

The State and the Architecture of National Systems of Innovation

Mario Scerri and Helena M. M. Lastres

The series of global financial and economic crises which have been escalating since 2008 have caused shock waves not only in the global economy but also in the stance of economic orthodoxy regarding the ideal relationship between the state and the economy. What is now seen as a singular crisis is very much a product of a particular variety of global capitalism, which is historic in its unprecedented closeness to a neoliberal ideal of the minimal state, both at the global and at the national level. At the very least the crisis is now generally seen as a failure of the global regulatory framework vis-à-vis financial markets, and even in this very limited sense the economic role of the state is now being questioned anew by economists, politicians and global civil society. In the case of evolutionary economics and that branch of it which looks at systems of innovation theory, the role of the state as a shaper and mobiliser of systems has consistently been one of the prominent areas of study.

This book provides a comparative analysis of the relationship between the state and the National Systems of Innovation (NSI) of Brazil, Russia, India, China, and South Africa (BRICS) and this chapter seeks to address four issues which we see as germane to this study. The first, and conceptually the most challenging, deals with the very rationale for placing the role of the state in the development of the NSI as a legitimate object of analysis. In the process of arguing for this rationale, we hope to show that the whole discussion of the location of the state in systems of innovation

discourse is quite complex and analytically rich. The second issue concerns the particular varieties of the NSI concept which have been adopted in the individual chapters. Although these five studies in this book generally fall within a broad definition of systems of innovation which goes considerably beyond the sphere of science and technology, there are nonetheless differences of emphasis in the application of this concept to individual cases. The third section provides a succinct comparative treatment of the five country cases. Finally, we outline the basis of future research in the area, arguing that the emergence of the BRICS grouping may have possibly laid the foundation for a new discursive formation in studies on the NSI.

There are several cogent reasons for engaging in the analysis of the relationship between the state and the NSI. Primary among these is the fact that if the fabric of the NSI is an institutional web, it is the Weberian (Mannheim 1947) state with its monopoly on violence and legitimate coercion which sets the foundation of rules and regulations, explicitly as sets of legislation, from which this institutional web emerges. It is this foundation of rules and regulations which shapes the evolution of the various institutional sub-systems which constitute the NSI. On this basis, it is therefore legitimate to claim for the nation state the theoretical position of the defining agent of the NSI. The rationale for the assignment of this primacy to the state in the study of NSI stems at least as strongly from the development of thought in the area of the economics of innovation as it does from empirical observation of the role played by governments in the development of systems of innovation.

We must, however, at the outset introduce a sense of misgiving about the very wording of the title of this book, an articulation which was inescapable but which opens up the discourse in this area to what we feel is a mistaken dichotomy between an entity labelled as the state and another as the NSI. This is a dichotomy which is all-pervasive in economics, whatever the ideological stance towards the state, and which pervades a wide range of development approaches. Whether the role of the state is seen to be circumscribed solely by the need to address the presence of public goods and externalities, as in neoclassical economics, or as formed as the agency of the capitalist mode of production, as in most Marxist literature, or as a Foucauldian account of power exercised through governmentality and biopolitics, or as the possible launch pad of development as in most of development literature, the implicit underlying assumption

is that of an organic separation of the *body politic* from the *body economic*.¹ This dichotomy has run throughout most of the economic literature on innovation, as it has through mainstream economics, but this was not a necessary outcome of the body of economic theory which came to be loosely defined under the rubric of innovation. This theoretical objection to the separation of the state and the economy echoes a similar disquiet in state theory at the separation of theories of the state from social theory.²

The systemic approach to innovation and to the economy in general, which has been adopted in the heterodox economic literature on innovation, contains the basis for a novel integrated study of innovation systems which has to be understood by looking at the various dimensions of economic systems. This perception allows crucial dimensions of the system of innovation approach to be explicitly discussed: the emphasis on historical and national trajectories and the importance of taking into account the production, financial, social, institutional and political contexts, as well as micro, meso and macro spheres.³

There are numerous reasons why innovation theory has yet to provide an alternative general theory of economics, not the least of which is its relatively short history combined with the overwhelming hegemony of neoclassical economic theory. In addition, and as argued by a number of authors, a new framework of thought capable of orienting the analyses of development problems related to knowledge, innovation and learning is also fundamental.⁴ In this line it could be argued that the attention the performance of BRICS has attracted in the beginning of the millennium — given not only their share of the world product and trade, their reserves of natural resources and of financial capital, the size of their domestic markets, but also their various challenges — can contribute to reinvigorate the interest in development issues and in the comprehension of how knowledge is acquired and diffused, thus enlarging theoretical contributions and the options for policy prescriptions. In addition, the huge task of reducing imbalances in countries of continental dimensions makes tackling regional and social development a core priority of the policy agenda. There are also opportunities for the development of new policy models which foster sustainable and coordinated development at national, regional and local levels. For those institutions which design and implement policies, the pressure for the elaboration and use of concepts, indicators and

models which help to reduce the imbalances, instead of reinforcing them, and which bind economic and social development within a long-term perspective become extremely relevant. This reinforces the need to develop new ways of looking at development issues. Policies emerging from this approach would include players, as well as production and innovation activities with different dynamics and paths, varying from the most intensive in terms of knowledge to those that use indigenous and traditional knowledge, as well as with different sizes and functions, deriving from the primary, secondary and tertiary sectors, operating locally, nationally or internationally. In other words, what is required is the development of new and broader forms of knowledge capable of contemplating the reality of all sorts of economies and societies. The theoretical base of this approach enables a fuller understanding of developing countries with the complexity of their ecosystems, biodiversity and mainly their social communities — including ethnic and cultural formations — and their own forms of interaction with nature and culture.

