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NATIONAL SYSTEMS OF INNOVATION: A BIBLIOMETRIC APPRAISAL

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National Systems of Innovation: a bibliometric appraisal

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Abstract

The literature on NSI is a relatively new field of research with a quite impressive diffusion rate in the last 15 years. Although the concept of NSI is nowadays widely used both in academic and policy contexts, and a set of comprehensive theoretical surveys were published in the most recent years, no 'quantitative' survey exists on this matter. The present paper aims to fill this gap. We offer a complementary, 'quantitative', description of the state-of-the-art in the literature resorting to bibliometric methods. Our exercise shows that the time evolution of articles published was quite irregular, and that the NSI contributions have not converged to an integrated framework. We further evidence that historically detailed descriptions on NSI à la Freeman are rare, and analyses using more rigorous and diversified quantitative methodologies for assessing the performance of NSI are on demand. The huge increase in the share of 'Conceptual/critical meta-literature on NSI' in the latter (2001-2007) periods interestingly documents the conceptual dynamism and methodological-analytical challenges faced presently by NSI approach.

Keywords: National Systems of Innovation; Bibliometrics; Econlit

JEL-Codes: O10; O30; C89

1. Introduction

The diffusion of the National Systems of Innovation (NSI) approach has been surprisingly rapid, and is now widely used both in academic circles and policy contexts. Indeed, several studies (e.g., Fagerberg, 2003; Balzat and Hanusch, 2004; Groenewegen and van der Steen, 2006) confirm that the literature on NSI is a relatively new and rapidly growing field of research. Additionally, the approach also finds broad applications in policy contexts – by regional authorities and national governments, as well as by international organizations such as the OECD, the European Union, UNCTAD and UNIDO (Edquist, 2005; Sharif, 2006). According to Lundvall (2007a), the diffusion of the NSI approach is quite impressive taking into account that 15 years ago, only a handful of academics had heard of the concept.

Taking a brief look into two majors books on Innovation, one by Dosi et al., published in the 1980s and the other, more recent (2005), by Fagerberg et al., the increasing importance of NSI within innovation literature is apparent – the relative amount of chapters and pages dedicated to the subject has nearly doubled, and new issues have been added to the analysis, namely the role of Universities within the NSI (Mowery and Sampat, 2005).

Table 1: Major books on innovation – comparison of the relative importance of the NSI issue and, within it, the case of Universities

	Dosi, G.; Freeman, C.; Nelson, R.; Silverberg, G. and Soete, L. (1988), ***Technical Change and Economic Theory***	**Fagerberg, J.; Mowery, D.; Nelson, R. (2005),** ***The Oxford Handbook of Innovation***
Nº pages	646	656
Nº chapters	28	22
Nº(%) ch./pp. on (N)SI	4 chapters (14%)/62 pages (10%)	6 chapters (27%)/139 pages (21%)
Chapters on (N)SI	**Nelson, R.,** "Institutions supporting technical change in the United States" **Freeman, C.,** "Japan: a new national system of innovation?" **Lundvall, B.-A**., "Innovation as an interactive process: from user-producer interaction to the national system of innovation" **Pelikan, P.** ,"Can the innovation system of capitalism be outperformed?"	**Edquist, C.,** "Systems of Innovation: Perspectives and Challenges" **Mowery, D. and Sampat, B.,** "Universities in National Innovation Systems" **O' Sullivan, M.,** "Finance and Innovation" **Granstrand, O.,** "Innovation and Intellectual Property Rights" **Asheim, B. and Gertler, M**., "The Geography of Innovation: Regional Innovation Systems" **Narula, R. and Zanfei, A**., "Globalization of Innovation: the Role of Multinational Enterprises"
(N)SI chapter on Universities?	No	Yes

Different authors may mean different things when referring to a (National) System of Innovation. Some major differences have to do with the focus of the analysis and some with how broad the definition is in relation to institutions and markets (Lundvall, 2007b). For instance, both Nelson and Lundvall define national systems of innovation in terms of determinants of, or factors influencing, innovation processes. However, they single out different determinants in their actual definitions of the concept, presumably reflecting what they believe to be the most important determinants of innovation. Hence, they propose different definitions of the concept, but use the same term. This reflects the lack of a generally accepted definition of a national system of innovation (Carlsson, 2006).

Table 2: Narrower and broader definition of NSI

Narrower + ◄——————————————► + Broader	
Nelson and Rosenberg (1993): systems of organizations supporting R&D that promote the creation and dissemination of knowledge as the main sources of innovation	**Lundvall (1992):** wider socio-economic system where 'narrow' organizations are embedded and in which political and cultural influences as well as economic policies help to determine the scale, direction and relative success of all innovative activities. **Edquist (1997):** all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations **Balzat and Hanusch (2004):** a historically grown subsystem of the national economy in which various organizations and institutions interact with and influence one another in the carrying out of innovative activity **Groenewegen and van der Steen (2006):** a layered system with a specific logic based on habits and routines.

Authors from the US 'tradition' mainly emphasize science and technology issues thus tending to focus on 'the innovation system in the narrow sense'. They regard the NSI concept as a follow-up and broadening of earlier analyses of 'national science systems' and 'national technology policies' (Mowery and Oxley, 1995: 80). The focal point of their analysis is on the systemic relationships between R&D efforts in firms, S&T organizations, including universities, and public policy. The analysis may include markets for knowledge - intellectual property rights - and the venture-capital aspects of financial markets, but more rarely do they include the broader set of institutions shaping competence building in the economy such as education and training, industrial relations and labour market dynamics.

The Freeman and the 'Aalborg-version' of the national innovation system approach (Lundvall, 1985, 1992; Freeman, 1987), the so-called ‘European tradition’, aims at understanding ‘the innovation system in the broad sense’. Thus, the definition of ‘innovation’ is more wide-ranging. Innovation is defined as a continuous cumulative process involving not only radical and incremental innovation but also the diffusion, absorption and use of innovation. Moreover, a major source of innovation, besides science, is interactive learning taking place in connection with production and sales. Therefore, the analysis takes its starting point in processes of production and product development assuming, for instance, that interaction with users is fundamental for product innovation.

Some important organisations in NSI are firms (which can be suppliers, customers or competitors in relation to other companies), universities, venture capital organisations and public innovation policy agencies. Institutions are sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals, groups and organisations (Edquist and Johnson, 1997). They are the rules of the game (North, 1990). Examples of important institutions in NSI are patent laws and norms influencing the relations between universities and firms. As the figure below might, albeit in a simplistic way, reveal the relations between organisations and institutions are important for innovations and for the operation of systems of innovation.

