Institute for Economic Research on Innovation

IERI Working Paper 2010 0002

Towards a Unified Conception of Innovation Systems

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Towards a Unified Conception of Innovation Systems

Angathevar Baskaran[1] and Mammo Muchie[2]

Abstract

In this paper an attempt will be made to identify what has been explicitly recognised as central and peripheral within the systems of innovation concept; the inclusion or exclusion of the factors that are important in understanding the political economy of innovation systems; the themes, issues and range of actors and spaces that must be included in NSI types of appreciative theory or modelling. We suspect that those who focus narrowly tend to exclude important variables that must be included in the understanding of the making and development of innovation systems. Conversely those who focus broadly may include factors that may not be helpful in creating clarity of conception and understanding of the innovation systems application to the problems and challenges of development.

It is thus important to reflect and review the variety of ways the system of innovation has been used by the economists who have used the NSI perspective in their search to develop alternative frameworks to understand the problems and challenges of economic system dynamics in general and economic development in particular. We will probe how the search for an alternative economic framework for economic development through the NSI perspective have been applied with a view to advance an argument for its judicious application as an intellectual conceptual tool to help understanding and explanation of the problems and challenges of development and underdevelopment.

A unified conception of systems of innovation that includes not only history and culture but also the critical political factor that closely impinges and shapes policies on the economics of innovation will be attempted with a view to valorise the explanatory analytical power of the NSI framework in the context of its value in generating new insights, practices and applications to the general problem of economic development.

IERI Working Paper ISSN 2070-5387

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1. Introduction

We have been listening and reading about the use and misuse of innovation systems concept as the concept gets diffused across the world. For example it was not easy to make out by what one would mean, by say: 'A south innovation system' in contradistinction with a 'north innovation system' implying the economic behaviour of the economic agents of the northern part of the world is different from that of those economic agents from countries like India, Brazil and South Africa (Panel Presentation, 5th Asialics, 4th April, 2008, Bangalore). This sort of use of the innovation system conception made us think that it may be both useful and necessary to reflect how to re-conceptualise and re-clarify the use and misuse of the innovation system approach to research in order to inject much needed rigour to the way the concept can be used appropriately. If there are uses that are inappropriate, it is necessary to identify how appropriate usage may be established through a proper discussion. The notion of encouraging and stimulating mobility of factors of production, knowledge, technology, investment, intra-regional trade amongst economies within the southern hemisphere is different from jumping to framing such connections with something like 'a northern vs. southern system of innovation'.(Pogue,2007,p.5). Many economies in the South get a raw deal from the existing international division of labour. South to South exchanges can be a lever to influence positively in creating a relatively equitable framework for the functioning of the international division of labour provided the emerging relations do not replicate unequal relationships in trade, investment, knowledge, mobility of factors of productions and technology amongst the countries in the South.

Whilst there is enormous value in encouraging innovation in charting new lines of inquiry, there is also a need to have strong discipline in the way the creation of new and original ideas are being developed. A community of innovation studies can put itself at risk if casual and rather perfunctory renditions of the traditions of evolutionary economics (Nelson and Winter, 1982), the economics of technical change (Dosi et al, 1988), and theories of innovation systems (Lundvall, 1992), national innovation systems (Freeman, 1987, and Nelson, 2000), sectoral innovation systems (Goto and Odagiri, 1993 and Malerba, 2002), and other types of conceptions continue to proliferate unchallenged with critical scrutiny. To date, the range of areas, the themes, frameworks, domains, levels, types, features and primitives that innovation system covered can be captured by drawing a mental map (see Figure 1).

If indeed the range for theme and domain extension is needed, it has to flow with a close proximity to the core achievements and theoretical and empirical insights that the use of innovation system concept has produced. The conceptual constraint that is distinctively associated with a system of innovation should not be transgressed, violated or invalidated beyond a point that the use of the concept no longer makes any sense or useful contribution.

In addition at the time when many developing countries and some multilateral organisations like UNCTAD are beginning to use the system of innovation for policy learning in establishing their science and technology policy systems, it is vitally important to distinguish the appropriate and inappropriate use of this concept. For example, South Africa used the system of innovation framework in 1996 to generate its White Paper on Science, Technology and Innovation Policy.

Today, the Department of Science and Technology of South Africa has produced a Ten –Year Plan on Innovation Towards a Knowledge Economy(2008-2018) based on the innovation system to confront the grand challenges of development that the country is confronted for spreading the benefits of knowledge to all its citizens.(DST,2008, pp.1-30)

We would like to present this concept paper to open the debate for the community to enjoy its own reflexive moment on the theories and practices it has been engaged in over nearly two decades. We intend to demonstrate the value of this reflection by identifying what we consider to be appropriate and inappropriate use of the system of innovation followed by a literature review highlighting the conceptual and empirical achievements that can be attributed to the system of innovation. We shall use graphic and/or mathematical representation of the way the system of innovation has been used followed by our own attempt to develop a unified and integrated system of innovation approach bringing together all the factors that need to be included in any proper discussion of such a theoretical enterprise. We shall include micro-level interactions between producers and users, users and producers, users and users, producers and producers in the context of their interactions with macro-level economic, production and technological innovation policy variations.

One of the reasons why we think such a debate is necessary also stems from our own attempt to carry out research on the developing world that we have been doing since 2002. We have had a strong interest in the linkages between innovation systems and industrial economic narrowly, and more broadly structural social and economic development/transformation. As a consequence we have generated a number of models, based on the innovation conception as it has been used by the originators (Freeman, Nelson, Lundvall and others) to capture as realistically as possible the uneven and lopsided existence of the innovation landscapes in developing countries like India, China, South Africa and Brazil and even smaller countries in Africa (Muchie et al, 2003, Baskaran and Muchie, 2006). Figures 3 & 4 illustrate the system of innovation conception as it has been used by its originators. We have then tried to elaborate on the model variations that are pertinent to the kind of research question we tried to puzzle through such as, for example NIS's impact on FDI, and FDI in R & D (Baskaran and Muchie, 2007 and 2008). You can see Figure 5 for the illustration of the relationship of NIS and FDI in R&D.

A more unified and integrated system of innovation conception that relates specific research issues with the broader systemic features remains to be studied, researched and developed. In this paper we would like to do the following: (i) show by producing concrete examples how the system of innovation has been used or misused; (ii) undertake a critical literature review; (iii) describe graphically the way system of innovation has been conceptualised; (iv) demonstrate both the strength and weakness of the system of innovation concept; (v) generate an alternative model by clearly showing how the system of innovation can be applied in contexts, cultures and histories where innovation is generally considered weaker by broadening the micro-level user-producer interaction to include user-user, and producer- producer and other varied forms of interactions; and (vi) we hope to suggest further research on how to use well this useful concept that have been a fruit of many innovation studies scholars across the world.

2. Formal theory and appreciative theory for developing an alternative economics framework

Nelson and Winter in their pioneering work define and distinguish formal and appreciative theory in economics as follows:

"A theory defines the economic variables and the relationships that are important to understand, gives a language for discussing these, and provides a mode of acceptable explanation."(Nelson & Winter 1982.p46)

Theory selects some phenomena as important or unimportant, peripheral or central, interesting or uninteresting, informed or ill-informed, sophisticated or unsophisticated by setting boundaries for inclusion and exclusion based on the relevance of the body of knowledge being sought to be generated.

When theory provides a' framework for appreciation,' it serves as a 'tool of inquiry'. The focus is on the 'endeavour in which the theoretical tools are applied."(ibid.) In formal theory, "the focus is on improving or extending or corroborating the tool itself..." (ibid.)

Formal theory is a source of ideas for appreciative theory and the vice versa. In general, drawing linkages or connection between these distinct forms of theorising can enrich understanding of economic enquiry.

Nelson and Winter have proposed boldly an innovation framework to economic theory as an alternative to neo-classical framework (Nelson & Winter, 1982: 128-130) building on earlier criticisms of mainstream economic thinking mainly from the writings of Veblen, 1909), Schumpeter, 1911, 1942) on modern dynamic economic theory building.

Today it appears that the formal theory is mainly pursued by the evolutionary economists. Appreciative theories based on empirical studies and research for policy selection or application has been pursued by the national innovation system perspectives and others in institutional and business economics. It seems to us there has been a proliferation of the appreciative variant of theorising as part of the generation of the alternative framework on the economics of innovation.

There appears to be a sort of unwritten division of labour between the formal and appreciative theory where the formal theory of economic dynamics is dominated by evolutionary economists, and appreciative theorising is largely populated by those who are empirically and policy orientated. It is not clear how much significant interaction and learning takes place between the formal theory and appreciative theory with mutual gain to each other. Formal theory concentrates mainly on economic structure. Appreciative theories focus mainly on system of innovation actors in their role in the processes of the development of economics of innovation dynamics and systems.

Both share the language brought out by the alternative economic theory such as: the use of evolutionary biological metaphors as opposed to static metaphors of mechanics in physics, they focus on institutions and change through new combination of routines. Above all they introduce

innovation as deviation from routine behaviour capable of upsetting equilibrium by a process of creating and destroying in the process of economic growth.

Issues that seem to preoccupy much of the economists hoping to create an alternative to the main-stream neo-classical economic framework appear to be understanding economic growth; short term and long term economic firm level and/or national performance, micro and meso level competitiveness, firm and national level productivity, economic catching up, learning and knowledge creation and absorption in a given economic structure, and inter linkages between firm competitiveness and national competitiveness and productivity, symmetry and system building such as national, sectoral and other types of innovation systems. Since innovation is characterised by the process of creating and destroying, some economists including Veblen earlier on have not been open to the notion of innovation systems and symmetry. They focus more on asymmetry and system breaks than makes, associating innovation more or less with a dynamic that disrupts systems and symmetry rather than the opposite.

The scepticism on innovation systems is understandable given that the available coordinating mechanisms such as the market, the state, the firm and others tend to operate in a way that may not facilitate symmetry and systems. However, the system perspective is important as a focusing device to conceptualise, identify and select from the range of emerging forms of possible interactions, variations that are either emergent and to be made yet or already made, efficient or inefficient, strong or weak, necessary or contingent for generating outcomes and impacts on national economic development, productivity, competitiveness and overall better long term economic performance. In other words different innovation systems can be correlated with different outcomes and impacts on performance, productivity, competitiveness, capability, learning and competence or any combination of them. And how systems are constituted and the taxonomy and complexity of interactions, and the work to understand and explain them remains significant. To be sure, the real economic processes may deviate from what may be desirable, and from the way systems of innovation are forged. That does not invalidate the choice of how innovation systems emerge and are formed by the interaction of the structures, institutions, policies, knowledge and incentives in given environments and situations.

Regardless of whether system building or not occurs in real economic systems, the national system of innovation perspective has been popularised. It has constituted perhaps a significant development of appreciative theorising. Its main inquiry is to understand the variations or differences in the innovation performance of nations that enters into explaining the long-term economic performance, national productivity measured in such macro-economic variables as GDP and national competitiveness. The degree to which micro-level firm innovative capability, performance and competiveness can be aggregated to contribute to national innovative productivity, performance and competition has been analytically contentious.

