18. An Outlook on Innovation Policy, Theory and Practice

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INTRODUCTION

Innovation – especially innovation aimed at turning scientific and technological potential into successful products, services and solutions – has risen up on the agenda of both developed and emerging economies over the past three decades. Structural changes in the world economy, including the growth of low-cost yet capable production locations in Asia and elsewhere, have forced advanced countries to shift increasingly away from cost-based competition to strategies built on added value. R&D and knowledge-based innovations are at the core of strategies to sustain economic leadership positions in an era of international markets and at the same time offer the promise of solutions to broader societal and environmental problems that, in turn, may stimulate further economic opportunities.

These transitions in corporate and national strategies have been accompanied by parallel shifts in approaches to the innovation process and to innovation policymaking. The linear pipeline of R&D leading through to the manufacture and marketing of new products has given way to models of innovation that draw on broader sources of knowledge and network linkages and which have a wider array of outcomes, including innovations in organizations and business models as well as products and process. Similarly, older policies which emphasized public R&D spending have been succeeded by systemic approaches to policy that seek to address the multiple factors, institutions and relationships that influence innovation performance. It has been recognized that R&D investments alone do not suffice to improve the innovative capacity of economies and societies. Policies also should strive to improve the conditions in the environment – the innovation system – in which firms and other actors are operating. Crucial to advancing this system is an iterative learning process between policy, theory and practice – what we called the ‘three dancers’ at the beginning of this book.

In this last chapter, we focus on changes in the relations between these three dancers and consider some of the consequences of these changes. The chapter is structured as follows. First, we review the major goals and opening points of the

book and synthesize important trends in the wider world influencing the relation between policy, theory and practice. In the next section we then discuss some major observations about changes in the relation between the three dancers. These observations constitute the basis for conclusions and recommendations in the last section.

STARTING PROPOSITIONS REVISITED

The central theme of this book has been the interactions between policy, theory and practice of innovation. In so doing, we have targeted three major goals. First, to improve and update our understanding of the interactive relationships between innovation policy, theory and practice. Second, to search for options that can improve the added value, effectiveness and efficiency of policy and innovative practice. Third, to offer critical perspectives to inform ongoing discussions about the dynamics of innovation systems and related policies, as well as to generate questions that can guide future research.

In the first chapter of the book, a number of starting propositions were put forward. The following discussion reflects on these, taking into account insights gained from subsequent chapters.

Our first proposition was that innovation should not be perceived as a free-standing linear progression but rather as a complex multi-actor game taking place within a system of institutions, conventions and associations. Analyses of how innovation is influenced by the interplay of institutions and multiple actors have proven to be insightful in retrospective studies of the development and adoption of particular innovations. For example, Hargadon and Douglas (2001) detail how Thomas Edison's design and development of an innovative electric lighting system in New York at the end of the nineteenth century was influenced by a series of mediating economic, social and political institutions and organizations. Similarly, institutional and multi-actor perspectives have been engaged to understand the emergence of the military-industrial complex in the US and its impact on the development of new weapons systems, university innovation and the relationships between military and civilian innovation (Baack & Ray 1985; see also the chapter by Jordi Molas-Gallart in this book). Most importantly from the standpoint of this book, the innovation system heuristic has been increasingly adopted in recent years by policymakers and their advisors as an operational framework to rationalize and target government interventions (see for example Popper & Wagner 2002; OECD 2005; DIUS 2008).

Of course, analyzing the socio-economic and institutional relationships that influence innovation through the use of a system heuristic is not an entirely new idea. Lundvall (2007) reminds us that systemic socio-technical perspectives on innovation can be traced back to Friedrich List's 1841 notion of national systems of productions, as well as to Adam Smith's late eighteenth century observations

about modes of learning, Karl Marx's mid nineteenth century writing about the relationships of technological progress, and Joseph Schumpeter's early-to-mid twentieth century insights into the dynamics of the innovation process. Yet, it is only since the late 1980s and 1990s that the concept of innovation systems has fully entered into innovation policy thinking and practice (as discussed by Chaminade & Edquist in this book). This development has been stimulated not simply by academic revival or advance, but also by real changes in underlying conditions for innovation. These include such factors as globalization, the rise of networks, the more open character of innovation, the complexities of relationships with public organizations and intermediaries, internal organizational changes, the growth of multi-disciplinary problem approaches, and greater recognition of the role of multiple market and institutional elements in influencing innovation – all of which have prompted private and public actors to re-conceptualize the innovation process in systematic terms.

