Innovation Policy Studies Between Theory and Practice: A Literature Review Based Analysis[†]

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Abstract

This paper reviews the emerging literature on innovation policy from a practitioner's perspective, reviews the policy implications of an evolutionary perspective in economics, and identifies newly emerging areas of innovation policy analysis. We show that an innovation system is a dominant policy discourse, that there are limits of policy implications from an evolutionary perspective, and that there is a need for explicitly policy motivated analysis grounded in a broad evolutionary perspective. Innovation policy studies are an area in pre-paradigmatic stages whose dynamism originates from the interaction of theory, policy, and policy learning. The limited usefulness of policy implications derived directly from either conceptual or empirical analysis requires more explicitly policy focused research.

KEYWORDS: innovation policy, technology policy, evolutionary economics, innovation system, innovation studies

1. INTRODUCTION

Policy implications cannot be automatically derived from the analyses of innovation issues (i.e. normative does not automatically follow from positive) as there is always a need for additional

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theoretical and conceptual or empirical knowledge (Teubal, 2002). A view that a policy application can be developed as an afterthought of positive analysis is similar to the logic of a linear innovation model whereby normative is derived in a straightforward manner from the previous (positive) stage of research. The limited usefulness of policy implications derived directly from either conceptual or empirical analysis calls for explicitly policy focused research. Based on this rationale, this paper reviews the emerging literature on innovation policy from a practitioner's perspective to assess its usefulness; in particular, we assess the relevance of policy implications of an evolutionary perspective in economics. Finally, based on the literature review we identify newly emerging areas of innovation policy analysis.

Innovation studies is a rapidly expanding field. A recent thematic review issue of *Research Policy* (Martin, 2012; Martin et al, 2012; Fagerberg et al, 2012) showed that the field is transitioning from pre-paradigmatic towards an established mainstream academic field. Its overall state of the art is represented in two handbooks by Hall and Rosenberg (2010) and by Fagerberg, Mowery and Nelson, 2006). A study by Fagerberg & Verspagen (2006) showed that there is a global community of innovation scholars.

The area of innovation studies originates from science policy studies. This explains why Martin (2012) labels this area as 'science policy and innovation studies'. Indeed, the proximity of scholars, policy makers and consultants represent an important feature of an area that is being established as standard discipline. This proximity is an important source of dynamism in the area. Hence, it is quite puzzling why the innovation policy dimension of innovation studies has not been scrutinized more. Martin (2012:3) argues that *'there is unfortunately no obvious objective measure'* of the impact of innovation studies on policy. The last substantial academic survey of the policy side of innovation studies is Mytelka and Smith (2002). Their major argument is that *'the theory-policy link has been central to the intellectual development of this field, which would have been impossible within the constraints of existing disciplinary structures and university funding systems'* (p.1467). This survey builds on the contribution by Mytelka and Smith (2002) and examines whether their conclusions are still valid. Unlike recent surveys of innovation studies (Martin, 2012; Martin et al, 2012; Fagerberg et al, 2012), this survey is less rigorous or formalized. This is largely due to the 'slippery' nature of innovation policy studies where a strictly formalised survey that is confined to contributions to handbooks or to highly cited works would be irrelevant. We explore innovation policy studies from the perspective of practitioners based on relevance or usefulness for policy making.

We do not have a fully defined definition of innovation policy studies. We consider studies that explicitly address the issue of innovation or technology policy as well as all innovation studies from the perspective of policy relevance. In that respect, the boundaries of our inquiry are open to criticism. However, the majority of papers reviewed had to contain 'technology' or 'innovation' and 'policy' in their keywords. This ensures that authors consider 'policy' dimension an important word in their paper. We have excluded the word 'science' (policy) as that would lead to a large number of papers that are confined to narrow science policy issues while we are primarily interested in this area from the perspective of economics and innovation policy. Also, we have included papers and

books that do not meet the above formal criteria but remain highly relevant to our inquiry. It is inevitable that this survey has a high degree of subjective assessments; however, we have tried to be clear in the criteria used when reviewing literature and explain these criteria below. The, reader may object to some parts of the survey as superficial while others too detailed. The reader should bear in mind that (apart from an impossible task to capture the entirety of literature in some objective manner) our major criterion was the **policy relevance of literature from the viewpoint of a practitioner.**

In continuation, we present a brief bibliometric picture of the area of innovation policy (Section 2). Section 3 presents a taxonomy of systematically generated innovation policy literature where issues are grouped based on a combination of two criteria: level (conceptual/empirical) and diversity of issues (policy areas). Section 4 summarises the policy implications and discusses the policy relevance of a broad evolutionary perspective in economics that is currently considered the dominant perspective in innovation studies. Finally, Section 5 concludes and shows the major gaps and challenges in innovation policy analysis.

2. PROBING THE CONTEXT: BIBLIOMETRIC PICTURE AND ITS LIMITS IN UNDERSTANDING INNOVATION POLICY LITERATURE

This review is based on an extensive literature search and contains the advantages and drawbacks of such an exercise. The use of databases has tremendously improved the speed of searches and reviews. However, this has also led to biases towards the good coverage of journal papers and the poor coverage of books and conference papers. We have reviewed all database references in *the Web of Science* with the key words 'innovation', 'technology', 'knowledge', and 'evolutionary' taken solely or combined with word 'policy'. We focused mainly on papers published between 1995 and 2008 but have also searched older and newer references.[3] In addition, we searched JSTOR database, GLOBELICS conferences website, DRUID website, and Schumpeterian Society conferences website. We also searched the Google Scholar database, and completed a Web of Science search by checking *Ingenta, Informworld, and Science Direct* databases. Last, we complemented this by a search of our own database developed for research, teaching, or personal interest in research. This latter aspect is essential in the area of innovation policy where valuable analysis is not necessarily captured by databases like *Web of Science*. Activities of consultants, international organisations and national governments form an essential part of the research relevant in this area. In addition, a large number of mimeo and other unpublished papers are relevant. However, this survey does not pretend to be comprehensive in quantitative terms but rather in terms of capturing a *variety of qualitatively different contributions* on innovation policy from primarily heterodox and evolutionary perspectives.

The basis for this review is an *ad hoc* created database with more than 220 references that has been used as one basis to develop a taxonomy of major areas of research in innovation policy.

[3] This survey explores the policy relevance of innovation policy studies and surveying older works would be superfluous.

In continuation, Figure 1 and Tables 1-4 summarise a bibliometric picture of research in the 'innovation policy' area.[4] As background to this paper, we have explored bibliometric results for the innovation policy related areas through the use of keywords: 'technology', 'knowledge', 'science' and 'evolutionary' combined with 'policy'. However, the results do not substantially change the cross section picture generated with only the keyword(s) innovation and policy.

Figure 1 shows the fast growth of papers areas that (from the mid-1990s) started to grow from the more than 150 papers that used the term 'innovation' and 'policy' (IP) and about 500 papers with the term 'technology' and 'policy' (TP) in 1995. The annual number of papers has increased by three and five times for IP and TP respectively in 15 years to 2010. A shift in this rising trend after 2008 would require further scrutiny.[5]

FIGURE 1. Number of papers with keyword(s) 'innovation' or 'technology' and 'policy',1995-2011 in *Web of Science*

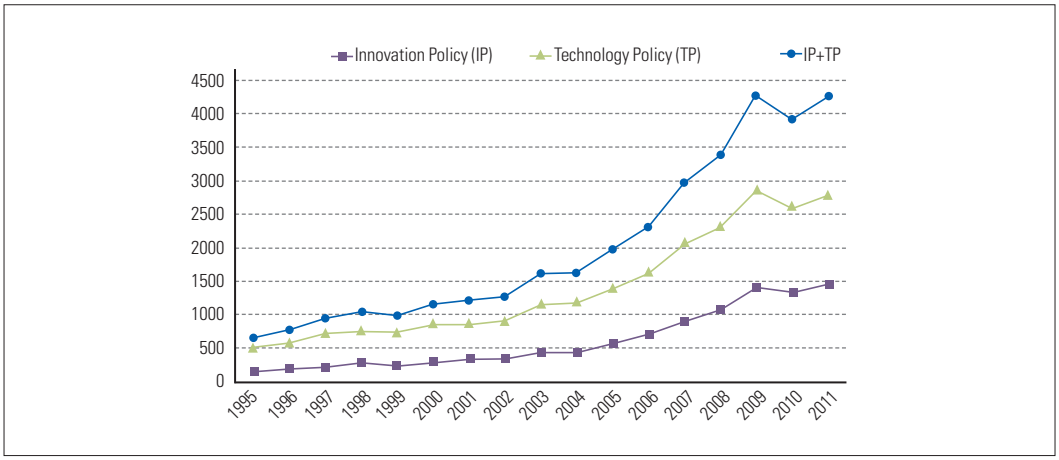

Table 1 shows the top 25 journals that published papers from 1995-2011 with the keyword(s) 'innovation policy'. Twenty percent of the papers in this area were published in these top 25 journals. This shows a much dispersed area that is very similar if we use the term 'technology' and 'policy. The only journal with a substantial number of papers (over 200) is Research Policy. It is interesting that innovation policy is also strongly present in Energy Policy and Telecommunication Policy.

A picture of innovation policy as a relatively dispersed area is confirmed by the list of ten major organisations whose authors have published in this area (Table 2). This (along with a list of

[4] The term 'innovation policy' in this survey contains the notion of 'technology policy'. However, in the bibliometrics survey we clearly distinguish when we use term 'innovation policy versus technology policy. Our survey addresses 'generic' innovation policy issues. Hence, the use of term 'technology' and 'policy' indiscriminately would give too much weight to specific technology areas like computer management information systems, engineering, energy, and environment.

TABLE 1. Major journals in innovation policy area: number of papers based on the occurrence of keywords, 'innovation' and 'policy' 1995-2011

	Journal		Total (11312)
1	RESEARCH POLICY	415	3.67%
2	ENERGY POLICY	191	1.69%
3	EUROPEAN PLANNING STUDIES	175	1.55%
4	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	164	1.45%
5	TECHNOVATION	157	1.39%
6	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	136	1.20%
7	TECHNOLOGY ANALYSIS STRATEGIC MANAGEMENT	107	0.95%
8	REGIONAL STUDIES	93	0.82%
9	ECOLOGICAL ECONOMICS	74	0.65%
10	ENVIRONMENT AND PLANNING C GOVERNMENT AND POLICY	73	0.65%
11	JOURNAL OF CLEANER PRODUCTION	62	0.55%
12	SCIENTOMETRICS	59	0.52%
13	SCIENCE AND PUBLIC POLICY	56	0.50%
14	JOURNAL OF TECHNOLOGY TRANSFER	54	0.48%
15	TELECOMMUNICATIONS POLICY	51	0.45%
16	SMALL BUSINESS ECONOMICS	50	0.44%
17	HEALTH POLICY	48	0.42%
18	ENVIRONMENT AND PLANNING	47	0.42%
19	HEALTH AFFAIRS	47	0.42%
20	ENERGY ECONOMICS	45	0.40%
21	POLICY STUDIES JOURNAL	44	0.39%
22	INNOVATION MANAGEMENT POLICY PRACTICE	42	0.37%
23	WORLD DEVELOPMENT	41	0.36%
24	URBAN STUDIES	40	0.35%
25	ISMOT 07 PROCEEDINGS OF THE FIFTH INTERNATIONAL SYMPOSIUM ON MOT VOLS 1 AND 2	39	0.35%

the most prolific authors) reinforces a picture that innovation policy is a popular area of involvement for researchers of innovation and related studies; however, it rarely constitutes the sole area of research.

