

# **Holistic Innovation Policy:**

## **Theoretical Foundations, Policy Problems, and Instrument Choices**

*Book authored by*

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## **Literature**

# **CHAPTER 1**

## **Why we need an holistic innovation policy: Goals, problems and instruments**

### **Abstract**

This chapter introduces the main idea of the book, namely, the theoretical foundations, the problem-oriented approach, and the focus on the instrument choices of an holistic innovation policy. The chapter argues that innovation studies have left unfinished the theoretical foundations for the design of innovation policy. The chapter also argues that a starting point for developing it is the identification of the problems that tend to afflict the performance of innovation systems and the ten determinants of innovation processes. This provides the basis for the choice of innovation policy instruments. The chapter provides a road map of the contents of the book.

## **Introduction**

This book is about holistic innovation policy: its theoretical foundations, its problem-oriented approach, and its instrument choices. We argue that most innovation policies today are partial rather than holistic. They are partial because they focus only on a few dimensions in the innovation system, rather than having an encompassing view on it. Hence, partial innovation policies leave aside and undervalue crucial problems that deserve policy attention. Developing an holistic innovation policy requires an understanding of the nature and dynamics of innovation processes in the socioeconomic context of innovation systems. Equally important, holistic innovation policy also requires an understanding of the nature of the problems, including the unintended consequences of policy itself.

Over the past decades it has become popular among many governments in the developed and developing world to adopt a series of initiatives influencing the direction and speed of innovation in different ways. National, regional, and local governments seek to provide conditions that foster innovation in their societies and economies. These governmental initiatives are very diverse in nature and aim at different goals, like economic growth and socio-economic development, the improvement of public health, better energy and transport systems in growing cities, or more effective environmental protection. Hence, there is today a bewildering number of cases with very different degrees of success. The situations that these policy interventions address, the resources deployed (monetary, organisational, authority, analytical resources, or otherwise), and the clarity of political goals behind those interventions are not the same. Neither are the outcomes of these policies.

The notion of 'innovation' is hype among political circles. This thrust originates from the widespread view that innovation is a positive source of transformation of the economy and society, and for social progress in general - albeit with some possible negative effects too (Schot and O'Donovan, 2016). This transformative view of innovation has been stimulated by international organisations' analysis and comparative assessments across countries and regions.

However, even if the notion of innovation has permeated much of the political discourse, innovation policies remain skewed, unfocused, and limited. They are partial, not holistic. This is clear when we look at the different areas that most governments focus on when defining their innovation policies. Whereas some areas like scientific production and basic research activities tend to receive a lot of attention from policy-makers, other issues that are absolutely key for fostering innovation in the economy and society have paradoxically received far less attention - for example, the link between skills formation and innovation performance, or the role of prototyping and demonstration: the 'D' in the 'R&D' notion. As we will see in chapters 4 and 5, education, skills formation, and training, as well as prototyping and demonstration activities continue to be undervalued in the design of innovation policies.

Another example of skewed and partial policies is the balance between a supply-side and a demand-side focus in the design of innovation policies. Most government initiatives and areas of attention have to do with the supply side, looking at the provision of specific technological capacities in the economy. It is only very recently that the demand side has received increasing attention (Mazzucato, 2016), focusing on private and public consumption patterns and demand (Edler and Georghiou, 2007) (Edler, 2009) (Edler, 2009; Edquist and Zabala-Iturriagagoitia, 2012). This again shows the unbalanced nature of most of current innovation policies.

All of the above shows that innovation policies today remain largely skewed and partial. For that reason, they need balance in terms of taking into account all the different activities of the innovation system (not only a few), the different aspects most relevant for the particular country or region, and the actual problems that hinder innovation processes from unleashing their transformative effects in that particular economy and society. In order to achieve these it is necessary to consider developing holistic innovation policies.

Almost three decades of the development and use of the innovation systems approach have put forward valuable insights on the context within which innovation processes take place (Steinmueller, 2006). By understanding that innovation is anchored in a

complex context, the systems approach has provided a broad analytical framework to examine how the comparative innovative performance of national or regional economies are related to the performance of socio-economically and politically defined frameworks. This approach has been particularly suitable to see the role of policy fostering innovation as an important dimension within the system.