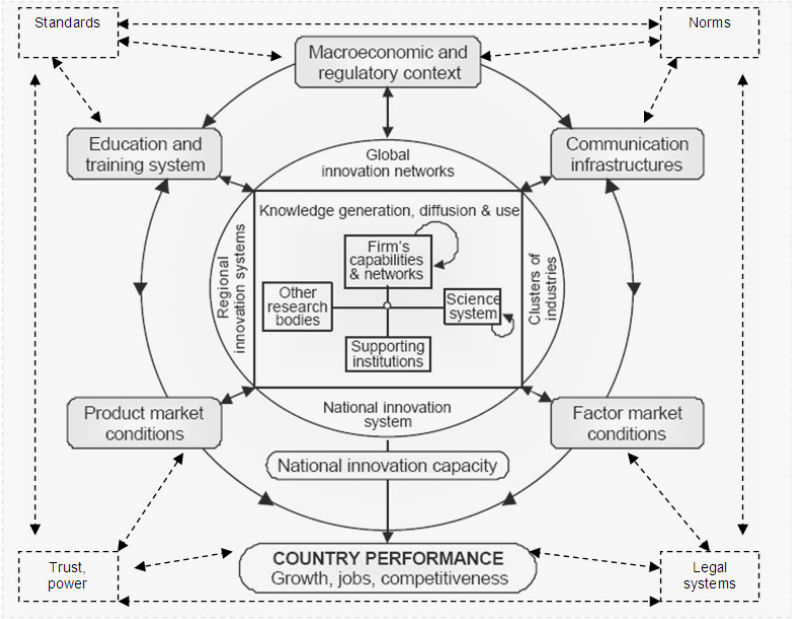

Figure 1: The NSI: a schematic overview
Source: Adapted from OECD (1999)

Organisations are strongly influenced and shaped by institutions; organisations can be said to be ‘embedded’ in an institutional environment or set of rules, which include the legal system,

norms, standards, etc. But institutions are also 'embedded' in organisations. Examples are firm specific practices with regard to bookkeeping or concerning the relations between managers and employees; a lot of institutions develop inside firms. Hence, there is a complicated two-way relationship of mutual embeddedness between institutions and organisations, and this relationship influences innovation processes and thereby also both the performance and change of systems of innovation (Edquist and Johnson, 1997).[1]

Although in the most recent years excellent theoretical surveys focusing on NIS were published (e.g., Edquist, 2005; Carlsson, 2006; Lundvall, 2007a,b), to the best of our knowledge no 'quantitative' survey exists on this matter. In this paper we aim at fill this gap.

The present paper is structured as follows. In the next section we document the origins of the concept. Then, in Section 3, we describe the underlying theoretical approach. Section 4 briefly survey in a 'qualitative' way the literature on NSI whereas Section 5 presents the bibliometric exercise documenting the general trends of the NSI literature in the past 15 years, namely regarding the evolution of the themes analyzed, type of studies, main outlets, and the evolution of the importance attributed to the study of universities' role within the NSI. Finally, Section 5 concludes.

2. The origins of NSI concept and the US and European traditions

The innovation system concept was developed concurrently in different places in Europe and in the USA in the 1980s. There is no doubt that the collaboration between Christopher Freeman, from SPRU (Science and Policy Research Unit, U.K.), and the IKE group in Aalborg at the beginning of the 1980s was important in coining and shaping the earliest versions of the concept (Freeman, 1982; Lundvall, 1985), but the basic ingredients and main inspiration can be found in the work of many other contemporary and even earlier innovation scholars, namely Babbage (1830, 1835) and List (1841).

Freeman brought a deep understanding of innovation processes, historical insight and wisdom to the collaboration (Lundvall, 2007a,b). His reference to Friedrich List (List, 1841) in his 1982 paper was crucial since it linked the concept to catching-up processes. List's concept of

[1] Another type of relation between organisations and institutions is that some organisations directly create institutions. Examples are organisations that create standards and public organisations that formulate and implement rules that we call innovation policy (Edquist and Johnson, 1997). Institutions may also be the basis for the creation of organisations, e.g. when a government makes a law that leads to the establishment of an organisation. There may also be important interactions between different institutions, e.g. between patent laws and informal rules concerning exchange of information between firms. Institutions of different kinds may support and reinforce each other, but they may also contradict and be in conflict with each other.

'national systems of production' took into account a wide set of national institutions including those engaged in education and training as well as infrastructures such as networks for transportation of people and commodities (Freeman, 1995). In his seminal study *The National System of Political Economy*, List focused on the development of productive forces rather than on allocation issues. As a German catch-up economist, he was critical of Adam Smith's 'cosmopolitan' approach, where free trade was assumed to be to the advantage of the laggard (Germany) as well as the lead economies (England). Referring to the 'national production system' List pointed to the need for the state to build national infrastructure and institutions in order to promote the accumulation of 'mental capital' and use it to spur economic development rather than just sit back and trust in 'the invisible hand' to solve all problems.

Although List is by far the most well-known pioneer of the NSI, De Liso (2006) insightfully points out that the contribution of Charles Babbage also needs to be accounted for in the genesis of the NSI approach. In fact, *Reflections on the Decline of Science in England* (1830), together with *On the Economy of Machinery and Manufactures* (1835), constitute an organic vision in which the economic role of science and technology is analyzed, while policies related to both are also considered. Babbage indicated explicitly different levels at which action had to be implemented: on the education level, on the R&D level and on the more general institutional level. In this view, Babbage's work might be considered the predecessor of the NSI in a more *US-related tradition* (Nelson, 1993).

The IKE group, inspired by French structuralist Marxists and development economists, contributed with ideas about ''national production systems'' and ''industrial complexes'' where vertical interaction was seen as crucial for national economic performance (GRESI, 1975; de Bandt and Humber, 1985) and linked this to the analysis of international specialization and international competitiveness (Sornn-Friese, 2000; Lundvall, 2007a,b). In the essay *Product Innovation and User–Producer Interaction* (1985), Lundvall suggested that a breakdown of a firm's environment into user–producer relationships would help to clarify the analysis of firm behaviour and provide it with a more realistic foundation than the prevailing microeconomic theory. In this work, Lundvall also introduced the notion of a ''system of innovation'' to capture the relationships and interactions between R&D laboratories and technological institutes, on the one hand, and the production system, on the other (Lundvall, 1985). He further highlighted differences in the innovative capacity of ''national systems of production'' which, he argued, depends upon the existing networks of

user–producer linkages (Lundvall, 1985). This essay was foundational for the NSI approach (Freeman, 1995; Sornn-Friese, 2000).

Later, in an analysis of technology policy, firm organization, and institutional influences on economic performance in Japan, Freeman (1987) applied the notion of NSI with an explicit reference to Lundvall's work. Freeman's study has since been both much cited and much used. With the volume on *Technology Change and Economic Theory* (Dosi et al., 1988), the NSI concept became central to further research on issues of national specialization, innovation, and economic performance.