As several of the chapters in this book have observed, innovation systems are not fixed and clearly delimited. As in all systems, boundaries are more or less porous and are moulded by the nature of innovation processes and their actors and relations, and by broader contexts including hard and soft institutions, markets and governance, and political, social, cultural and regional conditions. While there is naturally an ongoing search for patterns and commonalities across innovation systems, there is always a need to be conscious of the specificities of particular systems (especially when trying to transfer perceived 'best practices').

Ironically, even with the growing acceptance of multi-dimensional innovation systems approaches, the linear model still persists. Boekholt (in this book) points out that many innovation policies and instruments are still predicated on linear models of basic research followed by applied research leading to development, production and diffusion (Godin 2006) and that such models are retained and are active in the cognitive maps of the innovation process used by numerous policymakers (see also Boekholt et al. 2001). Why the linear concept endures is worthy of fresh research. Indeed, there is an argument that the linear model of innovation (albeit in a weaker form or in certain sectors such as pharmaceuticals) still has applicability (Balconi et al. 2008). Moreover, despite justified and important work in highlighting the contributions of organizational and non-formal (or hidden) modes of innovation (Damanpour 1991; NESTA 2007), it should not be concluded that science and technology no longer play important roles in innovation. Advances in – and application of – science and technology are the central sources of many innovations. Yet, even in these cases, the innovation systems approach indicates that science and technology may be necessary prerequisites while there are numerous other aspects that must be taken into account for an innovation to succeed. Moreover, the systemic approach stresses that that to become innovative, the capacity to exploit knowledge – from here and there, from now and then – is often as important as the ability to produce new knowledge. This observation has become arguably more relevant over the last decade as East Asian countries like China and India have rapidly developed their technological capacities by drawing, in large part, on knowledge transferred or

acquired from Western countries. However, these countries are growing not only through knowledge acquisition but also through the related hand-in-hand building up of their own technological and innovative capabilities.

The second proposition of this book is that there are mutual interactions between practices, policies and theories of innovation. We do not want to state that these three domains co-evolve, since such a statement could provoke inappropriate comparisons with biological phenomena by suggesting that change in one sphere directly triggers change in another. Rather, we observe that changes in the relationships between the three domains are frequently mediated or bridged by learning processes. For example, in the 1980s, the realization by practitioners and policymakers that increased R&D investments were leading to disappointing results stimulated theoretical interest in and adoption of innovation systems approaches (OECD 1991). In the 1990s, the innovation systems framework provided the context for many countries and regions to develop innovation cluster policies, spurred by concepts developed by Porter (1990) and others (including Saxenian 1994; Rosenfeld 1997). In the current decade, innovation systems approaches are being augmented by a new corporate and policy interest in open and networked innovation strategies (Chesbrough 2005). In these examples, several different types of learning processes have been engaged to transfer insights from one domain to another. These include learning by doing and using, complemented by interactive exchange between policymakers and practitioners; learning by searching and comparison, where ideas are interactively communicated between innovation scholars and policymakers, with scholars in turn translating these experiences into new theories and insights.

One important conclusion from this is that the stimulation of conditions favourable to a variety of types of learning processes constitutes a crucial element of innovation policies. In this book, many examples of such learning processes have been discussed. Significantly, less attention has been paid to formal learning processes as they take place in our education systems. We accept that most learning and exchange about innovation processes occurs through informal means. Moreover, public policies for innovation typically focus on horizons that are shorter in term than educational policies and are administered by different agencies. There has been movement in recent years at the level of higher education to develop innovation missions in universities (Youtie & Shapira 2008). Explicit attention is also being paid at national and regional levels in several countries to the policy mix for innovation, to better align streams of policymaking including education and training, as well as other policy areas which influence innovation (Flanagan et al. 2008). Still, it is noticeable that the alignment of educational and innovation policies continues to be a difficult challenge, reflecting institutional rigidities and conflicting goals. This reminds us that structural divides can intervene in the relationships among innovation practice, policy and theory. Sometimes not all of the actors are in step, for example when administrative responsibilities for different aspects of innovation are inevitably divided among agencies for research, enterprise, universities, secondary education and finance, resulting in fragmented policymaking with

