

I. Introduction. A Systemic Perspective: The Innovation Policy Dance

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This book is about the interaction between innovation practice, innovation policy and innovation theory. The book aims to increase insight into this interactive process, searching for options to improve the effectiveness and efficiency of policy and of innovative practice. The book also identifies conceptual or empirical lacunae and questions that can guide future research. We seek to inform and support policymakers, innovators and innovation scientists – not so much by providing a state-of-the-art, but by presenting a theory-based vision on the interrelated dynamics of innovation policy, practice and research.

In this introductory chapter we set out a framework for the book by taking three steps. First we introduce a systemic perspective on innovation as a social phenomenon as well as a subject of public policy and of socio-economic analysis. Second we offer the reader a guiding metaphor for the book's underlying approach: the 'dance of innovation practice, policy, and theory'. Finally we present an overview of the book's chapters.

INNOVATION IN A SYSTEMIC PERSPECTIVE

However named and valued, 'innovation' – the development and adoption of new and improved ways of addressing social and economic needs and wants – has occurred in society and economy since the early days of mankind. The stirring power of innovation changed the social structure of medieval societies as the art of printing unleashed the spreading of ideas and aided the birth of modern science and technology (e.g. Zilsel et al. 2003; Roberts et al. 2007). In the mid 19th century, the train, telegraph and other communication technologies transformed countries from loosely connected cities and villages to coherent nations, while the conveyor belt – together with Tayloristic organization principles – resulted in a tremendous increase in the productivity of factories in the first half of the 20th century (e.g. Geels 2006; Hughes 1989; Mumford 1964). Innovation is of a social, economic and technological character. It emerges sometimes spontaneously, sometimes as result of

actors' strategic endeavor. Innovations vary according to subject, location, actors, speed and numerous other characteristics. One may be in favor of an innovation or dislike it, facilitate or try to impede it; yet innovation occurs, in one way or another. Joseph von Schumpeter (1934) defined innovation as 'creative destruction': innovators afford 'new combinations' of hitherto disconnected ideas, knowledge domains, technologies, or markets. In this perspective, successful innovation requires transgressing limits. Also sociological analyses tell us that it is often border-crossers who dare to move around in different worlds with diverging rationalities leading them to discover new combinations and facilitating innovation (e.g. Burt 2003). Crossing boundaries is not easy: facing complex, fuzzy environments, we are inclined to simplify, to reduce our cognitive horizon ('bounded rationality') and to solidify borders. While we might sense undiscovered insights and options behind borders, we tend to be impeded by vested interests and the inertia of existing institutional, political and organizational structures from exploring such options and becoming exposed to unknown consequences.

Empirical innovation research has revealed the high level of 'path dependence' in the evolution of knowledge and institutions (Nelson and Winter 1977; Ziman 2000). Streamlined 'technological regimes' (Nelson and Winter 1982) are established which are characterized by specific patterns of technical change and mostly incremental innovations molded by the frameworks of engineers in that industry. Van den Ende and Kemp (1999) defined a technological regime 'as the complex of scientific knowledge, engineering practices, production process technologies, product characteristics, user practices, skills and procedures, and institutions and infrastructures that make up the totality of a technology'.

Rip and Kemp (1998) explicitly added to the 'grammar' of a regime the policies and actions of other technology actors including public authorities. Industrialists, scientists, policymakers and other actors in policy arenas typically follow bounded rationalities: experienced in a given arena, with limited scope, actors in one domain often lack insight into other arenas. Policy instruments and public regulation normally develop in an incremental and only rarely radical way; sometimes, though, actors might see a need for strategic change. In short, both innovation practice and innovation policy have to cope with a tense polarity between path dependence and creative destruction.

If one wants to discern the origins and dynamics of innovation, observing one company, one area of knowledge, one field of technology, or one policy normally would not suffice – the scope of inquiry has to be widened. Since the mid-1980s, both innovation research and policymakers, in search of the determinants of innovation as a means to strengthen economies, have adopted a systems perspective (e.g. Gaudin 1985; OECD 1991), leading to the development of the concept of innovation systems. With the growing share of knowledge-intensive products and services in international trade, explanations for the differing degrees of competitiveness of economies, especially of their ability to innovate, were sought. It was recognized that the variety of national, regional and sectoral patterns of technological specialization

and diffusion, each rooted in historical origins, characteristic and unique industrial, scientific, state and politico-administrative institutions and inter-institutional networks, crucially affected the ability of research and economic actors to produce knowledge and innovation as well as of policymakers to invest and regulate.

Innovation systems encompass, according to a widely accepted understanding (Freeman 1987; Lundvall 1992; 2007; Nelson 1993; Metcalfe 1995; Edquist 1997; Kuhlmann 2001), the 'biotopes' of all those institutions which are engaged in scientific research and the accumulation and diffusion of knowledge, which educate and train the working population, develop technology, produce innovative products and processes, and distribute them. Hereto belong the relevant regulatory bodies (standards, norms, laws), as well as the state investments in appropriate infrastructures. Innovation systems extend over schools, universities, research institutions (education, private sector and science systems), industrial enterprises (economic system), the politico-administrative and intermediary authorities (political system) as well as the formal and informal networks of the actors of these institutions. As complex and heterogeneous systems, they represent a section of the society that carries far over into other societal areas, e.g. through education, or through entrepreneurial innovation activities and their socio-economic effects. As a result, innovation systems are believed to have a key influence on the modernization processes of societies (OECD 1999).