A broad disciplinary base for innovation policy reinforces this picture. Papers in this area usually involve several disciplines though around 50% of the papers are in the area of business economics (Table 3).

Business economics, planning & development and environmental studies are three major areas of innovation policy studies; however, these are combined with a large number of other areas. The breakdown of combined 'technology' or 'innovation' and 'policy' keywords would significantly increase the share of energy, engineering, environment, and computer science information systems that further indicate the interdisciplinary nature of the innovation/technology policy area.

TABLE 2. Major organisations publishing in innovation policy, 1995-2011

	Organisations	**Papers**	**Total** (11312)
1	HARVARD UNIV	159	1.41%
2	UNIV CALIF BERKELEY	127	1.12%
3	UNIV SUSSEX	124	1.10%
4	UNIV MANCHESTER	115	1.02%
5	UNIV CAMBRIDGE	99	0.88%
6	UNIV TORONTO	99	0.88%
7	UNIV UTRECHT	84	0.74%
8	COLUMBIA UNIV	76	0.67%
9	GEORGIA INST TECHNOL	76	0.67%
10	MIT	76	0.67%

TABLE 3. Major ten subject areas (WoS) that address the issue of innovation policy: papers with keywords 'innovation' and 'policy', 1995-2011

	Area	**Papers**	**% of total**
1	MANAGEMENT	2472	21.85%
2	ECONOMICS	2431	21.49%
3	BUSINESS	1394	12.32%
4	PLANNING DEVELOPMENT	1365	12.07%
5	ENVIRONMENTAL STUDIES	1302	11.51%
6	OPERATIONS RESEARCH MANAGEMENT SCIENCE	890	7.87%
7	ENVIRONMENTAL SCIENCES	701	6.20%
8	PUBLIC ADMINISTRATION	637	5.63%
9	GEOGRAPHY	578	5.11%
10	POLITICAL SCIENCE	520	4.60%

A picture of a dispersed area with a broad disciplinary base is somewhat modified when we take into account the country/territory of origin for innovation policy papers. The degree of concentration here is the highest with the US having 35% of authored or co-authored papers followed by the UK behind with 20%. The biggest change is the rise of China which moved from 19th to 3rd place between 2008 and 2012. Korea and Taiwan are the only two other developing countries within the top twenty countries in Table 4.

This brief overview based on bibliometrics indicates a low concentration of journals, organisations, broad interdisciplinary nature, and a relatively low concentration of countries/territories. This suggests that there is no coherent paradigm or research agenda in the innovation policy area that will be further explored in the qualitative analysis undertaken in the next section.

TABLE 4. Major countries/territories publishing in the area of innovation policy, 1995-2011

	Countries and Territories		**% of total** (11312)
1	USA	3274	28.94%
2	ENGLAND	1507	13.32%
3	CHINA	1087	9.61%
4	NETHERLANDS	638	5.64%
5	GERMANY	600	5.30%
6	CANADA	569	5.03%
7	AUSTRALIA	425	3.76%
8	SPAIN	420	3.71%
9	ITALY	418	3.70%
10	FRANCE	367	3.24%
11	SWEDEN	239	2.11%
12	BELGIUM	204	1.80%
13	JAPAN	193	1.71%
14	SCOTLAND	182	1.61%
15	SWITZERLAND	175	1.55%
16	SOUTH KOREA	171	1.51%
17	FINLAND	159	1.41%
18	TAIWAN	157	1.39%
19	DENMARK	139	1.23%
20	NORWAY	133	1.18%

Why does this area not yet have a coherent research agenda? Keith Pavitt and William Walker (1976) argued 36 years ago that this is due to the lack of a theory in technology innovation to predict ways in which governments can influence innovation processes. Are we any closer to a technological innovation theory that isindispensable to generate empirically substantiated and theoretically grounded policy implications? One cannot deny a huge improvement in our empirical understanding of innovation patterns and innovation process compared to 40 years ago. In addition, evolutionary based theories of economic and technological change are better suited to illuminate stylized facts of technological innovation. However, unlike the natural sciences, our object of research keeps changing so that our knowledge frontier should always be assessed in relation to a continuously moving object of research. A continuous policy problem is 'fight (of) the last war '' i.e. addressing policy issues that just became much less relevant (Auerswald and Branscomb, 2008).

This moving frontier can be detected in changing innovation models that serve as first approximations of reality or 'lenses' for innovation policy to indicate the basic patterns of innovation. They largely reflect our increasing knowledge of the innovation process (see for example the review of models and the innovation management area by Gann, Dogdson and Salter, 2008). Yet, an analysis of these models that form the teaching foundation for innovation studies shows the imperfect devices at our disposal (Hobday, 2005).

In summary, it is not quite clear whether innovation policy will ever pass its critical stage and become an established discipline. Schumpeter wrote about the routinization of the innovation process; however, we should remember that innovation is an entrepreneurial and evolutionary process. Our ambition to canonize some of its determinants (including innovation policy) may represent a bad utopia. If innovation policy ever develops a coherent research agenda, it may be the end of innovation policy as we know it today.

3. A TAXONOMY OF LITERATURE ON INNOVATION POLICY

Based on an extensive literature review, we grouped over 220 references collected in database compiled for the purpose of this survey. The objective was to generate a sufficient number of references so that we can get an idea of the diversity of issues covered by the literature as well as their theory/empirics orientation. However, it also remains subjective as we do not have a clear formal criterion by which groups and sub-groups are generated. Such a criterion could have been based on methodology (theoretical, empirical, and appreciative theory), level of analysis (macro, micro, and mezzo), or disciplinary origin. However, as a taxonomic work, it would still contain a large degree of arbitrariness as many references fall across several of these categories.

Based on a detailed literature review of innovation policy, we distinguish four broad areas:

1. Economic Development and Economics of Innovation Policy
2. Theory of innovation policy
3. Innovation Systems
4. Policy evaluations

In continuation, we survey the key issues in each of these four major areas.

3.1. Economic Growth and Economics of Innovation Policy

The literature on Economic Development and Economics of Innovation Policy takes economic growth and long-term structural change from all its different conceptual perspectives as the point of departure.

3.1.1. Growth regressions based literature

The literature on economic growth and economic development is inextricably linked to issues of technology accumulation through explicit treatment of some aspects of technology (like R&D in endogenous growth theory) or the implicit treatment of technology through the concept of total factor productivity (TFP) in neo-classical growth approaches. This literature is often based on growth regressions and its policy implications are unclear. For example, the policy relevance share of TFP remains very limited (or at best a useful starting point for the analysis of technology accumulation). The results from growth regression studies often generate opposite policy conclusions (Bosworth and Collins, 2003) or they are quite vague and too aggregate (Temple, 1999, Easterly and Levine,

2001). It seems that a well-developed innovation system backed by good governance is essential for catch up (Fagerberg & Srholec, 2007). Innovation-oriented policies are necessary but not sufficient to reach the global technological frontier (Furman and Hayes, 2004).

The downside of these types of analyses is that policy implications are derived as a direct result of regression analysis. It is assumed that the variables that are significant to explain growth are the same that policy should influence. However, these variables are too aggregate to be useful for policy purposes. In addition, they may not be the best variables for a policy focus as they may be an outcome of other economic and socio-political factors i.e. proximate rather than true causes of growth. Instrumental regression variables do not solve this problem as they further complicate the understanding of policy issues. There is a lack of equivalence between outcomes and institutional variables. Subsequently, the institutional configurations that characterize national innovation systems of countries that have managed to catch up vary substantially (Furman and Hayes, 2004). However, these studies through their 'built- in' methodological bias reinforce the idea that there are common (universal) drivers of innovation and growth.

The limits of policy implications derived as an afterthought of growth regressions led to a new literature that explicitly addresses the issue of policies for development. For example, Tratjenberg (2006) explicitly addresses the issue of innovation policies for development based on evidence from Israel. He addresses the scope of policy (broad), its rationale and the main levers. Rodrik (2008) deconstructed the conventional case against industrial policy. The basic idea is that, through appropriate institutional design, the traditional informational and bureaucratic constraints on the exercise of industrial policy could be moulded. Most of these ideas have already been developed in the analyses of Chang Ha Joon (1993) and Peter Evans (1995) but with a more explicit political economy flavour. In our view, the good timing and 'policy dressing' of these ideas in Rodrik's version has made them more acceptable in policy circles. A broad and systematic attempt to explicitly address the issue of innovation policy for development is the work of the Stiglitz's led group (see Cimoli et al, 2007). Their work is about a new paradigm in development policy that is largely framed around the 'market enhancing view of government' which overlaps with views on systems of innovation as a growth theory.

3.1.2. Systems of innovation as growth theory: the absence of automatically derived policy implications

In his 2002 paper, Chris Freeman approached the analysis of long-term growth through the prism of national innovation systems (NIS). The essence of this approach is that growth emerges as fortuitous, partly a spontaneous and partly strategically driven coupling of complementarities between different societal subsystems (business, S&T, finance, trade, and government) (Freeman and Louca, 2001). Along a similar line of thinking, Nelson (2007) sees NIS as part of technology – institutions co-evolution. From our perspective, it is interesting that it is not possible to derive automatic policy implications from any of the NIS approaches.

From Freeman's perspective, the issue of complementarities between different social subsystems is not amenable to easy policy generalisations. Nelson's perspective on specificities of co-

evolution of technologies and institutions make automatic policy implications impossible. In Johnson, Edquist and Lundvall, (2003) perspective policies for learning should be reconciled with other policies for institution building and basic needs and thus cannot be automatically derived from analysis.

Scholars in this tradition are fully aware of the complexities of growth and technological development and are sceptical to derive automatic policy implications from their perspective on growth. Their analysis reinforces our conclusion that policies cannot be derived as an automatic outcome or afterthought of a specific conceptual approach. Instead of automatically derived policy implications, policies should be developed from explicitly policy focused research.

3.1.3. Techno-economic paradigm shifts and policy issues

A methodologically identical but global view of growth is represented by research on so called techno-economic paradigm shifts. A techno-economic paradigm is a view of growth as a co-evolution of technologies and an institutional framework that was originally developed by Carlota Perez in her Futures article in 1983. This perspective on long-term growth stems from recognition that technology and innovation processes have structural features (regularities) and that their interaction with the institutional frameworks are important to understand prospects and obstacles to long-term growth. This framework is quite powerful to illuminate a variety of organisational and strategic challenges linked to the diffusion of an ICT paradigm; subsequently, policy issues that are explicit in this perspective are developed in several later papers (Perez, 2006, 2001, 2000, 1992).