limited coordination (Braun 2008; Edler & Kuhlmann 2008). Similarly, disciplinary divides and competing perspectives are common in academia, which can be hard for policymakers and practitioners to sort out. Even when there is shared will among multiple stakeholders, for example to better link educational policies with innovation objectives, system construction may itself limit the effectiveness of implementation. These barriers may be self-reinforcing and hence limit the likelihood of breakthroughs in innovation performance, as suggested by path dependency theorists (see discussions in Fuchs & Shapira 2005).

Building on this review of our major starting points, we now turn to trends in the wider environment of innovation systems and processes that are of particular importance for the relationships of the three dancers of theory, policy and practice.

TRENDS IN THE INNOVATION ENVIRONMENT

The development of innovation theory, practice and policy is intrinsically linked to and influenced by trends in their environment. Some of these trends have a more general character; others are more specific for one of the three dancers. Many of these trends have already been discussed in detail in the chapters of this book, including developments in systems of science and knowledge production (Martin), the influence of increased international competition (Smith), broader changes in the organization of firms (Dankbaar and Vissers), and evolutions in policy governance (Smits, van Merkerk, Guston and Sarewitz).

We anticipate that internationalization and globalization will continue to become one of the most dominant trends that impacts all three dancers (Archibugi et al. 1999; Narula 2003; Edler & Polt 2007). There has been a dramatic rise of Southeast Asian countries, particularly China and India, as internationally-competitive producers of new knowledge and sites for innovation (Lundvall et al. 2006; Zhou & Leydesdorff 2006; Altenburg et al. 2008). Brazil is among other fast developing countries likely to enlarge global roles in innovation in the coming period (Cassiolato et al. 2003), while Russia has immense potential to do so (Gianella & Thompson 2007). These nations are now participants in the international innovation policy race, and in the near future others will possibly join them. While these new dynamics refer to 'nations' it is also appropriate to consider what might be the future role of nation states in innovation systems. More than ever, technology and innovation related producer-user chains are working either 'local' (within clusters, districts and other agglomerations) or 'inter-local', including inter- and transnational networks: they are often less rooted within 'national' economies and institutions. Similarly, in many thematic innovation domains tacit knowledge is getting embodied and institutionalized (in people, rules, organizations) either 'locally' or 'inter-locally' (with – often web-based – collaboration and through growing international migration of knowledge workers). The locus of tacit knowledge is less and less

'national'. Globalizing firms and their research and development, universities and other research organizations have become international actors.

These ongoing globalization trends reinforce demands on OECD countries not only to enhance domestic innovation capabilities, but also to improve their capacities to access and exploit worldwide knowledge pools. Moreover, pressures are also increased in advanced economies to stimulate innovation strategies that can maintain an edge, for example approaches that develop close relationships with innovation users. As a consequence, new actors have to be involved in innovation processes, adding to the complexity of innovation processes. For example, innovation users often have distinct interests and knowledge as compared to traditional scientific and corporate innovation producers. New relations and related learning processes have to be constructed. This increased and intensified involvement of users can be perceived as another motor behind the trend towards more open innovation systems and processes (Oudshoorn & Pinch 2003; Boon et al. 2008). Another consequence of internationalization concerns the organization of the value chain. The international restructuring and relocation of R&D, production and marketing functions greatly impacts the organization of innovation processes in home countries (whether through the sending or receiving of these functions). This presents further challenges for policymakers and innovators, who increasingly need to recognize international dimensions as they formulate their own strategies. Improving insights about the internationalization of innovation and its consequences in turn is one of the major challenges for innovation scholars.