There is one fundamental tenet which provides the initial departure of the approach adopted here from economic orthodoxy and this is the introduction of ideology in this particular economics discourse. We start from the proposition that theories and concepts are not ideologically neutral and that they are, often implicitly, value-laden. They derive from and reflect specific conditions and points of view. Most available concepts and theories are still limited to a restricted group of activities as the set of legitimate objects of economic analysis, and the actors and regions of concern are mainly located within the contexts of developed economies. This makes a number of activities, actors and regions invisible to both theoretical and analytical lenses. This invisibility is implicit in the exclusion of these agents and dimensions from the policy agenda. This exclusion highlights the importance of fostering the capacity to develop and use contextualised concepts, indicators and analytical and policy models capable of addressing the challenges and opportunities of each context given their geopolitical, institutional, scientific, technological, economic, financial, social, cultural, and environmental dimensions. The development of this capacity should simultaneously enable the association and articulation of these dimensions in an inclusive way. Of course, this is not an easy task. The main challenges involved still relate to the difficulty in working with new concepts, particularly those aiming at capturing and evaluating the creation, use

and diffusion of innovation and production capabilities in situations of high levels of inequality and informality. However, as knowledge results from interactive learning processes and pragmatic use has an important learning dimension, we also expect that the analysis of the BRICS innovation systems will shed new light not only on these five countries, but also on this concept itself, contributing to its further development.

Another reason why innovation theory has yet to provide an alternative general theory of economics is the wide span of the definitions of the NSI. These can range from a narrow focus on a network of formal science and technology institutions, at one end, to an incorporation of the whole spectrum of formal and informal institutions which come together in partially planned, but mostly unplanned, networks to provide the setting for innovation. Innovation itself may even be defined in its broadest sense to cover any alteration in economic relationships which is seen to be preferable to what is displaced. Within the context of such a broad approach to the understanding of the evolution and performance of economic systems there is a theoretical scope for the elimination of the false dichotomy between the state and the economy. This scope is allowed by the assumption of specificity and the role of history in determining the shape of innovation systems. The propensity to generalise about any group of agents, be it the state, the private sector, civil society, organised labour, etc., is therefore significantly reduced in an approach which holds contextual specificities to be significant non-trivial determinants of the shape and performance of systems of innovation.

Of course, one could argue that an excessive reliance on specificity as the source of understanding of particular systems also holds the danger that each specific NSI as an object of study is treated *sui generis*, bearing little or no relationship whether of similarity or of categorical difference with the studies of other systems. This would obviously eliminate the legitimacy of comparative analysis and eventually of theory. However, except for extreme approaches of this type, the introduction of specificity into analysis does provide the theoretical space for reconceptualising the nature of the concept of the state in relation to that of the NSI. On the other hand, and in line with the argument developed here, it could be argued that all knowledge is contextual. It could also be claimed that the novel understanding of innovation as a systemic social, political

and economic process not only requires advances in theory, but also implies the need to develop a whole new set of indicators and categories to analyse and compare experiences.

Since the introduction of the term, the definition of the NSI concept has varied considerably with often radically different implications for analysis and for policy.⁵ Generally, these definitions differ on the basis of two elements of the underlying concept. The first is the definition of innovation. This may range from frontier and radical technological innovations at one end, to one which includes any alteration in economic activity which represents a real or perceived 'better practice' within a specific context, at the other. There is obviously room for a large range of variations in-between these two extremes. The other element is the definition and choice of institutions which may be considered as part of the NSI. The inclusion of formal institutions would range from those strictly concerned with the promotion of science and technology at one extreme to all those institutions that govern all aspects of the economy at the other. These two elements are often interrelated where an increasingly broad definition of innovation implies a widening inclusion of institutions which are considered relevant to the NSI and to innovation policy. We should not see the possible variations of the definition of the NSI as lying across a continuum. At some point the degree of exclusion/inclusion that is adopted results in two fundamentally different concepts, with radically different implications for policy. As the definition of the NSI tends towards the system of science and technology, we have to admit the possibility of the non-existence of the NSI and the imperative to create one in the interest of promoting economic growth and development. If, on the other hand, the definition tends towards the all-inclusive one, the NSI exists whether planned or not, simply by virtue of the binding legal identity of the sovereign state. In this case the possibility of the non-existence of the NSI arises only where the state is under threat due to foreign aggression or civil war. Within the broad definition, the role of policy is not to create but to shape the evolution of the NSI along a path that is more appropriate to the sustainable improvement of the quality of life of the general public. Within the broader definition of the NSI, state policies outside the ambits of science and technology policy may still be seen by the analyst as innovation policies. Thus trade, industrial, labour, education and basic services policies may become a legitimate object

of the analysis of the relationship between state and the NSI, even if such policies are not explicitly defined as innovation-related by their designers.