Appreciative theory in this innovation system genre has produced such terms as the knowledge-economy framework, the learning economy framework, and with the Globelics initiative, a further development has occurred. Globelics has combined together knowledge, innovation, learning and capability building and suggested research applicable to the problems of development and underdevelopment by translating innovation systems into :' learning, innovation and capacity, capability and competence building systems.' This opens up a possible

line of inquiry where an alternative economic framework of combining "learning, innovation and competence building' into an 'innovation and development systems' can address the problems and challenges of transition from underdevelopment to development for the developing world, the BRICS and others.

If we proceed with the search and selection of an alternative framework that employs innovation systems perspectives on the problems of development and underdevelopment, there will be a need to advance theoretical knowledge further. This can be done by consciously developing linkages and combinations between economic and non-economic structure and actors, formal theories and appreciative theories, awareness and learning in connection between the tools used in each type of theorising, deepening evolutionary economic dynamics to include new thematic areas such as national economic integration in relation to reducing dependency on donors in different types of developing and transition economies, finding productive linking internal and external, domestic and international, political and economic, and empirical and policy changes and approaches in different national economic settings.

In this paper an attempt will be made to do the much more modest task of what has been explicitly recognised as central and peripheral within the systems of innovation concept; the inclusion or exclusion of the factors that are important in understanding the political economy of economic dynamics; the themes, issues and range of actors and spaces that must be included in NSI types of appreciative theory or modelling. In addition we review the variety of ways the system of innovation has been used by those economists who have used the NSI perspective in their search to develop alternative frameworks to understand the problems and challenges of economic dynamics.

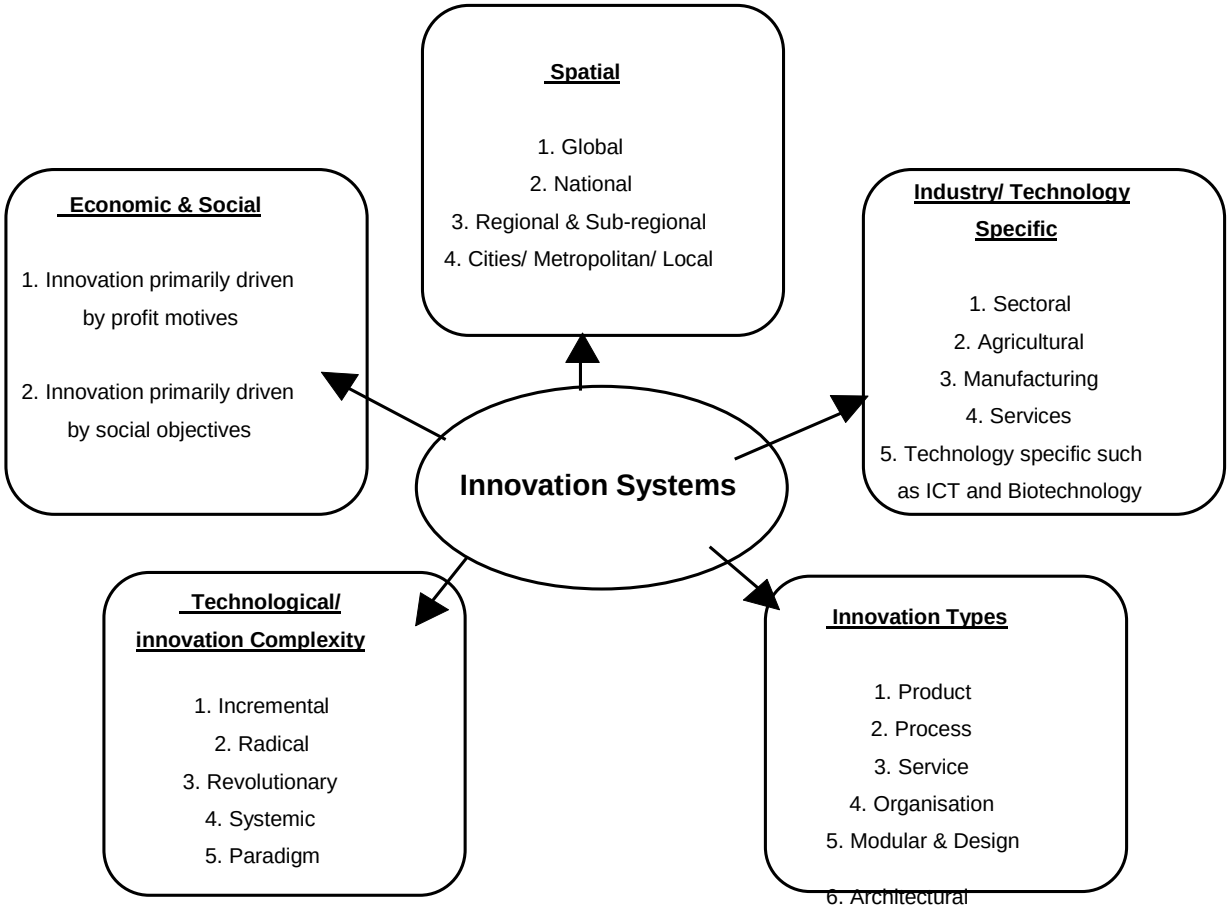
3. Varieties in the presentation of systems of innovation perspectives

Since 1980s theories on innovation and their use have gradually expanded their focus and complexity. From the initial focus on the individual firm or entrepreneur they expanded to include the environment and industry in which firms operates. They started focusing on the national system of regulations, institutions, human capital and government policies and programmes (Niosi et al, 1993). Subsequently, the focus also included regional level or local level systems of innovations. In other words, initial perception that innovation is basically an individual act of learning by a firm or entrepreneur has expanded to include the larger system (consisting of various institutions, policy framework, incentives etc.) in which this act occurs. It is now widely viewed and accepted that innovation is a process, which is not linear as it involves continuous interactivity between various actors and factors.

Figure 1 illustrates how the use of the concept of systems of innovation has grown and proliferated over the years. This can be traced in four major areas: (i) spatial; (ii) industry and technology specific; (iii) in terms of innovation types; (iv) in terms of level of technology/ innovation complexity; and (v) in terms of economic and social objectives. In the area of spatial we can identify global innovation systems, national innovation systems, regional and sub-

regional innovation systems, and local and city innovation systems. In the area of industry and technology specific innovation systems we can see studies focused on specific industrial sectors such as manufacturing, telecommunications, automotive, agro-food and service and specific technology focused such as biotechnology, information and communication technology (ICT), and electronics. In terms of innovations types we can see the focus of studies on product innovation, process innovation, service innovation, organisational innovation and so on. Similarly, studies focused on levels of technological or innovation complexities such as incremental, revolutionary, radical, systemic and paradigm and so on. Finally, we can broadly see studies focusing on innovations driven by social objectives and economic motivations or objectives.

Figure 1: Innovation Systems - Theories/ Concepts/ Typologies/ Taxonomies



4. Literature Review/ Strength and Weakness of the System of Innovation Concept

Theories on innovation emerged initially with the main focus on the firm and entrepreneur. Then they gradually expanded their focus to the environment and industry in which a firm operates. This led to the emergence of the national system of innovation (NIS) that includes regulations, institutions, human capital and government policy regimes. NIS framework further led to the sub-national (regional/ local/ city or metropolitan) and sectoral innovation system approaches.

In this section we will critically review the literature and identify the strengths/ advantages and weaknesses/ disadvantages of different theories/ concepts of the system of innovation.

4.1. Firm Level System of Innovation/ Innovation Types

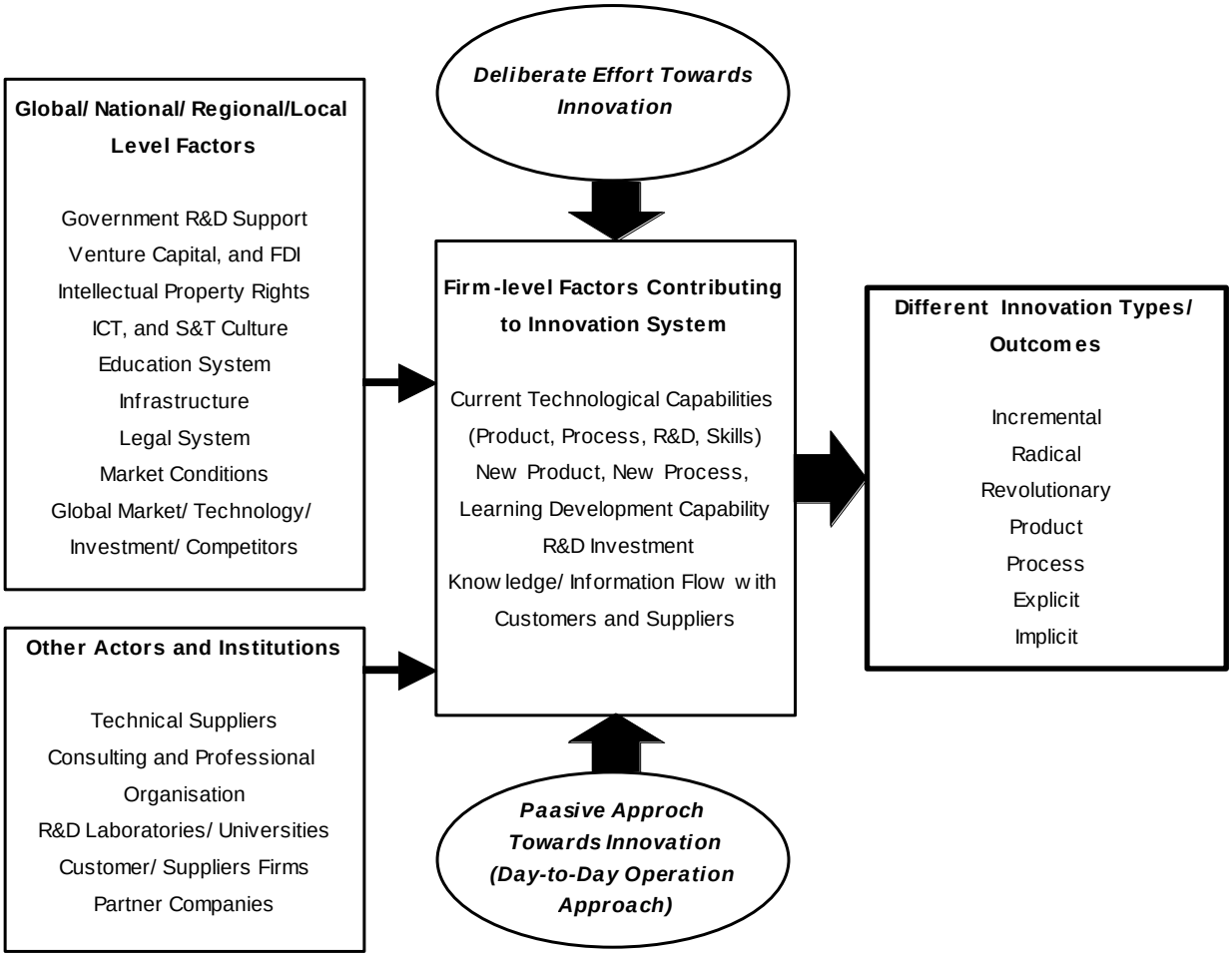
This section discusses the firm level innovation system and types of innovation activities centred at the firm level.

