The Theory and Practice of Innovation Policy
An International Research Handbook

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INTRODUCTION

A leading question addressed in this book is how to improve public policy, using insights from innovation studies and theory as well as from innovation practice and innovation policy. Innovation in this book is seen as a dynamic interactive process taking place in heterogeneous, more or less interconnected arenas with many heterogeneous actors, cutting across various levels of societal organisation. To explore this complex dynamic we adopt the innovation systems (IS) approach as a starting heuristic and assume – in line with the leitmotif of this book – that practice, policy and theory develop by mutual interactions. Three major conclusions from the foregoing chapters are central to the discussion in this chapter:

- Although innovation studies made advances over the last two decades, the prevailing IS approach has some major flaws. The concept is still disporing a too static character: there is a lack of adequate bridges between the system level and individual actors. Also the implications for advancing theory and for policy designs are still limited.

- Until now scholars in innovation studies did not pay sufficient attention to innovation policy as an object of research. Phrased differently, policy is considered as a trivial application of ‘other’ knowledge but not a field of knowledge in itself (Teubal 2002). This explains why researchers tend to not fully investigate the implications of the results of their work for policy.

- Partly as a consequence of this lack of theoretical interest (and partly as a result of inertia in policy making), actual policy making often follows the old linear mode or, while claiming to be designed from a systems perspective, applies a ‘one-size-fits-all’ approach (e.g. the fashionable ‘network-building’ funding policies.

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1 Joint work with Gil Avnimelech underlies the analysis of the first part of section four (Two Case Studies). See also Avnimelech and Teubal (2008b).
launched irrespective of knowledge fields, technology or market characteristics etc.; see Boekholt in this book).

As a consequence we rarely find strategic system-oriented innovation policies that build on innovation studies which suggest a revision of the institutional set up to achieve non-trivial changes in IS.

In this chapter we will focus primarily on innovation policy as an object of research in itself. We will concentrate on the question of how insights from innovation studies - from actual policies and from awareness of the interaction between the theory and practice of policy - may improve innovation policy in a practical and concrete way. Based on experiences with actual innovation policies and recent insights from innovation studies, including studies of innovation policies, we will focus on two major themes:

- At times IS are (or should become) subjects of dynamic structural change. Hereby the focus has to be on established systems in a steady state but also on processes of creative destruction and the formation of Neue Kombinationen (Schumpeter 1934). We have to understand better the implications of our systemic, co-evolutionary perspective on innovation processes, systems and policies for operational policies dealing with the steady state and for strategic policies facilitating structural change. We aim to improve the capability of these two types of policy at a conceptual level to better take into account the dynamic and systemic character of innovation processes and systems.

- Both policies deal with systems and are in need of policy instruments that take into account the systemic character of the policy object. Strategic policies dealing with radical changes in the institutional set-up need instruments that enable the development of new interfaces and arenas, a much broader process of consultation and the strategic intelligence to support this. Operational instruments have to find solutions for system failures (Wooldridge et al. 2003) that cannot be solved by one organisation or limited to the relation between two organisations. In this chapter we will propose so-called systemic instruments, that are able to tackle the problems and challenges of IS in an orchestrated and more effective way than the current, often linear model-based innovation policy instruments (Smits & Kuhlmann 2004).

We want to stress that this chapter does not provide full solutions nor even does it pretend to provide an all embracing analysis of the flaws and their possible solutions of innovation theory and policy as discussed in other chapters of the book. This chapter tries to take insights one step further by developing concepts and instruments, illustrated by practical cases, linking these insights to real-life policymaking.

In the first section we will summarise the debate on innovation systems (theory) and innovation policy while taking stock of the major insights and focusing on what we consider to be the main deficiencies of the prevailing approaches. In doing so we will give special attention to the IS approach and show that some of the insights from innovation theory still are not taken on board in this policy. In section two (Need for a Strategic Level of Policy), we will propose a systems-evolutionary innovation policy portfolio tackling two major perspectives: a strategic dimension of innovation policy designed to facilitate structural change of IS, as opposed to operational policies for IS in a steady state. In the third section (Need for Systemic Instruments), we will present the concept of systemic innovation policy instruments. Based on our analysis of major insights from innovation studies key requirements for systemic initiatives, both for strategic and for operational policy purposes, will be suggested. Section four (Two Case Studies), will then present two cases in which these proposed approaches are illustrated and further explained. The Israeli Venture Capital and High Tech Cluster case stresses the need for strategic policies to focus on the support of new, dynamic elements in the system. In the case of Dutch agricultural innovation policy systemic instruments have played a key role both in strategic as well as in operational dimensions. The last section winds up by drawing conclusions and presenting recommendations that may help policy makers and researchers to improve systemic innovation policies.

THE SYSTEM OF INNOVATION APPROACH IN AN EVOLUTIONARY PERSPECTIVE

We start by discussing major insights from innovation studies and will draw some conclusions on the implications of these insights that may help policy makers to develop a systemic policy approach that takes into account the co-evolutionary nature of innovation processes and systems. Hereafter we will go into some weaknesses of the IS approach that offer starting points to further the usefulness of innovation systems theory for policy.

Insights from Innovation Studies

Innovation studies have provided a number of insights that help to improve systemic policies. Below we introduce a selection of findings (building on Smits & den Hertog 2007) suggesting possible implications for policy (see Figure 17.1).

1. **Innovation is an interactive search and implementation process that takes place in uncertainty**. In innovation theory, an interactive innovation model has largely replaced the linear innovation model. The latter generally emphasises the central role of design, the feedback effects between the downstream and upstream phases of the earlier linear model, the overlapping of phases in the innovation process, and the numerous interactions between science, technology and the process of innovation in every phase of the process (Nelson & Winter 1977; Kline &
Innovation occurs in uncertainty.
2. Innovation is path-dependent.
3. Innovation co-evolves with society.
4. Innovation draws on varieties of actors.
5. Innovation builds on actors’ learning capabilities.
6. Often, innovation is spurred by vivid interfaces with science and "high technology".
7. Often, innovation is driven by demand (including non- or low technological).
8. Innovation builds on ‘soft factors’ (e.g. innovation-related services).
9. Innovation is shaped by institutional contexts and public policy.

Figure 17.1 Nine lessons from innovation research (based on Smits & den Hertog 2007)

Rosenberg 1986; Imai et al. 1988; OECD 1992). Many innovations are the result of a group or systemic process rather than the product of an individual innovator, a fact that also gets strong emphasis in the IS approach.