Successful innovation systems develop their special competitive scientific, educational, technological profiles and strengths rather slowly, in the course of decades, or even centuries, and change is also often slow to occur. Leading innovation systems are based on well-established exchange relationships among the institutions of science and technology, industry and the political system. They make possible the formation of a characteristic, system-specific spectrum of diverse role definitions of the actors actively involved, develop their own negotiation arenas, and stabilize mutual expectations of behavior. Finally, they bear particular intermediary fora and bodies which facilitate the transactions of the actors of innovation systems. Chris Freeman classically detailed these processes of system stabilization (and destabilization) when he compared the British and the German innovation systems during the first and the second industrial revolutions. During the first, the British system was superior due to excellent links between the science, political, cultural and industrial sub-systems. During the second, the British system eroded because of a widening gap between the science system and the other three components. At the same time the German system improved by building bridges among (industrial-) research, production and the political and cultural sub-systems (Freeman 1997).

In sum, the innovation system perspective helps us to understand the dynamics of innovation processes by pointing at path dependency and structural sclerosis as well as the potential for new combinations, related chances and options, and opportunities for innovation policy.

Historically, the institutional infrastructures and networks of research and innovation systems did not come into existence spontaneously and without control:

in the past 150 years, this area of society was shaped by state political interventions. National political systems, themselves increasingly differentiated, developed science, technology and innovation policy activities in which they acted as catalysts, promoters and regulators of the innovation bodies which were emerging within their countries. The establishment and growing economic significance of colleges of engineering and technical universities in France, Germany or in the USA document this clearly. The innovation systems of the industrialized countries that developed in the course of the twentieth century in co-evolution with their national political systems assumed a country-specific character. It is because of this close interweaving with the political systems that one speaks of 'national innovation systems'. Some analysts would include also regional (Braczyk et al. 1998) and sectoral innovation systems (Malerba 2002), with public innovation policies increasingly developed at these levels too.

As Boekholt in her chapter in this book demonstrates, state interventions shaping innovation systems cover a large and (since the 1960s) ever growing scope of instruments (working with financial, regulatory or information incentives) and areas of application (see also Rothwell and Zegveld 1981; 1985; Rothwell and Dodgson 1992; Dodgson and Bessant 1996; Branscomb and Keller 1998; Archibugi et al. 1999; Feldman and Link 2001; Biegelbauer and Borrás 2003). The European 'Trendchart' intelligence service distinguishes 25 categories of innovation policies, under five major headings: improve innovation governance and strategic intelligence for policymaking; foster an innovation-friendly environment; encourage technology and knowledge transfer to enterprises and development of innovation poles and clusters; promote and sustain the creation and growth of innovative enterprises; and strengthen entrepreneurial innovation including the protection and commercialization of intellectual property (European Commission 2006; see also Nauwelaers and Wintjes 2008). An OECD taxonomy suggests an even broader perspective which covers innovation policies, targeted at, as well as cutting across, sectors. These include policies directed at innovating industries and economic growth, and innovation policies in a wider sense aiming also to improve quality of life (see Table 1.1).

Policy in general can be defined as 'a purposive course of action followed by an actor or a set of actors in dealing with a matter of concern. Public policies are those developed by governmental bodies and officials' (Anderson 1990). In our case, the matter of concern is 'innovation'. If we accept the broad definition of innovation policy adopted by the OECD report (above) it appears wise to 'emphasize a holistic view of policy-making, a belief that the whole is greater than the sum of its parts, that individuals, institutions, interactions, and ideology all matter, even if there is notable disagreement about the proportional importance of each' (Nelson 1996). This holistic view of policymaking fits with the perspective adopted in this book: not surprisingly we will apply a quite generic notion of innovation policy which could be defined as 'a set of policy actions to raise the quantity and efficiency of innovative activities, whereby "innovative activities" refers to the creation, adaptation and adoption of new or improved products, processes or services' (Cowan and van de

Table 1.1 A taxonomy of innovation policy

Goals	Sectoral innovation policy	Multi-sectoral innovation policy
Innovation policy, i.e. aimed primarily at innovating industries and economic growth	Innovation policy in a limited sense (basically technology and industrial policies)	Integrated STI policies
Innovation policy in a wider sense, i.e. aimed at economic growth and quality of life	Innovation policies in other sectoral domains, e.g. innovation policies in health, innovation policies in the environment	Horizontal/comprehensive/ integrated or coherent/ systematic innovation policies

Source: OECD (2005, 22). STI = science, technology and innovation.

Paal 2000). Obviously, this broad definition covers a large number of heterogeneous policy actors, instruments and measures – as will be shown in several chapters of this book. Thereby innovation policy can be characterized as ‘systemic’ in a double sense: as a system-wide distribution of varieties of innovation-related policies across domains (e.g. manufacturing, services), or as policies designed to work on system characteristics, such as demand-oriented policies (see Chapter 13 by Edler in this book) or strategic policies (see Chapter 17 by Smits, Kuhlmann and Teubal).