In the spirit of Perez, Fulvio Castellacci (2006) points to the temporary nature of the current mismatch between the techno-economic and the socio-institutional system. The Stiglitz group (Cimoli et al, 2007) expresses a similar Perezian viewpoint when arguing that policy challenges are inextricably linked to the nature of technology (cf. changes in the type of knowledge that countries need to accumulate and improve upon). Aghion and Howit (2005) demonstrate through a Schumpeterian position that appropriate growth policies should vary with a country's distance from the technology frontier and with its institutions. This argument has been taken by the Stiglitz group (Cimoli at et al, 2007) when arguing that the stringency of the new international constraints is likely to depend on the distance of any country from the international technological frontier. Radosevic and Kaderabkova (2011) apply this Schumpeter-Aghion perspective to the analysis of innovation policies in the EU.

Policies are dependent on underlying technological regimes. Policies differ with respect to the degree to which they take into account their interaction (or co-evolution according to Nelson) with institutions. The issue of institutional changes and their impact on innovation policy is incorporated into literature that looks at the effects of liberalisation policies on the accumulation of technological capabilities.

3.1.4. Liberalisation policies and their effects on technology accumulation

The conventional wisdom of economists recognises (with difficulty) that 'a free-trade shock does not automatically trigger any increase in the accumulation of knowledge and innovative capabili-

ties' (Cimoli et al, 2007: 19). The possible accumulation of knowledge and innovation in the liberalisation period of the 1980s and 1990s (especially in countries that followed import-substitution policies in the 1960s and 1970s) is an area of literature with important policy implications. Three examples of literature that look at the effects of economic liberalisation on innovation activities are: technological capabilities in the liberalisation period of India by Basant and Chandra (2002), the effects of trade liberalization on innovation in Turkey by Pamukcu (2003), and the accumulation of technological capabilities in Brazil by Figueiredo (2006; 2007).

There is no consensus on this issue because technological accumulation is a process affected by a variety of factors of which opening of the economy is only one factor. However, it seems that there is a lack of automatic positive effects of liberalisation on technology accumulation. Second, the literature shows the importance of systemic policies through the increased importance of linkages. This is in line with the emerging consensus that innovation policies in developed and developing countries give prominence to objectives related to the creation of networks, linkages, and FDI related technology spillovers. A series of studies on technology accumulation in Latin America summarised in Dantas et al (2007) show the importance of the development of linkages and flows as well as the local capabilities of the firms. This conclusion is highly relevant in the context of literature that looks at the impact of globalisation on the NIS as well as literature on the balance between domestic technological autonomy and reliance on FDI as a major source of technology.

3.1.5. 'State versus markets' versus 'market enhancing view of state' policy debate

The issue of openness and autonomy in technological development are salient in the political economy of development. This literature is extensive and it is impossible in this survey to provide a fair representation. Hence, we focus on a few relevant issues for innovation policys.

The debate in this area evolves around state versus market and the emerging consensus on the 'market enhancing' view of the state (Aoki et al., 1997). This view *"stresses the mechanisms whereby government policy is directed at improving the ability of the private sector to solve coordination problems and overcome other market imperfections"* (Aoki et al. 1997: 2). Government is regarded as an endogenous player interacting with other organisations (firms and business associations). This leads to a state governance perspective rather than a state versus market perspective, focused on underlying institutional and political conditions rooted in the notion of governance (Ahrens, 2002). This supersedes the view of state promotion versus market, a view demonstrated by the analyses of Chang and Cheema (2002) on the conditions for the effective design and implementation of a technology policy. These conditions include state autonomy, institutions that control resources flows, bureaucracy, state-owned enterprises (SOEs) and control over the financial sector, and intermediary institutions (Chang and Cheema, 2002; Ahrens, 2002).

The different forms of the market enhancing view (which has become the mainstream and widely accepted view) do not address the issue of state autonomy in relation to foreign capital. This is an important issue because globalisation and networked firms have led to an ongoing trend of delinking production from the accumulation of technological capabilities (Westphal, 2002). Westphal (2002) sees MNC-mediated development as the dominant form in the future because strategies

focused on the domestic market are unfeasible. An important issue in this context is the room for manoeuvre in autonomous policies in relation to the WTO regime of the global political economy, see Westphal (2002), and Amsden and Hikino (2000). The reduced room for autonomous industrial policy can also partly explain the increased popularity of innovation policy.

The 'state versus market' view and the 'market enhancing view' of state are very important distinctions to understand the broader context of innovation policy; however, they have little relevance on the specifics of innovation policy. A reason for this is due to what Nelson and Langlois (1983) described as 'complexity' in a wide diversity of technological and institutional details, knowledge structures, and the incentive structures involved in innovation policy activities. Their account suggests that industrial and innovation policies are too broad to be subsumed under one type of industrial policy. It is a diversity of policy practices and their complexity that evades easy generalisations such as are found in the 'state versus market' view. The contrasting stories of Korean government intervention in two related areas of IT standards suggest that the success of government intervention is contingent on a variety of factors. Its success depends on the technological conditions related to technology knowledge and the technology cycle, market conditions concerned with market governance structure and market prospects for technology, and on conditions for government capability that provide the technology knowledge and the technology market (see Wang and Kim, 2007).

In conclusion, the current literature on economic development and innovation policy does not lead us very far in terms of establishing a theory – policy link but it seems that it is telling and instructive for policy.[6]

3.2. Theory of Innovation Policy

Theory of innovation policy is understood here as an area of innovation studies literature that addresses policy from a conceptual perspective i.e. from a specific theoretical framework. In this section, we review the evolutionary economics literature which explores policy issues by taking a strong theoretical perspective on the nature of economic and technical change. First, we include a discussion on old and new rationales for innovation policy. Second, we explore the policy implications of an evolutionary economics perspective and point to the major tenets of evolutionary technology policy. Third, we point to the major methodological and conceptual issues that arise from a 'systems of innovation' perspective and their links to policy.

3.2.1. New, old and against rationales

One of the most cited papers with the keyword 'innovation policy' is Teece's (1986) paper 'Profit-

[6] The literature on the sociology of innovation policy represents an important component of the literature on innovation policies for growth. For empirical examples, see Schwartz (2006), Hadjimanolis and Dickson (2001) and Vavakova (2006). However, our understanding of the role of different policy stakeholders and social dynamics on different innovation policies is limited. We come back to this issue when we address the role of state in innovation policy in section 5.2

ing from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy'. This paper on appropriability touches one of the cores issues of innovation policy. A traditional rationale for support to knowledge is the poor appropriation of benefits by private providers who would underinvest in R&D. However, there is now an important body of literature which argues that the traditional rationale for market failure is flawed in its understanding of the wider process of innovation and competition. Teece's 1986 paper clearly opened the way for policy rationales from different perspectives (Chesbrough et al, 206). His answer to who actually profits from innovation pointed to owners of complementary assets, particularly when they are specialized and/or co-specialized.

The literature that addresses the issue of innovation policy rationale departs from market failure to embrace several new types of failures (Laranja et al, 2008). Arnold (2004) expands the idea of failures to: capability failures (inadequacies in the ability of companies to act adequately in their own interest), failures in institutions (failures in social institutions such as universities, research institutes and patent offices to fulfil their NIS functions), network failures (innovation system interaction problems), and *framework failures* (framework policies with a negative effect on innovation).

The most frequently used alternative type of failure is a system failure (OECD, 1998). A need for an alternative failure stems from the over emphasis on high-tech support measures which neglect the variety of interacting factors affecting technology accumulation (Andersson, 1998). For definitions of systems of failure, see Teubal (1998) and Andersson (1998); for different types of systems failures see Woolthuisa et al (2005). Edquist (2001) also identifies four main types of system failures. Peneder (2008) creates a policy mind map to help link systems failures to different policy tools.

The concept of a system failure is still in its embryonic stage and there are a variety of views on what it should represent. An application of this idea in the context of specific sectors should provide clarity and agreement on a definition. For an example of this type of analysis, see Hennessy et al (2003). However, the importance of rationales should not be overestimated because policies are rarely derived from theories and their rationales (Laranja et al, 2008). The alternative view is sceptical regarding the general rationale or justification for active government support in R&D (see Nelson, 2007).

We are currently in a flux as to accepted policy rationales. However, this by itself may not be that bad because good policies do not necessarily require a theoretical justification of why they are good.

3.2.2. Evolutionary technology policy

An evolutionary perspective is useful to explore the dynamic aspects of technological change. When compared to a neo-classical perspective, it is better atcapturing conceptually the dynamics of economic change; in addition, there is a great expectation that its application to policy purposes

could lead to new and more effective innovation policies. Here, we refer to a 'narrow' or proper evolutionary policy perspective that derives its policy views from evolutionary theory as outlined by Nelson and Winter (1982). We distinguish it from a 'broad' evolutionary perspective that includes a variety of systems of innovation and structuralist issues.

The evolutionary analysis of economic policy shows that policy-making is largely an experimental process of trial and error (Pelikan and Wegner, 2003). The most prominent economists working on the evolutionary theory of technology (innovation) policy are Metcalfe, Witt, and Teubal. The key features of the evolutionary theory of technology policy are articulated by Metcalfe (1994, 1995 and 2007). The key features are the policy focus on variety and selection, adaptive policymaking, policy focused on diffusion as well as on the generation of knowledge, the importance of the wider institutional context, and policy on the facilitation of the self-organization of innovation systems (Metcalfe, 1994, 1995). Implicitly or explicitly, this suggests that the rationale for evolutionary policy is a system failure.

Technology policy generates variety and balances selection with destruction effects (Metcalfe, 1994). The evolutionary policy is about learning and adaptation in light of experience and not about optimisation (Schwerin and Werker (2003). Ulrich Witt (2003) further highlights the experimental and adaptive nature of policymaking from an evolutionary perspective and makes it clear that (unfortunately for policy practitioners) an evolutionary perspective does not imply any normative conclusions.

Evolutionary policy focuses on diffusion as well as on the generation of knowledge and it must encompass the wider context ((Metcalfe, 1994; Witt, 1993). In an evolutionary perspective, technology is embodied as knowledge, skills and artefacts and in each case there are different variety-generating mechanisms, different selection processes, and different institutional structures. This implies that for policy purposes, the degree of connection between these different dimensions of technology is at the core of technology policy (Metcalfe, 1995). Technology policy focuses on technology in its different forms, on institutions and market processes that generate variety (novelty and R&D) to influence the selection (diffusion) of different forms of technology. In reality, all these dimensions are either closely connected or difficult to separate; subsequently, technology policy is a complex area. Finally, policy is about facilitating the self-organisation of innovation systems (Metcalfe, 2007).

Morris Teubal has progressed furthest in applying an evolutionary perspective to policymaking (Teubal, 1997). He recognises that 'normative' aspects of systems innovation (SI) based policies are *'framed in terms so general to make them insufficient or inadequate as guides and tools for actual policymaking'. Hence, he argues that there is 'a strong need for additional theoretical and conceptual knowledge'* (Teubal, 2002: 12). His major contributions are in the development of the concept of 'horizontal' technology policy (as opposed to traditional vertical picking up winners) and functional polices geared towards improving markets (in particular factor markets) without favouring particular activities. Horizontal policies lie in between these two policies and can pro-

mote cross-sector selectivity. They address activities that are absent in markets or are particularly difficult to create. Lall and Teubal, (1998) describe this approach as market stimulating policies that consist of *'different forms of intervention (..) eligible to develop missing markets'* and consider them opposite to market friendly policies.