This extensive literature on innovation has insisted on the need for policy to build effective innovation systems (Mytelka and Smith, 2002), in the sense that they become true selection environments for the evolutionary processes of innovation (Metcalfe, 1995), and effective also in terms of building frameworks fostering the co-evolution of innovations, the economy, and society (Nelson, 2009) (Dutrénit; Puchet Anyul and Teubal, 2011).

However, when dealing with innovation policy from a systems of innovation perspective, the literature has continuously suffered from two important gaps.

The first gap is what we might call the 'unfinished business' of the innovation systems literature, when it comes to providing specific and detailed theoretical foundations (including policy rationales) for innovation policy. This unfinished business refers to the large distance that exists today between the very abstract theoretical considerations about the nature of knowledge and the generic precondition of public intervention on the one hand, and the concrete problems that require policy intervention on the other. Because they are so abstract, those general considerations seem poorly equipped to provide a clear theoretical anchorage to the real complex world of policy-making in specific and concrete areas. The system of innovation approach was a great leap forward in innovation studies when it was defined in the late 1980s and early 1990s, but it has so far not been able to provide a specific theoretical background for policy-making.

The second gap has to do with the widespread tendency in the literature to separate the analysis of innovation processes from the analysis of the existing policies. In other words, many studies do not include innovation policy as part of the object of study, as part of the analysis. Instead, in those studies, policy typically comes into the picture in

an *ex-post* manner when discussing the ‘policy implications’ of the findings. This ‘policy implications syndrome’ as we may call it, means that policy recommendations are being formulated normatively and in a generic manner, rather than concretely and upon the examination of the policy actions and initiatives already in course. For this reason, these policy implications run the risk of being redundant (because the public actions already exist – in which case it is a question of why the existing policies are ineffective). Or they run the risk of being unnecessary (suggesting public action for problems that are not relevant or suitable for public intervention). Even worse, they might suggest some policy interventions in a direction that ignore other more acute problems in the innovation system (turning a blind eye to the ‘elephants in the room’, particularly when existing policies and public structures are part of the problem). Sometimes this is related to the needs of some specific countries in emerging economies (Kuhlmann and Ordonez-Matamoros, 2016). Other times it is related to some generic areas that have been somehow under-explored, as explained above.

This book is about the theoretical foundations of innovation policy. It follows the tradition of innovation policy from an innovation systems approach (Kuhlmann; Shapira and Smits, 2010). In that sense, this book takes the point of departure from the above mentioned gaps in the current literature, and aims at making a contribution to the field with at least two novelties.

The first novelty of this book is to provide a theoretically anchored foundation for innovation policy-making that avoids the traps of too abstract theoretical considerations, or too metaphorical treatments. Therefore, this book provides a mechanism to identify and explain concrete policy problems that tend to afflict innovation processes. Innovation systems are characterised by ten (or more) essential determinants of innovation processes. Explaining the nature and features of concrete policy problems that afflict each of these ten determinants (or activities) is a necessary stepping stone for the identification of viable, relevant, and down-to-earth policy problems and their solutions.

The second novelty of this book is to provide a problem-based approach to innovation policy rationales and instruments, as being part and parcel of the innovation system, and not something that comes afterwards in the analysis. This book offers a critical analysis on policy, its instruments, and its way of pursuing public action in the complex area of innovation. It is not a 'recipe' nor an uncritical 'how-to' guide, ready-made, 'one-size-fits-all' book for policy-makers. Instead, this book aims at providing analytical depth and substantial critical considerations about the ways in which policy might be providing solutions to convoluted policy problems, as well as the negative, unintended consequences that policy itself might pose.

### **The unfinished theoretical foundations of innovation policy**

The question of the theoretical foundations for public action in the field of innovation has been discussed in the innovation literature since the seminal work of Arrow (Arrow, 1962) (Nelson, 1959). Following those initial steps, the literature has traditionally pointed at three forms of market failure associated with science and technology inputs in the innovation process. These are the limits of the appropriability of new knowledge (due to its non-rival and non-excluding nature); the uncertainty about the industrial applicability of basic research (or its serendipity) and its ultimately possible industrial utilisation; and the information asymmetry in capital markets, between the scientist and the investor (Aghion; David and Foray, 2009b).