At this point we can conclude the following: (1) Innovation practice and innovation policy normally do not start from a systemic/holistic perspective; nevertheless – as several contributions to this book will show – such a perspective is receiving increasing attention. (2) In this book when considering innovation processes we take such a perspective, in the double sense of domain variety and system-level action. (3) In analyzing innovation policies we start from a holistic concept aiming at improvement of policy and practice. In doing so, we will now introduce the guiding metaphor of this book – the three dancers and their potential for interactive learning.

THE INNOVATION POLICY DANCE: INNOVATION PRACTICE AND INNOVATION THEORY AS PARTNERS

It has been suggested that there is no coherent theory on innovation and on innovation systems (Lundvall 2007). Rather, related research is rooted in heterogeneous theoretical strands: evolutionary economics, in particular growth theory; micro-economics; innovation economics; sociology, in particular sociological system theory; action theories; neo-institutional approaches; sociology of organization; sociology of science; political science, in particular policy analysis; neo-corporatist analysis; international relations; science policy studies. For the time being we use the term ‘innovation system’ just as a helpful heuristic aide (Kuhlmann 2001; Lundvall 2007) speaks of it as an ‘analytical focusing device’.

The theoretical perception of 'innovation' and 'innovation policy' has undergone considerable change in recent decades. While since the 1950s in economics and sociology research, development and innovation processes were seen as subsequent activities of institutionally and organizationally distinct units (linear approach) this changed in the course of the 1980s and 1990s. Today, most concepts and theoretical constructs agree largely on the interactive character of idea generation, scientific research, development, product and process innovation (in a narrow sense), and introduction into markets or other areas of use. This has been simplified with the tag of 'Mode 2' innovation as suggested by Gibbons et al. (1994). In a way, the Mode 2 perspective on knowledge production and innovation builds on a long strand of studies into the relation of science and technology (e.g. De Solla Price 1965; Rip 1992; Weingart 1997) and, at least implicitly, rediscovering older, more systemic concepts from the late eighteenth through to the early twentieth centuries (in the work of Smith, Marx, List and Schumpeter, among others; see Lundvall 2007). Meanwhile the innovation system approach has been made more dynamic, inter alia by introducing the concept of 'functions' or 'critical success factors' of innovation systems (see Chapter 6 by Bergek, Jacobsson, Hekkert and Smith; also Hekkert et al. 2006) which can be related to innovation policy instruments. Still, the question remains how actual policymaking refers to functions, and how functions translate into policymaking and policy effects.

Three chapters of this book explore the emergence and conceptual potential of the innovation system notion in some detail (Carlsson, Elg and Jacobsson; Chaminade and Edquist; and Bergek, Jacobsson, Hekkert and Smith). Other chapters address several of the key weaknesses to date of this influential concept. The innovation system approach is most dominant in Europe. In the United States, innovation scholars refer to innovation systems, but there is not much use of the concept in the policymaking and business communities. The innovation systems approach has been communicated widely by OECD and others, and has received considerable interest in other part of the world – although the fit is less clear with the needs of 'less developed economies' (see Chapter 15 by Cozzens). Other weaknesses of the innovation system approach are addressed in Chapter 17 by Smits, Kuhlmann and Teubal. These include the tendency to conceive systems as stable if not static instead of also conceptually modelling them as permanently evolving social structures; the fact that policymakers only occasionally design interventions in light of a systems perspective; and weak attention of policy designs for actors at the micro level.

A Learning Perspective

The relationship between innovation practice, innovation policy and innovation theory could be considered as an expression of 'co-evolution' between various actors interested in influencing technological change and innovation in terms of their own goals:

Firms will think in terms of market success and strategic advantages. NGOs have their issues to pursue, for example health improvement or a clean environment. National governments and other government agencies have overall goals like security, quality of life, sustainability, under which a variety of actions are formulated and implemented. Their assessments of the situation, actions and interactions actually contribute to the co-evolution. (Rip 2008)

In this book, we do not over-emphasize the notion of co-evolution with its allusion to biological processes. Instead we place as central to system development the conditions and modes of interactive learning of organized actors in innovation policy arenas.

We start from the basic assumption that the ideas, rationales and instruments of innovation policy emerge as a result of interactive learning among actors involved in innovation practice (I), innovation-related public intervention strategies (P), and innovation research and theory (T). One may conceive the interactive learning space between I, P and T as a 'dance floor'.¹ For the purposes of this book we suppose that the three dancers while moving observe each other, and react to the others' movements: they copy, comment, complement, counteract, neglect, and thereby learn. Mutually learning, they constantly create and change IPT configurations. Sometimes innovation practice is the driving force in a configuration, sometimes theory, sometimes public or private policy. The dancers may happen to bump into each other or may enjoy phases of pure harmony. Table 1.2 makes an attempt to characterize the dance of the three groups in a systematic way.²

Learning on the innovation policy dance floor may occur as first-order or as second-order learning (Argyris and Schön 1978). First-order learning links outcomes of action to organizational strategies and assumptions that are modified so as to keep organizational performance within the range set by accepted organizational norms. The norms themselves remain unchanged. Second-order learning concerns sorts of inquiry that resolve incompatible organizational norms by setting new priorities and relevance of norms, or by restructuring the norms themselves together with associated strategies and assumptions, hence escaping tunnel vision and crossing borders. In our perspective not only is innovation itself a matter of new combinations but also the 'innovation policy dance' between innovation practice, theory and policymaking.