For many the genesis of the 'National Systems of Innovation' (NSI) concept is unambiguously traced back to academia (Sornn-Friese, 2000; Carlsson, 2004). However, more attentive research uncovers some uncertainty in this regard. According to Sharif's (2006) ingenious research, this uncertainty about the origins of the NIS concept is a function of interconnections between the academic and policymaking spheres in which the individuals were most involved. His research shows that it emerged concurrently in both the academic and policy fields. This was possible because many of the key proponents of the concept (Chris Freeman, Francois Chesnais, Bengt-Åke Lundvall, Keith Smith) occupied roles in both academia and policymaking organizations.

Thus, while it is often observed that the concept of 'National Systems of Innovation' was first introduced in academic circles by Freeman in 1987 in his book on Japan (Sorrn-Friese, 2000; Lundvall, 2004), Lundvall in fact used the concept 'Innovation Systems' in 1985 but without the adjective 'national' attached to it. What we might underline here is that the first *widely* published use of the concept is that of Freeman's (Sharif, 2006; Lundvall, 2007a), who connected NSI with his analysis of the institutional reasons for the 'developmental gap', that is, differences in the rates of economic growth among nations.

Preceding both these developments, however, was the first use of the terminology in written form by Christopher Freeman in August 1982 in a paper titled, '*Technological Infrastructure and International Competitiveness*', which was presented at the OECD's expert group on Science, Technology and Competitiveness, but which went unpublished at the time (Freeman, 1995; Carlsson, 2006; Lundvall, 2007a).[2] Freeman was working then as an advisor to the OECD ad hoc group on science, technology, and competitiveness. In the paper presented to the group, Freeman described in detail Friedrich List's advice to Germany on catching up

[2] This paper was only recently published (Freeman, 2004), with a foreword by Lundvall (Lundvall, 2004), 22 years after it had originally been presented.

with the UK, resolutely defended Listian economics, and also described why qualitative, history-friendly (indeed historically deterministic) economic analyses have a place in economic thinking (Freeman, 1995; Freeman, 2002).

Among several of the chief proponents of the NSI concept to have taken up positions in policymaking, Lundvall himself worked as the Deputy Director of the DSTI at the OECD from 1992 to 1995 (Sharif, 2006). Even before Lundvall assumed this post, however, the NSI concept had been used in an OECD publication (1992). In particular, attention should be drawn to a major initiative whose work began towards the end of the 1980s under the OECD's 'Technology/Economy Programme' (TEP). The TEP was launched in 1988 to help integrate science and technology policies into other aspects of government policy, particularly economic, social, industrial, energy, education, and manpower policies. From within this programme, an important publication entitled "*Technology and the Economy: The Key Relationships*" emerged in 1992. A core element of the report is that innovation is a kind of interactive process *à la* Kline and Rosenberg (1986).[3]

Setting aside uncertainty as to whether the concept arose from academia or policymaking (taking the OECD to be a policy-oriented body), we can straightforwardly pinpoint the first use of the concept for the purpose of providing a concept for country-level policymaking. The first notable, widespread, and significant instance of a country adopting the concept was Finland in 1992 (Vuori and Vuorinen, 1994; Miettinen, 2002). The NIS concept underpinned three important reviews conducted by the Finnish Science and Technology Policy Council in 1993, 1996, and 2000. The 1993 review was especially important, as it was produced when Finland was in the midst of a severe economic recession. In the 1993 review, the NSI concept was heralded as part and parcel of the country's developmental and recovery strategy (Vuori and Vuorinen, 1994).

As scholars and policymakers involved in the NSI concept sought to challenge the dominance of neoclassical economics, especially in relation to the issue of technical change, they formed an informal network or 'epistemic community' (Haas, 1990, 1992; Adler and Haas, 1992). Here, the 'epistemic community' is created by the informal associations of practitioners involved in the innovation studies field who developed it in an interdisciplinary manner, so as to study relationships among technological, economic, organizational, and institutional

[3] The "chain-linked model'' by Kline and Rosenberg (1986) was important because it gave specific form to an alternative to a linear model, where new technology is assumed to develop directly on the basis of scientific efforts, and, thereafter, to be materialized in new marketed products. The chain-linked model comprised another important step toward the idea of a National Innovation System.

changes. Adler and Peter Haas (1992) describe an epistemic community as an international community of researchers and experts whose ideas influence the adoption of public policies. This community exerts its influence primarily by "diffusing ideas and influencing the positions adopted by a range of actors, including domestic and international agencies, government bureaucrats and decision-makers" (Adler and Haas, 1992: 379), and by acquiring bureaucratic positions within public organizations. By occupying influential roles in policymaking bodies (notably the OECD) and academia, many of the early proponents of the NSI concept combined to function as a collective epistemic community, thereby forming the power base in both domains that the NSI approach enjoys today.