Firms' internal capacity to absorb and utilize the diffusion of knowledge and generate new knowledge is important in the context of national innovation system, as firms' innovation capacity is central to a nation's industrial capacity and competitiveness (Porter, 1990). The firm level innovation may include different types such as incremental, dramatic or radical, and explicit or implicit. The innovation outcome may be due to deliberate effort by the firm or as a result of day-to-day operations.

According to OECD (1997) model to measure innovation activities of a country, there are three layers of firm's innovation system. At the innermost layer firms act as drivers of technological innovation in a national economy. Their performance is dependent on the capacity of transfer factors in the middle layer such as technical suppliers, consulting and professional organizations, and research and technology organizations to generate knowledge flows and transmissions. The outer layer consists of framework conditions in the outer layer such as education system, legal system, physical infrastructure, market and industrial structure, and science, technology and engineering base of the country which influences the middle layer (Virasa, 2002).

The factors that determine the performance of innovation system at company or firm level include; (i) current technological capabilities (product, process, R&D, and skills); (ii) new product/ process development, learning; (iii) R&D investment; (iv) human resources/ capital development; (v) knowledge and information flow with customers and suppliers; and (vi) market conditions. Innovation strategies followed by firms include R&D expenditure, technology efforts concentrated on production organization and product quality and modernization of production processes, normally through equipment import, focus on learning capacity to increase organizational efficiency, the purchase of new equipment and so on. Figure 2 illustrates the firm-level innovation system/ process.

Figure 2: Firm-level Innovation System/ Process



Companies/ firms play a major role in innovation process which includes internal linkages between various actors within the company or firm and external linkages, that is, with outside agents and organisations including other firms such as customers, suppliers, subcontractors, partner companies, financiers, research institutes, semi-public and public research and development organisations, etc. However, the degree of linkages internally and externally may be at different levels and intensity. Also the innovation could be incremental or radical or revolutionary, tactical or strategic, because of deliberate effort or just due to route operations.

Many studies focused on the relationship between firm's innovation capability and its performance and almost all these studies found a positive and significant relationship between innovation and different measures of firm performance. For examining the relationship between innovation and firms' economic performance, several independent variables such as physical

capital, human capital, R&D and other innovation-related investments as well as firm size are considered important (Janz et al., 2003).

Hobday (2005) critically reviewed firm-level innovation models based on research in the industrially advanced countries to draw lessons for advanced developing economies such as Korea and Taiwan. Although models based on industrially advanced countries are found useful in analysing the management of innovation and the decision-making processes within firms, a number of problems are also identified. That is, there is insufficient empirical evidence to verify these models, weak theoretical underpinnings and also a failure to take into account the diversity and unpredictability of innovation processes.

Increasingly it was recognised that innovation process is not linear, as it involved continuous interactivity between various entities such as suppliers, clients, universities, productivity centres, regulatory bodies, financial institutions and other social and economic actors (Mytelka, 2001). Also, it was recognised that innovation is not merely an individual act of learning by a firm or entrepreneur, but is situated within a larger national innovation system where a number of actors and institutions are linked and connected through flow of finance, skills, knowledge and information and is also influenced by social factors such as social rules, cultural norms.

Linear model of science and technology (Freeman, 1995), where investment in basic R&D is believed to lead to new technology applications and innovations was increasingly found to be inadequate in explaining differential rates of technological innovation and economic development experienced by industrialised countries. That is, despite similar level of high R&D investments across industrialized and semi-industrialized countries "evidence accumulated that the rate of technical change and of economic growth depended more on efficient diffusion …and as much on social innovations as on technical innovations" (Freeman, 1995, p. 10). This led to a different approach by conceptualizing the complex interactions in an innovation system. That is, it was recognised that a linear approach -- either 'technology push', "aimed at strengthening science and engineering education in the nascent universities," or on locally generated 'demand pull' for scientific and technological research is too simplistic (Mytelka, 2001, p. 1). Furthermore, it was also felt that the "mainstream macroeconomic theory and policy have failed to deliver an understanding and control of the factors behind international competitiveness and economic development" (Lundvall, 2002, p. 214). Therefore, these factors led to the mergence of the concept of national innovation system (NIS).

To recapitulate, the NIS concept emerged due to the recognition that a complex relations, linkages, and co-evolution between a numbers of institutions also play a major role in the innovation process apart from the firms that are directly involved in bringing new products and services to market.

3.2. National Innovation System

The national innovation system (NIS) approach attempts to rectify the shortcomings of other approaches employed to study technology development and accumulation. For example, the inputs-outputs approach focused on inputs such as science and R&D funding and outputs such as publications and patents. The linear model assumes that science leads to improved technologies,

which in turn leads to industrial development. In contrast, the NIS approach emphasises on dynamic networks of policies, institutions and human capital that facilitate knowledge and information flows within and across national borders. Furthermore it also takes into account the role of broader macroeconomic and educational policies towards innovation process. This is illustrated by Figures 3 and 4.

Different authors have defined NIS in different ways. For example: Freeman (1987) defined it as the "network of institutions in the public- and private-sectors whose activities and interactions initiate, import, modify and diffuse new technologies". Lundvall (1992) defined it as the "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". For Nelson and Rosenberg (1993) it means the "set of institutions whose interactions determine the innovative performance of national firms." According to Niosi and others (1993), NIS is the "system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology." Metcalfe (1995) viewed NIS as "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" (Niosi, 2002, p. 292).

Figure 3: Major Elements of National Innovation System (NIS)

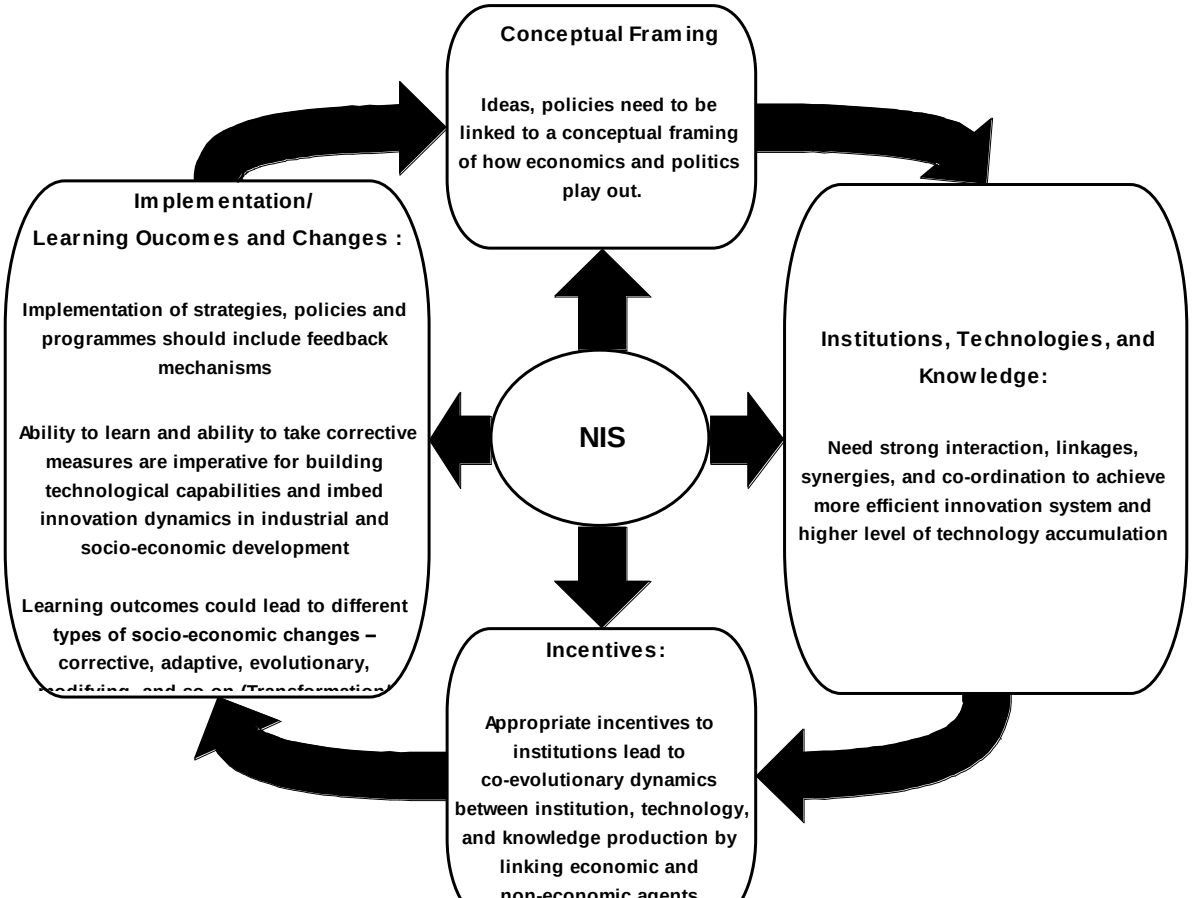
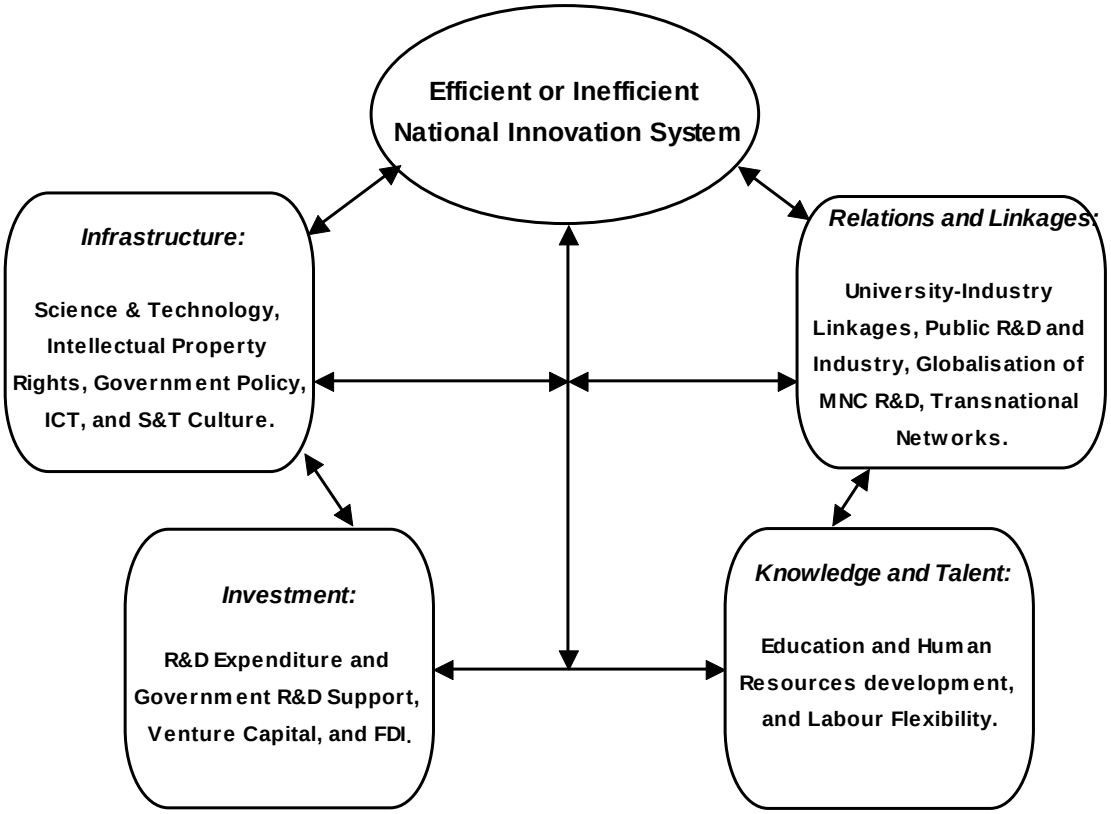


Figure 4: Linkages between Institutions, Technologies, Knowledge and Incentives in NIS



Niosi (2002, p. 292) argued that NIS is dynamic due to the "financial flows between government and private organizations…human flows between universities, firms, and government laboratories, regulation flows emanating from government agencies towards innovation organizations, and knowledge flows (spillovers) among these institutions".