The rise of the neo-Schumpeterian tradition (Schumpeter, 1942/2005), particularly the institutional and evolutionary economic theories since the early 1990s, has challenged some of the views on the role of technical change in the economy (Nelson and Winter, 1982), with relevant theoretical connotations for the design of innovation policy. The evolutionary and institutional approach sees innovation as a socially embedded process in a complex system where many elements (other than R&D) intervene, and where institutional frameworks play a major role. From this systems perspective, where context matters a lot for innovation, scholars have questioned assumptions of linearity

of the innovation process (the process assuming that scientific research leads to innovation) (Kline, 1985) (Godin, 2006).

Such considerations are the backbone of evolutionary and institutional economists' recommendation to focus on a wider perspective, one that takes market failure as one among other possible failures (or policy problems), and looks at a wider array of possible failures (Kline and Rosenberg, 1986) (Carlsson, 1995) (Carlsson and Jacobsson, 1997) (Smith, 2000) (Klein Woolthuis; Lankhuizen and Gilsing, 2005) (Chaminade and Edquist, 2010). Some of the barriers and obstacles mentioned in the literature include infrastructure provision and investments, barriers associated with the transition towards sustainability, innovation lock-in, network barriers, capability and learning issues, or lack of institutional complementarity. It is worth noting that these obstacles and barriers go beyond the traditional concerns of the three market failure rationales mentioned above. Taken together, this approach represents a novel effort to bring forward the importance of the contextual issues, and how these dysfunctions might negatively affect patterns and outcomes of innovation activity in its many different dimensions.

However relevant those obstacles and barriers, the theoretical foundations for innovation policy design from the innovation systems approach remain underdeveloped today. Despite the growing amount of literature devoted to these matters, the question of when and how public intervention in the innovation system is motivated or required, remains rather open-ended. To be sure, the innovation systems literature provides some relevant blueprints for public intervention. However, oftentimes the theoretical foundations are formulated very abstractly and generically, without a clear description of which problems might afflict the innovation system. Moreover, they tend to disregard the potential problems generated by policy itself.

For that reason, clearly identifying the obstacles and barriers in the innovation system is a necessary first step for defining the scope and the nature of policy-making. We need a process in which a series of observations from theory, from innovation processes, and from the real world of policy-making are used to develop specific views about the

obstacles and barriers that often afflict innovation systems. This will not only bring policy practice closer to the scholarly work, but it will also provide critical clues for further theoretical development. The latter refers to the process of theorising, which entails a certain degree of real-life observations in the context of discovery, as well as considerations from previous findings (Swedberg, 2012). To be sure, theorising is a process by which abstractions are developed in this context of discovery and into a gradual approximation towards the final development of a theory (the product of theorising) (Sutton and Staw, 1995). 'Perhaps the ultimate trade-off is the one between process and product, between theorizing and theory, between doing it and freezing it' (Weick, 1995, p. 390).

Hence, the ambition of this book is to provide a solid theorising process that will ultimately, in the future, bring forward a fully-fleshed theory about the design of holistic innovation policy. In other words, this book constitutes a first step into the theorising process that consists of building some stepping stones that bridge the gap between the observations of the real-world of innovation policy-making, with the stringency and strengths of analytical scholarship. In order to do so, this book puts a particular emphasis on observing in detail the obstacles and barriers that are most often afflicting innovation systems. Thus, this book is a theorising endeavour observing and identifying specific obstacles and barriers in the real-world of innovation processes and the systems in which they are contextualized.

With this purpose in mind, the leading questions of this book are related to identifying and developing the theoretical foundations of innovation policy: Towards what specific dimensions and problems in the innovation system should governments direct their attention? Can policy solve all types of problems in the innovation system – and if so, which ones? What should public policy try to do and what should it not? What are the unintended negative consequences of innovation policy? What specific policy instruments and combinations thereof are most suitable for solving different problems in different innovation systems?