Through the chapters of this book we hope to demonstrate how practice, theory and policymaking interact – across a number of aspects: how they 'dance' with each other and thereby learn, both first-order, i.e. reacting to observed changes in a conservative manner, and second-order, i.e. adopting or developing new assumptions,

1 Drawing on Kuhlmann (2007) and Smits and Kuhlmann (2004). The dancing metaphor has earlier been used by Arie Rip (1992) with respect to the relation of science and technology, inspired by Derek de Solla Price's discussion of this relation (1965).

2 This table is a variation of the PIT Matrix presented by Smits and Kuhlmann (2004).

Table 1.2 The innovation practice, policy and theory dance floor (IPT matrix)

	Innovation Practice	Theory	Policy
Innovation Practice (e.g. sustainable housing)		I→T Learning by searching (e.g. researchers learn on user-producer relations from real life experiments with sustainable housing) Learning by interacting (e.g. researchers use experiences of actors as empirical input for user-producer research)	I→P Learning by using (e.g. policymakers learn from the impact of their policies by evaluations) Learning by interacting (e.g. policymakers learn from the impact of their policies by talking to actors in the field)
Policy (e.g. environmental innovation policies)	P→I Learning by using (e.g. entrepreneurs learn by using policy measures)	P→T Learning by searching (e.g. researchers learn on user-producer relations from (the impact of) policies focusing on sustainable housing) Learning by interacting (e.g. researchers use experiences of policymakers as empirical input for user-producer research)	
Theory (e.g. user-producer interaction)	T→I Formal learning (e.g. entrepreneurs learn from theories on user-producer innovation and change their mental frame, conceptual use) Learning by interacting (e.g. researchers act as consultants for entrepreneurs)		T→P Formal learning (e.g. policymakers learn from theories on user-producer innovation and change their mental frame, conceptual use) Learning by interacting (e.g. researchers act as consultants for policymakers)

targets and measures. While moving on the dance floor, learning and finally even changing perspectives, bounded rationality will remain the actors' prevailing mode of guidance. Even second-order learning could be subject to trends, fashions, or waves in innovation practice, theory or policy – or in the surrounding 'music'. In other words, a note of caution is required, asking for reflexivity, in particular on 'our' side, the side of 'theory' as a dancing partner (Kuhlmann 2007).

External changes (new 'music fashions') could imply new roles of dancers on the floor, or even the appearance or (temporary) farewell of an actor. Has, for example,

theory always been a relevant dancing partner from the perspectives of innovation practice or policy? Also, obviously there is not just one theory: innovation practice might prefer other dances with theory than public policy would like (e.g. different choices of theories, with different policy targets and designs as a consequence). Furthermore we know that different national political systems and related political elites revolve around different intellectual traditions and styles (Galtung 1981), hence expose marked preference for specific innovation theories. In the US, for example, there is a strong interest among actors in innovation policy and practice for (quantitative) economics-based analytical concepts (since 2005 re-emphasized in the 'Science of Science and Innovation Policy' initiative of the National Science Foundation). This can be compared with the continental European tradition of sociology and evolutionary economics-based analysis of public and private institutions as the shaping force of 'innovation systems'. These variations in conceptual emphasis have influenced the design of evaluation regimes for science and technology policy in the US and Europe (Shapira and Kuhlmann 2003).

Innovation Theory and Innovation Practice as Dancing Partners

Practical innovations, i.e. technology-based processes or products and social and organizational innovations in private and public services, are at the heart of the working of capitalist economies. The social and economic centre of gravity of practical innovation locates in the (mostly private) 'firm'. Dankbaar and Vissers state Chapter 3 in this book that the 'firm will continue to play the central entrepreneurial role in processes of innovation and technological change in capitalist economies – and even in economies that are not formally capitalist, decision making on innovation is decentralizing towards the level of the firm'.

Modern innovation theory is largely based on empirical analyses of social and economic change in the 'practice' of firms and public organizations, starting not only with Joseph Schumpeter (1883-1950), but even with the research and writings of Adam Smith (1723-90) and Karl Marx (1818-83) (see Antonelli 2008). Over decades, a large number of economic and sociological studies into the patterns of (in particular technological) change in firms and in sectors have helped to accumulate knowledge on the dynamics of innovation as a core phenomenon of modern economies (e.g. Freeman and Louça 2001), a phenomenon with generic and systemic characteristics: searching in and interacting with innovation 'practice' has been a key resource of theory-building.