As we complete the writing of this chapter (in late 2008), a dramatic new twist in global economics appears – that of massive crisis and upheaval of financial systems. It remains to be seen whether this will generate an international economic recession that, while deep, can be turned around in one to three years, or a longer slump that will require up to a decade for recovery. Irrespective, there are many implications for innovation. On the one hand, with credit squeezed, demand down and uncertainty about the future, many companies (large as well as small) face retrenchment or collapse. In this environment, corporate R&D investment and projects for new products and services are greatly at risk. Increased government regulation is apt to affect innovation in the financial sector. Yet, from a longer-term view, as Joseph Schumpeter observed almost a century ago, innovators can take advantage from downturns in the business cycle, and upturns in growth can be aided at least in part by innovation. In November 2008, entries such as 'Innovation Loves a Crisis', 'Crisis Could be Right Time for Innovation' and 'Crisis, the Mother of Innovation' were being posted in entrepreneurship web blogs. Much of this is surely wishful thinking. Yet, as policymakers move through their first (and massive) tranche of emergency measures to shore up banks, address mortgage defaults and free-up credit, they can at some point be expected to turn to ways of regenerating growth and stimulating innovation. Again, there will be opportunities for innovation thinkers and practitioners to contribute to debates with policymakers about how best to do this.

Sustainability presents one of the most prominent opportunities for linking innovation not only to economic growth but also to environmental, social and developmental challenges. Attention to sustainability has indeed been a growing trend in the innovation domain (Meyer-Krahmer 1997; Elzen et al. 2004; Lehmann-Waffenschmidt 2007; Murphy 2007). We expect that policy demands and measures to address sustainability will have even greater influence on innovation in future years, just as innovators themselves focus on opportunities to address needs and demands for low-carbon, high-value products and services. In the US, the incoming Obama administration has pledged to invest \$150 billion over ten years to support clean energy initiatives. To be effective, this initiative requires innovation across a spectrum of sectors, from automobile manufacturing and energy production to housing and recycling. Moreover, frameworks and incentives for sustainable innovation will be required. Other countries are implementing similar policies. However, as policies and programmes for sustainability become widespread, tensions will increase between proponents of a more sustainable society and those in favour of economic growth – indeed, the global economic crisis will amplify these strains. Here, linking sustainability with innovation could play an important role in bridging this gap. As perhaps the lack of attention to sustainability in this collection indicates, there are needs and opportunities for innovation scholars to more fully engage with this trend.

A more general but related trend concerns the need for sectoral transformation in major components of Western economies, and the time required to implement these changes. The challenges of heightened international competition and sustainable development generate both push and pull towards smarter and greener products and services. These processes of change involve fresh and more intense knowledge needs and new relations with different actors – which in turn can have profound impacts on the set-up of existing innovation systems (see den Hertog in this book). The following example illustrates the seriousness of these impacts. As was described in the chapter by Smits, Teubal and Kuhlmann, the Dutch agricultural sector has for many decades been successful through a knowledge-intensive but mass production approach. It is an approach with high environmental impacts. In the future, the sector is challenged to shift to more environmentally-friendly methods of production. This may only be possible by restructuring the Dutch agro innovation system from a supply-side oriented, top-down system producing for homogeneous markets to a bottom-up oriented system with close links to varied set of users and with fresh approaches to product, process and service innovation. In fact, the shaping of this new system, including the reshaping of policy instruments, institutions and actor roles and relations has been going on for some 10-15 years and is expected to go on for at least the next decade. This demonstrates the time and effort necessary to both break down and build up new innovation systems. It also puts in perspective the time horizons and resources that policymakers need to commit to see through major changes in sectoral innovation systems.

Trends impacting more specifically the innovation practitioner include the ongoing development of current technologies in such fields as computing, electronic networking and communications, and the emergence of new technologies like genomics or nanotechnology with a broad array of possible applications. Also to be addressed are challenges of increasing international competition, the drive to force firms to produce products and services with higher added value, changes in the nature of the research system and its relations with the outside world, market and regulatory uncertainty, and demands for sustainability. These trends have important consequences. Firms often have to develop more intense and stronger interfaces with a growing set of heterogeneous innovation system actors demonstrating new demands. An important consequence of the increased competition for 'added value' is that mature and small-mid-sized enterprises (SMEs) outside of glamorous high technology industries have to improve their innovative capacities (Hirsch-Kreinsen et al. 2005). Over the last decades many policies have been developed to stimulate innovation in SMEs (as Shapira notes earlier in this book). Those efforts which have tried to promote the take-up of innovation from outside (for example, through technology transfer) have not had great impact on most SMEs. In the future these firms will be forced to develop their innovative capacities from within. Employees with adequate qualifications and management capable of exploiting the knowledge and creative potential of employees are necessary preconditions. In order to increase the added value of their products and services firms have to develop new relations with knowledge institutions, knowledge-intensive business services or intermediaries in between in which they position themselves as demanding clients and no longer as passive receivers of knowledge.