## **What goals? What problems?**

Policy rationales are the set of underlying reasons—the logical basis—for the course of a public action; in this case, for policy intervention. Therefore, a rationale can be seen as a consistent and well-defined argumentation that is used to justify (*ex-ante* or *ex-post*) the decision and shape of a policy intervention. They can be *ex-ante* in the contexts of political discussions and negotiations. They can also be *ex-post* in situations where policy-makers are arguing about decisions that were made previously, in the absence of explicit formulations. This argumentation, logical basis, and reason can be very differently formulated, but in the context of our current endeavour policy rationales are essentially the result from the process of theorising. By collecting and putting experiences and observations from the real world into the context of discovery, the process of theorising brings concrete phenomena into broader scholarly discussions. This is to say that, necessarily, these scholarly discussions will be related to a certain level of concreteness and move into a more general level of discussion.

A good starting point for such an endeavour is to ask questions about the specific goals of innovation policy, e.g. public health, economic growth, and environmental protection. What are the ultimate goals of innovation policy? The identification of clear goals gives an important sense of directionality and an ultimate purpose of policy interventions. This might sound trivial, but real-life goals are not always explicitly formulated or obvious.

Thereafter, at a more concrete level, the question that emerges is, what specific problems are innovation policy aiming to address? As we will discuss later, not all problems associated with innovation are amenable to being addressed by public interventions. For that reason, it is paramount to identify those problems in a clear way. Describing the specific nature of the innovation system suggests observations about the unwanted or harmful situations that need to be overcome and that are amenable to policy intervention. It is a matter of identifying the obstacles and barriers which typically and most often tend to afflict the good functioning of the innovation system, when aiming to achieve the ultimate goals suggested above.

The issue that arises at this point is how to identify the problems and how to formulate them. Here we need to revert to the characteristics and nature of the innovation system. This book focuses on ten crucial activities that define an innovation system, and looks into them one-by-one in order to identify the problems. Hence, based on our previous discussions above, this book will undertake the process of theorising in three interrelated steps.

Firstly, it describes the features that characterise the specific activities and dimensions in the innovation system. This serves as guidance to proposing a mechanism or method for identifying policy problems in the system. Such policy problems may be mitigated by means of innovation policy instruments that are related to the activities.

Secondly, this book looks into the problems generated by policy intervention itself. This is an important matter, as governmental failure might be an important source of problems in the innovation system. Policies may be designed in a way that generate unexpected negative effects (for example, by distorting incentives).

Thirdly, this book identifies a series of more specific obstacles and barriers that might plague each of the different ten activities and dimensions in the innovation system, and which might be addressed by public policy (see section 12.4). This is done taking into account the available policy instruments, their choice, and their implementation.

### **Instrument choice and the learning policy-maker**

The choice of policy instruments is a crucial matter in the process of designing or, more correctly said, of constant re-designing of innovation policy. Yet, the availability of instruments and the logic behind their choice is always constrained by budgetary as well as politico-administrative matters and other circumstances. Yet, the specific forms of instrument mixes that governments develop through time, in new combinations, have to be based on a systematic review and appraisal of the obstacles and barriers that innovation encounters in a given country, region, or municipality. To do otherwise might

run the risk that innovation policy becomes too conservative (without any significant or relevant changes in the instrument mix), and hence an oxymoron. Yet, policy-makers are always bounded one way or another (by limited resources, information, etc); and, even if their choices might not be entirely free, their decisions have to be adaptive and based on continuous learning from experience.

Policy-making is certainly not always a rational and mechanistic process. On the contrary, it has been famously described as a process of 'muddling through' (Lindblom, 1959). This is so because the problems that policy-makers are dealing with are complex, interrelated, and ever-changing. Moreover, policy-makers have limited resources, limited information, and operate within values-based political systems that determine political priorities (Forester, 1984). Furthermore, policy operates in a context of uncertainty, which means that there are no 'ready-made' or 'one-size-fits-all' policy solutions. For all those reasons the real life of policy-making tends to be incremental and based on gradual adjustments of existing instruments, rather than on great leaps or sudden deep changes. Hence, it is more accurate to talk about the constant re-design of innovation policy-making, transforming, and changing it in a gradual manner, according to what is needed but also to what is feasible.