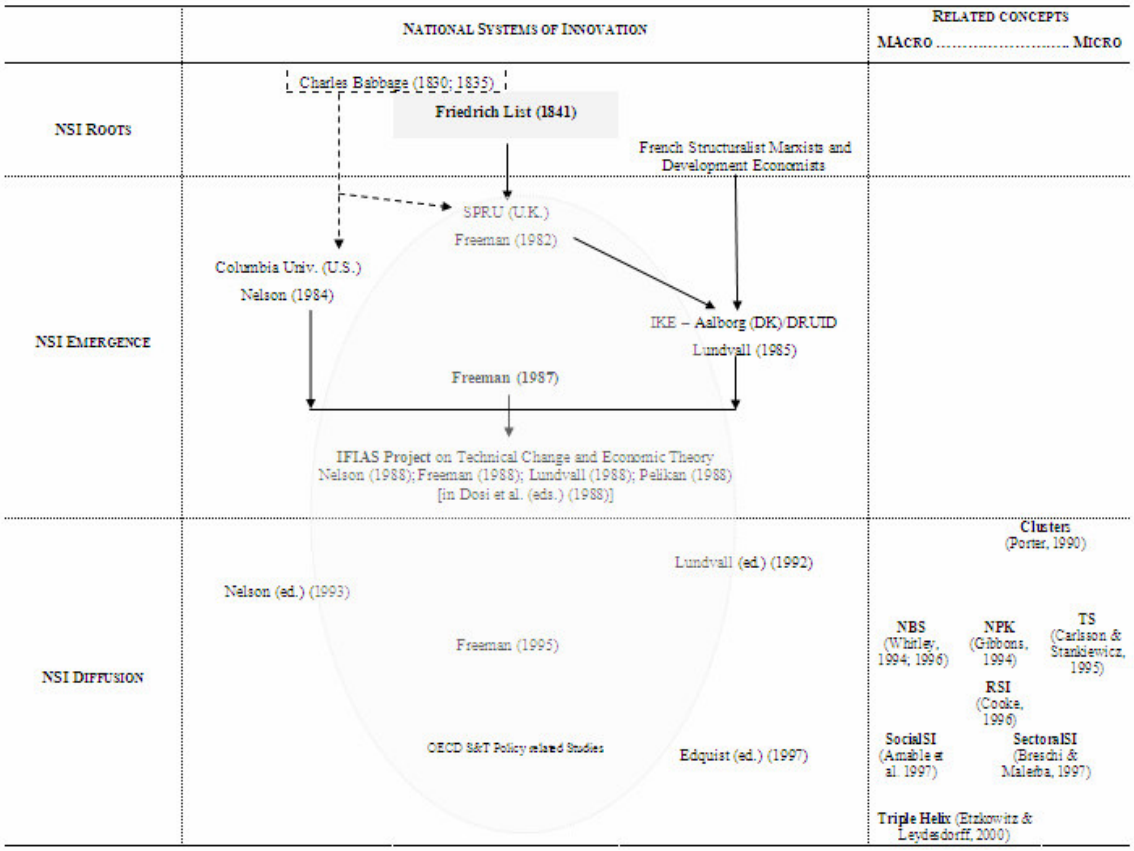

Figure 2: Mapping the genesis and diffusion of the NSI concept

The presence and importance of the NSI epistemic community can be clearly exemplified by elucidating their numerous informal contacts through major book projects in the NSI field. When Freeman collaborated with Nelson and others in the major IFIAS-project[4] on technical change and economic theory, the outcome was a book (Dosi et al., 1988) with a section

[4] The IFIAS – International Federation of Institutes for Advanced Study – supported these authors' proposal 'Rethinking Economic Theory'.

including chapters on ‘national systems of innovation’ (Freeman, 1988; Lundvall, 1988; Nelson, 1988). After that, three major edited volumes on the subject followed (Lundvall, 1992; Nelson, 1993; Edquist, 1997). While the book edited by Nelson brings together a number of national case studies, the books edited by Lundvall and Edquist were organized according to different dimensions or perspectives of innovation systems. These book projects sufficiently illustrate how the NSI epistemic community was formed through professional relationships linking policymakers and academics in order to effect change in both academic and policymaking bodies.

As a result of this shared approach, they maintained regular and frequent contact to work on the abovementioned book projects, thus creating valuable channels for the flow and exchange of ideas and ways of understanding the NSI concept.

Two ‘traditions’ can be identified within the studies on NSI: the US “Science and Technology” tradition and the European “Innovation” tradition. The *US tradition* tends to regard the NSI concept simply as an incremental continuation of earlier analyses of national science systems and technology policies (Mowery and Oxley, 1995). The key issue is to map indicators of national specialization and performance regarding innovation, R&D, and the scientific and technological set-up. In a large country such as the USA with dominant firms operating at the technological and scientific frontier, formalized scientific knowledge and ‘‘high-tech’’ investments are the most important direct sources of economic growth. In many of the old, industrialized small- and medium-sized countries, formalized scientific knowledge and ‘‘high-tech’’ investments, while still of some importance, are not the most important direct sources of economic growth (Maskell, 1998; Maskell et al., 1998). Here, investments in ‘‘low-tech’’ sectors with a long national and institutional history may indeed contribute more to economic growth and performance (von Tunzelmann and Acha, 2005). Also, at least in small open economies, economic growth depends more on a wide range of factors than on formalized scientific knowledge and technological development (Teixeira and Fortuna, 2006). It also depends strongly on the interaction between education, knowledge diffusion, structural flexibility, innovation, and competition (Lundvall, 1999). According to this latter line of reasoning, in the *European tradition*, innovation is seen to involve complex long-term inter-firm relationships (especially interactions between the users and producers of technology), and long-term inter-firm relationships are held to be much more important than spot market one. In particular, the European approach takes as its starting point the fact that important parts of the knowledge base are tacit and emanate from routine-based learning-by-doing,

learning-by-using, and learning-by-interacting, and not only from research activities related to science and technology (Sornn-Friese, 2000). In theoretical and in empirical NSI analyses in the ‘‘European’’ tradition, emphasis is put equally on the firm, on inter-firm interaction, and on the wider institutional environment.

NSI, as mentioned earlier, might be viewed as part of ‘Innovation systems’, seen as a generic concept that has found application in several other contexts than the national (Carlsson, 2006). Over the last decade there have been several new concepts emphasizing the systemic characteristics of innovation but with greater focus on other levels of the economy than on the nation state. The literature on ‘regional systems of innovation’ has grown rapidly (Cooke, 1992; Maskell and Malmberg, 1997). Bo Carlsson with colleagues from Sweden had already introduced the concept ‘technological system’ at the beginning of the 1990s (Carlsson and Stankiewicz, 1991; Carlsson and Jacobsson, 1997), while Franco Malerba and his colleagues in Italy developed the concept of sectoral systems of innovation (Breschi and Malerba, 1997). Furthermore, at the time of NSI development and more widespread diffusion, other approaches were also ‘competing’ with the NIS concept (against neoclassical economics as well as the linear model of innovation). At the very least, these competing approaches and models also addressed issues that neoclassical economics failed to consider adequately. These ‘competitors’ to the NSI concept included Michael Porter’s ‘Cluster’ or ‘Diamond’ model of thinking, published in *The Competitive Advantage of Nations* in 1990, the ‘Triple-Helix Model’ of university–industry–government interactions developed mainly by Henry Etzkowitz and Loet Leydesdorff (1997, 2000), and the ‘New Production of Knowledge’ approach of Gibbons et al. (1994).

3. The theory underlying the concept of National Systems of Innovation

The NSI concept has a particularly important place within the evolutionary research programme (Saviotti, 1995; Edquist, 2001; Eparvier, 2005), because it challenges and is challenged by the new neoclassical growth theories concerning the explanation of the convergence/divergence process among the developed economies (Freeman, 1995, 2004). It is also very powerful in order to elaborate arguments for technological policies (Sharif, 2006). In addition, its evaluation cannot be disconnected from its theoretical content (Lundvall, 2007a). Given the recent tendency for some neoclassical proponents to use (or, according to

some, abuse) evolutionary concepts,[5] Eparvier (2005) sharply argues that NSI will not be helpful for the neoclassical growth theories because the assumptions it relies on cannot be accepted by these theories.

The evolutionary research programme on technology and industry initiated by the seminal work of Nelson and Winter (1982) is based on three traditions. First, the reference to Schumpeter is central, with his emphasis on the endogenous source of technological change and its disrupting role on economic equilibrium. Indeed, as some of the endogenous growth theories also refer to Schumpeter, it has to be noted that the main differences between them and the evolutionary theories is that the former only mention the 'industrial' Schumpeterian notions, and remove the 'dynamic' notions (Eparvier, 2005). Second, the firms' behaviours are explained by borrowing the Simonian bounded rationality concept (Simon, 1955). Third, the biological analogy (more or less stressed) is essential, whether it be the Darwinian conception of natural selection or the Lamarckian notion of inheritance of acquired traits.

