstract and lasting questions. More specifically one can identify the following problem clusters:

1.1 Measurement Problems

To evaluate the effectiveness and efficiency of various organizational structures, these should be compared with performance indicators. The measurement problems involved in that have not yet been solved.

What measurement problems should one be aware of? The fact that R&D represents only a small part of total development costs (as well as costs of design, marketing, prototyping, tooling, set-up of distribution and service)? The fact that R&D tends to be underestimated especially for small firms (due to 'informal' R&D), and the implications for inter-country comparison if in some countries business is on a smaller scale than in others? How to deal with the usual problems of patent measures, R&D inputs and so on. How to make use of other data, such as novel product announcements?

Measurement problems pertain not only to performance indicators, but also to indicators of the independent variables in the idea-innovation chain. How do we measure the variety of ideas or knowledge in firms (as one determinant of innovation) and the degree of decentralization? What dimensions of networks should we measure, and how, as one aspect of explaining innovation, or the lack of it? How do we measure appropriability of innovations? And tacitness of knowledge? And the degree to which costs are sunk? And the specificity of assets in inter-firm relations? And the complexity of contracts?

And the degree of trust that prevails? Are Hofstede's measurements (Hofstede 1980) of culture valid indicators and useful for such an analysis?

1.2 Structure

1.2.1 The Idea-innovation chain

What is the idea-innovation chain? How does it relate to the (often cross-border) industry structure (supply chain)? What stages or functional domains are there in the innovation process? What are the interdependencies between these stages – are they sequential, and is the chain linear, or are they also reciprocal, with feedbacks and reiterations (as for example in Kline and Rosenberg 1986)? Or is there pooled interdependence? Is the cycle, the arena, or the pool perhaps a better metaphor?

1.2.2. Units in the idea-innovation chain

The basic units ('actors') in the idea-innovation chain are the bearers of the competences that are needed in the chain of developing an idea into a successfully marketed product (or service), that is, they fulfil a certain function in the chain (research, development, manufacturing or marketing). They are knowledge producers and/or absorbers. Carriers of competences are usually individual persons with specific skills and knowledge (either tacit: knowledge kept to themselves; or codified and learned by them). However carriers can also be machines and instruments that embody or have codified knowledge. These carriers of competences are usually organized successively into larger units to work towards the common end, the successful marketing of an innovation. This organization implies an aggregation of competences at successively higher levels: departments, firms, networks or clusters, industries, nations.

Which patterns of unit grouping (small, larger) favour organizational learning and hence innovation? This question has already been much researched, but as yet not conclusively answered – the question of the respective advantages of small versus large: small independent firms in markets and networks, versus large hierarchies. The construction of the chain out of basic units brings up two related problems considered below.

1.2.3. Multi-level analysis

Micro-behaviour of individual competence bearers has to be connected with the higher levels of aggregation of competences: 1) the meso-environment, that of departments, organizations and forms of inter-firm cooperation (such as networks), which structure tasks and incentives for individuals; 2) the macro-level of industries and nations. The influence of relations between these levels has to be further explicated. As Nooteboom writes: 'In what way are

macro phenomena produced by micro-behaviour? What are the macro implications of micro behaviour?' These fundamental problems in economics (distance between micro and macro-economics) and in sociology (action and system approaches) are also relevant for studying the idea-innovation chain. How can we make 'methodological interactionism' (as in the compromise of methodological individualism and methodological collectivism ('social facts') concrete in the structures and processes of innovation?

1.2.4 Boundaries

The question of defining units in the chain – individuals, departments, organizations, networks, industries – brings up also the question of what the boundaries of these units are.

- Boundaries of firms are becoming fuzzy, with many intermediate forms 'between market and hierarchy'. Increasingly, management must be seen in terms of entanglement of the internal and external. This reinforces the need to look at different levels: within firms, between firms and other organizations, and institutional environments. An important variable is the kind and degree of integration – the kind of ownership (claims to residual profits), and of decision making (claims to residual control).
- If one takes as point of departure for empirical study specific industries (as is often done), then again the problem of boundaries of industries emerges. Do they include supplier and customer industries, or industries supplying substitute products or complementary products and/or technologies? One could also take domains of technology, which might connect different industries as well as cut through industries. How useful is the concept of cluster?
- What industry variables should one take into account? The traditional variables from industrial organization: scale and scope effects, concentration, entry barriers, degree to which costs are sunk, relation of fixed and variable costs (with implications for price competition), product differentiation, price elasticity and appropriability of innovations? Or other new variables such as: the degree to which knowledge is tacit (which affects spillover as well as the type of interaction required for cooperation, and the role of distance); and the degree to which the technology is systemic or stand-alone?

Differentiation and integration may be intra- and/ or inter-organizational. That is, the various stages in the chain may be located within one organization, such as a holding company, a vertically integrated firm, a Japanese *keiretsu*, or in what Whitley (1992) has called a society's 'modal business system'. In

such a case, firms do their own research and product development, scan markets, train their own workers and finance their own projects. However, the various stages may also be distributed over different independent organizations coming from a variety of institutional settings such as research institutes, organizations for training of labour and management, financial institutions, systems of industrial relations and regulatory authorities (such as the state). Thus, the degree of differentiation may refer to an intra-organizational division of labour, but also to the relations between organizations or different institutional sectors.

1.2.5 Differentiation

Which patterns of division of labour within the idea-innovation chain facilitate learning and innovation? Should units (departments, organizations) specialize in one functional domain, or should they cut across such domains? Is it better to have organizations specializing in basic research, product development and marketing? Or should they specialize, for example, on product categories – either in parallel or in serial relation to each other – and involve themselves with different functional domains? How should such specialized units be grouped into larger units? Again: what is the relevance of the cluster concept here? Obviously, this will have consequences for the patterns of coordination.