According to Teubal (2002), horizontal technology policies are not specific to a particular sector or technological area (i.e they are neutral in the support of R&D/innovation) and are supportive of variety and of a more efficient market selection mechanism. Teubal (2002) develops ten "Salient Normative/Policy Principles or Themes" that give a conceptual vocabulary to analyze innovation policy from a horizontal policy perspective. In Teubal (1997), the horizontal policy perspective is applied within a technology policy cycle with distinct infant, growth, and mature phases. Avnimelech & Teubal (2008) develops the idea of evolutionary targeting.

The work of Richard Lipsey on technology policy closely relates to the cited contributions of Metcalfe, Witt and Teubal. The perspective of Lipsey (2002) is structuralist-evolutionary i.e. micro-based and stresses the uncertainty associated with technological advances. Lipsey (2002) shows that the large amount of policy advice that follows from structuralist-evolutionary theories can only be context-specific. The framing of policy of Lipsey is in line with a 'market enhancing view' of the state and overlaps with the 'market stimulation' framing policies by Lall and Teubal (1998).

What is the novelty and usefulness of evolutionary technology policy proper? Our conclusion is quite ambiguous in the sense that conceptual developments within this perspective frees policy makers from the constraints of a neo-classical market failure framework, which cannot tackle dynamic innovation policy issues and dimensions like uncertainty and system of innovation. However, the limitations of an evolutionary technology policy perspective (in terms of policy specificity) become obvious through a simple observation of general principles and policy taxonomies. Similar to Freytag & Renaud (2007) in their review of the evolutionary policymaking, we conclude that evolutionary technology policy demonstrates a trade-off between specificity and relevance of policy implications. It does not lead to substantial normative conclusions with respect to detailed policy rules but it shows the complexity of economic and innovation processes as well as the need for specific policy responses. Finally, the evolutionary metaphor is more appropriate than the neo-classical concept for innovation policy.

3.2.3. Conceptual and methodological issues of Innovation Systems perspective and their policy implications

A wider institutional context of innovation processes is recognised through the evolutionary perspective as an important component of innovation policy. An increase complexity and interactivity of innovation process as reflected in different innovation models and an increased systemic nature of technological change represents an important technological driver for the emergence of innovation systems. In conceptual terms, the idea of innovation systems is based on the view of the economy as *'an ensemble of connected elements not an aggregate entity'* (Metcalfe, 2002).

Why are conceptual and methodological issues of innovation systems relevant from a policy perspective? Policies inevitably reflect underlying conceptual thinking, frameworks and ideas. Policy concepts rest on theoretical ideas and their empirical soundness is (at least partly) reflected in the relevance of policy. Specifically, methodological and conceptual issues (related to systems of innovation) are reflected in the scope and shape of innovation policy. We now highlight several conceptual/methodological issues related to systems of innovation research that impact innovation policy.[7]

3.2.4. The scope of national system of innovation: broad or narrow

The term NIS is used in two meanings: broad and narrow NIS (Lundvall, 1992). 'Narrow' refers to formal R&D systems and organisations that are systematically active in knowledge generation and diffusion. These narrow institutions are embedded in a wider socio-economic system (broad NIS) 'in which political and cultural influences as well as economic policies help to determine the scale, direction and relative success of all innovative activities' (Freeman, 2002).

Johnson et al (2003) consider that 'authors from the US with a background in studying science and technology policy, tend to focus on 'the innovation system in the narrow sense'. For them NIS represents 'a broadening of earlier analyses of national science systems' and they focus on 'the systemic relationships between R&D-efforts in firms, S&T-organizations, including universities, and public policy' in high tech-sectors. Johnson et al (2003) contrast this view with the 'Freeman and the 'Aalborg- version' of the national innovation system-approach' which aims to understand 'the innovation system in the broad sense'.

These two perceptions of NIS underlie different conceptions of innovation policies. The scope of Innovation Policies differs whether broad or narrow NIS is taken as a unit of analysis and of policy focus. For example, the World Bank in its Knowledge Assessment methodology (KAM) (http://www.worldbank.org/kam) takes a view of NIS in a narrow sense. The idea of the 'third generation innovation policy' rests implicitly on the understanding of the NIS in its broad sense.

For Lundvall (2007) these differences are far from trivial as understanding NIS in a narrow sense leads to 'policies aiming almost exclusively at stimulating R&D efforts in high-technology sectors'. This in turn led 'to so-called 'innovation paradoxes' which leave significant elements of innovation-based economic performance unexplained'. Accordingly, Lundvall argues we need to focus on broad NIS and on competence building.

3.2.5. Innovation system (broad) between theory and low-level theory

Among analysts of systems of innovation there is no agreement regarding what should be included in and what should be excluded from a '(national) system of innovation' (Sharif, 2006). This leads to a variety of approaches in terms of what is included as NIS, from studies that are confined only to the public R&D system to those that include a variety of non-technological factors into analysis. Some scholars see this variety of perspectives, frameworks, and differences in the scope of analysis as an advantage. The broad nature and flexibility of the concept are seen by some *'as a great ad-*

vantage since it makes it useful for practical purposes." (Lundvall et al 2002: 221). In addition to Lundvall, a similar position is held by Richard Nelson based on several public and private communications. Another view is that the NIS approach is under theorized. Shariff (2006) cites OECD as having this position. Among innovation scholars, Edquist holds this view. For a critique of theoretical inconsistencies in definitions of system of innovation see Radosevic (1998).

By being a low-level theory, the use of NIS as a concept will inevitably lead to abuses, distortions and misinterpretations. The objections of Lundvall that the biased use of NIS will lead to narrow policies and innovation paradoxes while at the same time citing its flexibility and broad nature as useful for practical purposes are contradictory. Paradoxically, Lundvall has made some initial steps to overcome the looseness of an innovation system concept by first outlining a common analytical approach or method to study NIS (see Lundvall, 2007).

Scholars of regional innovation systems have also struggled with the theoretical versus practical relevance issue. For example, Cooke et al (1997) tried to make this concept more operational as a regional level of analysis requires a much more direct approach than is the case at national level. The biggest difficulty is to explore the extent to which innovation processes at the regional level could be defined as systemic. A focus of innovation policies at regional level is learning which can be improved 'through certain institutional changes and properly oriented active policies' (ibid).

3.2.6. Institutional versus functional approach to innovation system

NIS is usually defined in institutional terms. For example, Freeman (1987:7) defines it as 'the network of institutions in the public and private sectors whose activities and interactions initiate, import and diffuse new technologies'. This, and other definitions of national and sectoral and technological systems of innovation, defines system in institutional terms, i.e. as a network of agents, a population of firms, a set of institutional actors, the system of interacting public and private firms, universities and government agencies (see Radosevic, 1998). The methodological problem of defining NIS only in institutional terms is that there is no simple relationship between the institutional forms of national systems and economic functions. Radosevic (1998) concludes that systems of innovation should be defined in institutional terms as well as in technological terms or, more generally, in functional terms. Otherwise, there is a danger that definitions will become circular, i.e. any institutional variety could be declared relevant from an economic or technological perspective, which would be misleading. The issue is the identification of relevant institutions to explain the systems of innovation or the relevant diversity between two systems. Radosevic (2007) argues that only an institutional variation that performs a different economic function (functional variety) can be considered relevant from a technological or economic perspective. Alternatively, only a variety that performs a different technological function (technological variety) can be considered relevant from an institutional perspective.

Why is it useful to focus on functions in innovation systems? Johnson (2001) sees several benefits. First, the concept of function provides a tool to create system borders. Second, the concept of function can be used as a tool to describe the present state of a system. Third, by mapping

functional patterns (i.e. how functions have been served) we can study system dynamics. Fourth, it allows us to assess the performance of innovation systems by analysing its functionality (i.e. how well the functions have been served). Fifth, by focusing on functions actors may be uncoupled from what happens in an innovation system. This may be useful in comparative studies since it reduces the risk of comparing system structure instead of systems functionality; 'two systems may function equally well even though their structure is totally different' (Johnson, 2001: 17).

Hekkert, M. P., Suurs, R. A. A., Negro, S., Kuhlmann, S. and Smits, R., (2006), proposed a model to structure empirical work on functions in innovation systems not focused on institutions. However, the most applied version of the functional view of an innovation system is the Manual on functional analysis of innovation systems created by the Swedish Group (see Bergek et al, 2008). The usefulness of a functional view is that 'policy makers often experience difficulties in extracting practical guidelines' from innovation studies. Bergek et al (2008) operationalize a functional approach to analyze the innovation system dynamics in a practical scheme of analysis for policy makers. Policy makers can use their scheme to identify the key policy issues as well as set policy goals. This analysis is the most useful for the emerging technology systems, and much less for mature technological areas.

It is worth mentioning here Bell's analysis of a neglected function of innovation systems in developing countries - design and engineering activities. Bell (2008) argues that bodies responsible for science, technology and innovation policy in developing countries inherited a preoccupation with R&D as the core focus for policy from more advanced countries.

Why are these methodological and conceptual issues of innovation systems relevant for innovation policy? The concept of innovation systems is a loose, all encompassing, and vague but nevertheless useful heuristics device. It currently operates more as a metaphor than analytical approach for policymaking. Unless the concept becomes more analytically founded, it will exhaust its life as a metaphor.

3.2.7. Methodological issues of innovation policy (uncertainty, time)

Several dimensions of policy remain specific to innovation policy; the two obvious ones are uncertainty and time. As pointed out by the evolutionary perspective, uncertainty turns policymaking into a learning and adaptive activity. However, by being 'adaptive' innovation policy may become one more source of uncertainty. This issue has been addressed by Marcus (1981); however, it is surprising that this issue has not been explored empirically given the proliferation of innovation policies.

Closely related to uncertainty is the issue of the time scale of innovation policy, which is linked to how long it typically takes firms to move through a sequence of stages in the process of technology and innovation capability building, especially in situations where innovation policy targets these capabilities. As shown by Bell (2006) (and elaborated by Figueiredo, 2006), *'we remain an enormous distance away from being able to offer any insight into how and why such time periods vary under different sets of circumstances'*(p.3).

The shortening of technology cycles poses another set of challenges in terms of the inability of policy to anticipate the speed of changes (see Rycroft, 2006). This is important for leaders as well as for followers because it increases the importance of broader perspectives and intelligence-gathering that is essential to policymaking.

3.3. Innovation Systems

Contemporary innovation policy is framed within the systems of an innovation perspective. As we have already pointed out, this has to do with the increasing realization that innovation and technical change is a systemic activity. The system of innovation approach opens up the possibility of analysing S&T and innovation in integration with a broader economic policy. For developing countries, this enables a broader perspective on development that is usually confined to past investment or institutional convergence issues. The World Bank's 'Doing Business' analyses (http://www.doingbusiness.org) is an example of the current mainstream type of analysis that is somewhat limited in its scope. As this survey indicates, it is still an open question whether this opportunity has been fully used.