Possible implications: With strong uncertainty, policy strategies favouring evolutionary variation are important, e.g. in the early phase of creation of a new industry. The same accounts for the early phase of economies where – prior to the identification of areas/industries/technologies providing the economy or region with a sustainable competitive advantage – business sector innovation is in its infancy. In terms of types of policies to be adopted, for contexts where business sector innovation is in its infancy, there may be strong reasons for adopting horizontal policies (Teubal 1997) for the support of R&D and innovation in firms.

2. Innovation is path-dependent, or evolutionary and/or accumulative in nature.

Innovation is a search process directed by search rules or heuristics that largely remain implicit, though they indicate how certain problems should be tackled (Nelson & Winter 1977). In this context, some authors speak of ‘technological paradigms’ and more recently of ‘technological regimes’ (Rip & Kemp 1998) which provide the framework within which solutions to problems are sought. At the level of technologies or types of solutions, this can mean that certain search directions are not considered and further development of innovation tends to continue along the same lines (path dependency) and eventually even run the risk of ‘lock-in’ and irreversibility. This makes it much more difficult to switch to another (and possibly better) solution, merely because a routine has already been established.

Possible implications: Path dependency underlies the difficulty of targeting new areas, technologies and industries and the frequent failures in ‘picking winners’. Still, targeting of new industries has succeeded in the past, e.g. in the Korean ICT sector and salmon industries in Chile; and it may be a very important tool which cannot be dispensed of; in particular when rapid strategic adaptations of IS (‘regime shifts’, ‘system transitions’, see e.g. Geels & Schot 2009) are required. This means that an appropriate ‘evolutionary’ targeting perspective should be developed implying a strong strategic process of selection by government (which, if successful, the system as a whole including the business sector will accept). Thereby it is imperative to assure that sufficient creation of new options and associated experimentation and learning (‘variation’) take place before a finalized targeting policy be implemented (Sercovich & Teubal 2007; Avnimelech & Teubal 2008b). This also means that new arenas of interaction and new mechanism of interaction and mutual adaptation should be objectives of pre-targeting policy making. Strategic Niche Management (Kemp et al. 1998) and various types of strategic intelligence (see Chapter 16 by Smits et al. in this book) as for instance Constructive Technology Assessments could be helpful in this context.

3. Innovation and technological change are endogenous processes and the result of co-evolution of technology and society. At present, the dominant view among innovation theorists (probably with the exception of many neo-classical economists) is that technology and innovation should not only be conceptualised as ‘ready-made’ artefacts (‘cannonball view’ of the impact of technology). Technology and innovation are endogenous, and therefore their development is not strictly deterministic or linear. In economic terms, they are usually the result of a complex process of interaction and development between demand and supply. In terms of more socio-cultural perspectives, they are the result of a co-evolution of technology and society, or of the ‘technological culture’ (Bijker 2000) in which we live.

Possible implications: The centrality of co-evolutionary processes gives further weight to the perspective that focuses on sparking and sustaining cumulative processes of emergence (as one of the possible objectives of policy, see Avnimelech & Teubal 2008b). This – together with the implications of path dependency mentioned above, and the fact that cumulative processes must involve not only economic and technological factors but also societal features – implies that relevant and potentially successful policies could become very complex and difficult to undertake. Scholars have made a plea for ‘economics and socio-politics of collective experimentation’ (Felt et al. 2007), characterised by emerging or strategically created situations which allow to try things out and to learn from them. Here ‘experimentation does not derive from promoting a particular technological promise, but from goals constructed around matters of concern and that may be achieved at the collective level. Such goals will often be further articulated in the course of the experimentation’ (Felt et al. 2007). Policy makers should be aware of this and strive to generate an additional set of strategic and operational skills and routines. A hypothetical example of the importance of societal factors with respect to venture capital policies is culture: it may very well be that a cultural shift towards innovative entrepreneurship may be required prior to the implementation of venture capital policies (this is one factor explaining the failure of German policies in this area in the early 1980s).

4. Innovation as an activity is no longer the prerogative of a genius inventor working in ‘splendid isolation’, but is a systemic activity to which a variety of actors contribute.
Some people have an almost romantic image of the inventor working in solitude in his or her lab or garage, coming up with inventions that lead to innovations. However, the great majority of innovations are achieved by groups of people. The terms 'multi-actor activity' and 'system activity' refer to this aspect. In addition to companies, many knowledge institutions, intermediary organisations and, in some cases, also the government (through various types of policy including science and innovation policy), play a role in these innovation processes. A special case of interaction is feedback between users and manufacturers (e.g. von Hippel 1988; Oudshoorn & Pinch 2003). The IS approach emphasises precisely this multi-actor character of many innovation processes.

Possible implications: There is a need for ' fora' facilitating exchange and debate of heterogeneous actors on innovation needs and potential (Eidler et al. 2006). Public policy can act as a catalyst here, e.g. organise multi-actor foresight processes, or provide support for intermediary organisations enabling interaction between users and producers of innovative achievements.

5. Learning and creating learning environments are crucial to innovation. An important theme in innovation research is the way people arrive at innovation and the role that learning processes play in it. Distinctions between different types of learning (e.g. learning by searching, learning by doing, learning by using, and learning to learn (Rosenberg 1976; 1982)) and different types of knowledge (e.g. the basic distinctions between codified and tacit knowledge and between instrumental and conceptual knowledge (Caplan 1979)) are key here. This learning takes place at many different levels. Individuals must learn to develop in an increasingly complex knowledge society. Companies must learn to keep abreast with the latest insights in their branch of trade or industry and stand out from the competition, if possible. Policymakers must learn to organise economic and social learning processes as efficiently and effectively as possible and learn from earlier policy interventions (policy learning). At pointed out by Lundwall (1993) learning and experimentation are basic prerequisites for successful innovation.

Possible implications: While the promotion of learning should almost always be an explicit objective of innovation policies providing creating conditions for learning deserves special attention of policy makers in the pre-selection phase. Learning is an inherent part of the variation process preceding policy induced strategic selection. This learning process may have to encompass a large and varied set of agents including the government itself. Creating room for experimenting and a strategic intelligence infrastructure providing innovating actors with the (tailor made) information on the possibilities and consequences of new technologies are important elements of policies that want to contribute to the conditions necessary for learning in pre-competitive stages of innovation processes.

6. An important share of innovation and technological change are increasingly linked to scientific knowledge and involve a variety of transfer mechanisms. A growing number of industries depend ever more directly on the progress of (fundamental) research for innovation. However, this applies not only to hard technology, but also to the soft aspects of innovation such as user behaviour, design of client interfaces and organisational change processes. The transfer mechanisms involved go beyond R&D collaboration and personal mobility. The nature and exact operation of the many knowledge transfer mechanisms are in practice varied and complex (see also OECD 2002).