Andersen (1994) lists the core elements of the evolutionary research programme. In his opinion, an 'evolutionary-economic explanation' includes a mechanism of preservation and transmission, a mechanism of variety creation and a mechanism of selection. Garrouste (1997) adds a unit of selection to this formulation, that is, the firm, industry or technology. Thus, for a model or a theory to be considered to be evolutionist, it has to present three characteristics. The first one is a process that endlessly generates diversity among a population of firms, technologies, industries or institutions. As a consequence, there is no stable equilibrium, because even if such an equilibrium is reached, it will collapse with the appearance of new varieties. The second is a process of selection, that is, selective mechanisms, e.g., market procedures and/or public choice procedures. The firm, technology, industry or varieties of institution that obtain the best results will be selected and their population will increase to the detriment of the less viable varieties. The third is a process of reinforcement that helps transmit some of the characteristics of the best fitted units into the

[5] With regard to technology policy, it must be noted that evolutionary theories and endogenous growth theories could also share some conclusions. Nelson and Romer in a paper they co-wrote in 1996 agree to define what the government should do for the definition of educational programmes and for the establishment of property rights. They explained that the links between the scientists and engineers from universities and from firms should be enhanced and strengthened. They also pointed out that knowledge should be seen as a public good instead of a private one. In the same way, in order to determine specific programmes to increase the number of scientists and engineers in the US economy (i.e., the human capital level of the US economy), Romer (2000) argued that every programme should be focused on one specific goal. What is most interesting, though, is that, according to Romer, some programmes could be more or less experimental. In his view, government should try a *'variety'* of programmes and stop or modify those that failed to attain their goals. This representation, reinforced by the fact that Romer himself uses the word 'variety', is obviously close to the evolutionary conception of a policy.

other units. They will adopt some characteristics of the best-fitted units, according to their learning capacities, and more or less voluntarily. This notably implies that the population is composed of heterogeneous units.

Focusing in particular on the concept of National System of Innovation (NSI) and on its theoretical justification, Saviotti (1995) analyzes the implications of evolutionary theories for industrial policies. According to this author, the existence of properties like irreversibility, path dependency and multistability, which are shown in real NSI, are predicted by evolutionary theories. The possibility of out of equilibrium processes and the limited determinism which are inherent in evolutionary theories have radical implications for industrial policies.

NSI stands in fact as a powerful instrument for evolutionary theories to explain/justify some stylized facts on international convergence/divergence of rates and levels of growth and to propose arguments for technology policy. In this respect, NSI cannot be disconnected from its inherent characteristics and from the fact that it is implicitly used to compete with neoclassical theories. In this vein, the NSI evolutionary concept cannot be absorbed by neoclassical theories, even if some of their conclusions are compatible with their core reasoning (Eparvier, 2005). For example, non-optimality and radical uncertainty are not compatible with the neoclassical research programme, whereas they are at the heart of the NSI concept.

Moreover, whereas the institutional nature and dynamics of technological change and the evolution of productive knowledge is largely disregarded in standard economic theory (and is not incorporated into new growth theory either) (Sornn-Friese, 2000), it occupies centre stage in the NSI approach. Both the NSI approach and new growth theory accept technological change and the evolution of productive knowledge to be the main factors influencing the competitiveness of firms, sectors, industries, regions, and nations (Nelson and Romer, 1996). The most important conception in the NSI approach is that these factors are themselves dependent on national economic structures and institutional set-up. In the NSI approach national structural and institutional differences explain the diversity in economic performance and the differential growth rates of different countries (Sornn-Friese, 2000). The basic idea is that the development, introduction, and diffusion of technology and productive knowledge is organized differently across national borders and has path-creating effects.

From the perspective of the NSI approach, national specializations and economic growth need not become a virtuous circle; nations may differ in their ‘‘dynamic potential’’ and the circle may be vicious in the long run (e.g., Dosi et al., 1990). The emphasis of the approach is thus on both virtuous and vicious circles in national specialization and economic development, resulting from the match and mismatch between elements and subsystems. This indicates a broader and more interdisciplinary approach to economic growth than that prevailing within mainstream economics and economic theories of growth. It also differs in that it is more explicit in terms of the institutional assumptions made and especially in avoiding any assumption about factors being independent.

4. Main trends of the NSI literature in the last fifteen years. A qualitative view

The recent boom in analytical work and studies using the NSI concept makes it difficult to establish a classification. An interesting proposal for a classification is put forward by Balzat and Hanusch (2004). They draw the distinction between recent studies of highly developed economies with focus on *benchmarking* and a new wave of studies of less developed countries paying more attention to the *historical* character of the concept.

Particularly since the late 1990s, several attempts have been made to evaluate and to compare innovation systems in terms of their performance, which in turn is defined and measured in different ways. In some cases, comparative studies on the system-level have been utilized as a preliminary step to generate rankings of national innovation systems (see, e.g., Porter and Stern, 2002). These have been classified in *policy-oriented studies* and in *research-driven* advances of the NSI approach (see Table 3).

The growing number of policy-oriented studies on innovation systems signals that the creation of an innovation-enhancing framework has become a central target of policy makers around the globe, and particularly in highly industrialized countries (Balzat and Hanusch, 2004). Due to the pragmatic assumptions underlying the NSI concept, and due to the insightful outcomes gained so far in studies of national innovation patterns, the systemic approach to innovation enjoys growing popularity among technology policy makers as a means by which to derive technology policy implications (Nelson, 1984). At the same time, learning processes from own experience and from the experience of other countries in the organization of national innovation systems are recognized as an important input to innovation policy design (Lundvall, 2000, 2003). This awareness calls for broad international

comparisons of innovative strength and institutional frameworks, especially of incentive mechanisms to innovative action.

Indeed, political interest and political agreements triggered the development of national benchmarking studies while employing innovation systems terminology (Carlsson, 2003). Most importantly, the European Union urged its Commission to work together with the EU-15 countries in order to "develop indicators and a methodology for the benchmarking of national research policies" (EC, 2000: 3).

Thus, we currently observe an intended convergence of two conflicting methodological streams, namely a systemic perception of innovation processes with strong country-specific features, on the one hand, and objectives to obtain clear-cut policy recommendations through benchmarking exercises, on the other (Balzat and Hanusch, 2004; Sharif, 2006; Lundvall, 2007a).

Typically, the intended "benchmarking studies" follow, at least implicitly, a two-step procedure (Balzat and Hanusch, 2004). First, by resorting to various indicators of innovative efforts or outcomes, the studies aim to identify "best practice" policies and/or "best practice behaviour" among the countries under study. In a second step, and grounded on the results of the search for best practice, policy recommendations are derived.