Driven by the challenges of international competition and the rise of major societal problems like sustainability, policymakers experience great pressure to develop policies to contribute to an environment that facilitates firms to innovate and to take the lead in developing innovative solutions for societal problems. As Keith Smith (in this book) rightly observes, internationalization does not necessarily minimize the role of national/regional public innovation policy. He argues that innovation system elements such as those for knowledge infrastructure, risk management and education are 'largely independent of the constraints of globalization' and that they 'remain open to discretionary policy strategies'. However, many current strategies and policies are obsolete or ineffective. Policymakers are challenged to change their mindsets and develop new, more systemic policy concepts and instruments. The heritage of old mindsets as well as the far more complicated nature and long-term orientation of the systemic approach can cause many problems.

Although the systemic approach has gained broad support in circles of innovation scholars, the consequences for policy are still rather unclear. One of the major reasons for this is that the approach has often been a static one. Research into the dynamics of innovation systems and in the emergence of new systems is still relatively recent. Also insights about various types of learning, a crucial element of innovation systems, have often not found their ways into policy implementation.

These trends put pressure on scholars to invest more in strengthening the systemic approach in such a way that these dynamics are taken into account, the role of various actors is better understood and ideas are developed for instruments that are better able to deal with the systemic character of innovation processes.

POSITIONED TO INFLUENCE CHANGE?

The concept of innovation as a systems activity is gaining ground among a broad range of actors. Various actors take the systemic character of innovation processes into account in their actions and policies. Reasons for this include the influence of conceptual and empirical research which, as clearly demonstrated, has broadly the systemic character of innovation processes (beginning with landmark works such as Freeman 1985; Lundvall 1992; Nelson 1993; and continuing with subsequent research as discussed in several chapters in this book). This has been complemented by business-oriented research from authors like von Hippel (1988), Porter (1990) and Chesbrough (2005) who have provided influential models of innovation within systems of multiple producers, users, knowledge sources, and networks. Other push factors have included disappointment with the outcomes of more linear-based policies, financial, market, technological and strategic pressures which have stimulated firms to enter into more open types of innovation, and changes in the range and role of actors, intermediaries and institutions in the innovation process. These forces have all reinforced the point that innovation has a systemic character.

The observation that actors increasingly adopt a systems approach to innovation may seem obvious. However, although innovation always has been a systemic activity, for much of the post-World War II period, there was a perception that innovation was a straightforward supply-driven process that could be best influenced through public policy by investing in public R&D. This perception influenced not just policymaking but the allocation of public resources, tilting them to support the expansion of R&D in universities and national laboratories. This perception now seems to be waning. In part, this has been through the impact of innovation scholars – who were once marginal but who are now more engaged and drawn upon in deliberations by policymakers, research managers, industrialists and other stakeholders. We need to be cautious in over estimating impact. Many scholars are still bounded by conventional disciplinary boundaries and canons (for example, micro-economic theories of market operations are still often taught with knowledge and technology as exogenous variables). Yet, as demonstrated by the chapters in this book by multiple authors from different disciplinary backgrounds and countries, the embracement of systems approaches to innovation by scholars has become widespread.

The question thus arises: how well positioned is the scholarly innovation community to respond to emerging challenges in the innovation environment and system? Strength is found in the cumulative build-up of knowledge and the testing

and validation of concepts about innovation systems that has occurred over the past two decades. Moreover, there is opportunity in that the increasingly complex and interlinked innovation problems that policymakers and practitioners face demands coming to grips with the systemic nature of innovation. However, there are weaknesses too. There are many different versions and perceptions of the theoretical concepts put forward under the systems of innovation umbrella. Furthermore, one should not be over optimistic about the role of scientific research in policymaking and practice. The gap between theory and practice can be a difficult one to bridge. In the field of innovation studies, there are even more reasons to take a critical stand on the relation between research and practice. Often theories are developed in close interaction with policymakers and other actors. By it is not surprising that these actors often wholeheartedly receive results of research. Often actors accept the results because they were part of their production and they are familiar to them instead of basing themselves on rigorous (scientific) evaluations. Moreover, these co-produced researches are rather context- and time-dependent. Attempts to transfer and apply them as 'best practices' in other contexts often fail.