1.2.6 Intra-organizational coordination

Which patterns and instruments of intra-organizational coordination are most conducive to the generation of new ideas and their further development into marketable products and processes? By now it is accepted wisdom that coordination patterns typical of 'organic' structures are best suited to this: that is, decentralization, informal communication and mutual and flexible adjustment. But does this hold both for exploring new ideas and for developing some of them? Could the latter not profit from more 'mechanical' structures? And should one not differentiate between types of innovation, and hence industries, since different industries are characterized by different types of innovation. Also how should flexible horizontal coordination be organized in larger organizations? What horizontal liaison devices have proved to be fruitful: task forces, standing committees, integrating managers, staff with coordination tasks or matrix structures? What is the ideal size of such task forces, committees or units in the matrix for generating ideas?

1.2.7 Inter-organizational coordination

Similarly, which patterns of inter-organizational coordination facilitate learning between firms resulting in innovation? How 'close' should firms get, allowing both for enough cognitive distance to spur diversity, but also enough cognitive proximity to learn? How effective are spot-market transactions? And

how effective and efficient are various liaison devices for inter-organizational relations: bilateral joint ventures, long-term contracts, multilateral networks, alliances, consortia or neutral intermediaries, such as as state agencies, research organizations or trade associations?

Are long-term stable joint ventures, networks or alliances between customers and suppliers or between competitors with somewhat different competences (as one often finds in Japan and Europe) more conducive to learning than short-term relations and frequent partner changes between customers and suppliers? The reduction of cognitive distance in the first type of relations requires asset- and relation-specific investments; that may stimulate learning and innovation. But there are the dangers of hold-up and spillover for the partners, dangers that are fewer in the more market-intermediated relations. How can such dangers be reduced? Is this not dependent on the broader institutional and cultural environment? If so, should countries not profit from the 'social capital' (trust relations, traditions of pragmatism and consultation) that facilitate such long-term relations. And nurture such social capital?

The importance of integrating users and customers in the innovation process is well established in innovation theory (Hippel 1976, 1977; Nelson and Winter 1982). The quantity and quality of demand can have a major influence on the scope of a firm´s innovative efforts and on the speed of innovation processes. However, the role of users and customers in the innovation process may vary in different respects, such as 1) the strength of ties between users and producers, 2) the innovativeness of users or 3) the market position of users. We may hypothesize that innovative users closely linked to producer firms, and occupying a strong market position, may be highly conducive to the innovativeness of a national innovation system.

Important also, particularly in science-based industries, are technology transfer links between universities and other public research organizations and industrial firms. Modes of coordination here also range widely, from long-term consulting and training relationships, consulting or formalized technology licencing, to organized spin-off activities with the active involvement of professors or other public research personnel in private-sector ventures.

1.2.8. Functional equivalents

Intra- and inter-organizational coordination are in a way functional equivalents. Coordination may take place through internal firm hierarchies; but also through markets, networks, alliances, trade associations or even state agencies. In the literature on the economics of innovation, a number of arguments and empirical evidence for the relevance of cooperation among competitors through networks and associations have been provided (Jorde and

Teece 1990; Sydow 1992). AnnaLee Saxenian´s study on *Regional Advantage* (1994) is an excellent example. Saxenian compared two American regions with strong computer industries: Silicon Valley in California and Route 128 near Boston. Both regions had much in common: territorial concentration, a tradition of defence industry, and close proximity to famous universities (guaranteeing a good supply of highly qualified labour). For years both regions were characterized by entrepreneurship, vitality and growth. But from 1980, the development diverged. Silicon Valley still has a blooming industry, but Route 128 is in a decline. How can this divergence be explained? The answer, by and large, is that the industries were differently organized. In California the industry is small scale and there is much horizontal cooperation in networks and trade associations. In contrast, the firms near Boston are large and centralized and there is little inter-firm cooperation. Firms in this case 'communicate' through the market. Are such findings merely ideosyncratic, that is, only relevant to the American computer industry? Or do they have wider validity? More of such controlled comparative case studies need to be done.

1.3 Processes

1.3.1 Flows

How important for communication and learning are flows through the chain – flows of capital, of information, but particularly of people with their tacit knowledge? Does it favour innovation to rotate employees between the research, production and marketing departments?

It has been maintained (Aoki 1988; Hollingsworth 1991), that in Japan various stages in the idea-innovation chain are integrated within one firm and coordinated through flows. Large Japanese firms tend to have research, production and marketing processes very tightly linked together, with researchers moving into production and marketing processes, while people engaged in marketing and/or production often move into research. On the one hand, such tight coupling or integration within firms seems to foster rapid product development and improvement and the adoption of new technologies. On the other hand, such a tight coupling seems to diminish the country´s capacity to develop new basic research and radically new products (Aoki 1988; Soskice 1996). In contrast, in European countries such stages are differentiated between organizations. For example, most French research is located in the public sector, whereas companies tend not to do much research (Chenais 1993). Such an organizational model raises the problem of linking science and industry in the innovation process and the specific solutions found (or not found) may explain why the French have a poorer performance in the commercialization of scientific research. Other countries, such as the United

States, lie in between these two extremes. American companies which are vertically integrated may include the various links in the idea-innovation chain; but, unlike the Japanese, they have a tendency to keep them quite separated in different departments and different locations. They have tended to place their research and development sites in areas away from where production, marketing and distribution occur. This has placed constraints on product development and the commercialization of new products. On the other hand, it has allowed them to come up with totally new ideas, products or industries, as the history of Bell Labs and the research facilities of IBM or Du Pont have demonstrated (Hollingsworth 1991).

1.4 Technological Regimes

Idea-innovation chains are orchestrated within the context of competitive industry dynamics. It is important to examine the constraints imposed by the logic of commercial processes on the organization of particular functional areas within the idea-innovation chain, and in particular on the forms of coordination, types of knowledge flows and patterns of incentives used. In this respect two separate literatures are useful. One is the sprawling discussion of particular sector dynamics found in the strategic management literature. Of interest here is the degree to which 'best practice' as it is often defined within particular industries places constraints on the organization of idea-innovation chains within particular countries.