It is also important to bear in mind that the question of whether or not to create an NSI becomes less legitimate as we move from the narrow to the broad definition of the concept. It is more relevant to sub-systems but the broader context and the web of informal institutions which comprise the system exist regardless the nature and extent of planning. More relevant is the discussion of what type of NSI to shape through planning and policy and it is here that, in some cases, policy choice is contaminated by the observation of the structure and dynamics of a specific context. Resulting knowledge is formed (and deformed) by this experience. When applied to a different environment this knowledge ends up frequently inducing the reproduction of behaviours and other elements which, while possibly working well in a specific system, prove to be inappropriate for the local conditions and potentialities of another. The main point here is that context matters both in terms of understanding and promoting innovation. History and specific territorial conditions are essential to explain how production and innovation capabilities are acquired, used and further developed. Analytical models, taxonomies and policy prescriptions that disregard these parameters put their usefulness seriously at risk (Lastres and Cassiolato 2005). In other words, 'general history (social, political and cultural) economic history and industrial history are not only indispensable, but really the most important contributors to the understanding of our problem. All other materials and methods statistical and theoretical are only subservient to them and worthless without them' (Freeman 1982: 8, quoting Schumpeter 1939). In a similar line Lundvall (2006) has argued that to develop a general theory of innovation systems that abstracts from time and space would undermine the utility of the concept both as an analytical tool and as a policy tool. One main conclusion here is that by adding new knowledge derived from the observation of new innovation dynamics and contexts, this book can represent a significant analytical and theoretical contribution with even more fundamental policy implications.

In spite of the width of the range of possible variations in the definition of the systems of innovation concept, the central role of the state in the formation of the NSI is always prominent. Even so, however, the various possible combinations that these definitional

options offer open up the possibility of variation in the assessment of the role of the state in the development of the NSI. There is also a strong possibility of a divergence between the analyst's definition of the NSI and its definition by the state. This adds yet another dimension to the analysis of the relationship between the state and the various conceptualisations of the NSI. For the purposes of this study, the broader definition of the NSI is adopted. This definition, which goes beyond the analysis of activities that directly determine technological innovation, captures the overall economic framework which sets the context for innovation. Furthermore, the definition of the economic framework itself is expanded beyond the normal ambit of economic orthodoxy to include all aspects of human capital formation as economic strategy variables. This broad approach is particularly relevant to developing economies where fundamental changes in the underlying institutional infrastructure often form the national development policy strategy framework.

Theoretically, the system of innovation approach with its focus on institutions, formal and informal, provides the broader context within which development economics should properly be based. In this case we have a strong possibility of a convergence between science, technology and innovation (STI) policy and development policy, especially if the broader definition of innovation as any novel and demonstrably superior manner (relative to a specified context) of reallocating resources is adopted. The other two areas of convergence between development economics and innovation theory are the issues of regional disparities and income distribution. In the case of the former, the study of sub-national systems of innovation may enable us to understand the process of regional convergence. In the case of income distribution, we have implications for the process of human capital formation which lies at the core of the evolution of the NSI. The basic assumption of development economics is that of the fundamental inadequacy of economic structures to attain specified development and growth objectives. Consequently, development policy should be designed to engineer the radical structural transformation of the economy in pursuit of the goal. From this perspective, broadly articulated NSI theory with its focus on the institutional foundations of economies provides a comprehensive framework for a coherent approach to development policy.

Even if we accept this argument, we still need to ask about the role played by the state, however defined, in the study of the evolution

of systems of innovation. After all, it is widely acknowledged that it is firms which produce, diffuse, adopt, adapt, and even deploy innovation. Firms, however, normally tend to act within a context, determined by market structures, established practices and routines, as well as formal regulatory frameworks. They rarely, except in the most exceptional of cases, act consciously and in a coordinated manner to alter the context in which they operate. This context is, to varying degrees, the product of the 'extra-market' policies, rules and regulations laid down by the state, by regional (supranational) bodies and global protocols. Again, it is in the context of developing economies where there is a recognised need for structural transformation that the role of the state in the development of the NSI becomes paramount. This role should generally be more pronounced than in the case of mature, developed industrial economies where we should be able to assume (at least prior to the current global financial crisis) the underlying institutional framework to be stable, under healthy public regulation and appropriate for growth, stability and international competitiveness.