At the same time innovation 'practice', though socially located quite distant from academic theory, has been influenced by innovation studies in many ways. This certainly holds for the broad scope of 'innovation management' literature which has had a considerable (and sometimes fashionable) impact on firms' understanding of innovation and on their strategies (see Dankbaar and Vissers, Chapter 3 this book). By and large, the systemic perspective on innovation as a socio-economic and technological process has advanced – to some degree also in firms – that any

'innovation success' in product creation processes should rather be viewed as by-products along 'innovation journeys' than as end results (van de Ven et al. 1989). Such 'journeys' are characterized by numerous setbacks along the road; when one wants to deal with contingencies during a journey, retrospective attributions of success to certain approaches or persons is risky. Following this perspective the understanding of innovation management as fundamentally a control problem unpacks as a myth: rather it should be seen as one of orchestrating a highly complex, uncertain and probabilistic process of collective action in a systemic context (van de Ven et al. 1989).

Innovation Theory and Innovation Policy as Dancing Partner

The evolutionary approach of Nelson and Winter (1977), the innovation system tradition as inspired by Freeman (1987) and developed further by Lundvall (1992), Nelson (1993) and Edquist (1997) as well as the cluster approach advocated by Porter (1990) heavily influenced the development of innovation policy concepts and instruments. These assume that with globalization, dynamic clusters of innovative firms and knowledge-generating public organizations are becoming key factors in a country's capacity to attract the international investment that generates new technological expertise, to interest investors in innovation (venture capital, etc.) and to benefit from the international mobility of skilled personnel (OECD 1999; 2001). The Dutch cluster policies of the 1990s represent a prominent example which applies these theories (Jacobs and de Man 1996; Jacobs 1998). Also bodies of knowledge dealing with the broader embedding of innovation processes, such as for instance the social construction of technology (Bijker et al. 1987), technology assessment (Smits et al. 1995) and research after the role of users in innovation processes (von Hippel 1988; Lundvall 1992; Moors et al. 2003), had a considerable impact on the policymaking processes and their design. The underlying constructivist perspective has, for example, facilitated the development of policy-related specialized Technology Assessment organizations (see the detailed discussion in Chapter 16 by Smits, van Merkerk, Guston and Sarewitz), or the rise and high visibility in innovation policymaking of foresight exercises (see e.g. Georghiou et al. 2008).

In addition to economics- and sociology-based research and theory, innovation policy has benefited from contributions from the academic domain of policy analysis. The political science notion of governance offers a heuristic, denoting the dynamic interrelation of involved (mostly organized) actors, their resources, interests and power, fora for debate and arenas for negotiation between actors, rules of the game, and policy instruments applied (Schön and Rein 1994; Kuhlmann 2001; Benz 2007). The governance heuristic helps to understand the context, options and limitations of public policy; it refers to analytically distinguishable forms of

institutional coordination of autonomous but interdependent actors.³ Hierarchy, competition, network, association and community are such ideal types of governance capturing the rules of a game at a highly generalized level (Hollingsworth and Boyer 1997). In reality, these governance forms are often interconnected, thus forming governance regimes. Actors have to find out how to cooperate with competitors or to compete with partners in networks, to negotiate an agreement under tight organizational constraints or to find approval for the outcome in external arenas in their own organization or group (Benz 2007). In order to also explore the dynamics of emerging new actor constellations and institutional settings we consider it necessary to also analyse 'soft' forms of social rules, not yet frozen into codified regulations. Following Scott (1995) one can conceptualize institutions as sets of rules of a regulatory, normative or cognitive character providing stability and meaning to social behavior, transported by various carriers like cultural patterns or routines. Institutions guide human behavior by (1) utility-oriented rules which may be enforced by coercion ('regulatory'), (2) norm-based obligations ('normative') and (3) immediate participation in taken-for-granted models of reality ('cognitive'); institutions store historical experience in idiosyncrasies guiding the day-to-day action of their members.⁴ This broadened definition of 'institution' implies a notion of governance exceeding the classical definition of political control and steering. Mayntz (1998) identified two even more extensive definitions: (1) 'a more cooperative mode where state and non-state actors participate in mixed public/private networks' and (2) 'modes of coordinating individual actions, or basic forms of social order'. The second definition includes both the classical steering idea as well as network-oriented 'softer' aspects. The identification and reflection of the dynamics and impacts of experiences inscribed in institutions may help to better understand the actual orientations and strategies of corporatist and other organized actors in the actual governance of innovation systems, thereby interpreting governance as an evolutionary social order.

The governance perspective has gained relevance with the increasing inter- and transnationalization (but also regionalization) of both innovation practice and innovation policy initiatives. Increasingly, we see innovation issues being negotiated under conditions of multi-level, multi-actor agency and governance (e.g. Grande 2001; Kuhlmann 2001). Take as an example the various attempts of national or regional governments to launch overarching 'innovation policy strategies' (LEG 2008) In the United Kingdom, a new ministerial department for Innovation, Universities and Skills was established in 2007, bringing together policies on skills, higher education and innovation for the first time, aiming at an integrated approach.

3 The term designates a certain analytical perspective determined to make apparently opaque and over-complicated structures and processes of collective action in the state, economy and society comprehensible. As an analytical tool, the term can be used to describe or evaluate reality' (Benz 2007).

4 I.e. through 'scripts', 'taken-for-granted-rules', or embedded in 'central themes' (Powell and DiMaggio 1991; Lepsius 1995; Scott 1995).