While strategic management accounts are useful in understanding idiosyncratic and fast changing industry factors, they are often unsystematic in their analysis of the substantive organization of innovation processes, especially at a cross-national level. However, the broader institutional economics literature has in recent years begun to overlap with strategic management accounts. Chapter 5 by Nooteboom reviews particular strands of this literature in terms of its implications for studying the relationship between institutions and innovations. Of particular importance for the study of idea-innovation chains are recent analyses of the 'technological regimes' underlying particular sectors (see Breschi and Malerba, 1997). While we wish to avoid the technological determinism implicit within this approach, it has developed a number of concepts by which one can classify important differences across particular sectors. These include indicators of technological turbulence, appropriability conditions, knowledge properties and opportunity structures within particular sectors. Table 9.1 summarizes the most important of these factors.

Analysing these and related technological characteristics may help identify important organizational problems facing actors within given idea-innovation chains. For example, most accounts of commercial biotechnology note

Table 9.1 Technological regime characteristics

Characteristic	Definition	Range of indicators
Opportunity structure	'The likelihood of innovation for any given amount of money invested in search'	Level; variety of technical approaches/solutions; pervasiveness of knowledge (range of applications)
Level of appropriability	'The likelihood of protecting innovations from imitation and of reaping profits from innovative activities'	Level (low to high); means of appropriability (e.g. control of patents, control of complementary assets
Degree of cumulativeness	'… the degree of serial correlation among innovations'	Level (low to high); the amount of competency destruction created by technological change at firm or sector level
Knowledge	How do various knowledge properties influence the organization of innovative activities	Codified knowledge versus tacit knowledge; generic versus specific; simple versus systemic/ complex

Source: Quotations and indicators from Breschi and Malerba, 1997, pp. 133–137.

generally wide open opportunity structures within this industry, meaning new entry is fairly easy, but also note that appropriability conditions can be difficult (as established pharmaceutical firms own important specialized and complementary assets within the innovation chain, such as development and regulatory expertise) while low technological cumulativeness, particularly on the firm level, leads to much internal competency destruction. National institutional frameworks often crucially influence the management of organizational dilemmas created by technological market dynamics. For example, to continue this biotechnology example, high amounts of technological uncertainty combined with high financial risks more generally appear to create a general prerequisite that firms be embedded within extremely active labour markets for scientists and managers due to high amounts of competency destruction.

We hypothesize that the idea-innovation chain will vary across different sectors due to differences in technological characteristics and market structures. Firms competing in the therapeutics segment of biotechnology, for example, are likely to have organized themselves differently in an idea-innovation chain than a producer of machine tools.

1.5 Institutional Embeddedness

The effectiveness of specific organizational structures and processes as regards learning and innovation – within the constraints and demands of sectorally specific technological regimes – depends also on the institutional environment: does it provide the resources of capital and labour needed? Does it facilitate useful differentiation and effective coordination, either within firms, or between them? What effects does the institutional framework have on the incentive structure within the idea-innovation chain? Therefore, research should address the embeddedness of the organizational structures in the idea-innovation chain in the institutional framework. As already stressed, it should also elaborate exactly how macro-institutions affect meso-organizational structures and micro-behaviour.

National institutional frameworks create patterns of incentives and constraints that directly influence the ease with which particular competencies or links within the idea- innovation chain may be created and maintained. Competencies may be defined both as substantive modes of coordination used to orchestrate the idea-innovation chain and patterns of incentives used to motivate particular types of personnel activities within innovative activities (efor example, financial rewards, career prospects and so forth). We aim to link the development of these competencies to incentives created by national institutional frameworks. We now discuss the role of national institutional frameworks on the structuring of idea-innovation chains in more detail.

1.5.1 Studies

Early studies, in particular Nelson's 1993 edited book on national innovation systems, recognized that a variety of institutional variables structures the organization of innovative processes, but made little attempt to identify institutional sectors of particular importance to different areas of the innovation process, or create systematic comparisons of how these particular institutions differ (or are similar) on a country by country basis. Rather, the major point of these studies was simply to establish the fact that government policy combines with societal institutions to impact crucially on the organization of the innovation process.

A second generation of studies has attempted to undertake a more careful

analysis of how specific institutions influence the innovation process (see in particular Soete and Freeman 1997). These studies have generally adopted a rather narrow view, focusing primarily on the role of universities, technology transfer institutions, and, often in conjunction with studies of Japan, the state. The organization of the research system combined with the development of technology transfer organizations and laws are in many ways the institutions most closely associated with firm-level innovation processes. These studies can partially account for important obvious differences in industrial specialization across the advanced industrial countries.

For example, the US research system has long been extremely biased towards basic research, with large federal funding programmes supporting a large network of research universities that have excelled in particular in the biomedical science and physics, two areas in which important spin-offs into radically innovative industries have occurred. Technology transfer is primarily oriented towards basic research links, which have been very important for the establishment of biotechnology and information technologies. In Germany, on the other hand, very strong technical universities complement more modest spending on basic research, and the technology transfer system has generally been geared to more long-standing, applied research links with networks of large firms and their suppliers (for example, through bridging organizations such as the Frauenhofer Institutes) (see Abramson *et. al*. 1997).

However, to understand fully the impact of institutions on the innovation process, other institutional frameworks must also be taken into account. These include all the sectors of society that either 1) provide resources for the idea-innovation chain (the financial sector, the skill formation system, research and universities); 2) regulate product and factor markets, contracts, firms, corporate governance, public-private interaction, products, processes and externalities, and or 3) aid in conflict resolution (incomplete contracts and so on) in the idea-innovation chain. Four institutional sectors in particular appear closely linked to the structuring of idea-innovation chains.