We can therefore comfortably say that, at least at the national level, the state is fundamental in the promotion and shaping of the development path of the NSI, however that is defined. It is the state which usually lays down the formal institutional underpinning of economic activity, including innovation. The broader the definition of the system of innovation and the further it departs from a science and technology system, the more pervasive and complex is the role of the state. In a fundamental sense we can say that the state is ever present in the articulation and enforcement of the "rules of the game" which govern the way in which innovation occurs, the roles of the various agents who interact in the production of innovation, as well as the effects which emanate from innovations of various forms. The rules of the game introduced by the state often tend to be explicit but they can also be implicit in, for example, unspecified tender grant and procurement policies, labour market practices, environmental considerations, macroeconomic policies, etc.⁶ Explicit rules, established through laws and declared practices thus also eventually permeate down to the layer of amorphous sets of routines and practices which are probably a stronger long-term determinant of behaviour than explicit rules. Even the most minimal state imaginable, within an extreme form of neoliberal ideology, still sets the 'rules of the game', by virtue of its absence.

The definition of the NSI adopted in this book is generally broad enough to, at least implicitly, allow for some resolution of the fallacious separation of the state and the system of innovation, or even of the economy. This definition extends significantly beyond the system of science and technology to incorporate a wide gamut of institutions, formal and informal, which affect all aspects of innovation. This certainly covers most functions of the modern state, ranging from those specifically concerned with science and technology, to broader concerns of economic policy, to those areas of state involvement which are often assigned to 'social policy' but which directly affect various aspects of human capital formation. In this sense the 'state' which is considered in relation to the innovation system covers almost the entirety of the state and its sphere of governmentality.

The inclusiveness of this approach is certainly firmly within the essence of the systems of innovation approach which highlights the specificities of the institutional interactions within particular systems as crucial to their analysis. It is here that the nature of particular states and their evolution over time has to be brought in as part of the core of the approach adopted in this book. The introduction of history then opens up to a rich and highly diverse treatment of the five NSIs which form the object of this body of analysis. The common structure of the chapters on the one hand belies the rich variety of the form of the state within and without the national systems which they shaped and which in turn shaped them. On the other hand, without a common structure it would have been extremely difficult to come out with a coherent analytical framework for the analysis of this complex relationship within these very different contexts. This commonality may actually bring to the fore the specificity of these five studies which have been brought together in this book.

The case studies of the five national systems of innovation presented are, by virtue of the core nature of the state within a context of structural transformation, closely concerned with policy, with its intentionality, its consequences, intended or otherwise, and with the various political, economic and historical determinants of policy. In this regard we need to discuss the relationship between innovation policy and other spheres of policy which lie within the specifically delineated terrain of state power. Again, this relationship depends critically on the definition of the NSI which is adopted since the extent of the domain of innovation policy is positively correlated

with the breadth of the definition of the NSI. The various studies presented here allude to the degree of integration of policies but again this treatment holds nuances regarding whether we are talking about integration between innovation policy and other policies (macroeconomic, investment, trade, labour, and social policies, to name the immediately obvious) and integration within a definition of innovation policy increasingly broadened to incorporate at the limit all other policy spheres. The significance of these nuances depends both on the analyst's theoretical base and on the official explicit or implicit formulation of innovation policy by the principals of the state. In the specific case of the five systems examined here, all of which are undergoing a rapid process of structural transformation, it is important to assess the relationship between innovation policy and development policy, its convergence or dissonance, and even more fundamentally, the degree of differentiation between the two.

The conceptual foundation of this book thus requires that historical analysis permeates all of the case studies and that specific periodisations are adopted in every case. This periodisation is applied both to the evolution of the role of the state and to the history of the political economy of each country. Again, the degree of convergence of the two areas, the extent to which the evolutionary path of the political economy was affected by the changing role of the state and the degree of convergence, and even possibly the identification, of the two evolutionary paths, differ in each case. This, we feel, makes for a particularly rich comparative analysis of these five very distinct innovation systems.

Certainly, the historical and structural differences of the five economies which are the subject of this book are deep enough to raise the question of the rationale for their grouping within the same body of work. This rationale is loosely based on a number of factors whose peculiar heterogeneity may itself prove to be a valid reason for this grouping of case studies. The immediately obvious rationale is that all five countries have had histories where the very nature of the state has been challenged and altered, often violently, a process which has radically altered the very foundations of the NSI. Second, there is the placement of these five economies on the global political economy topography. Each one of them, in its own right, is particularly influential within a region and as a consequence, its fortunes carry implications at a global level. India and China are now rightly seen as the two emerging economic giants, which, in

spite of their significant structural differences, are destined to alter dramatically the very foundations of the world economic order. The sheer size of the Brazilian economy and the diversity of its base place it at the epicentre of the Latin American development thrust and indeed at the forefront of the sustained countervailing centre of development economics over the past four odd decades. The Russian system of innovation emerging as it has from the total repudiation of the Soviet system of innovation constitutes the most dramatic experiment of the radical destruction of the foundations of one of the two most powerful systems of innovation, globally, until the late 1980s. South Africa is not only unique in its emergence from a particular legislated form of racial capitalism but its NSI stands as possibly the regional economic catalyst for the possibility of the development leap of sub-Saharan Africa. It is also worth pointing out that in three of these cases an important dimension was the influence of colonialism in the formation of the nation states and their very birth. These diverse histories also affect the placement of the respective analyses contained in this book within the broad definition of the NSI especially when it comes to the focus on specific policy areas.