This section briefly reviews the applied literature on different systems of innovation. We group literature based on the level of analyses: national, sectoral systems of innovation and on 'interaction intensive environments' (regions, clusters, and networks).

3.3.1. National Innovation Systems

Untile recently, innovation policy has been (mostly) treated as an extension of R&D policy. The diffusion of a NIS perspective was supposed to change this but judging on this literature review, this is not yet the case. Expanding the perspective on innovation to include interactive linkages in the innovation system has not entirely changed the framework for innovation policy. We can discern three types of literature.

a) Innovation policy analyses within the explicit NIS framework are rare. We refer to major comparative studies on NIS like books by Lundvall (1992), Nelson (1993), and Edquist (1997) as well as to individual country studies. They are usually published as books and rarely as journal papers. They require a good understanding of the NIS framework and concepts and their application in the context of individual country is not trivial. They are laborious and demanding in terms of the range of issues and can rarely be handled by individual scholars. When they are of high quality they usually use the conceptual toolbox of evolutionary technology policy. For example, papers on the Chinese NIS by ShuLin contain frequent references to interactive learning, policy experimentation, and adaptive policy.

The strength of these analyses is that innovation policy is explicitly considered as one of the factors that shape the NIS. This broader perspective on policy is realistic and provides the political economy background required to understand the profile of policies.

b) Innovation policy analyses with occasional or superficial reference to NIS framework reflect a

widespread phenomenon: NIS has become a common discourse so that even when analysis can be undertaken comfortably without NIS framework, the author still remains obliged to refer to NIS as background of their analysis. This lip service to NIS idea does not really improve our understanding of the issue at hand and contributes to conceptual confusion. Very often, analyses of public R&D policies are actually interpreted as analyses of NIS. For example, authors would usually reduce the issue to support of R&D by public organisations and would rarely explore the situation in the enterprise sector.

c) Innovation policy analyses within an essentially S&T system framework reflect more easiness to handle such a complex issue as innovation within this framework rather than the belief of authors that this is the most appropriate framework.

We are reluctant to cite examples of specific approaches to NIS because the grouping of specific authors into a specific group is always open to criticism.

Our conclusions regarding the analyses of NIS apply to an inter-country comparison of NIS. These are rare; we find much more comparative analyses of specific NIS focused innovation policies. The NIS focused analyses take a background understanding of NIS as given and implicit. The world centre of these comparisons is the EU with its huge demands to monitor and benchmark innovation policies of its 27 member states and other countries. EU ProINNO Trendchart exercise (http://www.proinno-europe.eu/trendchart) with the EIS (IU) Scoreboard (http://www.proinno-europe.eu/inno-metrics) and country reports are good examples of difficulties in converting conceptual ideas from innovation system and evolutionary technology policy into policy analyses. These exercises provide many methodological problems in attempts to make sensible and useful comparisons of innovation capacity and innovation systems that exist in different countries. For example, when forced to compare a large number of countries benchmarking inevitably turns into a narrow technical procedure that focuses on comparing quantitative data. However, identical indicators for countries which are at different distances away from the technology frontier make the whole exercise ambiguous. The gap between the need to have reliable indicators of the quality and intensity of relationships, interactions and networks and indicators that are actually available is too large. As pointed out by Lundvall and Tomlinson (2002), there is a need for 'new conceptual work before meaningful indicators can be constructed'. This further reinforces the conclusion that the NIS concept is in need of a stronger analytical basis.

3.3.2. NIS and Globalization

Globalisation and NIS is an area of research that has increasingly caught the attention of innovation scholars. A survey by Carlsson (2006) captures the majority of the literature and points to the continued importance of national institutions to support innovative activity, even though that activity is increasingly internationalized. However, this conclusion seems to be far from sufficient for contemporary innovation policy. For example, the analysis of IT policies in Europe shows that a mixture of different policy levels (supranational, national and regional) poses new challenges (Grande, 2001). This problem may be specific to the EU; however, the relationship of FDI and countries' capacity to

maximise technological benefits is increasingly relevant. Policies that encourage the innovation of domestic firms are often perceived as in conflict with policies that aim to acquire foreign technologies. Policies for NIS are perceived as opposite to policies to attract FDI. Unfortunately, a conceptual analysis is limited in its contributions to the policymaking area and we consider it an important challenge for innovation policy. We currently have conceptualisations that address only the policy implications of the globalisation of NIS and not the interaction of NIS and globalisation.

Research by Eva Dantas, Elisa Giuliani and Anabel Marin (cited in Dantas et al, 2007) opens a new avenue of research that surpasses a FDI spillover perspective with a focus on the links between FDI subsidiaries and NIS. The core of this perspective is a policy question of how to strengthen links between FDI and the capabilities of the local firms.

3.3.3. Sectoral systems of innovation

Work on sectoral innovation system (SIS) has remained in the shadow of literature on NIS; however, our literature survey suggests that this line of research is developing and this perspective is able to generate relevant policy implications. This is even more surprising given the silence of conceptual work on sectoral innovation systems regarding policy implications. For example, a review of a few papers by Franco Malerba (1999) (one of the major contributors in this area) does not demonstrate a clear view of innovation policy that follows from sectoral analyses. Subsequently, research on the SIS has less to say on policy than NIS research.

Within the *ad hoc* database constructed for this paper, we reviewed 40 papers on sectorally focused innovation policy and found that 15 of these are framed within the SIS perspective. We have reviewed these 15 papers and found that only one paper (Godoea and Nygaard, 2006) applies a conceptual idea when analysing policy: a system failure. In all other cases, policy issues originate in a grounded manner from the analysis of SIS; in addition, these analyses have demonstrated the relevance of the SIS as a conceptual approach and relevance of policy analysis within this framework. This type of analysis seems quite amenable to newly emerging sectors such as alternative energy where it is possible to identify actors including 'missing actors.' An interesting finding from this survey is that many sectoral issues are explained by the features of a country's NIS (see Szapiro and Cassiolato, 2003; Hung, 2006; Hung and Yang, 2003; and Shulin, 2007). This points to the need to undertake analyses that would combine sectoral and national level analyses (or be complementary). This also applies to sectors where national and global boundaries are muddled (see for example Sagar, J.P. Holdren, 2002).

3.3.4. Interaction intensive environments

An 'Interaction intensive environment' is suitable to describe a variety of mezzo level networks whose feature is a close interaction among actors of networks (regions, clusters, university – industry links, 'triple helix', and value chains).

The literature on regional innovation system (RIS) is still largely EU in origin because this

region has invested heavily in regional innovation activities within the RIS perspective. There is surprisingly limited literature on regions from the RIS perspective in developing countries.

Literature on other 'environments', especially on policy created institutional forms like S&T parks and technoparks, is significant. For example, the journal Technovation has a long stream of references focused on S&T parks. It seems that these papers reflect the demand to evaluate the relevance of different clustering initiatives rather than the genuine process of bottom up driven clustering.

NIS framed innovation policies, clusters and different forms of networks reflect the thesis that networking is a universal requirement of innovative activity (DeBresson, 1999, 1989). Recognition of the natural propensity of innovation to cluster has led to the development of policies that go *'beyond individual innovative capabilities in terms of technological systems and innovative clusters'* (DeBresson, 1989:13). However, the issue is whether poles of dynamic interaction make a system. Lundvall (2007) would argue that they are only subsystems that capture some types of linkages, especially science and innovation linkages in the case of academic incubators.

Our aim is to show that ideas of interactivity and collective learning have been fully embraced by innovation policy and have become mainstream. However, there is a huge gap between the principles of policies for clusters and value chains and specific policy practice. Policy principles require the promotion of external economies and inter-firm relationships like trust, business associations, and external linkages that are difficult to translate into a specific manual. Specific policy activities require ingenuity, location-(context) specificity, sector specificity, intensive coordination, and adaptability. Regional cluster policies represent a microcosm of the problem between innovation policy theory and practice. It is an area of research where action type of research should be a more prominent mode of work.

Innovation as reflected in interactive agents and flows of knowledge is essentially a social activity. This is an un-surmountable problem for policy that supports surrogates of interactivity in the form of organisations like S&T parks or technoparks. The idea of learning networks as a policy-induced form of inter-firm learning may be an alternative. If successful, they should induce action learning and experience sharing (social activities). A number of policy programmes have tried to establish learning networks such as best practice clubs; however, they face sustainability problems after the period of project support (Bessant and Francis, 1999).

An over focus on linkages neglects links that are as strong as actors or strong nodes. This emphasizes the role of intermediaries and the quality of interface between users and producers (Smits, 2002). We should remember that their role has increased due to the increasingly systemic nature of innovation as well as due to institutional changes in the direction of privatisation and commercialisation that leads to increasing market and systemic failures. For example, the privatization of agricultural research and extension establishments worldwide has led to the development of a market for services designed to support agricultural innovation (see Klerkx and Leeuwis, 2008).

The literature shows limits on the enhancement of the linkages in absence of organisations that are natural network organisers. These could be intermediate organisations as well as large firms (for Latin America, see Vonortas, 2002). The enhancement of linkages solely as a result of government policy is limited unless there are network organisers. The nature of such organisations is essential to understand the scope and strength of potential linkages. For example, there are high expectations about the role universities and public research institutions could have in the process of innovation through various schemes to promote university-industry links. Largely inspired by the US Bayh-Dole Act, some countries seek to introduce legislation that enhances patent protection for universities (ironically, this is happening at the time when analyses have shown scepticism regarding the effects of the *US Bayh-Dole Act*, see Leydesdorff and Martin, 2010; Mowery et al, 2004). These expectations neglect the complexities of universities as organisations and assume that it is possible for them to compensate for the lack of innovative firms.

In conclusion, it seems that the literature on 'interaction intensive environments' and regions has been overly focused on linkages and has neglected the nodes or key agents that form networks. As concluded by Teubal et al. (1991) policy support to networks is unlikely to be dynamic unless built around focal organisations or network organisers; in addition, the formation of these organisations depends on a specific context. This calls for a research and policy agenda that is more multifaceted and involves the support of potential local champions of networking, rather than one focused only on linkages.

3.4. Policy Evaluations

Policy evaluation is the basic activity of practitioners; however, it is a quite recent activity because until the 1980s, the evaluation of technology / innovation policy was rare in developed countries and almost non-existent in developing countries. In countries with a developed evaluation culture evaluation often precedes, accompanies or follows a completion of programs and policies. Only a minor part of this activity ends up in academic publications, some of it is increasingly accessible via the Internet while some of it remains in restricted circulation. Fortunately, some knowledge that generated in this activity has been converted into academic or policy analysis literature.

The literature that we surveyed under this heading lends itself to a three-fold classification. The majority of it is the *evaluation of national innovation policies*. There is limited literature that we describe as *'broad innovation policy literature'* and a limited literature on the evaluation of *specific innovation policy instruments*.