1.5.2 Finance and banking

A variety of financial instruments has developed across particular countries. These range from largely credit-based systems in which firms primarily rely on loans monitored by an array of commercial and publicly owned banks, to a variety of venture capital and investment banking instruments organized primarily in countries with large capital markets. Numerous studies have discussed the comparative merits of bank-based systems (for example, long-termism generated by ‘patient finance’) with capital market based systems (for example, the willingness of venture capitalists to support high-risk technology projects). However, few synthesis studies exist examining

how different financial systems create particular incentives or constraints for particular innovation trajectories. Analysis of financial flows and performance measures generated by investors within idea-innovation chains should help clarify these issues. In particular, corporate governance and monitoring issues might be connected with patterns of knowledge coordination within firms and across the idea-innovation chain. Venture capital finance is usually provided only if clear performance milestones are achieved that can be verified through codified knowledge, while bank-based systems are usually associated with 'insider-dominated' modes of corporate governance that might permit monitoring in contexts with high amounts of tacit knowledge, as is thought to exist with some 'incremental innovation' trajectories.

1.5.3 Industrial relations and company law

Countries vary greatly in the development of industrial relations and company law. Many continental European countries continue to have strong industrial unions with legally binding rights over wage bargaining and, through work councils, many work organization issues. Most Anglo-Saxon countries, on the other hand, have seen a rapid decline in union density, combined with the deregulation of labour markets and few, if any, worker representation rights within the firm. Other countries, such as Japan or South Korea, have long-established company union traditions. Variations also exist in company law. Many continental European countries have developed 'voice' or 'stakeholder' systems which limit the amount of control outside investors have over large public companies through creating company board systems with statutory representation for groups of workers and middle managers. This system differs substantially from the primarily financial control over large public corporations that has developed in the Anglo-Saxon world.

Recent studies have shown that differences in industrial relations and company law can have profound implications on the organization of decision-making structures, salary and performance-related pay, and the development of careers within firms. Within stakeholder systems, decisionmaking within large firms tends to be consensual, performance related pay is low, while careers within firms tend to be long-term and organized along well-defined advancement paths. Within less regulatory company law environments in which financial investors control company boards, hiring and firing is more frequent, performance-related pay higher, while more organizational autonomy tends to exist for particular managers or skilled employees. Virtually no research within the innovation studies field exists connecting these and other cross-national differences in company organizational structures and industrial relations traditions to the structure of innovation

processes, despite their obvious importance to the structure of the idea-innovation chain.

1.5.4 Education and training

In addition to the patterns of research specialization often emphasized by the national systems of innovation literature, we are especially interested in how human resource skills are generated, both within formal educational organizations and within firms. Again large cross-national differences exist. In both the United States and the United Kingdom there is very little organized industrial involvement in the skill-creation system. Rather, the onus lies primarily with individuals to obtain initial training and education. While public education provides some access to these skills, in recent years large competitive markets have emerged covering general technical skills as well as professional degrees that are widely saleable to firms. In continental Europe as well as many areas of East Asia state, and especially private sector involvement in the education and training system is much higher, particularly in the provision of applied vocational skills obtained through apprenticeships as well as through extensive technical universities with strong ties to industry.

The national system of innovation literature has focused on differences in knowledge flows generated within different education and training systems (especially Lundvall's work on 'interactive learning', which is highly relevant to the analysis of coordination issues across the idea-innovation chain). However, education and training systems have other impacts on the idea-innovation chain that have not been systematically explored in the innovation literature. For example, a main finding of recent comparative studies of vocational training systems is that they lead to different knowledge-investment incentives – in particular, systems with organized vocational training systems tend to generate higher investment in firm-specific skills by employees, while more market based systems do not. For example, is it easier to coordinate the organization of research networks which depend on high amounts of codified knowledge between firms with propensities to generate largely generic skill structures within the firm? Does the generation of high amounts of firm-specific knowledge lead to more tacit knowledge within the firm? If so, what are the implications for organizational integration across firms or research units within the idea-innovation chain (must they be more closely integrated to generate tacit knowledge transfer)?

1.5.5 Standard setting and inter-firm relations

Here we include industrial standard setting, the organization of collaboratory research projects, and the organization of long-term contracting relationships. Institutions structuring these processes again vary tremendously across the

advanced industrial countries. Germany, for example, has developed an extremely strong associational system, particularly among firms within the same industry. This has led to much formalized standard setting within industrial trade associations, as well as the active involvement of these associations in the generation of quasi-public legal frameworks in most areas of insurance, liability and contract law. Furthermore, an active culture of collaborative research and development has been developed within German industrial associations as well as within specialized technology transfer organizations such as the Frauenhofer Institute. Legal frameworks in Germany are generally regulatory and attempt to police the distribution of contractual risks, particularly across large and small firms. According to some scholars Japan has developed a similar system, though one organized neither on a formal nor industry-level basis, but instead through *keiretsu* groupings. Anglo-Saxon countries, on the other hand, have relied primarily on a combination of state regulation and market competition to set industry standards and have weak associational bodies with only limited collaborative R&D capacities and generally no collective law-making competencies. The corporate law system is far less regulatory, particularly in contract law, which more or less allows firms to distribute business risks as they please, so long as they can be codified within a written contract.

Again, few systematic studies have examined how these institutional differences impact on national systems of innovation, though many obvious connections exist. For example, how do long-term relational contracting systems as opposed to more market-based patterns of inter-firm coordination impact the flexibility of the idea-innovation chain? Does the prevalence of extensive 'non-market' coordination across firms within strongly associational systems facilitate the creation of innovation strategies that are difficult to sustain within primarily market-based systems? What 'lock-in' effects are created by non-market forms of coordination, and do they have a negative impact on flexibility which might be central to more radical innovation strategies? How do differences in standard-setting regimes influence the general 'competitiveness' of competing idea-innovation chains?