The following studies are examples of this procedure: a broad empirical cross-country analysis that in many places draws on OECD data is the analysis carried out by Eichhorst et al. (2001) (cited in Balzat and Hanusch, 2004), where Germany is "benchmarked" with seventeen OECD member countries; the international comparison of the relations between the private business sector and scientific research bodies by Polt et al. (2001); the work by the OECD on the employment situation in several of its member countries - one portion of the so-called "OECD Jobs Study" (OECD, 1998) was the discovery of best practice policies related to technology and innovation.

Apart from this political background, research aims in the economics of innovation literature can be observed as the second main driver towards comparative studies of NSI. In order to explain this argument, it may be helpful to recall some of the limitations of earlier NIS studies and of the research course pursued. First, these early studies have typically given verbal descriptions of national innovation patterns, while the number of indicators used of innovative activity has been rather small (Godinho et al., 2004). Second, early NSI studies have usually concentrated on one country in order to thoroughly describe the functioning of the innovation

system under consideration (Lundvall, 2007b). Third, the set-up of NSI studies has varied considerably because of the lack of a formalized methodology to conduct such studies (Edquist, 2005).

These limitations may have stimulated research efforts to carry out system-level comparisons as well as to formalize the NSI concept. These efforts have lead to the introduction of descriptive frameworks and to the development of analytical models. An example of a descriptive model of national innovation systems that is meant to capture the structure and performance of an NSI is the conceptual framework introduced by Liu and White (2001). This framework is built on five different activities of innovation processes. These activities are research, production, "end use (customers of the product or process outputs)", "linkage" and "education" (Liu and White, 2001: 1094). In this respect, this descriptive model differs from the widely accepted actor-specific view of the analysis of innovation systems which Liu and White criticize sharply. They apply their descriptive concept of an NSI in order to analyze the innovation system in China through an inter-temporal comparison between different development stages (or regimes) of that system. In detail, differences in the set-up, the organization, and the performance between China's former (socially planned) NSI and China's current (democratically organized) NSI are highlighted.

Another model employed to study the composition and strength of a country's innovation system has been introduced by Chang and Shih (2004). Based on previous work by the OECD (1999), the model is made up of six elements – R&D expenditure, R&D performance, technology policy, human capital development, technology transfer, and the climate for entrepreneurial behaviour. With these basic criteria, it is intended to allow for an analysis of the structural specifics of a national system of innovation. To capture the performance of a system, four fundamental groups of indicators have been employed: formal and informal co-operation in R&D, measures of the dissemination of innovations, and finally the mobility of the national workforce. A comparison between China's NSI with its Taiwanese counterpart is carried out in the empirical part.

In contrast to these descriptive NSI models, a formalized way of conducting cross-country comparisons of innovative performance has been introduced by Furman et al. (2002) with the concept of "national innovative capacity" (NIC). This concept is based on a combination of three different – though closely related – theoretical concepts: endogenous growth theory (see, e.g., Romer, 1990), the theory of international competitiveness as developed by Porter (1990), and the national systems of innovation approach as described above. National

innovative capacity is defined as "the ability of a country to produce and commercialize a flow of innovative technology over the long term [...depending] on the strength of a nation's common innovation infrastructure [...], the environment for innovation in a nation's industrial clusters, and the strength of linkages between these two" (Furman et al., 2002). The NIC model can be considered as an ingenious contribution to the NSI approach, because it builds a bridge between elements of economic growth theory and a modern, systemic approach to innovation, which is extended by a (non descriptive) technique to carry out international comparisons of innovative strength.[6] In spite of this, the model's major drawback is that it only takes account of one output measure of innovation, given that, in an NSI, various actors contribute in many different ways to the system's performance.

An alternative way to accomplish formalized system-level comparisons has been presented by Nasierowski and Arcelus (1999, 2000), where coherent country groups in terms of technological capabilities are identified on the basis of a system of structural equations that consist of inputs, outputs and moderators. Cluster analysis techniques lead to a classification consisting of two country groups, one covering technological leaders, the other embracing emerging countries that base their technological progress mainly on the import of innovations developed abroad. Through factor analysis methods, the analyzed countries are then ranked according to their technological strength. The basic idea underlying the efficiency measurement by Nasierowski and Arcelus (2003) is to perceive a national innovation system as an isolated sector of the entire economy. However, such a definition of the term can be misleading because it contradicts the widely held stance that innovation systems need to be understood as open systems.

A third research trend regards the analysis of innovation systems of countries outside the group of highly industrialized nations, including developing countries, transformation economies in Eastern Europe, and newly industrialized countries in Asia. The idea to draw on the NSI approach to analyze technical change in such countries is not new, as the collection of five different country studies in Part III of Nelson (1993) shows. However, further studies of low- and middle-income countries have since then been rare. Recently, various efforts have been made to close this gap. These studies are insightful extensions of the NSI approach because they highlight important differences between national systems. In particular, they point to specifics of the different development stages that the various systems have reached. Compared with mainly numerical performance comparisons, these studies are hence more in

[6] Porter and Stern (2002) have recently applied the national innovative capacity model to a larger number of countries (75 countries in total) than Furman et al. (2002).

line with the basic ideas underlying the NSI approach, particularly with the idea of revealing country-specific innovation patterns. For instance, by using Brazil and South Korea as two representative cases, Viotti (2002) deals with innovation patterns in technological laggards, the transforming organization of innovative activities in former socialist countries in Central and Eastern Europe is addressed by Freeman (1999) and by Radosevic (1999), while the innovative success of developing economies in Latin America and in Asia is examined by Alcorta and Peres (1998) and by Intarakumnerd et al. (2002), respectively. In these and related studies, attention is not only drawn to the development stage and the functioning of the corresponding innovation systems, but the relevance of the NSI approach in the case of these nations is also discussed. This latter issue is – in light of the fragmented structure of most of the systems analyzed – viewed controversially.

Alcorta and Peres (1998) do not reject the relevance of the NSI concept in their study of innovation systems in Latin American countries. Radosevic (1999: 313) claims that "catching up and growth of the CEECs is closely related to the emergence of systems of innovation" but that it is "not yet possible to talk about national or regional systems of innovation in CEECs". With this position, however, the issue of whether or not the very framework of national systems of innovation is suitable in describing technical change in these economies remains open. Viotti (2002: 654) refutes the usefulness of the NSI concept in the case of technological laggards when he points out: "The NS[I] approach is not appropriate for dealing with the processes of technical change typical of industrializing economies, which are extremely different from those of industrialized countries". Based on this critique, he develops the notion of national learning system (NLS) as an alternative. The distinction he draws between these two concepts appears too sharp, however. The reason for this is that the NSI concept does by no means exclude the consideration of learning processes. Indeed, learning has always been considered a fundamental activity in any NSI (see Lundvall, 1992, 2007a,b).