3.4.1. Evaluation of National Innovation Policies

Innovation policies should be about national innovation capacity, i.e. the generation of new knowledge as well as its absorption, diffusion, and demand. Our survey of collected references is a representative sample; however, it not yet understood in innovation literature. Literature on the evaluation of national innovation policies can be divided into three sub-groups: literature focused on evaluation of R&D organisations, partnerships, and programs, a sparse literature that evaluate

diffusion policies, and newly emerging literature on systems evaluation (R&D).

References that reflect that innovation policies have moved beyond R&D policy are not yet present. This may shows the usual lag of academic literature in relation to changing policy practices; however, it could also reflect the practice of innovation policy. We should consider whether policies to increase the capability of firms to absorb and generate innovations are easy to monitor, evaluate, and whether these types of analyses can generate results of broader importance for academic press.

Here it is useful to highlight key trends in innovation policy for developed countries. We draw on thematic issue of *Research Policy* (Editors, 2001) that explore the issue of innovation in innovation policy of the US and EU. The editors of this issue have highlighted three emerging trends, broadening of the institutional locus, shifting targets of innovation, and new models of innovation policy; however, these remain largely unobserved in innovation policy literature. There are only a few references to indicate some of these issues (for example, the issue of coordination in innovation policy at national level has been addressed in the case of Germany), see Wilson and Vangelis Souitaris, 2002. The issue of coordination of innovation policy at the EU level and analysis of trend of an increasing transnationalization of innovation policy in Europe is discussed by Kuhlmann and Edler (2003). The issue of horizontal and vertical coordination in innovation policy has been addressed within the European Commisison policy circles; however, these issues are not yet visible in academic literature. A rare analysis of policy to support the development of innovation networks is Eickelpasch and Fritsch (2005).

The overt focus on R&D shows that innovation policies have not understood the importance of firm level learning and issues related to technology absorption. There is a much stronger bias of innovation policy towards what Lundvall et all (2007) calls, 'Science, Technology, and Innovation' (STI-mode) that give the main emphasis to promoting R&D and creating access to explicit codified knowledge than to 'Doing, Using, and Interacting' (DUImode). Based on our limited survey it seems that this applies more to developing than to developed countries; innovation theory and policy suggest that it should be inverse.

There is an increasing number of references that analyse innovation policy of fast growing Asian economies like China, India, Singapore, Korea, Malaysia, and Taiwan. They do not have a specific underlying conceptual basis but are informative and heavily focused on government policy, see Koha and Wong (2005) and Jian (2008). The level the robustness analysis improves in cases when analyses are based on or have an underlying conceptual framework like NIS or an evolutionary technology policy, see Breznitz (2007) and Vekstein (1999). This suggests that interaction between the conceptual basis and practice of innovation policies improves the level of analysis.

3.4.2. Evaluations of R&D (R&D system, partnerships, and programs)

The literature on evaluations of R&D systems in developing countries is representative of innovation policy; however, only some of it is available as academic literature and most of it is presented

at conferences and accompanying volumes. Its quality varies and an analysis of R&D system is often presented as the component of the NIS, see Adeyinka (2005). In our *ad hoc* compiled database based on *Web of Science* there are no examples of this type of analysis for developing countries. This literature does not use the conceptual toolbox of innovation theory but applies some concepts, in particular the concept of linkages of R&D with the economy.

Related to the issue of the R&D system is the literature on R&D partnerships as well as the literature on public R&D as a complement/substitute to private R&D that forms niches within industrial economics literature. Once again, our search has identified only one reference to partnerships in R&D and technological development for developing countries (Hall et al, 2001). This suggests that for many developing countries all the talk about interactivity and linkages (i.e a systemic view of innovation policy) remains more at the level of policy objectives 'than in the design or practice of effective policies' (Viotti, 2007).

3.4.3. Evaluation of diffusion policies

Innovation and the diffusion of innovation are inseparable within the evolutionary perspective because diffusion shapes the pattern of technology development. The appreciation of diffusion within innovation theory has influenced innovation policy; however, assessments of its presence as a component of innovation policy widely differ due to a dependence on the scope of diffusion policy. In an assessment of technology diffusion in the late 1980s and early 1990s, Stoneman and Diederen (1994) concluded that despite its theoretical importance there are very few policy initiatives in developed countries. This assessment is in contrast to Park (1990) who argues that, advanced countries have implemented a wide variety of diffusion policy measures and programs. This difference is due to differences in what is meant by diffusion policy. Stoneman and Diederen (1994) perceive specific diffusion programs while Park (1999) defines a broader set of programs that include those focused on the absorptive capacity of SMEs and regions. What is certain is that in the last 15-20 years we have seen a proliferation of policy initiatives focused on the enhancement of the absorptive capacity of SMEs where the distinction between diffusion and absorption is difficult to establish. This may reflect an increased trend (noted by Park, 1999) of diffusion policy towards the inclusion of 'soft technologies such as know-how, technical skills, and information software'. Diffusion of soft technologies is difficult to discern from the absorption of knowledge.

In summary, policy has difficulties in handling an analytical distinction between diffusion and absorptive capacity; however, it may also suggest that conceptual categories (that make sense at a macro level) may be quite mundane when it comes to policy design and analysis. For example, the distinction between mission-oriented countries and diffusion-oriented countries and policies (Ergas, 1987) may be relevant as an analytical distinction but difficult to discern at the micro (individual program) as well as at the macro (country) level (Park, 1999).

3.4.4. System (R&D) evaluation

Evaluation of innovation as a systemic activity runs far behind the evaluation of individual pro-

grams. Erik Arnold (2004) has phrased it through the sub-title of his paper, *A Systems World Needs Systems Evaluations.*

Increased complexity in the innovation processes and the need for the further integration of disparate pieces of knowledge increases the need for the evaluation of an R&D system within the broader system context. This emerging trend in policy would need new evaluation tools and frameworks; therefore, an exclusively system of innovation perspective as defined and framed in the surveyed literature above may be insufficient. This calls for a variety of new methodological and theoretical advances focused around benchmarking and a comparison of national policies. An example of work in this direction is Bodas and von Tunzelmann (2008).

3.4.5. Broad innovation policy

A majority of the literature addressed so far could be defined as literature on explicit innovation policy. However, this is only an assumption that there are clear boundaries of research and innovation policies vis-à-vis competition, health, education, welfare, defence, energy, and environment policies. In fact, it could be argued that these (implicit) policies which are not directly focused on innovation may have often bigger effects on innovation activities than explicit policies. For example, David Hart, a contributor to thematic issue on innovations in US/EU research policy points out that *'regulatory policies outside the conventional instruments of science and technology policy need to be recognized as essential elements of contemporary national innovation policy'* (Research Policy, 2001:3).

The problem is that if we decide to recognise policies outside the conventional innovation policy as its essential element, then where do we start from and how far do we go or where do we stop? There is surprisingly little that policy analyst can rely in trying to capture this problem. The idea that we should try to capture the innovation effects of non-innovation policies is elsewhere defined as 'the third generation innovation policy' (EU, 2002). The traditional innovation policy was primarily oriented towards R&D, i.e. the supply side of innovation. The current mainstream is second generation thinking oriented towards systems and clusters. Emerging at present is a third generation of innovation policy that assumes that there is a potential for innovation embedded in other sectors or policy domains. This potential can be realized by ensuring cross-sectoral optimisation of the components of various sectors' innovation policies through co-ordination and integration. This cross-sectoral administrative optimisation could be horizontal, vertical, and temporal (OECD, 2005).

In continuation we are only able to highlight several issues that fall within this area, largely within competition policy and regulations. An area that should be part of this review is finance and innovation systems, yet it is too complex and can be dealt only within a dedicated survey.

3.4.6. Competition policy

Competition is an essential dimension of the business environment. Competition policy aims to pre-

vent excessive market power and other distortions. In the absence of competitive pressures toward innovation, market shares may easily turn into market power and monopoly rents without growth benefits. Usually, competition policy is designed based on the assumed ability of competition to maximize static allocative efficiency. However, from an innovation view, competition policy should be seen as a mechanism to foster economic growth through innovation, which could be understood, from an evolutionary perspective, *selective* efficiency. In this case, the issue is to assess 'the extent to which a market, as a selective environment, induces the *evolution* along any innovative trajectory' (Gaffard and Quere, 2006).

Empirical research has found evidence of a positive correlation between innovation and competition (Gianella and Tompson, 2007). However, recent research shows that this relationship is more complex and that the effect of competition depends on how far firms are from the technology frontier (Aghion et al, 2002; Carlin et al, 2004). Reduced barriers to the entry of foreign products and firms have a more positive effect on economic performance for firms and industries that are initially closer to the technological frontier. In contrast, the performance of firms and industries that are initially far from the frontier may actually be damaged by liberalization (Aghion and Bessonova, 2006). This polarising effect of liberalisation has an important effect on competition policy that should incorporate the technological level of local industry in the assessment of the effects of competition on performance. In policy terms, this would require coordination between competition and industrial policy. In a traditional static perspective, this would be interpreted as a conflict between objectives of competition and industrial policy. However, in a new environment, the trade-off between competition and industrial policy may be lower than traditionally assumed. This problem is adequately defined by Gaffard and Quere (2006) in *What's the Aim for Competition Policy: Optimizing Market Structure or Encouraging Innovative Behaviors? Their conclusion is that 'instead of targeting any optimal market structure, it must be aimed at enforcing viability (and growth) conditions' (p.16)*. Another side of this issue is argued by David Teece (1992) who shows that *'complex forms of cooperation are usually necessary to promote competition, particularly when industries are fragmented. ... Cooperation in turn frequently requires interfirm agreements and alliances'*. The aim here is not to review the area but to highlight that when we move outside innovation policy proper, innovation scholars and innovation policy practitioners are in a complex area where it is quite difficult to formulate policy implications. No simple solutions and policies exist; what isrequired is an intimate knowledge of specific innovation and markets from a dynamic perspective.

Another example of the complex relationship between innovation and seemingly non-technological policies are energy market regulations (Jorgenson, 2005). The opinions on market based instruments widely differ (see Jaffe et al, 2002). In these border areas of innovation policy we are faced with the question of what constitutes empirical evidence. The best proof of this is the absence of references in the border areas (in general) and for developing countries (in particular).

3.4.7. Evaluation of specific innovation policy instruments

In countries with a developed evaluation culture, there is a considerable body of individual policy measures analysis. However, information that appears as a literature is actually quite limited and is

confined to assessment of patent protection and tax incentives. One of these examples is the assessment of the US patent system by Jaffe (2000). The other example is a conceptual analysis of public procurement with a focus on the EU by Edler and Gheorgiu (2007), see also Edquist and Zabala (2012). The absence of references in relation to developing/catching up countries (with exception of venture capital) illustrates a limited number of evaluations of individual innovation policy instruments.

4. POLICY IMPLICATIONS OF AN EVOLUTIONARY PERSPECTIVE IN ECONOMICS

A point of departure for this literature survey is a proposition that although being closer to technical change and innovation, the evolutionary perspective has not generated a body of applied knowledge which would make it useful for policymaking (Bartzokas and Teubal, 2002; Fagerberg, 2002). However, before we summarise policy implications of an evolutionary perspective we should try to explain whether there is a common evolutionary perspective.