Several correspondences exist among the innovation systems analysed in this volume. In terms of ruptures and continuities, South Africa and Russia both went through a sudden and radical transformation of their political systems, with the demise of apartheid and the dissolution of the Soviet Union at around the same time. The effects of those political transformations on the respective NSIs, however, may from a normative perspective be seen as diametrically opposite. In the case of South Africa there is a growing body of literature which sees no significant structural rupture with the previous system of innovation accompanying the radical change in the legal basis of the state. This continuity in the evolution of the NSI is now widely seen as one of the main obstacles to the transformation of the South African political economy to an effective, as distinct from the legal, democracy. In the case of Russia, the opposite is often claimed to be true, that the change in the political order brought in too radical a rupture with the previous system of innovation with the rapid emergence of an extreme form of predatory capitalism. The abruptness of this rupture poses one of the major obstacles to the development of a viable NSI. The evolution of the Chinese and the Russian systems of innovation stand in stark contrast in terms of the

ruptures and continuities engendered by the respective changes in their ideological underpinning. Other correspondences exist. Thus India and China are both seen as the emerging economic world powers, through a combination of the size of their economies and liberalisation of their economic policies. The 20th century histories of these two systems, and the radically different structures which emerged from those histories, again lay the basis for a comparison of the implications of policy and ideology for the evolution of NSIs.

The thematic organisation of this and accompanying books in this series is aimed at providing a comparative analysis across the five systems of innovation and in that light there is a loosely defined common structure across the five chapters. Each chapter looks at the nature of the state within the specific NSI and presents an overview of the evolutionary path which led to the current relation between the state and the economic system. In the process of this depiction, ruptures and continuities are identified and the relevant periods of analysis delineated. From this general overview of the evolution of the state, each chapter then focuses on the evolution of institutions and policy frameworks directly concerned with innovation policy, with a particular reference to the relationship between innovation policy and broader economic policy. This analysis requires that the specificities of the particular NSI with its particular national, regional and local production and innovation structures are examined. In the process, the main constraints on the viability of the systems of innovation, in terms of their capacity for reproduction, growth and evolution, are identified.⁷

The chapters follow with a description of explicit and implicit state policy on science, technology and innovation, with a classification of such policies into supply-push and demand-pull categories. Explicit policies are defined as those directly designed to affect innovative activity, specifically related to technological innovations and the deployment of innovation in production. Implicit policies are those which affect sectors which appear peripheral to innovation but which nonetheless form the institutional context within which innovation occurs and which governs its impact on the overall economy.

As mentioned earlier, the particular structures of the five cases determine the specific emphasis on the choice of the relevant policy sets in each case. Thus in the case of India, a mixed economy from its post-colonial inception, with the outward expansion after the liberalisation of the economy in the early 1990s and with a recent

reversal of the brain and skills drain, the chosen focus is on STI and industrial policies. In the case of Russia — one of the two former main superpowers (militarily, politically, economic, scientific) — the rapid deterioration of the innovation base with the disintegration of the Union of Soviet Social Republics (USSR) and the Council for Mutual Economic Assistance (COMECON) has created probably the most dramatic transformation of an NSI in recent history. In the Russian case, with a heritage of a broad human capital base the main innovation strategy is to restore and retool the scientific base to attain international competitiveness and the focus of that chapter is on the re-orientation of STI policy to achieve that goal. China's opening up to its particular variety of capitalism is creating a novel model of export-oriented industrial growth which is built on a rapid and radical transformation of its NSI and its policy focus is broad as it seeks to leverage the sheer size of the economy for a development leap in the new world order. Brazil, since the beginning of the 2000s, has struggled to recover its capacity to implement and articulate economic and STI policies, after 15 years of liberalisation that has both impoverished the capacity to design and implement policies and resulted in the destruction of industrial and technological capabilities in sectors such as information and telecommunications and auto parts. In the case of South Africa, the impact of the apartheid legacy is most evident in its systematically impoverished human capital base and the main focus of the South African chapter is on the extent to which post-apartheid economic policy and innovation policy have been congruent and suited for development.