Strengths/ Advantages of NIS:

(i) As it is generally accepted that technological development is primarily a nation-specific and industry-specific phenomenon, NIS helps to study not only developed economies, but also developing economies. There are significant differences and variations among and within these economies due to country-specific issues and factors, and the NIS approach provides the necessary tools of analysis to understand them.

(ii) In the context of developing economies, NIS approach provides an alternative to neo-classical economic theories of growth. Lundvall argued that innovation is rooted in processes of interactive learning that is problematic in pure markets. This difference with neoclassical

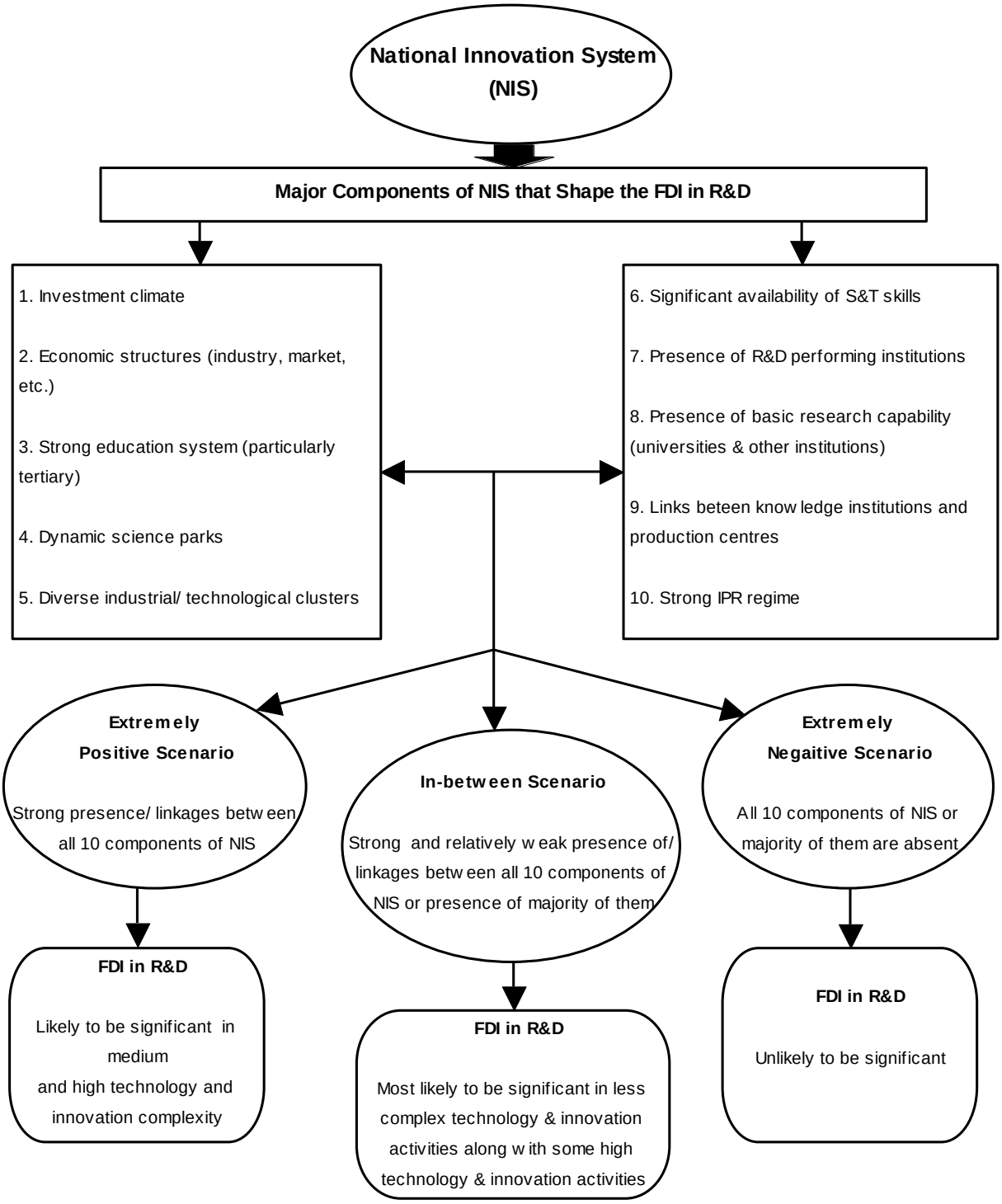
theories means a shift in the analytical focus from allocation to innovation and from making choices to learning (Lundvall, 1997).

(iii) NIS provides a flexible conceptual framework to study both the developed and developing economies and helps to examine the problem of "technological gap" between the developed and developing nations, that is between the developed technological leaders and the developing technological followers, particularly the advanced and emerging developing economies such as China, India, Korea, Brazil, South Africa, Thailand and Malaysia. It is argued that it is necessary for developing countries to create technological and innovative capabilities to close this gap. In other words, in developed economies the innovation system focuses on maintaining or improving an already established level of competitiveness and growth, while it has to focus "catching-up" in developing countries.

(iv) NIS also provides different approaches to study innovation process in developing countries. For example, Charles Edquist (2001) has proposed the Systems of Innovation for Development (SID) concept, which modifies the NIS framework applied to developed economies. He stresses the importance of product innovations than process innovations, incremental than radical innovations, absorptions than development of new innovations, and innovations in low and medium technology sectors than in high technology sectors. Others emphasis more on learning than innovation, both passive learning absorb the technological capabilities for production and active learning where deliberate effort is made master technology (Juma et al., 2001).

(v) The emergence of globalising economy has led to the inevitable question as to the appropriateness of the concept of NIS when significant flow of finance, knowledge, skills and production are increasingly influenced by factors outside the national boundaries. However, it is widely accepted that domestic policies, actors and institutions still play an important role. Therefore, despite its failure to deal with global issues and factors, NIS still provides a strong conceptual framework to understand innovation and economic growth. Niosi (2002) argued that although capital and knowledge could flow across national boundaries, other important factors such as human capital do not flow easily across national boundaries and nations possess distinct governmental policy regimes, institutions, and natural resources. And therefore national borders and location are still relevant.

Figure 5: NSI and FDI in R&D - A Conceptual Framework



(vi) NIS also helps to capture the uneven economic development dynamics in developing economies. It helps to identify the linkages between innovation systems and industrial economic narrowly, and more broadly structural social and economic development/transformation. It enables elaboration and variations to analyse and capture particular aspects of innovation process. For example, we have tried to elaborate on the NIS model variations that are pertinent to the kind of research question we tried to puzzle through such as, for example NIS's impact on FDI, and FDI in R & D (Baskaran and Muchie, 2007 and 2008). Figure 5 illustrates the relationship of NIS and FDI in R&D.

Weaknesses/ Disadvantages

(i) In the era of globalising economy one can question the usefulness or validity of the NIS concept which emphasises in understanding innovation at the national level. One can argue that there are factors that are beyond the control of national governments which can influence the innovation system. While the national level may be the most relevant due to the role of country-specific interactions in creating a climate for innovation, international knowledge and technology flows, information and capital flows and international collaborations are increasing in volume. Intellectual property regimes, trade and labour systems, regional economic alliances, multi-national firms, and foreign sources of scientific and technological research such as NGO's, universities, and other governments' S&T systems are having increasing influences on NISs. The recent collapse of trade negotiations between developing and developed countries, the economic slowdown caused by oil prices and escalation of food price across the world and other such issues suggest serious limitations of national governments and national analytical framework. Although one can argue that national boundaries still matter and NIS is still relevant, it is clear that there are factors that are outside the national boundary (global economic/ innovation environment) and they are yet to be addressed satisfactorily. Therefore there are arguments for fresh approaches (Juma et al., 2001).

(ii) Although the national policies have still been considered as critical in influencing the behavior of national actors towards innovation, increasingly regulatory regimes and other factors at the global level have become more influential. These include the influence of transnational corporations on the structure of markets, investment in R&D and innovation, and international agreements dealing with trade, investment and intellectual property. There is still knowledge gap in understanding fully the impact of TNCs on local learning and innovation and also the role of international institutions that shape both the strategies of firms and the policies of national governments (Feinson, no date).

(iii). NIS has been well established and widely used to study innovative and technological capabilities in developed economies and has been increasingly used in the context of developing countries, particularly the advanced economies among them. However, there are still problems and challenges in applying the NIS concept to study the large number of small least developed economies in Asia, Africa, and Latin America. The interactions of the institutions and actors that are central to forging the NIS are hardly present in these economies.

(iv) Mytelka (2000) argues that there is still a common perception that "that innovation is something that only takes place in countries like Japan or the United States, in large corporations

or in what are regarded as the high-tech industries. Indeed, much of the conventional literature continues to associate innovation with the kind of activity by firms that takes place at the technological frontier or what Schumpeter has called invention." However, few firms in the developing world are capable of operating at the frontiers of technologies and also many of these economies are small.

(iv) There is also a problem with NIS in determining its scope within the national boundary. That is, an analytical distinction between a 'narrow' NIS concept, which includes the institutions and policies directly involved in scientific and technological innovation, and a 'broad' NIS perspective, which takes into account the social, cultural, and political environment of the country needs to be examined. In other words, whether it is necessary to expand it to include virtually all aspects of a country's social, economic, political, and cultural activities or it is important to restrict it to include only certain aspects and functions (Edquist, 2002). For example, Liu and White (2001) suggested the functional boundaries of an NIS based on five fundamental activities that are considered 'nation-specific': (i) research (basic, developmental, engineering); (ii) implementation (production); (iii) end-use (customers of the product or process outputs); (iv) linkage (bringing together complementary knowledge); and education. OECD identified five institutions in the narrow NIS context: (i) Governments (local, regional, national and international, with different weights by country); (ii) Bridging institutions, such as research councils and research associations, which act as intermediaries between governments and the performers of research; (iii) Private enterprises and the research institutes they finance; (iv) Universities and related institutions that provide key knowledge and skills; (v) Other public and private organizations that play a role in the national innovation system (public laboratories, technology transfer organizations, joint research institutes, patent offices, training organizations and so on) (OECD 1999).
(v) Linkages between various institutions and actors in the NIS linkages via formal and informal channels, flow of knowledge and resources between the narrow and broad levels determine the efficiency of the NIS. Although there are strong measures such as R&D expenditure, patents, productivity, number of S&T personnel, there are still problems and challenges in measuring the linkages, flows and outcomes in the NIS.