Possible implications: An insufficiently considered policy in this regard in Europe concerns the creation of a strong 'innovative entrepreneurship' module closely linked to and co-evolving with universities (both through research and training) and government labs. The core of such a module might be a high-tech start-up segment and a linked venture capital industry and/or market. Such a module would represent a new type of critical complementary interface to the usual links through technology transfer offices and supply and demand for new graduates in the engineering and other sciences. Such an interface may stimulate the development of new firms and stimulate - via the manifold linkages in innovation systems - less innovative firms to become more innovative.

7. In addition to knowledge creation, knowledge diffusion and demand-driven knowledge utilisation are crucial. For a long time, innovation has been associated with progress in the knowledge-intensive and high-tech industries. This has led to a preoccupation with radical innovation and high-tech activity in innovation theory, practice and policy. However in innovation both incremental and imitation innovations are involved (e.g. Hirsch-Kreinsen et al. 2003; Hirsch-Kreinsen 2008). This certainly accounts for the many, not so technology-intensive small and medium-sized enterprises. O'Doherty and Arnold (2003) note that these latter innovations which seek limited improvement of existing products and processes, and which are sometimes seen as 'diffusing' new technologies, are the numerically and economically dominant variety.

Possible implications: Systemic innovation policy would seek to address also low-tech, incremental and imitation innovations, and policies would recognise support a new concept of high-tech start-up company (which was considerably different from the old R&D companies'); by a new type of financial institution (venture capital organised as limited partnerships with an 'early phase' strategy of investment in high-tech start-ups); and involving a completely different role of Government (promoting emergence of a new market industry through a targeted programme involving a one-shot government venture contribution of 100 Ms). Both business experiments and policy learning were critical ingredients in the above (see below and Avnimelech & Teubal 2006).
Adaptability play a major role. Edquist (1997) distinguishes three functions of institutions: (a) reducing uncertainty by providing information; (b) managing conflicts and collaboration; and (c) providing stimuli. Moreover, a system-specific institutional set-up is quite likely, precisely because of differences in history and specific context. In an IS approach, a government can intervene in various capacities. It can act as a co-innovator, for instance as a launching customer or as an articulator of important societal problems in areas as health, the environment and safety, or by providing the necessary framework conditions. Not only market failure, but also system failure - an institutional set-up that does not give the right stimuli to encourage the innovation process - can serve as an argument for a more broadly defined public innovation policy.

Possible implications: The institutional and policymaking set-up itself should be considered as subject to strategy development and systemic policy designs in the light of innovation system dynamics. This would call for procedures of 'reflective governance' (Voß 2007), taking into account that policy and its reliance on policy instruments is itself embedded in, and constituted by, broader ongoing changes (e.g. Voß et al. 2006). Reflective governing strategies would not aim at full control, but interact with ongoing change with a view to modulate it - while recognising the ironies that are involved in doing so (Rip 2006). An important consequence of the foregoing is the need to develop competences, stimulate - and sometimes take part in - processes of creative destruction and the building of Neue Kombination. Creative destruction as far as government is concerned may include the abolishment of obsolete institutions, rules and regulations and organisations. The development of Neue Kombination may be stimulated by developing policies that stimulate the further development of new and promising sectors.

Weaknesses of the Innovation System Approach

At present, the IS approach is becoming the de facto standard in the world of innovation policy, even though its application can be, and is, very diverse and demonstrates - as we will see - severe shortcomings. Why is this model so attractive and which role does the IS approach play in current developments in the policy thinking (see also chapters of Chaminade & Edquist, and of Carlsson, Elg & Jacobson in this book)? The attraction of the IS approach has to do with several factors. In the first place, the IS concept seems to fit in with the idea of an economy as a comprehensive system of actors between which flow and feedback is possible and where interventions on one of the relations have consequences for other actors and relations in the system. The IS approach is a recognition of the fact that innovation (and policies to further innovation!) is no longer a 'single act', but the result of a complex interplay of sometimes very diverse actors, who arrive at innovation in interaction. Besides thinking in terms of market failure (which is strongly based on neo-classical economic theory), the failure of the broader innovation system is
increasingly recognised as a basis for government intervention. A second factor that may explain the attractiveness of the IS approach is the finding that the IS approach offers both a flexible heuristic that is sufficiently malleable to be practicable for many different policymakers and an idiom that indicates a contemporary understanding of innovation (Sharif 2006). For instance, the IS approach recognises the roles played by different institutions in the innovation process, allows a broader interpretation of innovation as such (more than just technological innovation) and can be operationalised at different policy levels (supranational, national, regional/local, at the level of complex technological systems, clusters/sectors).

The third attractive aspect of the relevance for policymaking of the IS approach is its integrated character and the fact that this provides for an organisational framework (analytical, but also very practical) for innovation policy in practice. It offers a framework not only for visualising the main (perceived) problems surrounding innovation, but also for designing a mix of policy instruments to solve the problems once they have been identified.

Despite all these pros (see also Lundvall 2007), as already noted, the IS approach still shows considerable weaknesses. The major ones are:

- The IS approach in its traditional sense does not capture the dynamic aspects of innovation processes, systems and policies. The functions approach as discussed by Bergs, Jacobsson, Heldert & Smith in this book is an attempt to deal with this deficiency, but still is in an earlier stage of development.
- An important element of the dynamic character of IS, the emergence of new markets and new industries is either ignored or not considered (see Blind in this book and Avnimelech & Teubal 2008a). This weakness is part of a broader weakness of the IS approach as far as policy is concerned.
- The consequences for both strategic and operational systemic policies including relevant institutions, agents and capabilities are hardly discussed.

In the following two sections we will focus on the third and — to a lesser degree — the second weakness. In the next section we will go into the need for strategic policies and how this policy type distinguishes itself from operational policies. In the third, we will introduce and explain the concept of systemic instruments. Hereafter, in section four two cases will further illustrate our major arguments.

NEED FOR A STRATEGIC LEVEL OF POLICY

With respect to system dynamics a major distinction has to be made between the steady or stationary state of a system on the one hand and a system in transition on the other. Creative destruction, e.g. the creation of new industries and markets, which are disruptive of existing arrangements, and the establishment of Neue Kombinationen are at the core of innovation processes and their impact, and therefore

<table>
<thead>
<tr>
<th>Steady state</th>
<th>Structural change</th>
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<td>Operational innovation policies</td>
<td>Strategic innovation policies</td>
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<tr>
<td>• focus on implementation of existing set of policies</td>
<td>• generating new set of policies</td>
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<tr>
<td>• aiming at keeping system vivid and competitive</td>
<td>• seeking better fit to new global or domestic context</td>
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<tr>
<td>• removing system failures</td>
<td>• facilitating creative destruction and the emergence of Neue Kombinationen</td>
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Figure 17.2 Systems evolutionary approach for innovation policy

the basis for system transformation. Policies at these crossroads must incorporate a strategic element; they have to generate a new set of policies, seeking a better fit to a new global or domestic context. Strategic policies would go beyond the implementation of the existing operational policy portfolio designed to keep a given system profile vivid and competitive (see Figure 17.2).