Within this policy framework, the national integration of the innovation system is assessed in terms of the forms of the relationships and interactions of policy between the national and sub-national levels of government. This analysis seeks to identify coordination mechanisms and impediments to coherent coordination mechanisms among the various levels. One particular area of concern in the assessment of the viability of systems of innovation is the development of human capital (or human capabilities). As the definition of the NSI broadens away from that of a system of science and technology, so does that of the relevant human capital base. The centrality assigned to this particular component of the system of innovation rests on the core role which technological capabilities play in the evolution of systems. The long-term investment and appropriability characteristics of human capital development have a particular

relevance to the role of the state in shaping the evolutionary path of the system of innovation. Policies in this area, especially when we adopt a broad definition of the constituents of human capital and move it away from an instrumentalist neoclassical definition, could be enhanced if they advanced from the traditional supply-push and demand-pull approach to an effective systemic approach. Finally, each chapter ends with an assessment of the effects of state policy on the respective NSI. Given the complex nature of the relationship between the state and the NSI, this can only be, at best, a tentative assessment taking some specific policy targets as the reference point. On the basis of this assessment, a brief listing of recommendations for the future of state policy in this regard is provided.

At this relatively initial stage of the research on the role of the state and the NSI, as reported in this book, we have five independent chapters for each of the BRICS countries. This constitutes the first assessment of this topic for the five cases but it is as yet only a stage towards a full comparative analysis of the theme across the five systems. At this stage the outlines of such a comparative analysis can only be sketched in this introductory chapter through a summation of the main findings for each country's system of innovation.

At a global level, innovation policy, as distinct from science and technology policy, and the NSI policy framework only entered into the lexicon of national policy makers in the early 1990s and the history of innovation surveys date from that period. Thus, in this sense, innovation policy set within the NSI theoretical framework is generally young. In this book we consider a different measure of age — that of the current form of the systems of innovation themselves, while taking into account those global and regional changes which define the context within which the global economy evolves. In the assessment of the age of a specific form of a system of innovation we have to identify ruptures in its evolution and we have to judge the extent to which a particular rupture represents such a dramatic break that an entirely new phase emerges. The most obvious cause of such radical ruptures is an overthrowing of an established political order which brings about a new legal definition of the nation state and of the NSI. Other, less radical ruptures originate from a paradigmatic change in the ideological base of the political system. Such assessments are obviously inevitably highly contestable but the very fact that they are so makes them a rich ground for research. In terms of this measure of age, therefore, the present form of the Indian system of

innovation dates from its independence in 1947. In Brazil it could be said that the only real rupture was colonisation, which started in 1500. All subsequent transformations — independence in 1822 and the inauguration of the republic in 1889 — could be characterised as soft changes, most of them aiming to allow the maintenance of the status quo since they do not entail the radical politico-legal redefinition of the nation state base of the system of innovation. Thus the ruptures, particularly in the case of Brazil but also of China, are relatively 'softer' since they do not entail the radical politico-legal redefinition of the nation state base of the system of innovation. In the case of China, the progressive shifts in economic policy since the late 1970s, culminating in its relatively recent massive emergence on the global markets, dramatic as it may have been, still occurred within the context of a generally stable politico-legal structure. Russia and South Africa possibly constitute the youngest systems whose current structure and form dates from the radical political change of the early 1990s. In the case of Russia the dismantling of the communist state also resulted in the fragmentation of the USSR and of its wider political economic domain within the COMECON region. The total redefinition, not only of the governance system but of the political and geographic terrain of the nation state certainly resulted in the emergence of a new NSI. In the case of South Africa the rift was marked by the demise of apartheid and the creation of the first South African democratic state; there is however a strong sense of reservation, expressed in the chapter on South Africa, about the degree to which the political rupture was accompanied by an equivalent shift in the evolutionary path of the system of innovation. However, and as stressed earlier, one cannot ever ignore the time span of history and the very fact that the old forms which mark these systems' inheritance profoundly affect the shape of the subsequent new forms of systems. The chapters of South Africa and Russia serve as exemplary cases in this sense. They both identify problems which have their origin in the old forms of their respective systems of innovation as main challenges to the development of the current new forms of their systems.

The periodisation discussed in the five chapters also provides the reader with another dimension of age, that of innovation policy. The chapter on Brazil identifies three main enduring deficiencies of innovation policy. These are the excessive focus on technological innovations, the exclusive targeting of the partnership between

enterprises and science and technology institutions as the vehicle for innovation and the adoption of the linear model of innovation as the informing vision for innovation policy. It is worth pointing out the aim of consolidating the Brazilian system of innovation, as well as of linking STI, industrial, social, and other policies as main objectives of the policy discourse adopted since 2007, even if it is not yet possible to perceive any effective systemic vision put into practice. In the case of the Russian system of innovation the turmoil of the breakdown of the USSR and the initial swing to a *laissez faire* capitalism retarded the adoption of innovation policy at pace with other industrial countries. The adoption of a comprehensive innovation policy and its integration with other economic policies only started in the mid-2000s. The chapter on Russia identifies a number of current obstacles to the implementation of an effective innovation policy. Generally, these obstacles are due to the relegation of innovation policy as secondary to broader economic policy currently dealing with the impact of the global financial crisis. This has set back the integration of innovation policy into the broader development policy framework. Specifically, the single most significant obstacle to the development of the Russian system of innovation is identified as the low demand for innovation by private sector enterprises, itself perhaps a testimonial to the effects of the unplanned transition to a market economy from the central planning model of the USSR. In the case of India, the overall policy of self-reliance adopted since independence until the liberalisation move in the early 1990s strongly promoted supply-side explicit science and technology policies but the absorption of innovation is also considered to have been retarded by a demand-side failure. Innovation policies are still fragmented and persistent low R&D ratios and low rate of human capital development still pose significant obstacles to the development of the Indian system of innovation. In the three decades since the political shift in the late 1970s, China, starting from a low innovation base has seen progressive shifts transferring science and technology functions from state institutions to enterprises, deepening the indigenous innovation base and moving innovation progressively from cost-reducing to product innovations. The identified constraints to the development of a viable NSI are mainly due to the ongoing process of transition to a market-oriented economy within the context of a single-party socialist governance structure. The main constraints are the lack of integration of the science and technology sector with other