Finally, apart from empirically-led studies, there has been a recent boom in critical meta-literature on innovation systems. One of the first interesting critical analyses of the concept and its use in theory and policy is by Miettinen (2002). But other more recent and comprehensive works such as those by Eparvier (2005), Groenewegen and van der Steen (2006), Sharif (2006), and Lundvall (2007a), also deserve be included in this important and 'theory-building' category.

Table 3: A taxonomy of recent empirical research on NSI

			Key elements	Methods	Main limitations/strong points	Countries analyzed	Authors (date)
Policy-oriented studies			The studies aim at identifying "best practice" policies and/or "best practice behaviour" among the countries under study	Resort to various indicators of innovative efforts or outcomes; Grounded on the results of the search for best practice, policy recommendations are derived.	Lack of systemic view of the innovation process; Overemphasis on S&T	Germany is "benchmarked" with 17 OECD countries	Eichhorst et al. (2001)
						OECD countries	Polt et al. (2001)
						OECD countries	OECD (1998)
Research oriented studies	Comparative studies on developed countries	Descriptive models	To build descriptive frameworks of NSI able to capture its structure and performance	Use of innovation indicators	Negligence of historically grown – innovation patterns – institutional frameworks	China and Taiwan	Chang & Shih (2004)
						China	Lui & White (2001)
		Analytical/ formalized models	Efforts to give the NSI concept an operational dimension Performance measurement /"efficiency" measurement of NSI	Use of innovation indicators Calculation of index numbers (ranking of the systems analyzed)		17 industrialized countries	Furman et al. (2002)
						75 countries	Porter & Stern (2002)
						G7 + highly developed west European countries	Nasierowski and Arcelus (1999, 2000, 2003)
	Comparative studies on low- and middle-income countries		Analysis of the development stage of the national system of innovation Verification of the relevance of the NSI concept	Detailed verbal descriptions Analytical models	Emphasis on historically grown – innovation patterns – institutional frameworks	Asian countries	Intarakumnerd et al. (2002)
						Brazil & Korea	Viotti (2002)
						Eastern and Central European countries	Freeman (1999)
							Radosevic (1999)
						Latin America countries	Alcorta & Peres (1998)

5. A quantitative-bibliometric account of NSI-related studies

From the above account, it seems apparent that NSI contributions have not converged to an integrated framework. In order to illustrate the more important paths emerging in this field in the last two decades or so, we conducted a bibliometric exercise based on a review of the abstracts from articles published in all economic journals gathered from the EconLit database since its founding (1969) to the present day.[7]

Based on the 'qualitative' survey of the literature undertaken in the previous sections, particularly on the relevant division proposed by Balzat and Hanusch (2004), we put forward the following categorization for our bibliometric analysis: 1) Conceptual/critical meta-literature on NSI; 2) General Description of NSI; 3) Policy-oriented Studies on NSI; 4) Performance Assessment-oriented Descriptive Studies on NSI; 5) NSI Studies Focusing Developing/Transition Economies; 6) Globalization (e.g., Multinationals, Foreign Direct Investment); 7) Formalized/Analytical Models of NSI;[8] 8) Other.

Our bibliometric analysis seeks to capture the recent paths that NSI has been reinforcing. More than twenty years after Freeman's (1982) seminal contribution, it is important to develop such an appraisal. As mentioned above, the exercise is based on a review of the abstracts from journal articles published in all economic journals gathered from the EconLit database, which covers, among others, the core journals in the subject such as Research Policy, Industry and Innovation, and the Cambridge Journal of Economics, over the past fifteen years (1993-2007).

Before describing the outputs of the bibliometric exercise, it is important to clarify two major points. First, only 'journal articles' are considered. This might represent a major limitation as research is disseminated in many varied forms, whether it be through books, journals, word-of-mouth or the Internet. However, journal articles are publications that are subject to the widely-accepted thorough peer-review process. Therefore, most academics would agree, despite the imperfections of this process, that it provides the 'fairest' measure of quality. It can be argued that publishing a book can enhance an academic's reputation. However, the heterogeneous nature of books and publishers makes it extremely difficult to derive an

[7] EconLit is the American Economic Association's electronic bibliography of economic literature throughout the world. It is considered a fundamental research tool in economics, providing different types of information, from bibliographic citations, with selected abstracts, to international literature on economics since 1969. It covers a broad range of document types published worldwide, namely journal articles.

[8] Recall (cf. Table 3) that 'Formalized/Analytical' studies contrast with 'Descriptive' studies since the former use quantitative methods to conduct comparisons or performance assessment whereas the latter use innovation indicators in a rather straightforward, descriptive manner.

objective quality measure. So, we have opted for publications of 'similar' perceptive quality, that is, journal articles. Second, although our database search covers the period 1969-2007, the first journal article, related to NSI, to be published in an EconLit indexed journal was that of Maureen McKelvey, "*Technologies Embedded in Nations? Genetic Engineering and Technological Change in National Systems of Innovation*", published in 1993 in a relatively 'non-core' innovation journal, the Journal of Socio-Economics. Thus, as we detailed in earlier sections, NSI research is in fact a relatively 'young' field, at least as far as journal articles are concerned.

The database was obtained using as the search keyword variations of the term 'National Systems of Innovation'. The total number of analyzed records was 156, published in 72 different journals, involving 189 different (co)authors. In the next point, the publication activity in NSI-related research during the selected period is analyzed.[9]

The time evolution of articles published is quite irregular (Figure 3). We could state that the true departure point of publishable academic research on NSI occurred in 1995 when the *Cambridge Journal of Economics* published a special issue on NSI, including articles by seminal authors such as Chris Freeman, Stan Metcalfe, and David Mowery.

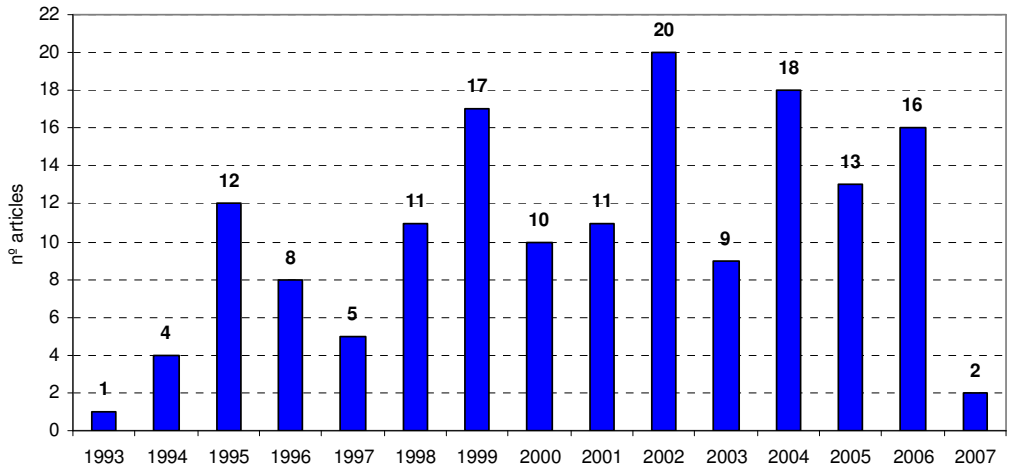

Figure 3: NSI-related articles published in Journals indexed in EconLit, by year

An interesting pattern which arises here is that, in general, the years that are associated with higher numbers of published articles coincide with the existence of 'special issues' in renowned journals: *Research Policy* and *Technology Analysis & Strategic Management*

[9] A similar bibliometric exercise was undertaken for other areas of research such as evolutionary economics (Tavares Silva and Teixeira, 2008) and structural change (Silva and Teixeira, 2008).