A strategic level of policy (for simplicity we call this 'strategic policies') by necessity focuses on an extended policy process, one which begins with the setting of new strategic priorities and continues with efforts at articulating these in terms of a new set of policies. Their relevance is enhanced whenever strong changes in the global and/or domestic environments call for a new or adapted innovation system, one inconsistent with the existing set of policies. In contrast to the operational level of policy which focuses on the implementation of an existing set of policies, action at the strategic level aims at generating a new set of policies, one better fit to the new global and domestic context (Avnimelech & Teubal 2008b; Rostelio et al. 2008). In this context, policies should gross mode be conceived as comprising three main components: incentives and incentives programmes; institutional and regulatory changes; and other actions (like technological forecasting, setting new priorities and creating new 'strategic' policy institutions). The latter are critical when shifting from a dominant operational level of policy to a mode which includes both an operational and a strategic level.

Despite enhanced awareness of the need for analysing the emergence and transformation of IS there are still important gaps in existing research. In this section we will focus on one important aspect of this dynamic process4: the analysis of the emergence of new organisations or sub-systems such as new markets and new industries and associated emergent properties. The recent literature on cluster dynamics and venture capital have considered both the conditions that should be in place and the nature of the cumulative, feedback-driven processes which lead to the emergence of new, sometimes high-tech clusters and new venture capital industries.

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3 The examples of 'other policy actions' given above strongly relate to the systemic (policy) instruments analysed above (Section 4, Need for Systemic Instruments).

4 Here, we exceed Schumpeter's notion of Neue Kombinationen and include the long-term impact of creating and destroying sectors.
and markets (Bresnahan et al. 2001; Avnimelech & Teubal 2004a, b; 2006; 2008a, b). This literature and the associated industry life cycle literature (e.g. Klepper 1996; 2001) should be duly incorporated into innovation system dynamics. Related to this is the recent emphasis on co-evolutionary processes requiring a truly dynamic perspective on changes in various sectors of society such as for instance the agro-sector, water management and the energy sector. Here the issue not only concerns co-evolution between the technology and the institutions supporting it (Nelson 1993), but other critical co-evolutionary processes involved in innovation system transformations, or ‘regime transitions’ (e.g. Eizen & Wissocrek 2005; Geels & Schot 2007).

Preliminary work (Avnimelech & Teubal 2008a, b among others) has shown that the implications of the strategic policy perspective can be momentous indeed both in connection with the inherent dynamic approach (with strategy linking the past with the future) and in connection with the objectives of policy. Foremost among the latter is the identification of emergence of new sectors, product classes, markets and clusters as legitimate objectives of policy to be activated, given favorable ‘transition facilitating’ or pre-emergence conditions, by the triggering and sustenance of cumulative processes with positive feedback. When such conditions are not present, policies might aim at generating them.

While existing research on agent interaction, agent capabilities and infrastructures is important and useful, it has not informed us sufficiently about the higher organisational level implications, e.g. concerning the emergence of new markets, industries and clusters. It should be noted that given the existing turbulent global environment it is very likely that these emergent entities and phenomena acquire a greater importance than in the past. The rise of the BRIC countries without any doubt will force Western economies to develop new sectors at a more rapid pace. In other words, while existing research significantly advanced beyond the policy objective underlying linear models – particularly beyond achieving R&D ‘additionality’ and even in the area of clusters – it still has to incorporate other emergent phenomena and associated dynamics centrally into its analysis. In fact, the under-emphasis of the objectives of creating new markets and industries – including new systems-evolutionary views of infant industry development – is particularly surprising. In Schumpeterian terminology: innovation scholars should pay more attention to the underlying dynamics of the creation of neue Kombinationen, the necessary creative destruction and their potential impact in terms of new multi-agent structures at higher levels of organisation like new sectors, clusters, etc. (Avnimelech & Teubal 2008b).

Once emergence of new meso-level entities is recognised as one important aspect of policy, the dynamic analysis of creation of pre-emergence conditions and the facilitation of a transition from pre-emergence to emergence acquires greater significance. Related to this is the issue of timing of strategic policies: right timing may be important both for the creation of adequate domestic conditions as well as for conditions which, while critical, are exogenous to the focal IS. Moreover, this dynamic, strategic approach to policy also spills over to questions of design, since the system failures that policy must overcome relate first and foremost to the triggering and to the sustaining of cumulative processes of emergence and their overcoming may be intimately related to policy design.

Finally, existing systems of innovation approaches exaggerate the divide between ‘positive’ and ‘normative’ analysis or alternatively between the world of ‘policy’ on the one hand and the ‘real world’ on the other. Policy actors, institutions and capabilities are part and parcel of our description of an IS. Their interaction with other actors and the processes leading to new policies are integral parts of system dynamics. In fact, it is imperative to adopt a fully dynamic theory of innovation policy broadly defined, one involving appropriately linked phases and strong co-evolutionary processes with other components or elements of the system.

We conclude this section with two additional thoughts. First, contrary to past routines, policy aiming at innovation system transformation should aim at creating and supporting dynamic elements in the system, (creating neue Kombinationen and supporting creative destruction) a fact requiring specific attention to emergence processes, the conditions for targeting new industries, markets and technologies. Furthermore a dynamic, systems-evolutionary perspective to the emergence of venture capital industries and markets and also of entrepreneurial high-tech clusters is needed. Second, present policies, policy routines and organizational capabilities are a far cry from what is required for the promotion of a dynamic start-up segment of companies and of the broader innovative entrepreneurial cluster into which such a segment would be embedded. The same accounts for the possibility of undertaking a continuous process of innovation-based, structural change-led economic growth.