4.3 Cluster/ Regional/ Local/ City (Metropolitan) innovation system

Increasingly, researchers are analysing innovation systems by taking sub-national level entities, as it is felt that NIS is inappropriate or inadequate for such studies. These include concepts such as 'cluster', 'regional' 'city' 'metropolitan' and 'local' innovation systems. Often these are not distinct from each other. For example, review of writings focusing on sub-national level approach reveals that 'cluster' and 'regional' are used interchangeably to mean the same thing and 'regional', 'local', 'metropolitan' and 'city' innovation systems are used interchangeably to mean the same thing.

(i) Cluster Approach

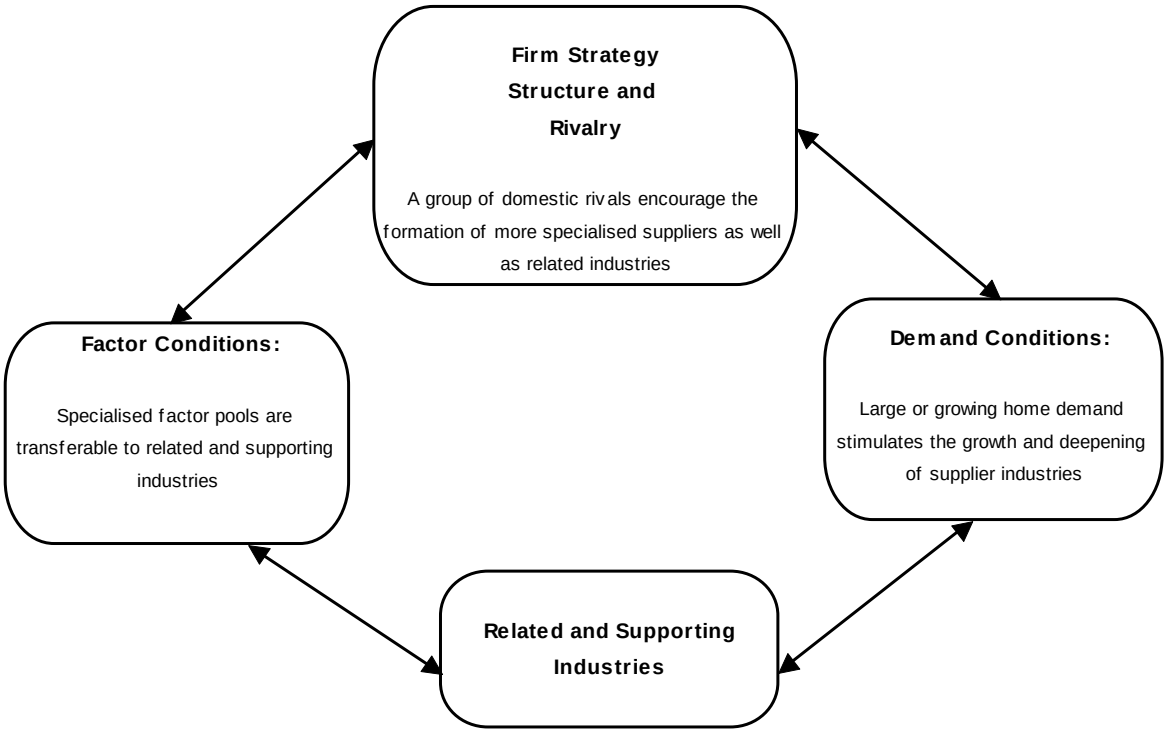
The 'cluster' approach was introduced by Porter by emphasising the importance of firm interactions with supply chains and with public research organisations (Porter, 1990; 1998). This gained wider acceptance among policy makers around the world because of the emergence of

successful industrial clusters or regions such as the Silicon Valley in the US and similar regions in Italy and Germany. Consequently, the 'region' became an alternative level of analysis (Acs and Varga, 2002; Cooke, 1992).

It is argued that as even the developed nations cannot successfully develop technological capabilities in all types of industries. Therefore, it is quite likely that industrial and technological capabilities are developed "in clusters of industries connected through vertical and horizontal relationships" (Porter, 1990). This occurs due to many factors: close interaction between certain types of firms and industries, interactions centred on key technologies, shared knowledge or skills or producer-supplier relationships. It is likely that clusters emerge due to certain demand patterns for products, rivalry among firms, and specialised factors or inputs such as skilled personnel or natural resources. This is illustrated by Figure 6.

The nature and characteristics of clusters can be different from one another within a same country. For example, a cluster can be science-based (e.g. pharmaceuticals, aerospace), scale-intensive (e.g. food-processing, vehicles), supplier dominated (e.g. forestry, services), or specialised suppliers (e.g. computer hardware and software) (Pavitt, 1984). Clusters are also identified by different approaches, that is, knowledge flows and producer-user interactions, the structure of patenting, citations of patents and scientific publications, and the level and flows of skilled workers. Each type of cluster has its own characteristics. For example, the science-based clusters (e.g. pharmaceuticals, aerospace) are R&D and patent intensive and therefore are closely located to public research institutes and universities (OECD, 1997).

Figure 6: Innovation system - The Concept of Cluster



Source: OECD (1997), *National Innovation System*, p. 26 (Original source: Porter, 1992)

Strengths of Cluster Approach

(i) Cluster approach helps to understand the dynamics of industrial clusters in particular regions and the factors contributing to successful clusters in different countries.

(ii) This approach has been widely employed by many developed and developing countries to foster particular industrial clusters in particular regions by following deliberately targeted policies.

(iii) Cluster approach helps to understand the development of particular industrial sector/ technology in a particular region which has its own characteristics, specialised factors or inputs such as skilled personnel or natural resources. This provides clear focus for analysing and identifying conditions that leads to a successful or unsuccessful cluster/ innovation system.

Weaknesses of Cluster Approach

(i) The global factors can have serious implications for the local innovation system where it is identified with clusters formed by actors along the value chain (Mytelka, 2000).

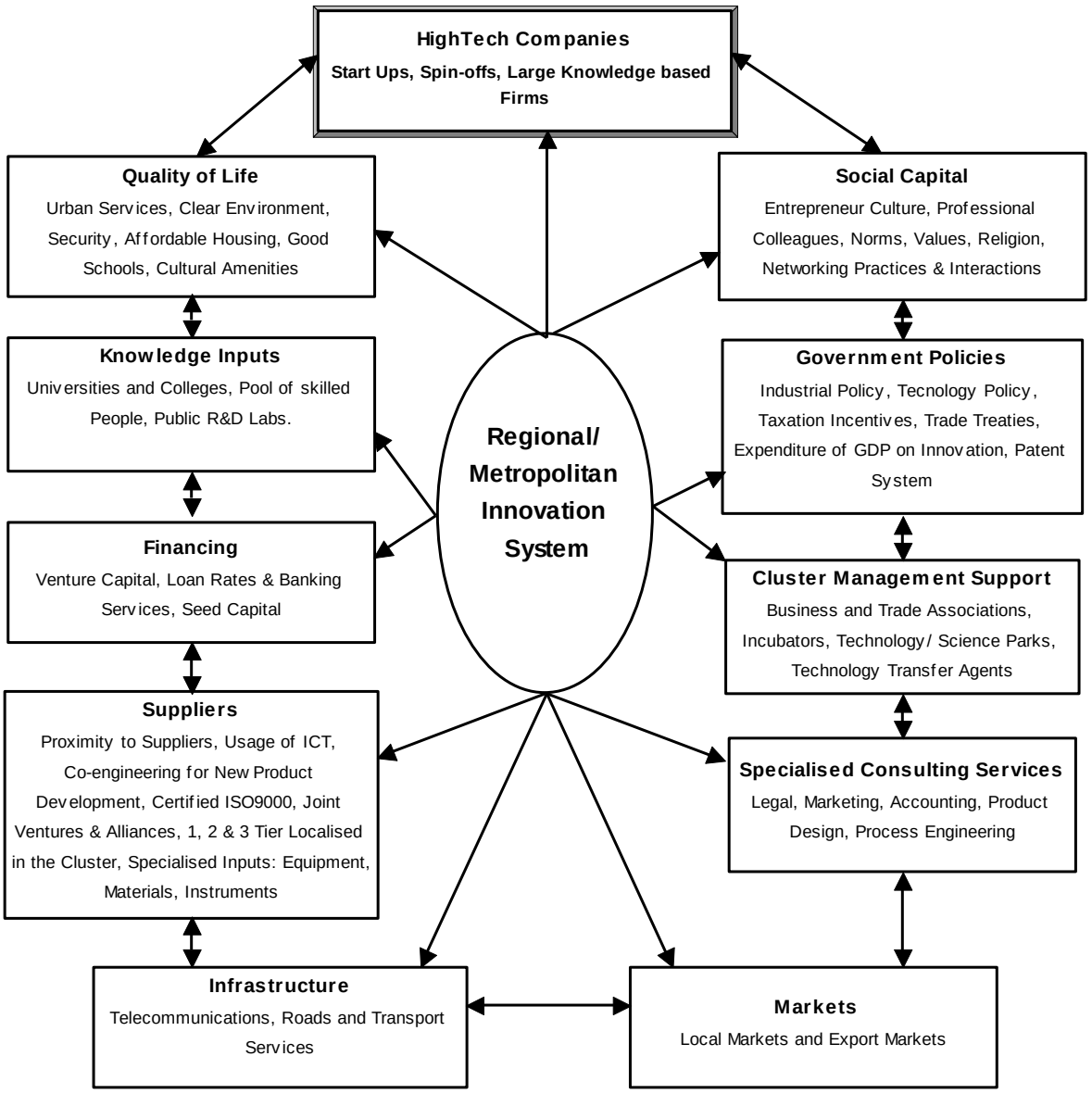
(ii) Cluster approach generates a static bias since it is defined in terms of the standard industrial classification. Its boundaries are thus fixed (Mytelka, 2000).
(iii) Sector-based cluster approaches cannot capture situations in which industrial boundaries are blurring (Delapierre and Mytelka 1998).

(iv) The nature and characteristics of clusters can be different from one another within a same country. Therefore, comparability of experiences of clusters is problematic.

4.4. Regional/ Local/ Metropolitan Innovation System

It appears that increasingly particular regions contribute significantly towards the industrial innovation and growth in particular national economies. That is, local innovation networks are considered to play an important role in the innovation process and economic growth of regions and cities. Local/ regional innovation process results due to interactions at economic and social levels between different institutions located in a particular region. Therefore, to understand the efficiency or performance of a regional/ local innovation system, it is important to examine not only the horizontal and vertical relations among firms but also the linkages between firms and other institutions such as universities, research institutions, supporting industry, provincial/ local government policies, and financial institutions. In other words, it is considered that the synergy among various institutions and actors in a region plays an important role in creating an efficient regional innovation system by increasing its innovation capability. This illustrated by Figure 7.

Figure 7: Regional/ Metropolitan Innovation System - A Conceptual Framework



Source: Drawn from: Flores, M (2004), "Proximity and Learning in Metropolitan Innovation Systems, Towards the Formation of High TechClusters in Monterrey and Milan," (Research Proposal), Globelics Academy, Lisbon. Originally adopted from: Isabel Bortagaray and Scott Tiffin (2002), National Governors Association (2002), *A Governors Guide to Cluster-based Economic Development*, and Lundvall (1994).