sections of the economy and a low human capital base. In the case of post-apartheid South Africa, the first innovation policy articulation was explicitly based on the NSI theoretical framework. However, the overall neoliberal macroeconomic planning framework which was simultaneously implemented, and the policy context which it produced, has prevented the integration of innovation policy with other economic policies. As such, therefore, there is still an absence of a comprehensive innovation policy. The failure to address the crippling human capital deficit inherited from apartheid is probably the single most significant impediment to the attainment of a viable system of innovation in South Africa. Though there is now recognition of this policy failure and a determination to address it in a comprehensive approach, it is still too recent a shift to enable a proper assessment of the significance in practice of this shift. The policy recommendations which are provided in each case flow directly from the respective assessments of the major fault lines in each of the BRICS countries' system of innovation. It is interesting to note the similarities in the recommended policy measures among these disparate political economies which still exhibit a striking number of common features in their national systems of innovation.

Finally, we need to come back to the initial issue of the theoretical validity of the study of the systems of innovation of the BRICS economies. We will have to interrogate the degree to which this study constitutes, along with the other books in this series, the basis for the emergence of a new discursive formation which may provide the scope for an ensuing and expanding distinct field of enquiry.⁸ This interrogation will have to proceed in a cascade from general theory to specific application. The general theory in this case is that which underlies the concept of systems of innovation. We can start from the assumption that this body of work already constitutes an established discursive formation which now offers the possibility for the emergence of an alternative theory of economics. The next level will be to enquire whether the grouping of the systems of innovation of the BRICS constitutes an identifiable and uniquely distinct space for the development of the possibility for a distinct body of emerging knowledge. This possibility stems from the combination of three factors — the commonalities in the characteristics of the BRICS systems of innovation, the commonalities of the presence of the BRICS economies in the global economy and their ability to form a new significant economic power bloc of the 'south', the conditions

for the possibility that the commonalities among the BRICS systems of innovation constitute a new empirical, but more importantly a theoretical, specificity in systems of innovation theory. The last condition is possibly the most crucial one, given the basis for the inductive origin of the bulk of innovation theory as we know it.

Unlike neoclassical economics, innovation theory, starting from the massive case studies project initiated by the Science Policy Research Unit (SPRU) at Sussex University, and its particular articulation as a system of innovation theory, is decidedly evidence-based theorising. It emerged from a growing sense of disquiet at the failure to explain the residual in growth accounting and gradually grew as its own discursive formation from the growing body of observations in the field. There is consequently always the possibility that a new body of empirical evidence may alter theory and in the process provide the basis for the emergence of a new discursive formation. In a rapidly changing global political economy, the conglomeration of the BRICS systems of innovation as an area of study may well prove to be a case which goes beyond a simple application of an existing body of theory to new empirical terrain. It may affect how we conceive of the theory of innovation systems and open up new theoretical explorations. We hope that this book, and the others in this series, will provide a step in that direction.



Notes

1. One important exception is the work of the so-called Latin American Structuralist School. See, for instance, Furtado (1964).
2. 'Theorizing the state is further complicated because, despite recurrent tendencies to reify it as standing outside and above society, there can be no adequate theory of the state without a theory of society' (Jessop 2008: 1).
3. For details, see Freeman (2003); Lastres et al. (2003); Lundvall (2006).
4. See, for instance, Arocena and Sutz (2003).
5. '[T]he network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies' (Freeman 1987).
'[T]he elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state' (Lundvall 2010: 2).

'[A] set of institutions whose interactions determine the innovative performance ... of national firms' (Nelson 1993).

'[T]he national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country' (Patel and Pavitt 1994).

'[T]hat set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.' (Metcalf 1995).