In Denmark, the government adopted a horizontal 'Globalization Strategy', including 350 measures pertaining to the areas of education, research, innovation and entrepreneurship. This strategy has been built up with the involvement of several ministries and a wide range of stakeholders. In 2006 the German Federal Government announced an overarching 'High-tech Strategy', designed as a holistic innovation policy concept. Although the effects of the suggestions and measures of this initiative can be evaluated only after years, the strategy can be characterized as a major attempt of strategic co-ordination at the national level. The initiative consists of diverse measures, including defining areas of competence for the Federal Ministry for Education and Research and the Federal Ministry for Economics and Technology and fostering public procurement for innovation, a 'better' IPR regime, thematic programming, public-private partnership models, venture capital, spin-off activities, cluster financing and increased spending in education.

In short, the holistic concept appealed to policymakers, not least because the systemic perspective provided an argument for a broadened scope and reach of public STI policy (Smits and Kuhlmann 2004). Some have used it as a branding device. For example, the Swedish state office for innovation policy calls itself the 'Governmental Agency for Innovation Systems'. In other Scandinavian countries, and also in the Netherlands and Germany, relevant policy initiatives and agencies draw justification from this notion. Indeed, it turns out that the very concept of innovation systems, while being designed by innovation researchers, was also inspired and strongly supported by Scandinavian policymakers (see Carlsson, Elg and Jacobsson, Chapter 7 in this book) and by the OECD (Lundvall 2007). The concept became 'theory in action'. Of course, our Swedish academic colleagues could have tried to maintain academic distance to the borrowing of their concepts and findings by policymakers and practitioners in innovation – but they chose to 'pro-actively' offer information, heuristics, analysis and theory to advance the policymakers' own theories. In other words, they danced with practice and policy and even jointly composed new melodies, while the innovation system concept served as a 'boundary object' ('fuzzy boundaries distinguishing academic and policy circles allowed for cross-fertilization by theoretical and practical considerations, and this accelerated the spread of the [this] concept', Sharif 2006).

Innovation Practice and Innovation Policy as Dancing Partners

Since the early days of innovation-driven capitalist economic development, 'innovation practice' in companies and private or public R&D labs has evolved in an interwoven manner with public policy. Innovators have asked for and received public financial support, pushed for changes in regulation facilitating the adoption of innovative solutions, and exploited state-guaranteed Intellectual Property Rights (IPR). From the perspective of innovation practitioners, public policy has to be responsive and to adapt to new, innovation-driven needs. This often gives rise to conflicts of interest among economic actors or with organizations representing

societal interests; think of the widespread concerns about innovation based on genetically modified organisms (GMO) and the inconsistent strategies of industries vis-à-vis 'functional food' innovations. Thereby, innovation practitioners may also borrow arguments from innovation research and theory – as societal organizations and public policy also often do. Also, the debates around 'open innovation' and patenting of software products provide a telling example: policy actors have made extensive use of theory-based empirical studies of patenting practice in order to develop strategic policies coping with contradicting industry positions (large software producers versus small open-source software developers; see Chapter 10 by Blind).

At the same time, innovation policy – though with different underlying rationales, institutions, and means across various cultural and national contexts (Hollingsworth and Boyer 1997; Hall and Soskice 2001) – has claimed to 'shape' supportive conditions for innovation-based economic growth and welfare. The above-mentioned adoption of the innovation system concept by many policy-making bodies is a case in point. The normative ambition of innovation system-based policymaking vis-à-vis innovation practice has occasionally been criticized as camouflaging deliberate political decisions into 'natural' and historically 'inevitable' measures (for the case of Finland, see Miettinen 2002).

Following the global financial and economic crisis that started in late 2008, the interaction between innovation practice and innovation policy as dancing partners is likely to become even more complex: practitioners are calling for more supportive innovation conditions, and there are broader pressures to foster sustainable economies through innovation. Policymakers may be preoccupied with immediate pressures to rescue financial institutions, housing markets and industrial companies, to address joblessness and to postpone tighter environmental regulations, even as they recognize the importance of innovation as a driver of renewed economic growth. It remains to be seen how innovation theory can adapt to this changed situation. Just as there has been a resort to Keynesian theory to justify deeper public borrowing and spending to address the macro-economic slump, there may well be a revival of interest in Schumpeterian arguments about the role of innovation in overcoming downturns in business cycles. But these are old ideas. A challenge for innovation theorists will be to critically contribute new ideas and analyses to the formulation of strategies and practices for innovation in and beyond the present period of economic duress.

Summing up, one can ask how distinct the identities of the three dancers actually are. Although at first sight industry, academia and the politico-administrative system appear clearly different in terms of membership, constituency, relevance criteria and reward mechanisms, taking a closer view one would face a more blurred picture. Innovation practice, for example, extends far beyond classical industrial innovation and includes socio-technical or organizational innovation in public services (such as health), thus overlapping with the sphere at public policy (though not the playground of classical innovation policy, hence hinting to domain and governance issues inherent to the public sector). Also, the spheres of innovation theory are in

relevant instances closely interwoven with the realm of public policymaking, with key figures developing their careers across both fields. Examples of this include the functioning of OECD as a social organization, or the development of the innovation system approach in Sweden (see Chapter 7 by Carlsson, Elg and Jacobsson), both providing exciting cases of blurred borders between dancers. Hence, while the distinction of three dancers is useful, their roles, identities and relations may change and overlap, and the intensity and nature of interaction varies over time. The chapters in this book provide more detailed evidence about the dynamics of these relationships.