1.5.6 Culture, tradition, and the general cohesiveness of national models

Scholars examining national institutional frameworks have, in recent years, stressed the interdependent or complementary nature of particular institutional frameworks within the economy. They stress that the general logic of market regulation will probably be similar across different institutional domains within the economy, that is, the financial system, skill-formation system, system of company law, and so forth. Table 9.2 illustrates this point through comparing German and US institutional framework orientations in the four

Table 9.2 National institutional framework orientations in Germany and the United States

	Germany	United States
Finance, Banking	Credit-based system with limited market for corporate control	Capital market based system with extensive market for corporate control
Industrial Relations, Company Law	Extensive labour market regulation, collective wage bargaining; stakeholder system of representation within firms	Largely deregulated labour markets with decentralized wage bargaining; owners of firms control company organization and board structure
Education and Training	Modest basic research system supplemented by technical universities with extensive applied research links to firms; organized vocational training system with extensive firm involvement	Large, well funded basic research system, but extremely weak technical universities with few applied research links to firms; no organized vocational training system, though extensive 'market' fo training in general skills
Standard-setting and Inter-firm relations	Extremely strong business associations set most industry standards and organize extensive technology transfer, especially between smaller enterprises; regulatory system of contract law encourages relational contracting	Weak business associations with minimal standard setting or collective R&D capability. Most standards set by government or through market competition; classical contract law tradition allows firms to distribute contractual risks flexibly as they plese, but does not encourage relational contracting

domains discussed above. Notice that broadly regulatory patterns of market regulation, coupled with extensive non-market, associational, or generally 'organized' industrial activities permeate each of these four institutional sectors within Germany, while in the United States primarily deregulated, market-centred patterns of coordination exist.

Investigating the coherence of national models is of core importance to gauging the relative autonomy by which government policies, and in particular regulation, can positively influence the orchestration of the idea-innovation chain within particular sectors. In this area a number of different theoretical perspectives are helpful. While a number of literature reviews touch upon this subject, two especially important theoretical traditions exist.

a. Cultural approaches According to this approach, a third 'layer' within which actors in the idea-innovation chain function is their own history. This includes the history of their organizations and of their technological specializations, but also the history of the institutions that are relevant for them. German firms innovate in the process and engineering industries. Is that because they have done so in the past as well? Has their historical involvement in these sectors provided them with organizational competencies – including much tacit knowledge – that give them a competitive advantage in these fields? Or is it more that history has directed their attention and interest in these sectors? To what extent also does the history of institutions structure their present nature – both the rule systems that structure and govern the idea-innovation chain and those that structure the resource bases in the environment? Institutions are by definition relatively stable and enduring sets of social mutual expectations, crystallized in informal and formal rules. To what extent are actors in the idea-innovation chain 'prisoners' of their history and the history of their institutions? Is history a constraining prison? Or is it a source of competencies providing particular clusters of opportunities? How deterministic are path dependencies? To what extent can idea-innovation chains 'escape' from their traditions, embodied in their institutions?

An important question in this respect would be to what extent institutions can be adjusted, especially on a sector-specific basis, to facilitate better the construction of necessary links in the idea-innovation chain. Our assumption is that, in the short to medium term national institutional frameworks are 'sticky' in the sense that they cannot be quickly reconfigured to favor particular industries better. Many of the critical institutions shaping commercial innovation patterns are economy-wide in orientation and relatively stable over time (that is, legal frameworks such as those shaping corporate governance patterns, finance or education and skill formation tend to be national in focus). They are stable because they express deeply held beliefs, or because they are part of a complicated and interrelated and complementary system of institutions, a system out of which individual elements cannot easily be withdrawn. If so, national patterns would seem to be quite 'fixed' in orientation and the room for governmental technology policies might be limited. Nevertheless, recent evidence does suggest that there

might be limited room for government policy – for example in the first few years of the 21st century the German government has been credited with creating a boom in high-tech biotech start-up activity through supporting a number of sector-specific infrastructure and financing programmes directly aimed at this sector. We expect that future case study research examining the orchestration of the idea-innovation chain should be able to examine the degree to which government policies can, in essence, create surrogate incentive structures.

b. 'Institutional complementaries' Recent work within institutional economics has focused on the degree of interdependence, measured in terms of efficiency, of particular institutional frameworks (see Chapter 2 for more on this approach). According to Milgrom and Roberts, complementarities are present when 'doing more of one activity increases (or at least does not decrease) the marginal profitability of each other activity in the group' (Milgrom and Roberts, 1992: 108). In other words, the value of non-market forms of coordination within, say, an organized vocational training system, increases when complementary spheres of the economy, such as the labour market, are organized along similar non-market principles. In this case, restraints on poaching created by the regulated nature of many Northern European labour markets (especially within Germany) increase the value of an organized vocational training system through limiting the opportunities for firms that do not train to poach highly skilled workers trained at considerable expense by other firms. Similarly, in Anglo-Saxon countries the efficiency of open labor markets might be increased when the training system and patterns of knowledge formation within companies are organized around the creation of generic skills that can be easily used by other firms.

The analysis of institutional complementarities is of major importance for the study of idea-innovation chains, since innovative competencies are clearly structured by a variety of intersecting institutional sectors within the economy. According to the logic of the argument, when institutional frameworks are highly interdependent, dramatic institutional reforms that run counter to the broad logic of industry coordination in an economy become difficult. If a society chooses, for example, primarily market-based forms of coordination to organize major institutional sectors within the society, such as finance, inter-firm relationships or the organization of labour markets, then it might be very difficult to organize coordinated or non-market forms of coordination in complementary sectors, such as, vocational training. Assessing the relative degree of institutional complementaries within particular countries has major implications for the relative autonomy of government policy in reforming particular institutions, and thus should be a major area of future institutional research.