4.1. Evolutionary or structuralist - evolutionary perspective?

In a review of evolutionary economics, Fagerberg (2002) argues that evolutionary processes are characterized by strong regularities (sequence of innovation and imitation; the influence of users in innovations; economic knowledge as a set of routines). These features suggest that a common perspective should be better described as structuralist. Why is that relevant for our survey?

First, variety is essential to economic and technological dynamics but its generation is not free. Variety is limited and strongly shaped by costs (technological and institutional) and by the ability of an economic and social system to absorb it. Hence, mechanisms of selection are essential and these are often structural in nature (cf. markets are always organised or in a process to be organised). Second, the recognition that evolutionary processes are characterised by strong regularities indicates that there are systemic features of both a technological and institutional nature that provide significant prominence to the structural dimension of the evolutionary perspective.

Whether there will be a sequence of innovation and imitation depends on the appropriability regime, which is largely the issue of an institutional system. For example, the tightening of IPR on a global scale rewards innovators and retards imitation. The clustering of innovation that follows from radical innovation follows a specific technological trajectory while the technological surge of several related radical technologies implies the existence of a techno-economic paradigm. The cumulative effects of incremental learning lead to organisational capabilities that are rare, inelastic, and which persist over time to create a kind of firm level system of innovation that strongly shapes sectoral and national systems innovation. The selection environment is a mixture of market and non-market elements created in a path dependent manner recognized as nationally rooted systems and institutional trajectories. The fundamental uncertainty of innovation processes leads to routine behaviour that further reinforces institutional forms and practices that work, which we recognise as some kind of system.

The institutional dimension of an evolutionary perspective originates from recognition that technological and market decisions are guided by price signals as well as by non-market signals, responses mediated through diverse country, and sector specific institutional fabric. Learning as a social activity par excellence does not take place through prices but through organisations, networks, and various forms of social interactions (conferences, associations, and informal know how exchanges); subsequently, there is an implicit institutionalist perspective in evolutionary theory (Edquist and Hommen,1999). However, it does not follow that a system of innovation approach necessarily contains an evolutionary perspective. The view of national innovation systems in a narrow sense (where it is often reduced to a public system to support innovation or on public – private institutions in high tech sectors) is not necessarily based on an evolutionary perspective. For example, the World Bank framing of an innovation system within four building blocks of Knowledge Assessment Methodology (www.worldbank.org/kam) is not rooted in evolutionary perspective as it views this system as external rather than co-evolving with other blocks.

Why is this important for our survey? An evolutionary policy perspective can be divided into two streams in dependence of the role to which evolutionary aspects are given importance as opposite to 'structural' or 'systemic' aspects.

A narrow evolutionary policy perspective is focused on two major mechanisms of evolution: variety and selection. A narrow focus on these issues is incapable to generate much useful information for policymaking. Hence, although being radically new, it is able to generate very limited policy implications deemed 'poverty of evolutionary policy'.

A broad evolutionary policy perspective co-opts the mechanisms of evolution (variety and selection) as drivers of economic dynamics as well as recognises that these dynamics are strongly shaped by technological and institutional regularities that co-evolve. The core of technological change is learning which is essentially a social process; therefore, technical change is inseparable from the institutional fabric of society and the economy. In view of a stronger weight given to structural or systemic features of evolutionary policy, implications of this evolutionary perspective are more embedded in history and institutional context. Hence, policy implications of this perspective are inevitably difficult to generalise across time and space, which results in strong 'indeterminacy of evolutionary policy'.

In the narrow perspective, implications are derived from evolutionary theory and their relevance or usefulness may not be obvious. For example, Fagerberg (2002) points out as an important policy implication of the evolutionary perspective, the system's carrier capacity or the capacity of the economic system to absorb innovation. This concept (originally developed for the firm level) has been increasingly used at a the country level; however, its policy usefulness is dubious because it is unclear how the absence of a carrier capacity could be translated into policy. Could this capacity be improved by training and education policies? By horizontally focused polices that aim to strengthen generic capabilities for technology management of SMEs? Alternatively, by a focus on the support of a few large firms that could then operate as promoters of the new best practices for their suppliers? Obviously, without taking into account policy, technology, country and sector con-

text, policy implications of generic kind will have limited relevance.

These two methodological perspectives are more unclear in the literature than delineated here. In particular, it would be misleading to try to group individual contributors into one or another group. If there are groupings, they are usually applicable only in respect to whether analysis is mainly theoretical or empirical. Therefore, we focus on policy implications of an evolutionary perspective as understood in broad terms where the system of an innovation perspective plays an important role.

4.2. Policy implications from an evolutionary perspective

In this section, we summarise whether broad evolutionary perspective in economics provide insights and guidance for innovation policy. The current literature argues that evolutionary economics should have some advantages when compared to mainstream neo-classical thinking. It is a perspective about dynamics (i.e it tries to explain how technological change takes place over time) and the selection of different technologies. It assumes that individuals, firms, government, and other policy stakeholders learn and adapt plans, strategies, and behaviour due to experience and the consequences of actions. Learning is imperfect (mistake ridden) and policy itself is a discovery process (Kash and Rycroft, 1994).

An important aspect of the evolutionary perspective is that the innovation process is a systemic activity that involves various players in an interactive process of generation, absorption, and diffusion. We should remember that evolutionary and innovation system perspectives are not identical but largely overlap, i.e. 'there is a close affinity between them (ibid) , to form a broad evolutionary policy perspective. The important feature of an evolutionary perspective is the emphasis on interdependency and interactive learning. From an innovation system perspective, innovation policy is largely about the support of interactions that identify existing technological and market opportunities (or create new ones).

An evolutionary perspective is neo-Schumpeterian which means that growth is driven by innovation with a subsequent diffusion (Edquist and Hommen, 1999).However, the generation of variety is not costless which creates the problem of selectivity. What are the mechanisms to select the entities (firms and technologies) present in the 'system'? The selection process is either a market selection or political-institutional selection; however, most often these two operate in a mutual and co-evolving fashion. When it comes to policy there is little that the narrow evolutionary perspective can say except that, 'policymakers should develop selection criteria, such as the impacts on economic growth and employment, while supporting the creation of novelty' (ibid). However, stating that these criteria should be explicit in terms of the economic and technical dimensions, innovation opportunities do not solve the problem of what these criteria should be under conditions of strategic uncertainty that are inherent when making such choices.

The most important feature of an innovation policy is the focus on the linkage between producers and users as well as on the demand side. However, the notion of technology demand is

undeveloped in innovation theory and cannot be equated with market demand. The demand for technology operates through the organisational structure of the economy and the organisational features of the economy like the size of firms, their interactions, and macro-context serve an important role. However, the system of innovation perspective has a large policy potential as long as demand can be equated with current or potential users. This is opposite to the original Schumpeter who as Lundvall (2007) points out , *'took an extreme position assuming that the demand side would simply adjust to the supply side'*(p.11).

From system of innovation perspective policy implications as depicted by Edquist and Hommen (1999) and Teubal (1991) are the following:

- A variety of firms should be supported and policy should recognise 'complementary strengths of different types of firms and seek to coordinate their efforts through creation of viable "chains of innovation" involving linkage structures among firms and other actors' (Edquist and Hommen, 1999: 15).
- Product innovation does not always reside with product manufacturers but also with lead users to justify calls for public technology procurement, enhancing user – producer links, or strengthening the innovation capacities of users.
- The quality of demand and supply is often more important than only the quantity. For example, the supply and demand for new telecom services requires tighter competition policies that take into account innovation as well as market structure.
- Policy support for networks is unlikely to be dynamic unless it is built around focal organisations (Teubal et al, 1991) or network organisers. Who could be these organisations will largely depend on specific context. They could be large firms or public agencies or any other organisation whose advantage lies in a networking capacity, for this approach in the context of post-socialism see Radosevic, 1999.
- Policy support to networking is unlikely to be effective without a critical mass of organisations and demand. Edquist and Hommne, 1999 argue that 'Public agencies may have to play this role where no "natural" entrepreneur is present—especially where technologies are extremely complex and demands for resources and influence are large'(p.16)().

4.3. Is evolutionary perspective evolving?

The evolutionary innovation policy lacks a coherent research paradigm whose emergence, growth, and cognitive development could be traced over time. Innovation policy research and practice are messy areas that are characterised by a strong interaction of theory and practice in ways that are not easily discernable. Nevertheless, it is possible to identify several trends and their drivers. First, the growing importance of technology and innovation for growth has made innovation policy a central economic policy. Second, the empirical understanding of innovation has improved and is changing at a relatively fast pace. This is reflected in a sequence of innovation models that have emerged and are now party of textbook knowledge. Third, systemic nature of innovation has led to conceptualisation of innovation from technical objects to networks, knowledge, and systems. Fourth, this latter trends had led to increasing focus from R&D to issue of 'hidden innovation' (NESTA, 2007).

5. CONCLUSIONS AND POLICY IMPLICATIONS

This section derives the main conclusions of analysis (5.1.) and formulates policy implications (5.2.).

5.1. Conclusions

First, Innovation System as a Dominant Policy Discourse

Innovation policy analysis encompasses a diverse body of literature that span several relatively autonomous areas analysed in Section 3. These areas include highly theoretical, conceptual, and general inquiries as well as descriptive analyses of individual policies and systems. Innovation policy analysis does not have a coherent research paradigm as reflected in a variety of disciplinary origins, methodologies, and empirical / theoretical orientations. The essential feature of the area is its continuous communication with policy that provides a unique dynamism. The area is structured in several communities with diverse degrees of mutual communication and with differing degrees of links to policymaking bodies. The representation of area, only through academic literature, cannot reflect the knowledge links and their effects on the generation of new knowledge that makes standard academic reference databases ill-suited proxy for developments in this area.

Despite the pre-paradigmatic nature of the area, innovation policy analysis shares a broad and vaguely defined common perspective. Innovation policy challenges are often framed through an innovation system perspective. This does not necessarily mean that the SI based policy perspective is quantitatively more present than an alternative, descriptive, and non-conceptual analysis. However, this perspective dominates the discourse of theory and is the dominant policy discourse in Europe and many Asian economies. In addition, irrespective of the discourse, a wide range of policy instruments directed at networking, clustering, and joint R&D are present in developed countries (that include the US) which further confirms the implicit impact of this perspective. In developing countries, the SI perspective is increasingly perceived as an alternative to mainstream policies and as a framework that may assist a structural change towards a knowledge-based economy. However, we have also detailed some significant weaknesses of this approach and the need to build stronger analytical foundations.

This conclusion may sound trivial and obvious but is far reaching in terms of understanding the gaps in knowledge that lie between theory and practice; subsequently, all that we can say about the challenges for positive innovation policy falls within this perspective. In addition, it is quite difficult to understand if these issues originate from theoreticians, practitioners, or through their dialogue.

Our literature review shows that a significant share of innovation policy analysis is undertaken within a non-SI/ non-evolutionary perspective and should not be interpreted as a sign of weakness or inadequacy of SI perspective. We should remember that economics is a non-Popperian science where one model does not displace another in terms of understanding by analysts and

researchers. Earlier models or perspectives continue to influence policy in parallel with new perspectives. This is present even within individual analysis where the authors sometimes use a neo-classical production function perspective to argue a neo-Schumpeterian point.