A THEMATIC INNOVATION POLICY HANDBOOK

This book combines attributes of a classical handbook and a thematic book. The book does not seek to provide an all-encompassing review of the state of the art of innovation policy, practice and theory. Instead we have tried to present a coherent, theory-based vision of the interrelated dynamics of innovation policy, practice and research. The handbook elements provide the reader with an updated overview of dimensions, concepts and challenges of innovation policy from a systemic perspective. The thematic discussion revolves around the mutual learning between three 'dancers': innovation practice, innovation theory and innovation policy, the last being the focal aspect of interest.

The first part of the book examines some basic driving forces of innovation practice, theory and policy – in a way the background music of the innovation policy dance. In his chapter, Martin addresses open questions in the context of changes in the modes of knowledge production and the emergence of new policies and institutional configurations for facilitating border-spanning research collaboration and increasingly science-based innovation. What are the consequences for the 'innovation systems' concept and for the role of public policy? And do we have the necessary 'holistic' policy instruments required for effective, integrated science and innovation policy, and for overcoming the main types of policy failures? Dankbaar and Vissers consider the changing role of the 'firm' in innovation processes and the way this has been reflected in academic literature. Processes of differentiation and specialization, requiring new organizational capabilities, have affected innovation, like so many other activities. Thereby interactions between theory and practice are not simply processes of mutual reinforcement: experiences made in one company, one sector or one country lead to concepts and understandings, which are then applied to completely different companies, sectors and countries. Theory then becomes a force for change and innovation of its own right. Smith explores data and recent trends in globalization, and the background to these trends in policy decisions over the past three decades. He argues that the combinations of liberalizing economic policies and new international institutions have created an environment in which far greater economic interdependence now exists. In many areas, including innovation,

it is claimed by many that the new economic environment constrains or prohibits independent policy action by government. Smith argues that this is not so. The key point about innovation policy is that, properly conceived, it affects the structure and operations of the innovation system – that is, the system of institutions and organizations that shape the behaviour of firms.

The second part of the book focuses on the conceptual evolution of the systems perspective as a result of various innovation policy dance configurations. In so doing three major flaws currently associated with this approach (too static, no policy consequences, the role of actors on the micro level) are highlighted. In 1987 the Swedish National Board for Technical Development (STU) invited a group of Swedish scholars in economics, engineering, management and sociology to do a joint study of 'Sweden's Technological System and Future Competitiveness'. In their chapter Carlsson, Elg and Jacobsson trace how that group – in interaction with policymakers – improved the understanding of the structural components of an innovation system, how such systems are formed, and how the development processes vary between specific systems. Chaminade and Edquist explore the implications of the adoption of the innovation system approach for public policy (what to do, when and how to do it), more in particular they discuss the rationales of innovation policies when this approach is adopted. They compare the basic assumptions of the neoclassical and evolutionary-systemic theories and the implications of the adoption of one or another for the rationales for public intervention. The next chapter builds on the preceding: Bergek, Jacobsson, Hekkert and Smith investigate the 'functionality' of innovation systems as a rationale and guide in innovation policy. They offer taxonomy of system functions, as a step towards an understanding of how systems affect innovation. Furthermore they suggest that functions of a system can form a framework for understanding and shaping both the foundations and content of policies in support of innovation.

As innovation policy covers in our understanding a very broad range of targets, instruments and areas of application the third part of the book deals with an inevitably heterogeneous variety of ongoing and new issues. In his chapter, Shapira addresses the relationship between innovation and small and midsize enterprises (SMEs) as a longstanding and central issue of innovation theory and policy. In particular he looks at the relationships between innovation system dynamics and policy strategies for promoting innovation in SMEs as an important mediating mechanism that policymakers use to understand innovation dynamics.

The next two chapters deal with the options various regulatory policies provide for the support of innovation. Blind offers an overview of types of regulations and their ambivalent impacts on innovation, and a new taxonomy of product market regulations. The role of product market regulations with respect to various functions of innovation systems is also discussed. Graham's chapter examines the role of regulatory policies for innovation, focussing on a specific case of the co-evolution of intellectual property (IP) protections and innovation policy within the context of a particular IP institution: the 'continuing' patent application procedure in the United

States. The continuation procedure allows a US patent applicant to postpone the issue of a patent, affording inventors several strategic opportunities, among which are delay and secrecy.

There has long been a relationship between civil and military innovation. Yet, the separation between military and civilian innovation systems has not always been so clear-cut. Different technological, economic and political environments have co-evolved with changing policy perceptions and interventions. Molas-Gallart explores the evolving relationship in his chapter, focusing on the experience of the US and some Western European countries since the Second World War and the systemic shifts now occurring since the start of the 21st century. He argues that the sharp distinction between military and civilian innovation systems is starting to fall apart. Mutually interdependent changes in technology, the political and security context, and innovation policies are leading to a new, more complex and integrated, innovation system. Edler addresses an area of innovation policy that in recent years has (again) attracted the attention of policymakers: demand-oriented innovation policies, defined as public measures to induce innovations or speed up the diffusion of innovations through increasing the demand for novel applications, defining new functional requirements for products and services or better articulating demand. Edler offers a policy typology and gives an overview of recent empirical developments. However, he also highlights severe governance challenges that set limits to demand orientation in innovation policymaking.