Regional innovation system can be defined as a system of innovation that strengthens the competitiveness of a region through strengthening the capabilities of firms which in turn can lead to the growth of the region (Cooke et al. 1998). Local and regional innovation systems have been widely employed by both researchers and policy makers in recent years (e.g. Cooke, 2000; Srinivasan and Viljamaa 2001; Kolehmainen 2002; Gabauer et al. 2003; Cumbers and McKinnon, 2004; Lim 2006).

However, it is perceived that the conditions of regions have changed significantly due to globalisation -- emerging global market and value chain, global competitors, global finance and more networking structure (Gereffi 1999; Schmitz 2004; Flores, 2004).

Strengths/ Advantages of Local/ Regional Innovation System

(i) Nation innovation system does not fully explain why there is an uneven development across different regions in a country. Regional innovation system concept helps to address this problem and throws light on the complexity of regional development. It demonstrates that regions matter for the implementation of national innovation system. Regional innovation system therefore emerged as a new concept and a new policy for regional growth.

(ii) It helps to understand the gap between advanced regions and less advanced regions.

(iii) Although regional innovation system is not an entirely a new model, it is different as it emphasises more on networking and linkages among regional actors and institutions (universities, research laboratories, and related and supporting services and industries) which helps to understand better problems associated with regional/ local development (Acs 2002).

(iv) Successful regional innovation systems highlighted the central role played by the universities at regional level by undertaking R&D for firms through university-industry cooperation (Varga, 1998; and Acs, 2002).

(v) Regional innovation system approach helps to understand to some extent why many of the leading firms in 'new economy' industries which need to innovate at a rapid pace (products, processes and commercialisation) have emerged in the same few locations across the world. The main reason for this appears to be that firms want to be close to other major players in the sector so that it helps them to innovate and keep up with other innovators (OECD, 2007).
(vi) Regional innovation system helps to understand not only the region-level interaction to promote innovation in traditional industrial sectors such as manufacturing, but also in service-related sectors.

(vii) Analysis at sub-national innovation system level helps to understand the factors that help sustainable competitiveness of SMEs and their technological capacity-building.

Weakness/ Disadvantages of Local/ Regional Innovation System

(i) Due to differences across regions within national boundaries and across different countries it is difficult to device 'common solutions' or general 'best practices' for regions. This is

problematic for policy formulations and learning from other regions (Cooke and Schienstock, 2000; Todtling and Trippl, 2005; Doloreux and Parto, 2005).

(ii) Due to differences across regions, one of the major problems with regional innovation systems is the lack of comparability across regions. Despite this problem, many regions appear to have been influenced by the Silicon Valley model as the route for success (Saxenian, 1994). It seems every region aims to develop an innovation system based on some successful models which may not be appropriate for them (Cooke and Morgan, 1998).

(iii) The concept of regional innovation system can lead to confusion, as 'region' is interpreted in different ways. One can interpret it as a global region, or supranational region, metropolitan or city region, sub-nation region or local. In the regional innovation system literature 'region' generally means local or regional unit at sub-national level.

(iv) It is argued that as industrial district (local level) and regional innovation system capture different aspects of regional economic development, the regional innovation system framework may be inadequate in explaing the innovation process at industrial district level. For this, local innovation system concept is considered as appropriate (Muscio, 2006).

(v) Although it can be argued that innovation is strongly influenced by region-specific factors, the ability of and incentives for firms to innovate are mainly linked to national level factors such as intellectual property right laws, taxation, corporate governance, tariffs and so on.

(vi) In the past it was usual that SMEs operated in local market by securing most of the input from the local area. However, now they are increasingly competing in the global market and therefore globalization is likely to have significant impact on SMEs. Therefore, how effectively the sub-national innovation system captures these trends and help analyse them is not clear.

(vii) Understanding, analysing, and supporting the local innovation systems are problematic without proper understanding of the changing nature of competition in globalised industries (Mytelka, 2000)

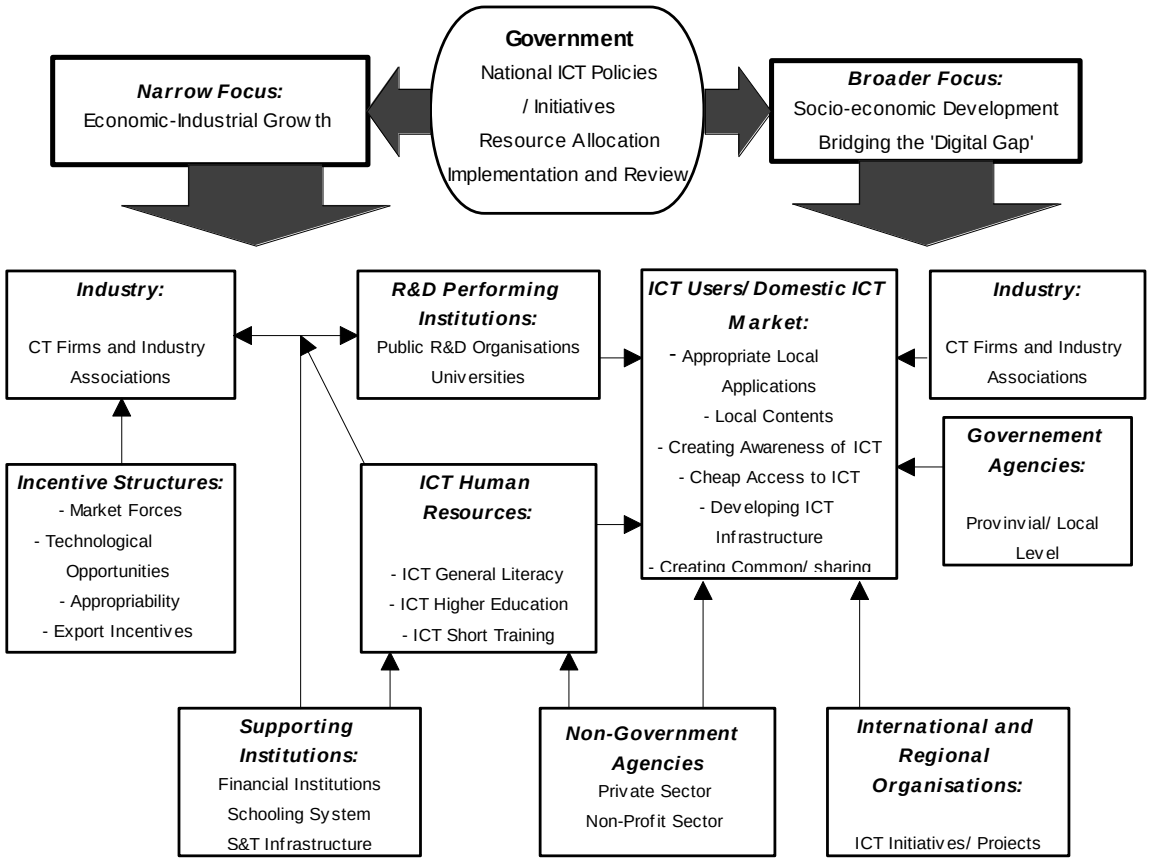
5. Technology/ Sector specific Innovation System

The concept of sectoral innovation system attempts to provide a multidimensional, integrated and dynamic view of sectors and helps to analyse sectors which allow for comparability (Malerba, 2002). The sectoral system of innovation approach encompasses and includes the technological system approach, by placing it within the sectoral context (e.g. biotechnology, ICT, aerospace, nanotechnologies, electronics, telecommunications, pharmaceuticals, automotive, and energy). The sectoral or technology specific approach focuses on three major areas that influences the technological capabilities at the sectoral level or in specific technology area: (i) knowledge and information flow; (ii) actors and networks, institutions; (iii) linkages between these entities. This is illustrated by Figure 8.

A sector is characterised by a specific knowledge base, technologies, inputs, and a boundary which could change over time. Also linkages between various entities and activities play a major

role in defining the real boundaries of a sectoral innovation system. These linkages can be static as input-output links and dynamic which take into account complex interdependent relations. Particularly, dynamic linkages among various actors and activities play a major role in bringing about technological change and growth in a particular sector. A sector is composed by various agents and organisations such as consumers, entrepreneurs, users, producers and input suppliers, firms, universities, financial institutions, and government institutions. These actors and organisations interact through both market and non-market relationships to generate and exchange knowledge relevant to innovation and its commercialisation. However, the nature of relationships and networks differ across different sectoral systems. Furthermore, it is likely that during the evolution of sectoral systems the technological and learning regimes will experience changes. Such change is also likely to result in a co-evolutionary process of various actors, institutions and knowledge flow (Malerba, 2002).

Figure 8: Sectoral/ Technology Specific System of Innovation - Agents Involved in an ICT Innovation System



Source: Baskaran and Muchie, 2006.

Advantages/ Strengths of Sectoral Innovation System

(i) The concept of sectoral innovation system provides an alternative analytical framework to the traditional concept of sector used in industrial economics, as it helps analyse other agents in addition to firms and brings in to focus the importance of knowledge flows, boundaries, market and non market factors and their interactions, and different institutions.

(ii) Also, this approach recognises that firms play active role in shaping their technological and market environments, unlike the traditional industrial economic view that they are passive, that is, they transform inputs into outputs in response to market price signals (Malerba, 2002).

(iii) The concept of sectoral innovation system is useful to: (a) analyse the differences and similarities in the structure, organisation and boundaries of sectors; (b) understand the differences and similarities in the working, dynamics and transformation of sectors; (c) identify the factors affecting innovation, commercial performance and international competitiveness of firms and countries across different sectors; and (iv) for the development of public policy initiatives (Malerba, 2002).

(iv) The sectoral system of innovation concept complements other concepts within the innovation system literature such as national systems of innovation delimited by national boundaries, and regional/local innovation systems in which the boundary is the region. National/ regional boundaries are not always the most appropriate ones for an examination of the structure, agents and dynamics of linkages in a sector.

(vi) Sectoral system of innovation approach helps to understand why often the characteristics of national institutions favour specific sectors that largely reflect the characteristics of these institutions. That is, some sectoral systems become far more important in a national economy compared to others.

(vii) Relationship between national institutions and sectoral systems can be a two way street. That is, although often national institutions impact on sectoral systems, sometimes it occurs in the other direction as well. For example, the institutions of a sector may become national when their contribution (employment, competitiveness, and so on) becomes very important at national level (Malerba, 2002).

(viii) Emphasis on the diversity of sectoral systems helps to formulate different policy measures for different sectors.

Weaknesses/ Disadvantages of Sectoral Innovation System

(i) Interactions between various agents in the sectoral system of innovation are shaped by institutions at both sectoral and national levels. Many institutions such as patent system are national. This shows that it is not easy to distinguish the boundary between national and sectoral. Furthermore, the characteristics of these institutions (norms, routines, common habits, established practices, rules, laws, standards) at both levels are nearly indistinguishable.

(ii) Similarly, sectoral innovation systems are also shaped by institutions at global level. In some cases the relevant geographical boundaries are global as well as sectoral. In such cases it is not easy to distinguish the boundary between global and sectoral.