2 APPLIED RESEARCH AND DEVELOPMENT: POLICY RESEARCH

2.1 Some Findings

Applied research should apply knowledge acquired in basic research. And of course there is already quite some. The various literatures surveyed in the past chapters have already provided some preliminary answers to the questions just posed. Some of those findings are:

- Organizational studies indicate that complexity of the division of labour, an 'organic' structure (that is, decentralization, low formalization, high levels of horizontal communication) and high risk strategies (for example, Collins *et al*. 1988; Hage 1988, 1996) increase the learning capacity of firms, as organizations with such structures tend to have a greater capacity for monitoring the environment. This facilitates or even encourages innovation (Chapter 4)
- Learning and innovation often emerges from interaction between different carriers of competences such as firms. 'Different' is important, because it creates some cognitive distance; 'interaction' allows for mutual learning. This is important especially for generating new ideas, for 'exploration', the basis for radical innovation. Therefore, networks (or inter-organizational relations) have an advantage over hierarchies (intra-organizational ones), when it comes to exploration. Close and relatively long-term horizontal cooperation between relatively small units of competences in joint ventures, alliances, networks and the like, allows for the combination of a certain cognitive distance to facilitate diversity and enough cognitive proximity for cross-fertilization or creative mutation. Hierarchies have the disadvantages that they can reduce cognitive diversity - given that firms are meant to focus competences towards a common goal or mission and strive to develop to that end a fiarly homogeneous culture; and as they tend to be larger, they tend to be more centralized, formalized, and have their work processes more often standardized, with less room for horizontal mutual adjustment as a coordinating mechanism. This tends to discourage exploration, but may facilitate exploitation. High integration of firms in the same sector, through networks, trade associations or joint ventures, allows not only for the generation of a common stock of knowledge, but also for mutual inspiration; and it may also help in shifting factors of production from sunset to sunrise industries.
- Inter-organizational cooperation is, however, fraught with risks and uncertainties. This holds for the stages of 'contact, contract and control'

(Nooteboom 1999a). Firms have to commit to the costs of surveying the field for prospective cooperators; of gauging the amount and relevance of its (tacit) knowledge; of acquiring knowledge and information for writing up relatively complete contracts or for securing appropriation by patenting shortly before entering into structured cooperation; and of relation-specific investments with the attendant dangers of hold-up and spillover. There are also the problems and costs of monitoring, influenced by information asymmetries.

- This makes governance of such inter-organizational relations a complicated matter. Ways have to be found of reducing information asymmetries, risks of hold-up, the 'opportunities for opportunism' (Nooteboom 1999a), distrust and so on, all translated in transaction costs.
- Which patterns of intra- and inter-organization are most conducive to innovation depends also however on what has to be innovated. This is contingent upon the technology, type of product and market in the sector, that is the type of innovation which is dominant.
- The ease of inter-firm cooperation depends on the broader institutional framework: on the presence of generalized trust in societal culture; on the absence of a litigious legal culture; and on regulation - whether it facilitates or punishes inter-firm cooperation.
- Territorial clustering facilitates learning and innovation. It allows for reducing cognitive distance and learning through face-to-face interaction, and it allows for the creation of a common pool of skilled labour, as such clusters attrach such skilled labour. (See for example the emergence of a new software industry cluster in the desert of Utah.)

2.2 Policy Measures

If this is all true:

Can a scientifically informed government technology policy do something to support the development and maintenance of such organizational structures that are apparently conducive to innovation? Is it possible for the state to further the development of small organically structured firms? Can it encourage inter-firm cooperation? Can it enhance organizational forms that combine elements conducive to exploitation (for example, a mechanical or bureaucratic form) with those that facilitate exploration (the organic model)? If so, by which instruments? Conversely one may ask: are there perhaps state measures that obstruct such organizational forms? What are possibly unintended effects of regulatory measures?

The questions become hence:

- what new policy instruments can be deduced from these insights of science (applied research?)
- how should existing policy measures and regulations be evaluated given these insights
- how can legal instruments facilitate product development and testing?

The systemic character of the national innovation systems approach might sensitize policy makers to the less obvious influences on innovative capacity, the possible unintended effects of regulations introduced as part of quite different policy fields. Such insights might also jeopardize some of the accepted truths, common understandings and policy theories taken to be self-evident, and underlying existing state interventions in the economy.

Traditionally technology policy has focused on the relatively direct variables, the obvious ones. More input – R&D expenditures, skills – should produce more output – innovation. How often does one not see that benchmarking studies on R&D expenditures make governments that score low on such benchmarks nervous and induce them to promise to raise expenditure: either directly through government investments in basic and applied research, or indirectly through tax privileges for private investments. This approach overlooks two things however – what has become known as the 'European paradox' with which we started this study: high R&D expenditures, nevertheless relatively low innovation outputs; and its converse, the Austrian paradox: low R&D expenditures but nevertheless good economic performance. Perhaps it is not so much a matter of quantity as of quality. We assume that that is the case. That one has to look in the black box between input and outputs: matters relating to organizations and institutions.

It could very well be that there is no direct relation between R&D expenditures and successful commercialization of new products. After all, one could also profit from R&D done elsewhere. Much of basic research is still mostly recorded, even if it is still private. And it can be copied. The more so as patent protection of basic and applied research findings is often less than useful. Where a product life cycle is very short people and firms do not even take the trouble any more to patent, because by the time they have the patent it is already outdated. Furthermore, it may be costly to defend it in court. So copying may be less of a problem than is often thought. And here the Netherlands has a good tradition. Did not most of our multinationals start out by copying or 'stealing' inventions made elsewhere at a time when the Netherlands had no patent law? Philips got its headstart by copying the light bulb from Edison, Van den Bergh and Juergens (predecessors of Unilever) copied the margarine production technique from a Frenchman. It had the advantage of an infrastructure being in place (trade, wholesale, auction halls), created for the butter industry. The concept of the idea-innovation chain points

our attention to other functional domains, equally important, where it could pay more to invest in: manufacturing, logistics, and marketing; and in training for those trades. It could very well be that tacit knowledge, which is more difficult to copy, plays a greater role here. And after all, these are areas where the Dutch have a traditionally strong showing, where they have built up path dependent competencies. Should one not build on these, rather than invest in R and D, the 'classic' policy instrument?