Den Hertog draws the reader's attention to the growing relevance of innovation in the service sector: he describes a slow but steady process in which new views on the transformation to a service economy and its implications for state-of-the-art innovation practices, innovation research and statistics and appropriate (innovation) policy interventions were exchanged. Service innovations were analyzed in more depth, new theories and typologies introduced and new statistical indicators introduced. An increasing number of firms realized that managing technological innovation needs to be combined with managing service innovation and some of these were looking for more formalized knowledge on how to accomplish this. In some countries innovation policymakers started to explore new, more service-friendly innovation schemes.

So the range of targets, instruments and areas of application of innovation policy has become very broad. Boekholt shows in her chapter the evolution of innovation-related policy instruments. In the 1950s until the 1970s there were two separate systems (the science policy system and the industrial policy system) that each followed different dynamics. The concepts of technology policy and later innovation policy emerged only in the late 1970 to mid 1980s. The first generation instruments clearly showed the characteristics of 'linear model thinking' and focused for instance on technology transfer, e.g. bringing inventions and technologies from the shelves of the laboratories to the manufacturing plants of industry to be transformed into innovations. In the 1980s, influenced by conceptual thinking about the interactive chain link models and the many feedback loops between science, strategic research,

applied research and the market, gradually more sophisticated bridging and networking policies were developed. The innovation systems approach, finally, became accepted as a useful analytical model for policymaking around the turn of the century, although first only in a small number of countries. Today it is more widely accepted but at the same time its practical use as a guidance for now well policy instruments can be designed is limited. In recent years the debate has shifted towards the definition of 'holistic' and 'horizontal' policy approaches where different policy domains coordinate the strategic approach to tackle specific issues.

The final part of the book looks ahead, identifying new dynamics in the innovation policy dance partly as a consequence of mutual learning, partly due to changes in the external environment ('new music'). By focusing on economic development, innovation systems research has contributed to the debate on how to reduce inequality between nations and also regions. Innovation systems research, however, has not given much attention to another dimension of development, namely, inequalities between individuals, households, or groups, as Cozzens shows in her chapter. A lack of a perspective on the role of individual actors in innovation systems is one of the major flaws of the innovation systems approach. This chapter attempts to fill that gap. Econometric studies have shown that income inequality within countries hinders economic development, and ethnic fragmentation has also been demonstrated to do the same. Such studies reflect the human reality that inequalities place barriers in the path of using innovation for development and keep it from achieving everything it could. We cannot have effective theory, policy, or practice in this area without addressing these issues.

The systemic character of innovation in general and the requirements of the 'innovation policy dance' in particular increase the actors' need for information enabling them to engage in innovative activities in an adequate and effective way. In this handbook this information is conceptualized as Strategic Intelligence (SI); actors involved in innovation require it to develop their visions, strategies and plans of action. Apart from this 'instrumental' role, Smits, van Merkerk, Guston and Sarewitz argue in their chapter that SI helps to reflect on the development, interaction and effectiveness of innovation theory, practice and intervention. By this, SI provides an important input in the further development of these three concepts. The chapter concentrates on one particular strand: technology assessment (TA).

All the chapters of this book show that although innovation studies have made advances over the last two decades, the prevailing innovation systems approach has some major flaws; in particular it is still conceptualized much in too static a manner. The dynamics of the 'innovation policy dance floor' are hardly reflected by the concept. Smits, Kuhlmann and Teubal argue in their chapter that one should differentiate 'strategic policies' dealing with radical changes in policies, setting up new interfaces and arenas requiring broad processes of consultation and strategic intelligence to support this, against on the other hand 'systemic instruments' that are only meaningful in a systemic and co-evolutionary perspective in relatively steady development stages of innovation systems.

Finally, the editors conclude the book by offering an overall summary and outlook (Chapter 18). This chapter notes that the concept of innovation policy as a systems-oriented activity is gaining ground and that the importance of one of the three dancers – theory – vis-à-vis the other two is growing. This requires researchers to take another role: they can contribute to reinforcing learning processes between the three dancers from a systems perspective. Here, encouraging more ‘hybrid actors’ – people and organizations who can serve as bridges and intermediaries between sectors – is likely to be useful. There is also a case for related changes in our educational systems related to science, technology, management, organizational and public policy, developed in the perspective of a long-term innovation agenda. This should assist both policymakers and practitioners in pursuing such agendas and in customizing them to best suit their own innovation system circumstances. Enhancements in strategic intelligence infrastructures and greater support for reflexivity and deliberation about innovation policy and practice are also important. There is a relationship between means and ends: we suggest that through such investments in the processes and tools of innovation policy, practice and theory – and by strengthening interactions and learning relationships among these three domains – then tangible steps forward can be made along the journey of building knowledge-intensive, equitable and sustainable economies.

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