(iii) The relationship between national institutions and sectoral systems could be different in different countries. That is, the same institution may take different features in different countries, and thus may affect the same sectoral system differently in different countries.

(iv) The nature of relationships and networks differ across sectoral systems and therefore it can be difficult and complex to compare them to each other.

6. Unified Conceptualisation of Innovation Systems

The notion of a unified conception of innovation systems in light of the need to use an alternative framework for economic development relates to the understanding that different selection of themes and strategies for research from the micro-firm to the national level has differential contributions to the outcome and impact on development. It may thus be necessary to find a way of unifying the insights and knowledge gained from the different systems in order to utilise them for advancing the development project in the developing world. It is also clear that the study of contributions from each type of innovation system in relation to development needs to be weighted and priorities for policy intervention selected. What is common and what is different from each type of systems of innovation category have to be differentiated and both formal and appreciative theories have to be used to help generate a unified conception of innovation systems for application to the problems of development. The alternative framework of innovation systems for development can benefit both from the application of the distinct innovation systems as they have evolved and from a unified conception of their combination in order to promote economic development. Both lines of inquiry are useful to undertake- the unified and combined and the separate and distinct levels both for the sake of identifying priorities for intervention and for pulling together knowledge to apply and generate accelerated outcomes and impacts on development.

The discussion of distinct and different systems of innovation – national, regional/ local/city, sectoral/technology specific clearly illustrates a number of common characteristics: (i) they consist of a network of actors and agents together with the institutions and policies that influence their innovative behavior and performance; (ii) the presence of an interactive process in which firms/enterprises interact with each other to innovate, develop and commercialise new products and new processes and bring abvout new forms of organization; (iv) Role played by the institutions and organizations such as universities, public R&D organisations, regulatory and standard setting bodies, specialist service provders, banking and other financing institutions in facilitating and supporting this process; (iv) some major aspects of system of innovation at any boundary level: knowledge and information flow; actors and networks, institutions; linkages between these entities; investment and learning; (vii) The analytical framework (based on evolutionary theory) for systems of innovations places main emphasis on dynamics, process and transformation; (viii) In different innovation systems, the learning, behaviour and capabilities of agents are determined by the technology, knowledge base and institutional context in which

firms act; (ix) Whether it is at the firm-level, or regional-level, or national level, the common view is that innovation is the engine of growth.

Table 1 compares the actors, activities and linkages between different types of innovation systems and also their strengths and weaknesses. It clearly illustrates that although there are some clear differences in the characteristics and emphasises among different types of innovation systems, there are also a number of common characteristics among them. These two aspects have to be reconciled if we attempt to develop a conceptual model that unifies different innovation systems. OECD (1999) has presented a model to unify the innovation systems, which is illustrated by Figure 9.

Table 1: Comparison of Strengths and Weaknesses of Innovation Systems

Innovation System/ Type	**Actors/ Institutions/ Activities/ Linkages**	**Strengths/ Advantages**	Weaknesses/ Disadvantages
Firm Level	1. Technical Suppliers Consulting and Professional Organisations R&D Laboratories/ Universities Customer/ Suppliers Firms Partner Companies 2. Government R&D Support Venture Capital, and	1. Firm and entrepreneur are central focus in theories on innovation. 2. Firm level approach helps understanding of innovation capacity at firm level and a nation's industrial capacity and competitiveness 3. Helps understanding that firms are drivers of technological innovation in a national economy. 4. Helps understanding differences in firms' performances. 5. Some scales and measures are employed for measuring firm's innovation	**1. Although models based on industrially advanced countries are found useful in analysing the management of innovation processes within firms, there is insufficient empirical evidence to verify these models.** **2. Weak theoretical underpinnings and also a failure to take into account the diversity and**

	FDI Intellectual Property Rights ICT, and S&T Culture Education System Infrastructure Legal System Market Conditions Global Market/Technology/ Investment/Competitors 3. Current Technological Capabilities (Product, Process, R&D, Skills) New Product, New Process, Learning Development Capability R&D Investment Knowledge/ Information Flow with Customers and Suppliers	performance.	**unpredictability of innovation processes.** **3. Also, innovation is not merely an individual act of learning by a firm or entrepreneur, but is situated within a larger national innovation system where a number of actors and institutions are linked and connected.** **4. Innovation process is not linear, as it involves "continuous interactivity between various actors, institutions and activities.**

National	1. OECD identified five institutions in NIS: (i) Governments (local, regional, national and international, with different weights by country) (ii) Bridging institutions, such as research councils and research associations; iii) Private enterprises and the research institutes they finance; (iv) Universities and related institutions that provide key knowledge and skills; (v) Other public and private organizations that play a role in the national innovation system (public laboratories, technology transfer organizations, joint research institutes, patent offices, training organizations and so on) 2. Network of these institutions in the public and private sectors interact and	1. NIS helps to study not only developed economies, but also developing economies, although there are significant socio-economic and political differences and variations. 2. NIS approach provides an alternative to neo-classical economic theories of growth. Innovation is rooted in processes of interactive learning that is problematic in pure markets. 3. NIS provides a flexible conceptual framework to study the problem of "technological gap" between the developed and developing nations (particularly the advanced and emerging developing economies). 4. NIS provides different approaches to study innovation process in developing countries such as Charles Edquist's (2001) Systems of Innovation for Development (SID) concept. Others emphasis more on learning than innovation - passive learning to absorb technological capabilities for production and active learning where deliberate	**1. In the era of globalisation the question is: how relevant is the NIS which emphasises on the national level? One can argue that there are factors that are beyond the control of national governments which can influence the innovation system.** **2. International knowledge and technology flows, information and capital flows and international collaborations are increasing in volume. There are constraints imposed on nation states and NISs by: intellectual property regimes, international al trade regimes and labour systems, regional economic alliances, influence of transnational corporations on the structure of markets, and investment in R&D.** **3. There is still knowledge gap in understanding fully the impact of TNCs on local learning and innovation and also the role of**

	initiate development and production of science and technology within national borders. 3. Continuous interactivity between suppliers, clients, universities, R&D organisations, standard setting bodies, financial institutions and other critical social and economic actors. 4. Interaction among these units may be technical, commercial, legal, social, and financial with the main goal of the development, protection, financing or regulation of new science and technology.	effort is made to master technology. 5. Despite the inevitable question as to the appropriateness of the concept of NIS due to the emergence of globalized economy, it is widely accepted that domestic policies, actors and institutions still play an important role. 6. NIS also helps to capture the uneven economic development dynamics in developing economies. Also, it helps to identify the linkages between innovation systems and industrial economic narrowly, and more broadly structural social and economic development/transformation. NIS model also enables elaboration and variations to analyse and capture particular aspects of innovation process (e.g. NIS's impact on FDI, and FDI in R & D).	**international institutions that shape both the strategies of firms and the policies of national governments** **4. There are still problems in applying the NIS concept to large number of small and least developed economies in Asia, Africa, and Latin America, as the institutions and actors that are central to NIS are hardly present in these economies.** **5. Another fundamental problem with NIS is determining its scope within the national boundary. That is, an analytical distinction between a "narrow" NIS concept, and a "broad" NIS perspective.** **6. Although there are strong measures such as R&D expenditure and patents, there are still problems in measuring the linkages, flows and outcomes in the NIS.**
Cluster	1. The 'cluster' approach emphasises	1. It helps to understand the dynamics of industrial	**1. The global factors can have serious**

	the importance of firm interactions with supply chains and with public research organisations 2. Close interaction between certain types of firms and industries, interactions centred on key technologies, shared knowledge or skills or producer-supplier relationships. 3. Clusters emerge due to certain demand patterns for products, rivalry among firms, and specialised factors or inputs such as skilled personnel or natural resources.	clusters in particular regions and the factors contributing to successful clusters in different countries. 2. It has been widely employed by many developed and developing countries to foster particular industrial clusters in particular regions by following deliberately targeted policies. 3. Helps to understand the development of particular industrial sector/ technology in a particular region. This provides clear focus for analysing and identifying conditions that leads to a successful or unsuccessful cluster/ innovation system.	**implications for the local innovation system where it is identified with clusters formed by actors along the value chain.** **2. Cluster approach generates a static bias since it is defined in terms of the standard industrial classification. Its boundaries are thus fixed and sector-based cluster approaches cannot capture situations in which industrial boundaries are blurring.** **3. Nature and characteristics of clusters can be different from one another within a same country and therefore, comparability is problematic.**
Regional/ Local/ City/ Metropolitan	1. Local innovation networks are considered to play an important role in the innovation process and economic growth of regions and cities. 2. Local/ regional innovation process results due to interactions at economic and social	1. Nation innovation system does not fully explain why there is an uneven development across different regions in a country. Regional innovation system concept helps to address this problem. It helps to understand the gap between advanced regions and less advanced regions.	**1. Due to differences across regions within national boundaries and across different countries it is difficult to device 'common solutions' or general 'best practices' for regions. This creates problems towards policy formulations and**

	levels between different institutions located in a particular region. 3. To understand the efficiency or performance of a regional/ local innovation system, it is important to examine not only the horizontal and vertical relations among firms but also the linkages between firms and other institutions such as universities, research institutions, supporting industry, provincial/ local government policies, and financial institutions.	2. It provided an alternative to growth without employment at national level. 3. It emphasises more on networking and linkages among regional actors and institutions which helps to understand better problems associated with regional/ local development. 4. Regional innovation system approach helps to understand to some extent why many of the leading firms in 'new economy' industries which need to innovate at a rapid pace have emerged in the same few locations across the world. 5. Regional innovation system helps to understand not only the region-level interaction to promote innovation in traditional industrial sectors such as	**learning from other regions.** **2. Due to differences across regions, one of the major problems with regional innovation systems is the lack of comparability across regions. It seems every region aims to develop an innovation system based on some successful models which may not be appropriate for them.** **3. The concept of regional innovation system can lead to confusion, as 'region' is interpreted in different ways (global region, or supranational region, metropolitan or city region, sub-nation region or local).** **4. Although it can be argued that innovation is strongly influenced by**