OUTLOOK: HOW MIGHT THE DANCE PROCEED?

What now can be gleaned about how the dance between innovation theory, policy and practice might proceed? In this section, we explore issues and options related to each of these three domains and how they relate to the others. We make no claims to be exhaustive, rather focus on what we see as pressing and interesting issues for engagement.

Innovation Scholars and their Links with Policy and Practice

From the foregoing it is clear that innovation scholars (can) play an important role in the further development of innovation policy and practice. Innovation scholars are important as producers of the resources learning processes need and at the same time play a role in these learning processes. They can contribute more to these learning processes between the three dancers by focusing on the improvement of insights in the systemic character of innovation. In doing so they could focus on three major flaws of this approach: the still too static nature of the innovation systems approach, the underdeveloped insight in the role of actors at the micro level, how they are framed by the system and – in turn – impact on the system and the consequences for policy in terms of concepts, strategies and instruments. Attempts to tackle these problems already are visible (in several chapters of this book, including Smits, Teubal and Kuhlmann), but still a lot more has to be done before this approach provides results that may help policymakers and practitioners in their daily work. With this we do not want to suggest that all innovation scholars should focus on improving the innovation systems approach. What we want to stress is that scholars dealing with

innovation should be aware of the fact that innovation is a multi-actor, multi-level game to be studied in an interdisciplinary context. Bearing this in mind, focused research on more isolated aspects of this system is of course necessary too.

The innovation systems approach is not (fully) in line with the role of a researcher as an objective outsider only. Until now, researchers dealing with innovation often take rather different stands regarding their involvement in real life innovation and policy practice. Sometimes the links between research and policy are too strong, preventing objective and sound research results. Sometimes, however, researchers do not want to get involved at all. For example, some scholars in the field of science, technology and society (STS) decline to work directly with policymakers or firms. STS started as a movement focused on the better embedment of science in society but over the years STS has become transformed into an academic discipline (Hackett et al. 2007). In its wish to get accepted by the scientific community, STS closely adhered to academic rules. This resulted in a distant, reflexive position. Over the last decade, however, it has become clear that STS cannot maintain this position and at the same time still take its original mission seriously. The need for contributing to and facilitating of learning in various forms sometimes makes a closer interaction with other actors necessary. To contribute to learning processes, researchers more often should take a deliberate and at the same time transparent role as a knowledge-intensive business service stimulating the transfer of relevant knowledge, if necessary translate this knowledge to make it useful for other actors and assist in articulating the demand for knowledge. In the chapter of Smits, van Merkerk, Guston and Sarewitz in this book, this information was called 'strategic intelligence'. The interaction with practitioners and policymakers that results from this role in turn will provide scientists with (often tacit) knowledge on the dynamics of innovation processes and the impact of policy interventions. Of course such a more active role may threaten the objectivity of the research. However, certainly in this multidisciplinary and problem-driven field, objectivity almost always is an unachievable goal. Instead of striving after absolute objectivity a more promising, and from a scientific point also acceptable, strategy would be to make the involvement of researchers as transparent as possible. Furthermore, to avoid tangling and disguise of interests, it will be necessary to reflect on the code of conduct of science and take care that this code of conduct is followed.

Adopting and shaping such a role will not be easy and will meet fierce resistance. The rules of the academic world reflected in the peer review system even force scientists away from engagement with practice. This of course is of extra importance for a young discipline such as innovation studies that has not yet acquired a broadly recognized position in the academic world. However, given the many attempts we see nowadays to stimulate science that is of high quality and at the same time relevant for society (see chapter by Martin in this book) and the examples presented in this book of the importance of mutual learning processes between science, policy and practice, adapting this new role might be considered one of the major challenges of innovation scholars. There is, meanwhile, encouraging evidence that explicit

'Science, Technology, Innovation, and Policy Studies' (STIPS) are turning into a self-standing field of academic reputation, education and research, with relative stable international networks, a number of accepted scientific journals, and regular conferences. An international community of STIPS has to facilitate complicated learning processes involving building bridges between worlds with rather different cultures, practices and reward systems. Also, STIPS would increasingly have to include both subject areas and colleagues from the 'non-OECD' world.