Second, the limits of evolutionary perspective policy implications and the need for explicit analyses grounded in a (broad) evolutionary perspective

An observer of the policymaking process will notice the contrast between theory (which underpins policy) and the implementation of policy (Jorgensen, 2005). Yet, it is not possible to develop and apply policy without some prior stylized model. Disciplinary knowledge becomes part of the policy programme and practical problems of policy are often resolved by references to disciplinary knowledge.

In areas like innovation policy, which is pre-paradigmatic in terms of a research program, the gap between theory and policy implementation should be limited. The dynamism of the area rests on 'bringing to the surface' the challenges of practitioners; however, the real dangers that confront theoreticians are presented as innovation policy challenges. Further development in this area is essential. Research into innovation policy should be shaped by the problems of practitioners and not by an agenda of how economic theory can be developed to deal with innovation. Otherwise, challenges to practitioners would remain hidden while theory induced challenges may be irrelevant for policy.

We detail the natural limits in the formulation of policy implications from a discipline based theory and research (Bartzokas and Morris Teubal, 2002). There is a need for explicit policy analysis and this survey has demonstrated the need for the integration of policy analysis with a positive analysis of the transformation of systems of innovation.

Third, co-evolving Theory – Policy link and Policy Learning

A pre-paradigmatic nature of the area favours a close interaction between innovation scholars and practitioners. Rather than a sharp distinction between academic and practitioners perspectives, our survey confirms the conclusion of Mytelka and Smith (2002:1468) that, *'the process of policy learning cannot be separated from the development of the field of innovation research itself. Theory and policy are best seen as co-evolving….'* However, we have not explored the actual processes of interaction between theory and practice, but only theoretical and empirical outcomes as depicted in innovation literature. Sceptics may criticize our conclusion and argue that the absence of significant innovation policy theory, a practice gap, is actually the case of 'practitioner capture', where the theoretical perspective has contaminated the practitioner who has been captured by a theoretician.

This proposition can be further subject to criticism. We should not assume that innovation studies always drive innovation policies. Gaps between studies and policy are driven by other factors like ideology, power, and complexity of the theoretical perspective. However, the conclusion of insiders (at least in the case of US) is quite the opposite of this critique. Rosalie T. Ruegg in her presentation at the Atlanta Conference on Science and Technology Policy 2006 argued that, 'innovation studies drive U.S. innovation policy, but not always directly, logically, or promptly, and always

within a political context'. U.S. innovation policy has not kept pace with contemporary innovation policy studies. It seems that the interaction of studies and policies currently works significantly better in the EU as confirmed by Mytelka and Smith (2002), Kuhlman (2006) and by the personal experience of the author in EU policy learning networks. Among international organisations, the OCED and the World Bank (cf. KAM initiative) have recently played an important interactive role.

The conclusion of Mytelka and Smith (2002: 1478) that 'learning in this field has been interactive, with a strong co-evolution of policy ideas and theoretical and empirical studies' remains relevant. The way to ensure continuation of this interaction is to further open the space for explicit policy analysis as well as for policy experimentation. This is the most effective way to turn policy into a discovery process.

5.2. Policy implications of the review

First, complementarities in growth, systems and innovation policies

An innovation system perspective focuses on interactivity and complementarities as major sources of synergies and increased returns. Institutional complementarities are defined as mutually reinforcing effects of institutional arrangements (Aoki, 1994). Within growth theory, this issue has been recognised through a stylized fact of growth where, *'the pervasive tendency for all factors of production, including physical and human capital, (is) to bunch together'* (Easterly and Levine, 2001). Aghion et al (2009:689) see the importance of complementarities in policies that should focus on the more *'"tightly coupled" elements and gives priority to identifying the ones that are strong complements of the activities or institutional structures that the policy intervention seeks to affect'*. Similar to Freeman (2002), they point to policy issues involved in coordination and complementarities between innovation policy and education, labour markets, competition, and macroeconomic stability.

For specific technology systems, studies have indicated that critical to system dynamics are complementarities like *'missing key agents, nonfulfillment of required functions, non-availability of required knowledge, and deviations between self- and cross-perception* (Wiek et al, 2007)'. These network or system failures demonstrate that the network features should serve *'as a starting point for discussing and negotiating arrangements among agents and joint action' (ibid)*. In addition, the exploration of complementarities in innovation policy has been initiated (see Mohnen and Roller, 2005).

Complementarities represent paradigmatic changes in evolutionary perspectives. This concept is essential to the view of the economy *'as an evolving complex system, exhibiting properties of increasing returns and self-reinforcing mechanisms in which the management of complementarities play a major role (...)'* (Aghion et al, 2009:685). By pointing to complementarities, we have highlighted the emerging perspective within the broad evolutionary perspective that should have strong policy implications. Unfortunately, the issue is still in its early stage of development and better analytical techniques are required to advance our understanding of complementarities in

growth, systems, and policies; however, there are limitations on how useful this perspective can be to policy. Progress in this area can only be achieved through the interaction of policy and theory.

Second, interaction between domestic and foreign led modernization

Autonomous (indigenous) innovation and knowledge creation or technology acquisition through global linkages and partnerships jointly shape national innovation systems. This issue is salient for contemporary China as well as for all catching up countries. Historically, this challenge is not particularly new. Mowery and Oxley (1995) demonstrate in a historical survey that 'the economies that have benefited most from inward technology transfer have national innovation systems that have strengthened their national absorptive capacity. Tidd and Brocklehurst (1999) give one of many examples of this good diagnosis forthe case of Malaysia.

In the context of Central and Eastern Europe, we have labelled it as a distinction between 'foreign and domestic led modernisation' i.e. as modes of modernisation based on foreign technology imports and autonomous technological development (Radosevic, 2006). At the global level, this issue is increasingly recognised through disappointing expectations that a strong process of innovation will emerge as a natural consequence of openness, strengthened IP regimes, and larger flows of FDI (Viotti, 2007).

A broad evolutionary perspective on this issue can be defined as an interaction of NIS and globalization. Innovation studies scholars have recognised this issue; however, there is a lack of empirical studies and little has been done to illuminate policymaking that promotes the interaction of FDI and NIS (Narula, 2003). Policy issues, like how transnational corporations (TNCs) could be challenged by innovation policy to give a large contribution to local technology development, remain unexamined. The issue of transationalization of NIS and policy issues that this involves remain in the periphery of innovation studies (see Dantas et al, 2007).

Third, broad innovation policy: a future growing area in innovation policy analysis

Innovation policy studies demonstrate the importance of a broad innovation system for innovation performance. The broader context is determined by institutional factors and policies that do not belong to a proper innovation policy area; however, they are often more important than narrowly defined innovation policies. For example, the diffusion of renewable technologies is more influenced by a specific policy regime that includes ownership and the role of markets than by narrowly defined programs for the promotion of new renewable technologies or their diffusion. For many developing countries, an unfavourable macro-economic context with a high external debt and high interest rates represent an important constraint to technological development and constitute an implicit innovation policy of greater importance than an intrinsic innovation policy.

The links between innovation and other policies have been recognised in areas like education, competition, finance, macroeconomics, and labour markets. Aghion et al (2009:683) recognised that there are *'critical aspects of interdependence between science, technology, innovation and growth (STIG) policy and the pursuit of related or independent goals by other classes of economic policy'*.

The issue of close interdependence of innovation and other policies is recognised in the notion of a third generation innovation policy, which assumes that there is potential for innovation that is embedded in other policy domains. This potential can be realized by ensuring cross-sectoral optimisation of the components of various innovation policy sectors through co-ordination and integration.

Section 3.2.3 indicated the absence of studies that fall within broad innovation policy and distinguished the obvious need to understand interactions between innovation and knowledge diffusion and broader systems as well as non-innovation focused policies. The OECD (2005) MONIT project has made initial strides in the direction of pointing to issues of administrative coordination embedded in policy or in governance systems across different policies that make this integration difficult. However, this does not address the issue of content (i.e. what policies should be coordinated and what should be the content of coordination). This is a broad and complex research and policy agenda that will occupy policy makers and analysts in the foreseeable future.

Fourth, state as a missing actor in the evolutionary perspective

A weakness of the evolutionary perspective is the neglect of the state. This same weakness has also been recognised within a system of an innovation perspective that *'lacks a component ('theory') about the role of the state'* (Edquist, 2001). This is a significant problem for the analysis of innovation policy as the state cannot be necessarily conceptualised as the expression of public interest. Moreover, the introduction of the idea of the state as a learning entity and policymaking as a discovery process linked to different theories of the state would be required.

A key weakness of the broad evolutionary perspective is that it abstracts from different political economy models of the state and how they are linked to innovation policy. Different political economy models imply different innovation policies. Innovation policy is a long term endeavour and different political economy models have different propensities towards different models of innovation policy. Many contemporary political economy models are excellent for stability, continuity, and the status quo. For example, many Central and East European (and some Latin American) countries have successfully implemented structural adjustment programs; however, they are now in a low-level equilibrium situation that is unfavourable to structural transformation. The core of this transformation should be a new (innovation) policy that (unlike previous stabilisation and structural adjustment programs) requires a variety of micro and mezzo level changes for which a new political consensus needs to be achieved. The example of Chile demonstrates some of these challenges (CGD, 2008).

Within the evolutionary framework, the state should operate as an adaptive policy maker that learns through experimentation in incremental fashion. We cannot ignore that different political economy models have different propensities to experiment and learn. As argued by a study by the Commission on Growth and Development (CGD) (CGD, 2008), many East Asian states have *'a desire to experiment with active government policies and revise them as and when failures occur'* (p. 27). Hence, the evolutionary perspective should study the institutional factors that favour policy experimentation. Do they have to do only with narrowly defined state capacity or also with the political economy context?

Charles Edquist (2001:18) argues that *'we need more knowledge about how innovation policy has actually been designed and implemented and which societal forces have governed these activities'*. This indicates the absence of studies that we group into the sociology of innovation policy. We currently have a situation where analyses and policy implications are derived by abstracting from the political economy context (including state capacity). It is encouraging that there are new/old approaches that address this important dimension. For example, studies by Peter Evans (1995), Alice Amsden (1989), Chang (1993) and Reinert and Reinert (2003) have explored some of these issues butnot really in a contemporary context. Dani Rodrik's studies build on this work and elaborate on a broader perspective of institutional conditions for industrial policy. The World Bank work on state governance is similar (see www.worldbank.org/wbi/governance); however, it completely abstracts from addressing the issue of country specific political economies. It posits the issue of state governance in a broader context and assumes an abstract benchmark for the best state governance. Governance is reduced to a technocratic process that assumes mechanisms are predominately managerial and devoid of political factors. A recent review of the role of the state in the innovation process by Mazzucato (2011) has quite rightly brought the state back into the discussion of these issues. Moreover, Lazonick and Mazzucato (2011) have begun to explore the issue of inequalities and innovation through the 'risk reward nexus' perspective. These are interesting new developments which will eventually bring the state back into the exploration of innovation policy.

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