**NEED FOR SYSTEMIC INSTRUMENTS**

The main conclusion from the foregoing is that innovation is not an activity performed in isolation but one which involves a variety of actions within the system of which the innovating organisation or innovator forms part. In other words, innovation is a systemic activity (Guy & Nauwelaers 2003; O'Doherty & Arnold 2003). One of the consequences of this observation is that actors involved in innovation processes not only need instruments that focus on individual organisations (e.g. financial and managerial instruments) or on the relation between two organisations (e.g. diffusion- and mobility-oriented instruments), but also instruments that focus on the system level. We will call these 'systemic instruments', broadly defined as policy instruments aiming to influence coherent parts of the system in an orchestrated way. A second conclusion is that managing systems is not limited to steady state situations but also involves the management of structural changes. In this context since a number of years the central role of and the need for

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5 Partly based on Smits & Kuhlmann (2004).
functions. Based on this concept we suggest considering the following functional dimensions of policy instruments:

- Re-shaping of innovation systems by construction and deconstruction of subsystems; building bridges and stimulating the debate, alignment and consensus (e.g. between science, industry and users of emerging technologies; Jacobsson and Johnson (2000) have shown this for innovative energy systems):
  - facilitating construction and deconstruction of subsystems, preventing of lock-in
  - supporting prime movers
  - ensuring that all relevant actors are involved

- Building cross-linking platforms and new spaces for learning and experimenting; learning by doing, learning by using and learning by interacting (Rosenberg 1982; Lundvall 1992);

- Stimulating demand articulation, strategy and vision development; e.g. building on the growing body of knowledge on the role of users in innovation processes (Oudshoorn & Pinch 2003; Moors, Enzing et al. 2003; Boon et al. 2008);

- Providing and exploiting an infrastructure for distributed strategic intelligence (building on technology assessment, foresight, evaluation, benchmarking etc.); building links between sources, improving accessibility for all relevant actors (clearing house) and stimulating the development of the capacity to produce strategic information tailored to the needs of the actors involved (Kuhlmann et al. 1999).

Clearly, these functions of systemic instruments are covering both operational and strategic policy missions, and they may play a role in innovation systems in a steady state as well as systems in transition. Figure 17.3 illustrates the relation of systemic instrument functions and operational or strategic policy missions; some systemic functions appear to be of more relevance for strategic than for operational purposes.

Given the co-evolutionary development of innovation policy, practice and theory, one would expect that traces from this type of policy instruments should be visible already in real life. In the fourth section, we will discuss two examples of systemic policies *ansia in acta*.

Having discussed the need for systemic instruments the question at stake is how far today’s instrument portfolios meet the formulated requirements and how traditional instruments relate to systemic instruments. Although instrument portfolios of many countries went through a development heading in the direction of more systemic instruments, recent evaluations show that financial instruments still heavily dominate the innovation policy portfolio of many other countries. In their comparative analysis of the innovation policy instrument portfolios of nine

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6 For an analysis of Dutch innovation policy illustrating this trend see Smits & Kuhlmann (2004).
TWO CASE STUDIES

In the following we will illustrate the system-evolutionary innovation policies with two real-life cases: (i) the emergence of a vibrant venture capital industry in Israel since the 1990s; (ii) the ongoing transition of the Dutch agricultural sector. Both cases dispose systemic policies on strategic as well as operational levels.

The Emergence of Venture Capital in Israel During the 1990s

During the 1990s a new venture capital (VC) industry and market emerged in Israel, one oriented to the early phase finance and support of high-tech start-up companies. While the first US VC company was created in 1946 (American Research and Development Corporation, see Bylinsky 1976) a significant VC industry and market emerged in the US during the mid-1970s (Gompers 1994; Gompers & Lerner 1999; Avnimelech et al. 2009) in the wake of the ICT and integrated circuit revolution and the creation of NASDAQ in 1971. Its diffusion to Israel during the 1990s took place in the context of globalisation of the main capital market focusing on IPOs of young technology companies: NASDAQ (which was the main channel for Israeli VC exits). When strictly defined, Israel's VC industry during the 1990s became one of the largest VC industries in absolute terms (only second to the US) and the largest in relative terms (VC as percentage of GNP, see Avnimelech & Teubal 2006).

Accompanying the process of VC emergence was the transformation of Israel's high-tech industry from a military-dominated industry to a sophisticated start-up-intensive high-tech cluster (see Figures 17.4 and 17.5). Several observers have suggested that this case probably represented the most successful instance of diffusion of the Silicon Valley model of high tech (and VC) beyond North America (Bresnahan et al. 2001; OECD 2003; Carmell & de Fontenay 2004).

Our perspective is useful for analyzing the impact of VC on an existing high-tech cluster or its possible contribution to the emergence of a new one. This issue has been largely ignored in the cluster literature, which seems to consider VC as one of many Marshallian "inputs" in the cluster formation process. In contrast to this our analysis strongly suggests that a central aspect of the impact of VC on high tech is a VC/start-up co-evolution (Avnimelech & Teubal 2006). Through this effect, VC has been a central axis in the emergence of the start-up-intensive high-tech cluster in Israel. It also suggests that the absence of a VC industry with strong co-evolutionary effects with start-ups may be a significant factor in the non-emergence or limited diffusion of Silicon Valley model of high tech clusters beyond the US up to the 1990s.

The analysis of the Israeli case is cast in terms of an extended industry life cycle perspective where the central phase is the VC emergence phase (Phase 3, 1993-2000). Since the focus is to explain the 'causes' of emergence in Israel (and possible causes

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7 For more details see Avnimelech & Teubal (2006; 2008a, b) and Brenttir (2008).
Figure 17.4 Israel’s high-tech cluster - selected structural elements (1969-2001)

of non-emergence in other countries, at least during the 1990s) we pay particular attention to the pre-conditions that, with the help of a Government targeted programme (the Yozma programme or simply Yozma), facilitated a successful outcome. These pre-conditions are expressed in terms of two phases - a background conditions phase (Phase 1, 1969-1984) and a pre-emergence phase (Phase 2, 1985-1992). Underlying the industry life cycle analysis there is also a dynamic analysis of innovation and technology policy with the focus on R&D grants to business firms during Phase 1 (a horizontal programme open to firms in any sector or technology) and Yozma’s targeting of VC (and indirectly, the new entrepreneurial high-tech cluster), during Phase 3. A central piece of the normative analysis is to analyse the conditions under which policies and other events in Phase 1, through their effect on the emergence of Phase 2 conditions, created pre-emergence conditions for targeting venture capital.

Transition to a successful VC emergence process (Phase 3) involves two groups of conditions: first, those underpinning early Phase 3 ‘demand’ for VC services; second, those underpinning rapid growth of VC supply.

An adequate ‘demand’ for VC services early during Phase 3 is a result of the appearance of a critical mass of start-ups during late Phase 2. The factors stimulating VC ‘demand’ (i.e., the pool of start-ups) are both ‘internal’ (domestic) and ‘external’ to the economy. For Israel, domestic factors included e.g. creation of a separately identifiable software industry during the 1980s; the restructuring of (and spin-offs from) large civilian-oriented companies and of defence-oriented industries; a cultural shift favouring technological entrepreneurship; and identification of areas of sustainable competitive advantages within Israel’s ICT sectors, and continued R&D support for high-tech start-ups. ‘External’ factors stimulating ‘demand’ include the growth in global markets for ICT products, deregulation of communications markets; ‘globalisation’ of capital markets for technology companies (NASDAQ); a significant growth in global acquisition activities of MNEs; etc.