2.3 Unintended Detrimental Effects of Other Ongoing Policy Measures

If inter-firm cooperation is so conducive to innovation, should one not develop policies that stimulate it and refrain from measures that discourage it? An example may be competition policy. Recently, the Netherlands has changed its competition policy, from an abuse principle to a prohibition principle. One may wonder whether sufficient thought has been given to the possible effect on innovative capacity. Economists often have a Pavlovian reaction as regards competition. It is 'good', provides incentives, keeps business on its toes, stimulates entrepreneurship and growth, and provides an incentive for innovation. Under certain conditions that may be true. However, it may also backfire, and have more or less unintended effects (compare also Nooteboom 1999).

Inter-firm cooperation becomes more suspect and is more liable to cause legal problems. If nothing else, that will make entrepreneurs more careful into entering into longer-term cooperation with competitors, suppliers or customers. This even though inter-organizational cooperation seems to be important, especially for 'exploration', but also 'exploitation'. Is not the strength of the agro-food cluster in the Netherlands the horizontal cooperation between firms and publicly funded research institutes? The agricultural university Wageningen is at the centre, with the *landbouwproefstations* and specialized research institutes like the Netherlands Institute for Dairy Research (NIZO) around it, and around that the firms? Funded in part by compulsory levies from other forms of horizontal cooperation in agro-food sectors, the sectoral *product- en bedrijfsschappen*, institutions 'tax' their industries for industry-specific collective goods. Is this not to be preferred over financing such collective goods out of the taxes all taxpayers generate? The Ministry of Economic Affairs has tried to get rid of the Pubkiehrechtekijke Bedrijfs Oorganisatie-schappen (Statutory Trade Associations). From what we know about organizations and innovation there is much to be said in their favour: they are focal points in sectoral innovation networks.

It may be true that competition policy makes an exception for R and D cooperation. Indeed, even the rather strict European competition policy does

so as well. However, this overlooks that mere cooperation in R and D is insufficient to motivate firms to get involved in such cooperation. They would also want to share the appropriations of such innovations afterwards, and such a form of cooperation may come close to pure cartels. Furthermore, effective innovation may not only or so much require the combination of R and D competencies, but also those in manufacturing, logistics and marketing. The latter competencies are often crucial for whether a new product also becomes a commercial success.

Greater restrictions on inter-firm cooperation (for example, cartels, trade associations) may force the firms involved to replace their networks or association by a hierarchy. If an association of firms, like a purchasing combination or a franchise, is not allowed to have a common price policy, while a hierarchy is, why not transform the association in a network? If Albert Heijn is allowed what de Spar is not, why should de Spar then not become like Albert Heijn? Thus a more strict competition policy may stimulate mergers, takeovers and the formation of large hierarchies. This is exactly what American anti-trust policy has done over the years. If the findings are right that small firms integrated in networks are more innovative, such transformation of networks to hierarchies may be detrimental to innovation. In sum, a more strict competition policy may backfire and be detrimental to innovation (see also Jorde and Teece 1990 on American anti-trust law).

A similar policy measure in quite a different field that could backfire is the intended deregulation of the legal profession in the Netherlands, something the Ministry of Economic Affairs has been an avid campaigner for. More competition, aggressive advertising, letting market forces reign unrestricted in the market for legal advice may accelerate an already ongoing trend towards greater juridification of societal and economic relations. Liability claims are increasing, a separate profession for injury lawyers is being created, and this could set in motion a trend towards more litigation – and before that, an increasing tendency towards transforming informal into contractual relations. Typical for the legal system is that trends tend to get a momentum of their own. In any case there are two parties. If there is a plaintiff, there is also a defendant, who has no choice but to seek legal counsel. The one lawyer helps the other into a job. Is there still anyone who can control the trend towards more and more costly liability damages in the US, and the uncertainty that comes with it? Such a trend may be good for the legal profession. One should however not overlook the fact that more contracts and litigation are costs to business: the transaction costs of inter-firm cooperation. Their increase will certainly not facilitate cooperation. We doubt whether the formulators of the policy of deregulation of the legal profession will have thought through such possible consequences on innovation. Do they realize what long-term processes they may be setting in motion?

The same could be said of some other policies introduced as part of the market liberalization programme. Do these not run the danger of economizing and juridifying social relationships, that hitherto have functioned on the basis of trust, informal consultation and cooperation, and pragmatic and flexible monitoring of mutual obligations and conflict resolution? Is there no danger that such policies destroy the very 'social capital' that has been one of the assets of the celebrated 'poldermodel'? So far Dutch firms have had low transaction costs for inter-firm cooperation, thanks to the low degree of litigation, and the easy, informal, flexible and pragmatic way of doing business. These elements are very much part of the basic institutions of the Dutch national system of innovation. It is typified not only by niches for certain products where the country performs strongly (flowers, bulbs, tomatoes, chickens, eggs, chicken slaughtering machines), but also by niches of institutions. After all, that is the essence of the varieties of capitalism argument. There is a serious danger that stricter competition policy and juridification could put sand in the wheels of inter-firm collaboration.

However, these are so far intelligent guesses, on the basis of the acquired knowledge in a variety of literatures and on the basis of earlier experiences elsewhere. It would make some sense to monitor the intended policy changes as to their possible consequences on inter-firm cooperation, learning and innovation. This would then be a form of 'product development' and testing of new products (that is, deregulation). Systematic comparisons with other countries with different institutions, and where such deregulation policies have already been implemented, could be useful. In Chapter 8 this has been done for the legal system, where the Dutch system has been compared with the American.