6. The literature on technology and development has stressed that economic conditions, in general, and macroeconomic policies, in particular, are important elements shaping microeconomic behaviour and dynamics as far as innovation and technology are concerned. It has been also argued that these so-called implicit policies can assume greater importance than specific technology policies in terms of orienting firms' strategies (Herrera 1975).
7. 'Reproduction is essential for the survival of a system, while (steady state) growth implies that the current shape of a specific system of innovation is well suited to its broader environment. There are various measures that may be used to estimate these two dynamic processes, depending of the breadth of the definition of systems of innovation. They may range from those pertaining specifically to systems of science, technology and innovation to those which reflect the wider political economy. The evolution of systems takes two forms. The first is essentially reactive in the sense that the mutation of the system responds to a changing environment. To use the biological analogy, this type of evolution is Darwinian. The other type, drawing on a Lamarckian analogy, is a conscious mutation, based on feedback effects, which alters the environment within which the system is set; it is initiative rather than reactive.' (Scerri 2009: 37).
8. Variava (1989: 50) describes the conditions for a discursive formation as follows:

'[A] discourse can be seen as a system of possibility which allows statements to be made which will either be true or false. This makes possible a field of knowledge. The rules of discourse ... provide the preconditions for the formation of statements. Foucault formulates four hypotheses in terms of which he attempts to identify and to isolate

a discursive formation:

- a discursive formation is identifiable if the statements in it refer to the same object;
- a discursive formation has a regular “style”, a common way in which statements are made;
- a discursive formation is identifiable if the concepts in the statements have a constancy;
- a discursive formation exists if all the statements support a common theme, or what Foucault calls in his later books a “strategy”, a common institutional or political pattern.’

References

- Arocena, R. and J. Sutz, 2003. ‘Knowledge, Innovation and Learning: Systems and Policies in the North and in the South’, in J. E. Cassiolato, H. M. M. Lastres and M. L. Maciel (eds), *Systems of Innovation and Development: Evidence from Brazil*. Cheltenham: Edward Elgar, 291–310.
- Cassiolato, J. E., H. M. M. Lastres and M. L. Maciel (eds), 2003. *Systems of Innovation and Development: Evidence from Brazil*. Cheltenham: Edward Elgar.
- Furtado, C., 1964. *Development and Underdevelopment*. Berkeley: University of California Press.
- Freeman, C., 1982. ‘Technological Infrastructure and International Competitiveness’, Draft Paper submitted to the OECD Ad Hoc Group on Science, Technology and Competitiveness, Organisation for Economic Co-operation and Development, Paris. http://redesist.ie.ufrj.br/globelics/pdfs/GLOBELICS_0079_Freeman.pdf (accessed 24 September 2012).
- , 1987. *Technology Policy and Economic Performance: Lessons from Japan*. London; New York: Pinter.
- , 2003. ‘A Hard Landing for the “New Economy”? Information Technology and the United States National System of Innovation’, in J. E. Cassiolato, H. M. M. Lastres and M. L. Maciel (eds), *Systems of Innovation and Development: Evidence from Brazil*. Cheltenham: Edward Elgar, 119–40.
- Herrera, A., 1975. ‘Los Determinantes Sociales de la Política Científica en América Latina’, in J. Sabato (ed.), *El Pensamiento Latinoamericano en Ciencia-Tecnología-Desarrollo-Dependencia*. Buenos Aires: Paidós, 98–112.
- Jessop, B., 2008. *State Power: A Strategic-Relational Approach*. Cambridge: Polity Press.

- Lastres, H. M. M. and J. E. Cassiolato, 2005. 'Innovation Systems and Local Productive Arrangements: New Strategies to Promote the Generation, Acquisition and Diffusion of Knowledge', *Innovation: Management, Policy & Practice*, 7(2): 172–87.
- Lastres, H. M. M., J. E. Cassiolato and M. L. Maciel, 2003. 'Systems of Innovation for Development in the Knowledge Era: An Introduction', in J. E. Cassiolato, H. M. M. Lastres and M. L. Maciel (eds), *Systems of Innovation and Development: Evidence from Brazil*. Cheltenham: Edward Elgar, 1–33.
- Lundvall, B.-Å., 2006. 'National Innovation System: Analytical Policy Device and Policy Learning Tool', Department of Business Studies, Aalborg University, Denmark, 1–19.
- , 2010. 'Introduction', in B.-Å. Lundvall (ed.), *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning*, London: Anthem Press, 1–20.
- Mannheim, K. (ed.), 1947. *From Max Weber: Essays in Sociology*. London: Kegan Paul.
- Metcalf, S., 1995. 'The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives', in P. Stoneman (ed.), *Handbook of the Economics of Innovation and Technological Change*. Oxford: Blackwell, 52–89.
- Nelson, R. R. (ed.), 1993. *National Innovation Systems: A Comparative Analysis*. Oxford: Oxford University Press.
- Patel, P. and K. Pavitt, 1994. 'The Nature and Economic Importance of National System of Innovations', *STI Review*, 14, Organisation for Economic Co-operation and Development, Paris, 9–32.
- Scerri, M., 2009. *The Evolution of the South African System of Innovation Since 1916*. Newcastle: Cambridge Scholars Publishing.
- Schumpeter, J. A., 1939. *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*. New York and London: McGraw-Hill.
- Variava, R., 1989. 'The Deployment of Racism in South Africa'. Unpublished Ph.D. Dissertation, University of Cambridge.