The ‘supply side’ conditions for a transition to the VC emergence phase includes domestic liberalisation of capital markets e.g. to create conditions for foreign flows of funds to the country, and other institutional adaptations e.g. of bankruptcy laws and of company or commercial law to make possible the foundation of Limited Partnerships, and of accountability procedures and routines to make them SEC compatible. These would pave the way for a rapid Phase 3 ‘supply response’ through inflows of funds from domestic financial & other sectors and private investors, from the global PE industry or other foreign sources, and from Government funds as part of a targeted VC programme.

The Role of Policy

Emergence as the objective of policy

Israel’s Yozma programme successfully targeted the VC industry in Israel by sparking a cumulative process leading to the emergence of the industry during 1993-2000. Government money (180M) seeded to hybrid funds (‘Yozma Funds’) and an additional 230M was directly managed by a government-owned fund (‘Yozma Venture Fund’). Government’s contribution leveraged an additional 875M mostly from reputable financial institutions and corporations from abroad and from Israel. This initial infusion of funds was invested in approximately 200 start-ups.

The policy process

The background to this programme was a set of new national priorities, which emerged in the late 1980s and early 1990s in the wake of changes in the external and internal environments of Israel. First, during the second half of the 1980s the Military industries laid-off hundreds of engineers and many start-up companies were created only to subsequently fail. Second, the massive immigration from the former Soviet Union during the early 1990s spurred the Government to search for means to employ the thousands of engineers that came to this country. Third, the grants to business sector R&D programme (the main policy of Phase 1 which in fact continues up to this day), which was the backbone to Israel’s innovation policy since 1969, was increasingly perceived as being ineffective. The Government concluded that the problem was not only lack of resources for the post R&D phases of the innovation process in companies but also lack of management and marketing capabilities. It spurred a strategic problem solving process which led to the identification of VC and support of start-ups (rather than simply ‘R&D additional’y) as new national priorities. The outcomes were two VC-directed programmes - a failed precursor programme (Inbal) and the successful Yozma programme (implemented during 1993-7). Yozma’s design played a crucial role in explaining its differential performance
since both programmes had almost similar goals and their date of initiation differed by only one year with a five years overlap in implementation.

**Sparkling and sustaining emergence processes**
The new infusion of VC in the aftermath of Yozma triggered a cumulative process with positive feedback in which more and more profitable VC activity 'today' spurred even more and more profitable VC activity 'tomorrow'. At the centre of this process was a VC/start-up co-evolution. Other dynamic processes were involved as well such as (1) entry of strategic investors in response to the early reputation earned from some excellent Yozma Funds' portfolio company exits during 1996-98; (2) this in turn extended the Israeli VC industry networks and added value abilities; (3) cluster effects enabling a wider set of VC/high-tech non-tradable services to be available locally (e.g. lawyers, financiers, accountants and consultants); (4) entry of MNCs into the cluster and continues stream of acquisitions by MNCs, which also extended the cluster's networks and capabilities; and (5) collective learning concerning the VC business, etc.

**Importance of background and pre-emergence conditions**
Within our framework the emergence or non-emergence of a new VC industry and/or market depends crucially on a set of pre-emergence, Phase 2, conditions. Examples are the demand for VC services as reflected in the pool of start-ups already operating prior to emergence, a process of liberalisation and de-regulation involving capital markets and foreign exchange, and a sufficiently strong process of variation and selection related to the organisation and strategy of both start-ups and VCs (undertaken by agents operating in the proto-VC industry/market). Other work on industry emergence or work on new industries has emphasized additional Phase 2 conditions, which could enhance the likelihood of new or infant industry emergence in general. Among these and depending on industry and context we have: high capability of early entrants and of proto-industry agents (Avnimelech & Teubal 2004b); a policy process and government policy capabilities which lead to the successful identification of a new set of relevant and appropriate strategic priorities (Avnimelech & Teubal 2005); and political legislative required e.g. for a new regulatory and institutional environment. The framework can also be applied to explain non-emergence and the frequent failure of VC-directed policies. For example, the failure of the German VC industry to emerge in the first half of the 1980s (Fiedler & Hellmann 2001; Becker & Hellmann 2002) could be attributed to the first of the pre-emergence conditions mentioned above and to other factors. A deeper understanding of the typical pre-emergence conditions required for VC and of the processes leading to them could have induced policymakers to abstain from targeting VC directly and focus instead on policies to create favourable pre-emergence conditions (creation of a pool of start-ups in the German case).

The importance of programme design and timing
Once the strategic goal of promoting industry/market emergence is accepted, and given other favourable Phase 3 conditions, the major decision to be made is whether or not to implement a targeted VC policy. ITP programme design for VC emergence should consider the crucial links between (1) the structure of incentives and the extent by which a critical mass of capabilities is achieved; and (2) government's venture contribution and how this could influence both the structure of incentives and the mass of financial resources. The Israeli experience suggests that simple tax breaks to investors in start-ups (as has been common in Europe during the 1980s and 1990s) need not suffice. Rather, attracting world class players as limited partners would require strong incentives to the upside. This in turn requires a 'Government venture capital contribution' in order to seed private VC funds; and a 'buy option' to private investors in VC funds. Alternatively and more extensively, the scope and design of the programme should effectively deal with the various components of the relevant system failure. The Israeli case suggests that these relate to (a) entry of professional managers of VC companies; (b) participation of reputable/linked foreign partners; (c) achieving critical mass; (d) selection of a suitable form of organisation which supports the generation of capabilities; (e) spurring a collective learning process; and (f) accelerating appropriate 'selection' of VC organisation, strategy, etc. This is a formidable task: it complicates the structure of incentives; and it requires policy makers to take account of a wide range of other factors not directly linked to incentives (see previous subsection).

This means that in estimating the scope of government investments account must be made not only of the fixed costs of managing a government VC fund, but the specifics of capabilities - both internal and external - that have to be accumulated. Moreover the greater the scope of government investments, the greater the incentives to the upside that may be offered and, at least up to a certain point, the greater the expected entry/participation of skilled agents in the new industry. This is a crucial link that seems to have been missed in the literature. Also the point that leveraging 'public' venture investments to assemble a critical mass of private VC capabilities is the way to transform a potential private capital crowding-out effect into a strongly complementary public-private capital contribution.