Policy-making is about choice, implicit or explicit, by action or inaction. There are also some elements of serendipity in policy-making, as sometimes charismatic individuals are able to take the initiative and act as policy entrepreneurs (Breznitz, 2007) in specific circumstances and windows of opportunity (Citi, 2014). At other times, loosely defined ideas become fashionable, promoting some specific solutions in the absence of identified problems or clearly defined goals. And at other times, societies might have anti-government and anti-policy discourses overemphasizing the role of the free market or of society, while their governments are simultaneously developing highly sophisticated and encompassing forms of public interventions. All of this shows how complicated innovation policy-making can become.

Policy-makers operate in a context where their policy initiatives need to be relevant and realistic. This requires not only high-level political will in the country, region, or

municipality, but also, very importantly, the acceptance and adaptation of the relevant stakeholder groups in the economy and society while implementing the policy instruments.

This latter remark brings us to a key dimension in policy-making, namely, the participation of stakeholders in policy-making. The participatory nature of policy-making has been advanced in the new forms of governance, where public and private actors co-create and collaborate intensively in the definition and solution of complex collective problems (Pierre and Peters, 2005). Governance refers here to these forms of interaction where the state or public actors are one among other actors engaged in these collective processes, yet, an actor that (in most cases, not all) has particularly strong resources (authority, budget, etc.) and hence is not simply 'an additional' actor.

In the field of innovation policy, participation has been mainly addressed at regional and municipal levels, sometimes in the form of conditionality from external funding (donors or international organisations) (Diez, 2001). But it has also been extended to non-parliamentary forms of public participation at the national level (Joss, 1999), typically in the form of broad societal consultations and discussions, as well as participatory forms of technology assessment and forecasting (Weber; Harper; Könnölä and Carabias Barceló, 2012) (Schot, 2001). This is mostly associated with the need of broad societal debates about the consequences of specific innovations, as much as about the general societal priorities for the direction of socio-technical progress and innovation in the society, and its self-defined limits (Schot and O'Donovan, 2016).

Our book follows this participatory tradition, acknowledging that these broad and open debates are the way forward to democratising important decisions about the collective future of a society. But also, they are the way to limit the harmful effects of sectoral interests capturing policy decisions. This latter point is not trivial in innovation policy. The large budgetary allocations of national and regional R&D public expenditure, and the regulatory frameworks authorising (or not) new products, are two areas that typically attract a substantial number of private vested interests. Striking a balance between those in ways that the collective will is ultimately respected is not easy at times.

This book takes these issues into consideration when examining one-by-one the different areas of innovation policy-making, as the dynamics might differ according to these areas. Enhancing the absorptive capacity of governments, reinforcing their internal knowledge capabilities, and intensifying their intelligence sources about the problems of its innovation system is a useful way to immunise policy-makers to the arguments of vested interests, while letting them keep a solid overview of other interrelated issues in innovation. This has to do with policy-learning (Borrás, 2011).

The literature on organisational learning, and particularly the seminal work of James March, shows that past experience is ambiguous and therefore learning (as a process of sense-making of that experience) can take several forms. It can be a process of trial-and-error and/or a process that links past experience with abstract analytical frameworks (March, 2010). Our book follows that second type of learning process. It aims at developing a solid theoretical and conceptual framework that will serve the double purpose of guiding policy-makers in their co-evolving and participatory learning processes, and of advancing the social sciences' theoretical foundations of innovation systems and innovation policy.

Stan Metcalfe's view that 'the evolutionary policy-maker adapts rather than optimizes' (Metcalfe, 1995, p. 418) is particularly salient here. Adaptive (learning) policy-makers muddle through, inducing gradual (yet substantive) change, participating with a wide array of stakeholders in open discussions and co-creation of solutions, while keeping solid and independent overview. Acknowledging the multiple and highly diversified state of traditions and politico-administrative systems, this book recognises that there are no silver bullets or ready-made solutions. Instead, it aims at stimulating theoretically-solid critical thinking among policy-makers and researchers. On that basis we propose a mechanism of identifying policy problems and mitigating them by proposing relevant policy instruments.