To stimulate this learning process it could be helpful to involve 'hybrid' actors. By this we mean people who work in more than one of the three domains, for instance scientists who become policymakers, consultants or entrepreneurs, entrepreneurs that became policymakers or policymakers turning back to academia. These hybrids experienced the differences between these worlds in their daily life and can provide valuable advice how to deal with them.

Policymakers and their Roles in the Innovation System

Policymakers – although they often advocate the systemic approach – still often rely on the linear model when developing policies and policy instruments. The lack of useful and practical insights from innovation scholars may be seen as an important reason for this. However, in changing the dance policymakers too have an important role to play. First, a more systemic approach as discussed in this book meets a couple of important blockades in the policy system. Systemic policies ask for horizontal policies cutting through well-defined and fiercely protected policy domains. A systemic policy approach requires – in principle – a global perspective, exceeding national borders and constituencies. Innovation actors *and* policy actors get embedded in complex international governance structures, driven by policy mixes and diverse actor strategies on multiple levels. Still, at the same time, national policymakers remain in charge of national budgets as (still) the major source of public investments in research and innovation; also national polity provides democratic legitimisation (legislation). Policymakers at all levels still frame their policies in a national systems perspective, firmly embedded in the political accountability of their national level. Existing international organizations are not yet sufficiently aware of upcoming common problems. Coordination mechanisms are still poorly defined, and truly global programmes are still odd exceptions; this holds in particular for non-OECD countries.

Also the short-term rhythm of our political systems provides problems given the long-term orientation of systemic policies. These are problems that cannot be solved by the other two dancers. A next problem policymakers have to solve is the problem of de-learning. The popularity of the linear model not only is caused by the lack of practical alternatives, it also reflects the tendency of bureaucratic organisations to segmentate interlinked fields of action in order to minimize the span of control and responsibility.

Even if one could suppress this mechanism, the shaping of systemic policies remains difficult. The first element concerns orchestration and long-term strategies. Strengthening the innovative capacity of economy and society asks for choices and a long-term orientation. Government could play a role here as an orchestrator stimulating, and if necessary organizing, the debate in (sectors of) our society on long-term innovative strategies. Broadly based and accepted innovation agendas may help to reduce the many uncertainties inherent to innovation and bundle forces necessary to survive in an ever more competitive world. The UK Foresight programme provides a rather successful example of such a guiding role of government and also countries like Finland, Japan and Taiwan recently developed such strategic initiatives. A second element relates to learning. The learning capacity is central to a high quality innovation system. As was demonstrated in the foregoing, the learning processes of and between the dancers are crucial for the further development of theory, policy and practice. In an innovation systems approach, learning refers less to the capacity to produce new knowledge and more to the capacity to select, acquire and handle knowledge and turn it into useful applications. In order to learn and develop visions, strategies and action plans actors need information on the options science and technology have to offer, what these options mean for their sector or domain, and need information on the consequences of the realization of these options. Often actors themselves will be able to acquire or produce the necessary information. However, some actors involved will not have the resources to do so and especially in the early stages of the development of scientific and technological options, actors are not aware of these options or find it too risky to invest in them. In such cases it is up to government to take care that there are institutions in place in the innovation system that provide the necessary information, i.e. 'strategic intelligence' (Smits et al. in this book). In order to stimulate innovation processes in an early stage and take care that all relevant actors have access to and are provided with the information they need to play their role, government should take the responsibility to develop an adequate strategic intelligence infrastructure. In many countries elements of such an infrastructure are already present, but given the growing importance of innovation for economic welfare and societal well-being, these infrastructures should be reinforced and better internationally interlinked. Understanding innovation systems and policies in a globalized context requires 'post-national' analytical approaches. In line with the metaphor of the 'three dancers', the various actors involved in innovation processes should play an important role in setting the agenda of this global 'strategic intelligence infrastructure'. So far there is no coherent conceptual and methodological framework addressing the multilevel and transnational nature of today's innovation systems, where the different spatial and organizational levels – from the regional, to national states, to the global – have distinct, but largely connected roles, and that take into account the strategies of key individual actors.