Summing up this case illustrates a successful shifting from Phase 1 to Phase 3, involving a relative shift from 'neutral/horizontal' support of R&D in firms to strategic support of a new industry and market (venture capital), i.e. a systemic instrument. The successful shift was facilitated by enhanced activity at the strategic level of policy starting with 'search, research and discovery' on the part of the dominant innovation policy institution (the Office of the Chief Scientist) followed by identification of a new vision and strategy for an entrepreneurial high-tech cluster with large numbers of start-up firms and venture capital funds.
Strategic Systemic Policies in the Dutch Agro Sector

As a second case we discuss a strategic systemic innovation policy in the Dutch agro sector carried by INNONET and one of its followers, the TransForum programme. In doing so we will try to make clear: (1) structural changes in innovation systems need strategic systemic policies and instruments, and (2) systemic instruments also play a role in steady state policies.

The Dutch agro-sector was a great success story for many decades. Fuelled by a strategic policy — starting at the end of the 19th century — to stimulate a knowledge-intensive agro sector, the Netherlands managed — despite its limited size — to develop in the 1980s into the second exporter of agro products after the USA. The major characteristics of the Dutch agro-sector in that period are: focus on mass production, rather homogeneous markets, high, knowledge-based productivity growth and a supply-oriented knowledge infrastructure with excellent feedback from users. Systemic, long-term policies played an important role in the build up of this system. A complete new innovation system was created by the setting up of the Wageningen Agricultural University, the agricultural test stations and a system of information officers that spread the results of research to farmers and fed back their experiences. Platforms where farmers and researchers could meet to exchange the latest knowledge and experiences complemented the system. Also in the steady state systemic instruments like platforms for learning and experimenting, continuous efforts to manage interfaces between the university, test stations and farmers and a strategic intelligence infrastructure to help farmers to stay informed of the latest developments, played an important role in the day-to-day activities of the sector. In the 1980s this successful system ran against its barriers: price erosion caused by competitors with much better factor conditions (energy and labour costs) like Spain, Israel, Kenya and Ecuador and external effects such as pollution and epidemic diseases. The latter were not only detrimental from an economic perspective but also undermined the societal ‘license to produce’ of the agro-sector.

As a consequence awareness increased that structural changes in the sector were necessary. The Netherlands Council for Agricultural Research (NRLO), one of the four Advisory Councils on Research (ACR) in the Netherlands (and an important actor in the strategic intelligence infrastructure), took the lead in this process of structural change. Given its basic structure the NRLO, as all ACRs, is a reflection of the status quo in the system. The developments in the foregoing, however, urged for structural changes in the system. In the mid 1990s the NRLO shifted its focus from managing a steady state system to changing the structure of this system. A salient illustration was the change of its name to the Innovation Network Rural Areas and Agricultural Systems (INNONET). This ‘new’ ACR was established in the middle of the year 2000. Structural change is a big challenge for researchers, producers and users in the knowledge-driven Agro Innovation System (AIS). They have to cope with a very complex transition of a — because of its successful history very well entrenched — system with many strong incumbents. The focus of INNONET was on building networks supporting the development of a vision dealing with a structural change from a mass production and not so sustainable system to sustainable production of specialties. The question whether or not INNONET realised a strategic innovation policy resulting in structural changes in the agro system is still difficult to answer. In terms of the systemic functions, some results were reached regarding the management of interfaces and the development of a joint vision. In terms of building and organising innovation systems results are less convincing and creative destruction of incumbent structures was hardly reached. Furthermore, the newly developed visions were rather abstract and did not (yet) translate in many concrete new initiatives. To wind up, although INNONET acted as an important prime mover of the debate on structural changes in the AIS, real changes in this system were hardly reached. The exclusive focus on research, a still too conservative approach, the lack of funds available for substantial investments in new (business) initiatives and — of course — the problem of creative destruction can be seen as the most important reasons.

In the early years of the new millennium INNONET was offered an opportunity to continue its activities at a more concrete level by the funds made available through the so-called ICES-KIS programme. This programme aims to invest in strengthening the Dutch innovation system by improving the interface between the production of knowledge and the users of this knowledge. For the period 2004-2010, 1.6 billion Euro was available. INNONET was one of the major initiators of the TransForum programme, a 60 million programme focusing on the transition of the AIS. The programme started in 2004 from three basic assumptions:

1. Sustainable value propositions (Neue Kombinationen) focusing on sustainable specialties are central.
2. The AIS aims to establish connections between businesses, markets and knowledge systems.
3. Cooperation between parties that jointly define the unique Dutch positions, the so-called KOMBI parties (knowledge institutions, governmental authorities, societal organizations and the business community) is essential for the realization of the perspective.

Whereas in the old AIS knowledge institutions played an initiating role, in the new system the knowledge infrastructure is guided far more by the needs of other actors in the system. This policy involves structural changes in the knowledge infrastructure (more demand-oriented), major changes in the way research funds are allocated, the interfaces between production and demand for knowledge, and asks for empowerment of actors to develop creative and sustainable business opportunities. Creative destruction of incumbent structures plays an important role in this transition. One of the changes that already took place was the quite painful — reorganisation of the Wageningen University and its merger with applied research institutes into the Wageningen University Research centre.
In order to contribute to this transition, the TransForum programme developed three strongly interlinked components:

4. A scientific programme.
5. Innovative practice projects (IPPs).
6. Knowledge projects.

Scientific projects not only have to inspire IPPs but-even more-answer fundamental questions IPPs are confronted with. Examples comprise research in the management of innovation in international agro food chains, research in the visions on sustainable agriculture, the involvement of users in the start and further development of IPPs and marketing-oriented research focusing on how consumers may be stimulated to buy more sustainable products. Meanwhile 25 IPPs (new business propositions), are on their way ranging from 'greening supermarkets' to 'development of transgenic research in apple resistance'. Knowledge projects concern the development of (new) elements of the innovation system that support the development and management of new business opportunities and stimulate the interaction between knowledge production and use. As such they are new structural elements of the AIS. Examples include the development of curricula for teaching purposes and the development of workshops and/or fora that facilitate the dialogue between the different KOMBI partners.

A first evaluation in terms of the systemic functions reveals the following. TransForum puts a heavy emphasis on the development of interfaces, more in particular between the KOMBI partners and on the development of new business opportunities with a strong link with scientific research. The programme contributes—bottom up— to the development of the building blocks of a new AIS. In doing so, two major problems became visible. First, developing more balanced interaction between practitioners and research appears to be a very stubborn problem. Different languages, (reward) cultures and goals make it difficult to develop fruitful interaction and alignment. Universities are in a difficult position in this game. Society is asking for a contribution of science to the solution of major societal problems. The internal dynamics of science, however, makes the survival of university researchers and groups more than ever dependent on the verdict of their scientific peers. This is a crucial dilemma that can not be solved in the context of the Dutch agricultural research because it touches on the identity of all scientific research (cf. Gibbons et al. 1994).