## **The contents of this book**

The next two chapters constitute the conceptual backbone of the book. Chapter 2 comes to grips with the nature of innovation and of the innovation system, and in so doing it identifies ten specific activities that define an innovation system. The ten activities are specific elements directly related to the performance of innovation, which collectively shape the way in which innovation takes place in a specific economy. It develops and presents the theoretical basis, i.e. the specific assumptions and conceptual underpinnings for the development and presentation of the holistic innovation policy approach.

Chapter 3 develops the core of the argument regarding the specific assumptions and theoretical propositions about the role and limits of innovation policy. The theoretical basis for the holistic approach to innovation policy proposed in this book includes the identification of the concrete policy problems that afflict the innovation system, including the unintended consequences when implementing policy. Following from that, the chapter argues that most innovation policies across countries are still partial, not holistic; that innovation policy must be separated from research policy; and that innovation policy-learning can only take place using an analytical model that helps understanding what worked, how, and why.

Chapter 4 focuses on knowledge production as one of the ten activities in innovation systems. It addresses questions like: Who produces scientific and technical knowledge these days? What type of knowledge is being produced, and for what purposes? Why are firms and governments funding research and development? It studies the role of public policy in knowledge production (especially R&D activities) relevant for the innovation process from a perspective of innovation systems. It examines how public actors have traditionally approached the issue of building, maintaining, and using knowledge in their innovation systems. It also identifies four typical policy-related obstacles and barriers associated with knowledge production in an innovation system. Next, it elaborates a set of overall criteria for the selection and design of relevant policy instruments addressing those barriers. Most importantly, the chapter argues that in most

countries, innovation policy continues to be subsumed under research policy. An holistic and problem-oriented innovation policy requires that innovation policy and research policy are separated from each other in the design phase – but they must support each other when implemented (in the same way as many other policy areas have to be coordinated with each other).

The main question that guides chapter 5 is how governments are focusing (and must focus) on competence-building (education, training, and skills formation) when designing and implementing innovation policies. After a brief literature review, this chapter suggests a typology of internal/external and individual/organisational sources of competences that are related to innovation activities. This serves to examine briefly the most common initiatives that governments are taking in this regard. The chapter identifies three overall obstacles and barriers in innovation systems in terms of education, training, and skills: the insufficient levels of competences in a system, the time-lag between firms' short-term needs for specific competences and the long time required to develop them, and the imbalances between internal and external sources of competences in firms. On this basis, the chapter elaborates a set of overall criteria for the (re-)design of policy instruments addressing those obstacles and barriers.

Chapter 6 looks at innovation-related public procurement as a specific form of innovation policy instrument operating from the demand side, as opposed to R&D that operates from the supply side, and has dominated - and is still dominating – innovation policy. The demand-side of innovation policy may affect both the rate and direction of innovation processes. This could particularly be realised if an increasing part of the products (goods, services, and systems) are procured on the basis of descriptions of problems (societal, environmental) and functions, rather than on the basis of descriptions of products. Public procurement amounts to about 15 per cent of GDP in the whole of the European Union, i.e. €2.0 trillion. Part of this enormous sum is already being used for supporting innovation by means of functional procurement and there is potential for much more of it to be used in that way. In this way, functional public procurement can become the most important instrument among all innovation policy

instruments. It would then also be an important element in the transformation of innovation policy from being partial and linear to becoming increasingly holistic.

Chapter 7 addresses organisations and organisational change, which are crucial elements in innovation systems. Yet, their role is so ubiquitous that it is difficult to grasp and examine from the perspective of public policy. Besides, links between the literature at firm and systems levels on the one hand, and public policy studies on the other, are still scarce in this field. The purpose of this chapter is to define the conceptual background of innovation policy in relation to the role of organisations, looking in particular at the role of entrepreneurship and intrapreneurship as examples of organisational change. In so doing, this chapter aims at making three contributions. Firstly, it defines the role of entrepreneurship and intrapreneurship in the innovation system, a crucial topic in understanding innovation dynamics and its blurring borders. Secondly, it identifies the obstacles and barriers related to entrepreneurship and intrapreneurship in innovation systems and examines the choice of policy instruments to solve them. Thirdly, it discusses the limits of public policy and suggests key issues in the design of innovation policy.