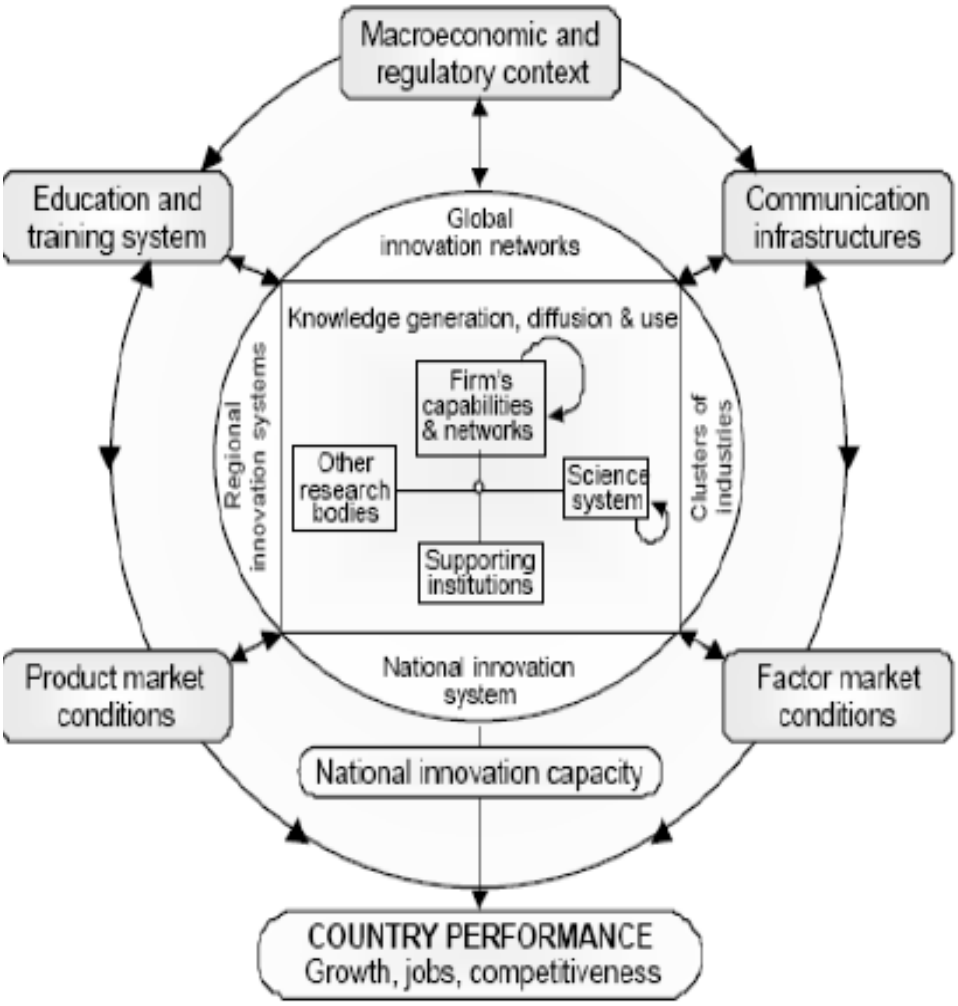
		manufacturing, but also in service-related sectors. 6. Analysis at sub-national innovation system level helps to understand the factors that help sustainable competitiveness of SMEs and their technological capacity-building.	**region-specific factors, the ability of and incentives for firms to innovate are mainly linked to national level factors such as intellectual property right laws, taxation, corporate governance, tariffs and so on. Also by global factors such as increasing competition in the global market.**
Sectoral/ Technology Specific	**1. A sector is composed by various agents and organisations such as consumers, entrepreneurs, users, producers and input suppliers, firms, universities, financial institutions, and government institutions.** **2. These actors and organisations interact through both market and non-market relationships to generate and exchange knowledge relevant to innovation and its commercialisation.**	**1. It provides an alternative analytical framework to the traditional concept of sector used in industrial economics, as it helps analyse other agents in addition to firms and brings in to focus the importance of knowledge flows, boundaries, market and non market factors and their interactions, and different institutions.** **2. It recognises that firms are active actors in shaping their technological and market environment; unlike the traditional industrial**	**1. Interactions between various agents in the sectoral system of innovation are shaped by institutions at both sectoral and national levels. Many institutions such as patent system are national. It is not easy to distinguish the boundary between national and sectoral. Also, the characteristics of these institutions (norms, routines, common habits, established practices, rules, laws, standards) at both levels are nearly**

	3. The nature of relationships and networks differ across different sectoral systems. **4. It is likely that during the evolution of sectoral systems the technological and learning regimes will experience changes. Such change is also likely to result in a co evolutionary process of various actors, institutions and knowledge flow**	**economic view that they are passive (they transform inputs into outputs in response to market price signals).** **3. It is useful to: (a) analyse the differences and similarities in the structure, organisation and boundaries of sectors; (b) understand the differences and similarities in the working, dynamics and transformation of sectors; (c) identify the factors affecting innovation, commercial performance and international competitiveness of firms and countries across different sectors; and (iv) for the development of public policy.** **4. Sectoral system of innovation approach helps to understand why some sectoral systems become far more important in a national economy than**	**indistinguishable.** **2. Sectoral innovation systems are also shaped by institutions at global level. In some cases the relevant geographical boundaries are global as well as sectoral. In such cases it is not easy to distinguish the boundary between global and sectoral.** **3. The relationship between national institutions and sectoral systems could be different in different countries. That is, the same institution may take different features in different countries, and thus may affect the same sectoral system differently in different countries.** **4. The nature of relationships and networks differ across**

		others. **5. Emphasis on the diversity of sectoral systems helps to formulate different policy measures for different sectors.**	**sectoral systems and therefore it can be difficult and complex to compare them to each other.**

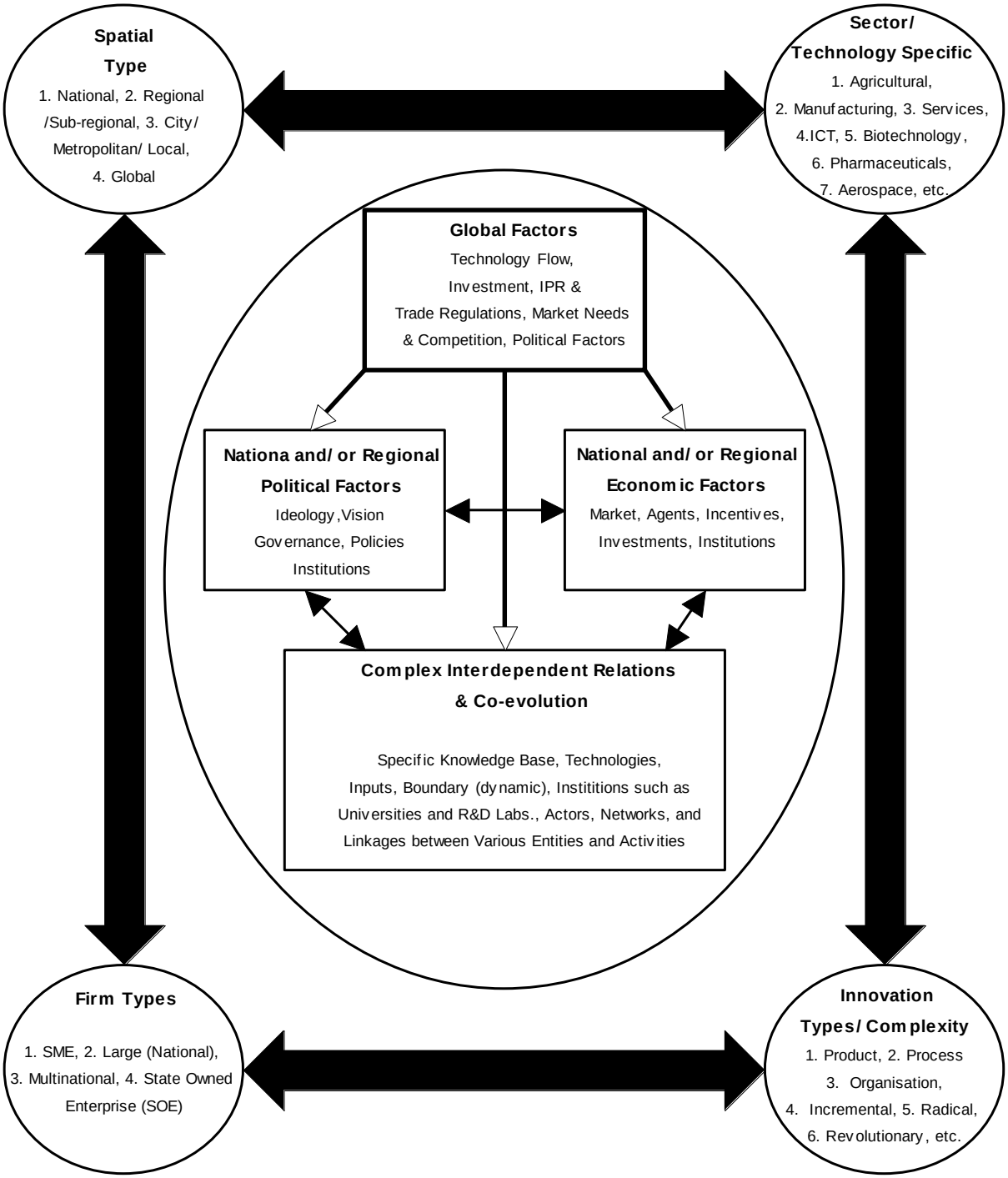
Although the OECD model addresses the issue of global factors that influence the innovation systems at different level, it has not addressed the importance of political factors at the national/ regional/ local levels that could play a major role in creating and developing an efficient system of innovation. We attempt to include this in our model as illustrated by Figure 10. Apart from this, our model attempts to clarify four major aspects of systems of innovation: (i) complex interdependent relations and co-evolution of actors, institutions, and activities that are common to all types of innovation systems (specific knowledge base, technologies, institutions such as public R&D organisations, and universities, investment and trade and economic policies) ; (ii) national and / or regional political factors (ideology, vision, governance, policies, and institutions) which have been proved to have played a major role in creating and developing efficient innovation systems at national/ regional/ local level; (iii) national and / or regional economic factors (markets, agents, incentives, and institutions) which have been proved to have played a major role in creating and developing efficient innovation systems at national/ regional/ local level; and (iv) global factors such as technology flow, global market competition, trade regimes, intellectual property regimes and global political factors that can impact on not only national innovation systems but also at regional/ local and sectoral innovation systems.

Figure 9: Actors and Linkages in the Innovation System



Source: OECD (1999), *Managing National Innovation Systems*.

Figure 10: Unified Conceptualisation of Innovation Systems



We emphasise on the role of political factors such as political vision and governance because it is evident from the history of innovation systems that these factors play important role particularly in the context of developing economies. For example, the creation and the subsequent role of MITI in Japan, *Chaebols* in Korea, large and sustained investment in higher education and S&T sectors in India, transformation of command economy to more open economy in China can be taken as initiatives of political vision by policy makers in these countries.

7. Some Concluding Remarks

Both evolutionary economics theory and systems of innovation perspectives have been used to frame alternative conceptual frameworks to neo-classical economic theory. We think that there is an even more relevant role to them in providing alternative frameworks to the problems and challenges of development and underdevelopment. We advance in this exploratory paper how a system of innovation that combines knowledge, learning, research, innovation, and capability building can provide an alternative framework to the study of development and underdevelopment.

For the system of innovation to play a creative and insightful role, its use and application needs to be understood with clarity where the relevant non-economic and economic structures, institutions and actors and their co-evolutions are well specified, and those that need to be included are included, and those that do not need to be included are excluded.

In this paper we reviewed the variety of ways of how the system of innovation has been used in order to help formulate an allowable way of the extension and application of the innovation system conceptual framework on the problems and challenges of development and underdevelopment.

There is always the risk of misuse and abuse of a framework when it is extended to new terrain and endeavors. In order to avoid such a mishap the review and exploration of how the system of innovation has evolved and been used has been undertaken.

The aim was to identify the core and peripheral themes that are allowed in the making of innovation systems by identifying those allowable variables from those that are excluded.

Such a reflexive take on systems of innovation is likely to improve the way it may be productively used especially when the innovation system framework is applied increasingly to the problems of development and underdevelopment.

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