A second major problem concerns the creative destruction of incumbent structures. To break down existing structures appears to be considerably more difficult in a successful sector with a long tradition and strong entrenchment in scientific, economic and political circles. Apart from increasing external pressure to change (e.g. a growing societal resistance against non-sustainable production), the only solution here are strategic policies including stimulating vision development, long-term investments in experimenting with new business opportunities, protection of these business opportunities until they are able to survive competition with the old options and adapting the AIS to these new ways of production (e.g. regulation, strategic intelligence infrastructure).

TransForum can be seen as a systemic policy instrument addressing all systemic functions in order to contribute to a major transition in the Dutch agro innovation system. INNONET strategically prepared the ground (and the minds of involved actors) for this programme. The experiences of INNONET and TransForum clearly demonstrate the need for a systemic approach. However, breaking through incumbent interests, securing long-term (financial) commitment and overcoming differences between the world of science and practice appears to be tough. Without a long-term, strategic, systemic and inherently long-term oriented innovation policy even the best systemic instruments will not be able to induce major structural changes in innovation systems. From the foregoing it also will have become clear that addressing systemic functions as 'management of interfaces', 'providing fora for learning and experimenting' and a 'strategic intelligence infrastructure' tuned to the needs of the KOMBI partners also are important in policies addressing the steady state of the new agro innovation system.

CONCLUSIONS

We started this chapter claiming that innovation policies should follow a systems perspective. It was concluded that, although many policymakers now have adopted this perspective, actual innovation policies are still largely inadequate in at least two respects: (i) they focus on the management of innovation systems in a steady state, not aiming at structural changes, innovation system transformation and processes of emergence of higher levels of organisation; and (ii) policy approaches have not been complemented by instruments necessary to tackle systemic problems, instead they often stick to the traditional, often linear-model-based toolkit. We proposed two solutions for these problems: a distinction between operational (steady state) and strategic policies (dynamic state) and systemic policy instruments, both being part of emerging systems-evolutionary perspectives to innovation policy broadly defined. In this final section we will draw some conclusions regarding these two concepts and also point at some issues that deserve further attention from policy makers and innovation scholars.

Strategic Policies

A strategic level of policy (for simplicity we can call this 'strategic policies') by necessity focuses on an extended policy process, one which begins with the setting of new strategic priorities and continues with efforts at articulating these in terms of a new set of policies. Their relevance is enhanced whenever strong changes in the global and/or domestic environments call for a new or adapted innovation system, one inconsistent with the existing set of policies and with a rational system
of innovation, which is in a 'steady state'. In contrast to the operational level of policy which focuses on the implementation of an existing set of policies, action at the strategic level aims at generating a new set of policies, one better fit to the new global and domestic context, i.e. aimed at achieving the required changes in the economy and innovation system. Strategic policies should be understood as comprising three main components: incentives and related programmes, e.g. supporting R&D in firms; institutional and regulatory changes, e.g. new IP laws and regulations; and other actions such as technological forecasting, setting new priorities and, whenever relevant, a long-term innovation agenda and creating new 'strategic' policy institutions. The latter are critical when shifting from a dominant operational level of policy mode to a mode which includes both an operational and a strategic level.

Systemic Instruments

Systemic policies ask for instruments able to cope with the characteristics and dynamics of the management of systems. Until now linear-model-based instruments that are not well equipped to handle these characteristics and dynamics heavily dominate portfolios. For this we introduced the concept of systemic instruments able to intervene in an orchestrated way in coherent parts of the system to manage steady state systems and guide the transition of structural changes in the system. In particular these instruments should address four functions: reshaping of innovation systems, building platforms for learning and experimenting, stimulating demand articulation and vision development and providing a tailor-made strategic intelligence infrastructure. From our analysis it appears that there are strong indications that systemic policy instruments are the product of learning processes in which policy, theory and process heavily interact. In other words, they are the result of a co-evolution of innovation practice, theory and policy.

Still, many such instruments have not been analysed thoroughly; there are also hardly any systematic monitoring and evaluation procedures to facilitate this analysis. In consequence, there is a great deal of uncertainty as to the nature and the magnitude and the structural character of the impact of these instruments. Up to now, however, the potential to reinforce the efficiency and effectiveness of other instruments in the portfolio has not been exploited because policymakers' focus is still rather on linear-model-based instruments addressing individual organisations or relations between two organisations and not the portfolio as a whole.

Apart from the problems related to monitoring, evaluating and analysing the impact of these instruments, the most important problems with the further development of systemic instruments concern questions such as: how to creatively destroy systems, institutions and relations that no longer meet the new demands; how to organise effective learning and experimenting; how to ensure that systemic instruments achieve structural, long-lasting results; and how to provide actors with the right attitude and appropriate skills.

Agenda for Further Research

Though there are some early experiences with strategic policies and systemic instruments, as illustrated with our two cases, there still are a lot of open questions. In our view the most important ones include:

- Further development of a systems-evolutionary perspective to innovation policy broadly defined, in particular concerning the strategic level of policy and associated policy institutions.
- Analysis of co-evolutionary processes involved in systems of innovation transformation and of associated learning processes including those involving policy in its various dimensions: process, institution and theory (including research into the impact of systemic instruments on these learning processes).
- In-depth analysis of a limited number of systemic instruments. The major issues that should be addressed in the analysis are: the contribution to the five functions, the realisation of intended (and unintended) impact, the impact on other instruments in the portfolio and the organisation of effective evaluation.
- In order to improve the insight into the use of systemic instruments a number of Begleitforschung projects (monitoring analysis) of major innovation projects with a strong systemic character, could be initiated. These projects could (i) provide innovation researchers with insights into the role of systemic instruments in complex and long-lasting innovation processes; and (2) offer actors involved in the innovation processes with concepts, information and instruments that might help them to realise their goals.

An essential condition for strategic innovation policies is the creation of a strategic level of policy including its organisational, capabilities and governance underpinnings. Policy must become more knowledge-based, drawing on Strategic Intelligence (see Chapter 16 in this book by Smits et al. on the Role of TA in Systemic Innovation Policy; Kuhlmann et al. 1999; Kuhlmann 2003) and strategic prioritisation (as a precondition for actual policies and changes in policies) should assume a central role within an expanded system-evolutionary policy process entailing the incorporation of an explicit strategic level.

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