Chapter 8 focuses on networks and complex forms of interactions in the innovation system. The logic behind this is that innovation systems cannot be conceptualised without understanding the networks that are formed by different actors in the system. These interactions take many different forms and dynamics, some of which have received specific attention in the literature, ranging from broad notions like social innovation and open innovation, to more specific forms of business-related and business-driven innovation interactions like firms' strategic R&D alliances, global and/or localised innovation networks, and user-driven innovation. This chapter aims at providing an encompassing view of these different notions, putting them directly into the theoretical context of the innovation systems approach. This is done not only for the sake of conceptual clarification, but above all for identifying the concrete obstacles and barriers associated with these interactions that might plague the innovation system. This serves as the basis for distinguishing and classifying the wide diversity of network-oriented innovation policy instruments that governments have deployed through time.

Just as in other chapters of this book, the unexpected negative consequences of these instruments are also examined as part and parcel of possible obstacles and barriers in the innovation system. Last, the chapter puts forward a set of criteria for the design and re-design of these instruments according to the specific features that define the obstacles and barriers in the system (and of policy itself).

Institutions (understood as 'rules of the game') are constitutive elements of innovation systems, and therefore cornerstones of innovation policy. Focusing on soft and hard regulation, chapter 9 identifies salient regulatory areas from the perspective of the innovation system. When addressing the effects of regulation on innovation, the chapter argues that there are three key issues that need careful empirical analysis. One is whether regulation is effective and efficient in terms of reducing uncertainty and generating incentives. Another is whether it is able to generate wider social benefits for the innovativeness of the economy at large. A third issue is the extent to which regulation is adapting to new (social, economic, and technological) contexts and is socially legitimate and accepted. These are three issues that innovation policy needs to address in this area.

Chapter 10 examines small firms' access to venture capital for financing innovation processes. We go to great lengths to discuss where, i.e. in which situations, private funding is not available and why this is so. We address the rationales for public intervention, i.e. in which situations policy should be pursued. We also address the policy instruments for financing innovations that the state has available. We present a description and analysis of the provision of risk capital by the Swedish state. We describe a situation where unintended consequences of the policy pursued led to the nonfulfillment of the additionality condition. We also describe how this mistake has begun to be resolved after discussions in the Swedish National Innovation Council, a government investigation, a bill from the government to the Parliament, a decision there and the subsequent creation of a new public risk capital company, wholly owned by the Swedish state with a capital of five-billion Swedish crowns (€0.55 billion). This means that we address innovation policy (re-)design in action.

Chapters 4 to 10 examine different crucial areas or activities in innovation policy, the obstacles and barriers that emerge around them, the innovation policy instruments different governments have used, and the typical unintended negative consequences of policy. These three dimensions have been examined in order to identify some crucial aspects when designing or re-designing innovation policy instruments.

Chapter 11 focuses more concretely on the different innovation policy instruments as a whole. The purpose of this chapter is to discuss the different forms of intervention by governments, to explore the political nature of instrument choice and design (and associated issues), and to elaborate a set of criteria for the selection and design of the instruments in relation to the formulation of an holistic innovation policy. The chapter argues that innovation policy instruments must be designed and combined in ways that address the problems identified in the innovation system. These mixes are often called 'policy mixes', although we prefer the expression 'instrument mixes'. The problem-oriented nature of the design of instrument mixes is what makes innovation policy instruments 'holistic'.

The concluding chapter 12 takes stock of the detailed considerations in its different sections, looking into a series of fundamental issues related to holistic innovation policy design. Most of all, this chapter summarises previous chapters' identification of the problems, obstacles, or barriers that can afflict innovation systems. Together, the previous chapters provide an encompassing set of theoretical foundations behind the design of holistic innovation policy, which includes not only framing the problems in the innovation system, but also considerations about the most suitable policy instruments for the tasks at hand, including the unintended consequences that might be posed by policy instruments themselves. Readers who prefer to cut to the main arguments of the book may read chapter 12 independently.