A second, more indirect aspect of the learning capacity of innovation systems concerns the educational system. This aspect becomes even more important because

in order to survive on worldwide markets, no longer only a limited set of high-tech and big firms have to innovate. Future developments ask for a reinforcement of the innovative capacity of firms in a much broader range. During the last decades policies stimulated innovation in SMEs in a linear model mode focusing on technology transfer. Often these attempts to stimulate innovation from the 'outside-in' were not very successful. From a systemic perspective it makes more sense to change these policies to 'inside-out' policies. To phrase it differently, instead of trying to introduce innovative resources from the outside governments should focus on strengthening the innovative capacity of firms from the inside. Such a strategy asks for adequately educated employees. Employees, for instance, able to live and act in the world of science and technology and in the world of the market and are able to link these two. This asks for fundamental changes in our educational systems. Strange enough, however, until now innovation scholars have hardly addressed the educational system. Research in the requirements the knowledge society asks from the educational system is scarce. As a result our educational systems do not provide our labour markets with people that are adequately equipped to take part in the learning processes innovation requires. In the long run this might prove to be the major weakness of our innovation systems.

Practitioners – Exploring Opportunities for Greater Connectivity and Reflexivity

Innovation is often seen in gladiatorial combat terms. Innovators in companies and other organizations are expected to be champions of change and to work hard to overcome barriers. Thomas Edison's aphorism (1 percent inspiration, 99 percent perspiration) is an apt description. Failure is to be expected, and often successful innovators are heard to say that you need to fail one or more times to learn how to succeed. But is this 'school of hard knocks' the most efficient way of fostering innovation? Does it have to be the innovator versus the system, or are there ways to ensure that the system is more conducive to innovators? It could be argued that there are immutable laws of human nature (i.e. we tend to resist change) that mean that innovation is typically going to be an uphill struggle. Yet, at the same time, the way in which the system of innovation is constructed surely also provides rules and conditions behaviour, and this system is subject to change. To be sure, it can be hard to change established institutional routines. But, if we could change the system to be more favourable to the acceptance of innovation and to enhance desirable outcomes (for example, to meet goals of sustainable economies), how would we?

One direction is provided in the chapter by Smits, van Merkerk, Guston and Sarewitz where they raise the possibilities of forms of constructive technology assessment and real-time technology assessment – where the best possible uses of promising technologies are considered early on in the innovation cycle. Through the early engagement of users, consumers, community and environmental stakeholders, business, scientists and policymakers, deliberations can occur which can send signals and help channel actions. Coupling the results of such deliberations with supportive

resource allocations and other incentives would increase the likelihood that desired societal goals as well as economic ones are addressed through collaborative rather than isolated or disjointed innovation processes. Similarly, as Edler discusses in his chapter on demand-driven innovation, greater use of demand mechanisms by policymakers could speed up the pioneering and take-up of desirable innovations. Success in moving along these collaborative innovation pathways is, of course, dependent on strengthening the links between policymakers and innovators, although there is probably much that can be done in fostering collaborative innovation through actions by private organizations (user-producer links) and intermediaries and advocacy groups (giving greater emphasis to the societal goals that innovation should address).

There may also be opportunities to stimulate greater reflexivity among those on the front-line of innovation, to learn from others – to avoid making old mistakes and to recover from new ones. Much of this learning is inevitably informal and perhaps unavoidably experiential. But, there are roles for educational communities and developmental organizations to engage more with the innovation process, through cross-training of young scientists (learning about management of innovation) and with young managers (learning about innovation and technology), facilitating exchanges and group innovation projects, and comparing practices across regions and innovation systems. Within companies and organizations, there may be new opportunities for managers to develop open innovation strategies and enable improved interfaces with other knowledge sources, resources and organizations, to facilitate the implementation of creative potential.

Other pathways are possible, and we recognize that many organizations around the world are indeed piloting new initiatives to foster new collaborative approaches to innovation which address a broad range of goals. The essential point is that while scholars, policymakers and practitioners each influence one another in the development of innovation concepts, policies and actions, there are also significant opportunities to collaboratively advance and improve the structure and operations of innovation systems themselves. We hope the arguments, ideas and cases discussed in this book will help in working through how innovation systems thinking, policy and practice can move forward over the next decade of change.

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