Technology policy research should focus less on the obvious: how to get more R and D, how to improve cooperation between firms and universities, the role of science parks and intermediaries, the lack of venture capital. That is not to say that these topics are not important, but: 1) because they are so obviously relevant for technology policy they are already heavily researched; and 2) the more important variables in the long-run could very well be the less obvious ones.

3 INTERDISCIPLINARY RESEARCH: REDUCING COGNITIVE AND INSTITUTIONAL DISTANCES

Finally: a creative tackling of these questions requires the linking of the different literatures presented in this study. We need more interdisciplinary research. There are various arguments for this. First of all, it is necessary to prevent redundancies and reduce inefficiencies. 'Some literatures are most

advanced in some respects and other literatures in others, and if this is not recognized, there will be much continued waste in reinventing wheels', thus Nooteboom in his conclusion of his chapter. And earlier on: 'It seems that in their study of institutions economics are naive and simplistic about social interaction, and are reinventing sociology, rather than making use of sociology. On the other hand, sociologists are simplistic about the working of markets and competition, rather than making use of economics'.

Secondly and more importantly: interdisciplinary research may be needed for innovation: for inspiration, for generating novel ideas and insights or Schumpeterian 'new combinations', for developing more or less radically new approaches in these sciences, including their insights into the innovation process. It cannot be coincidental that new ideas and avenues in science are often introduced by researchers that come from a different discipline: from mathematics to economics (Tinbergen), from history to economics (Fogel, North), from economics to social science (Becker). Different disciplines should complement each other, learn from each other, and develop insights from one discipline in a different direction in the new discipline. They may also compensate for each other's methodological strengths and weaknesses. Economists often sacrifice relevance and realism for rigour of reasoning. Sociologists do the opposite. There have been good and creative examples of such combinations recently. The Dutch economists Hartog and Teulings developed corporatist theory from political science in new directions, combining it with economic insights and applying the more rigorous style of reasoning and the urge to connect the micro with the macro, typical of the economist. Another example is the work of the new wave of economic sociologists (for example, Granovetter, Swedberg, Fligstein) or historians (Lazonick) in developing economic insights further, by 'embedding' economic action more explicitly in social interaction and societal institutions.

However, the need for interdisciplinary research is often and easily stressed or sometimes merely paid lip service to. The reality is more recalcitrant. The cognitive and institutional distance between the different disciplines is usually too great. The various disciplines and literatures have institutionalized and specialized in order to advance. They have tended to develop their own frames, categories and 'mental models' with which they perceive their task, the part of reality that they study, how they formulate their research questions, where they look for answers, and the relative importance they attach to rigour, consistency, validity, generalizability of their findings, and the environment within which they do so. In the process they have developed languages of their own. These frames and languages progressively isolate them from other disciplines. The institutionalization of their disciplines, and of their place in society, add further to this. They work in different faculties and sometimes universities. They have their own professional associations and journals, and

develop their own norms for performance and recognition – which usually discourage activities in the periphery. Thus economists at Dutch universities get less 'points' for publishing in non-economic journals and participating in non-economic conferences. They develop their own specialized links to policy communities. Thus the Dutch Ministry of Economics looks to economists and economic research institutes like Onderzoets Centrum Financueel-Economisch beleid (Research Centre for Financial and Economic Policy) when it needs policy advice; the Ministry of Social Affairs and Employment develops a policy community with social scientists; and the Justice Department with lawyers and criminologists.

Such specialization and isolation has certainly advantages. Not only is that the only way in which knowledge can progress, it also generates diversity, and is good for 'exploitation' of already basically known avenues in knowledge. However, the cognitive distance to others inhibits 'exploration', the development of radically new avenues in knowledge creation.

If one also wants to stimulate innovation in policy-related research, than measures should be taken to reduce the cognitive distance between disciplines, at least intermittently. Here one could link up with an existing tendency in the disciplines themselves to reduce this distance. In their process of differentiation and specialization the main disciplines also develop new specialities that could function as bridges between disciplines. Industrial economics can connect with organizational sociology and management science, institutional economics with economic sociology, and cognitive science with the economics of innovation. Such new 'bridging' specialities could be supported by facilitating their institutionalization: providing facilities in the form of academic chairs, funding for research, journals and professional associations.

Secondly, interdisciplinary cooperation could be stimulated through funding. At least a part of the public research funds for social science could be explicitly reserved for interdisciplinary studies. This may stimulate universities to create interdisciplinary institutes and research schools. Such institutes could help reduce cognitive distance. This is not to say that there is no good reason to fund disciplinary research. There is a need still for 'exploitation', for further development of disciplines – consider it as product development. There is a good case to be made that a substantial part of research funding should go to what the Amsterdam sociologist Bram de Swaan has called derogatively 'predictable project applications' for NWO, where one can more or less know already beforehand what will come out – and where subsidy givers do not run a great risk. This may advance the disciplines. However, there should also be room for 'exploration', for roaming in new, as yet uncertain directions.

In the end, cognitive distance could perhaps be most easily bridged in one

person's mind. Here mutual learning is also most immediate. After all, individuals are the final carriers of competences. This would imply an argument in favour of training and education as it is done at an American college of arts and sciences, where the student can choose courses from a variety of subjects, and specializes eventually in two disciplines: a major and a minor. At many British universities students combine two disciplines. A solid disciplinary training is necessary, but developing familiarity with a related discipline, cognitively not too far removed, can put this disciplinary knowledge into perspective. The combination and confrontation within one brain can breed creativity. Thus a technology policy should also be a science policy: a policy directed at facilitating learning across disciplinary boundaries.

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