(1999); *Research Policy* (2002); *Industrial and Corporate Change* (2004); *Industry & Innovation* (2006).

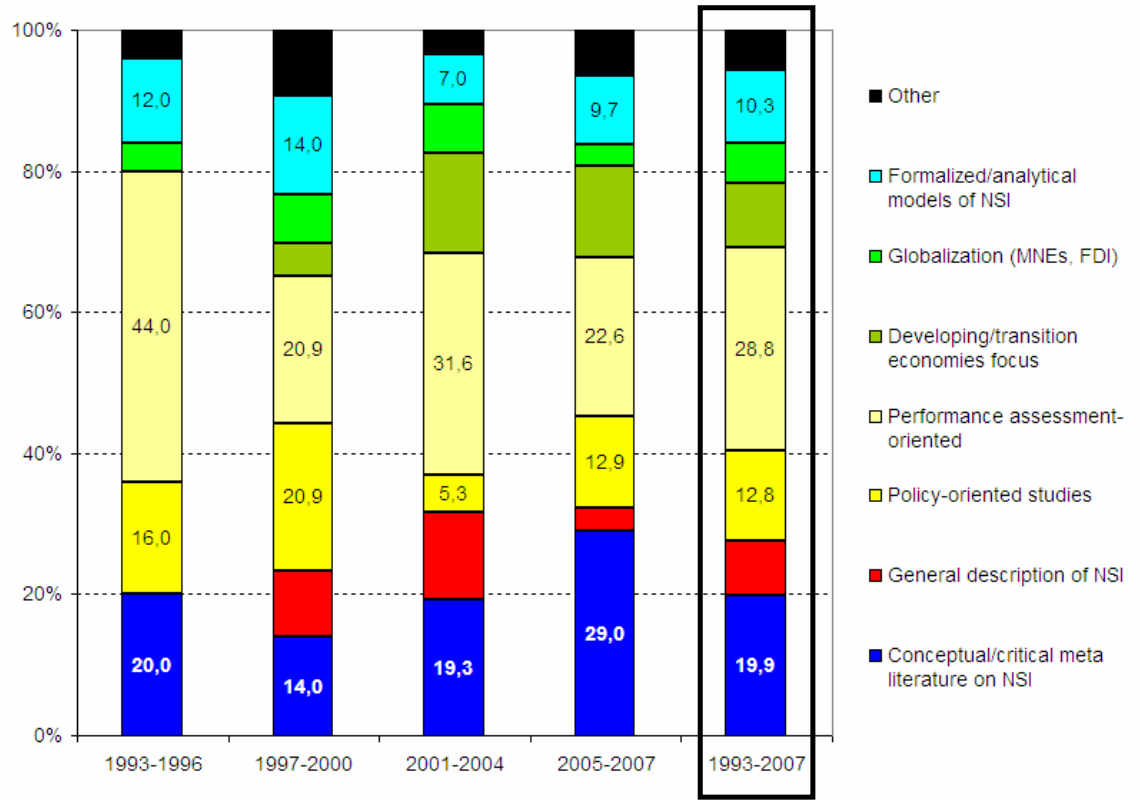

Figure 4: NSI-related articles published in Journals indexed in EconLit, by theme

Considering the whole period (1993-2007), we find that 'Performance Assessment-oriented Descriptive Studies on NSI' comprise the most representative category covering almost one third of the total published articles; 'Conceptual/critical meta literature on NSI' follows with approximately 20% (Figure 4). The categories that are underrepresented are 'Formalized/Analytical Models of NSI' and 'General Description of NSI'.

Such a distribution among themes seems to be in line with the account provided in Section 4, where it was highlighted that historically detailed descriptions on NSI à la Freeman are rare, and the scarcity of works using more rigorous and diversified quantitative methodologies for assessing the performance of NSI is apparent (see also Balzat and Hanusch, 2004). The exception lies in the 'Policy-oriented Studies on NSI' category. Indeed, according to Balzat and Hanusch (2004), this type of study is the most frequent. Such divergence is to a large extent explained by the fact that policy-oriented studies are more often published as Reports or (edited) Books rather than single journal articles.

In dynamic terms, the data reveals a rather remarkable switch between 'Performance Assessment-oriented Descriptive Studies on NSI' and 'Conceptual/critical meta-literature on NSI', where the former's relative importance is halved between 1993 and 2007, and the latter increases its share by almost 10 points. This trend reflects the conceptual dynamism and methodological-analytical challenges faced by NSI approach.

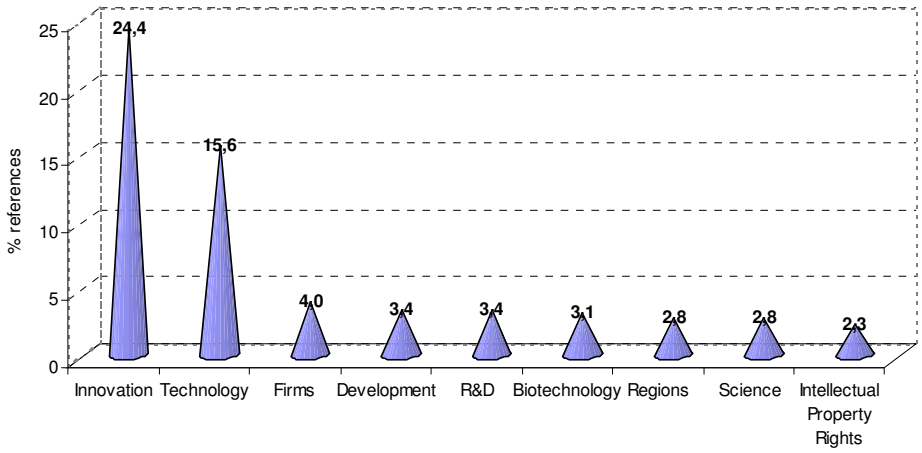

Figure 5: NSI-related articles published in Journals indexed in EconLit, by keyword

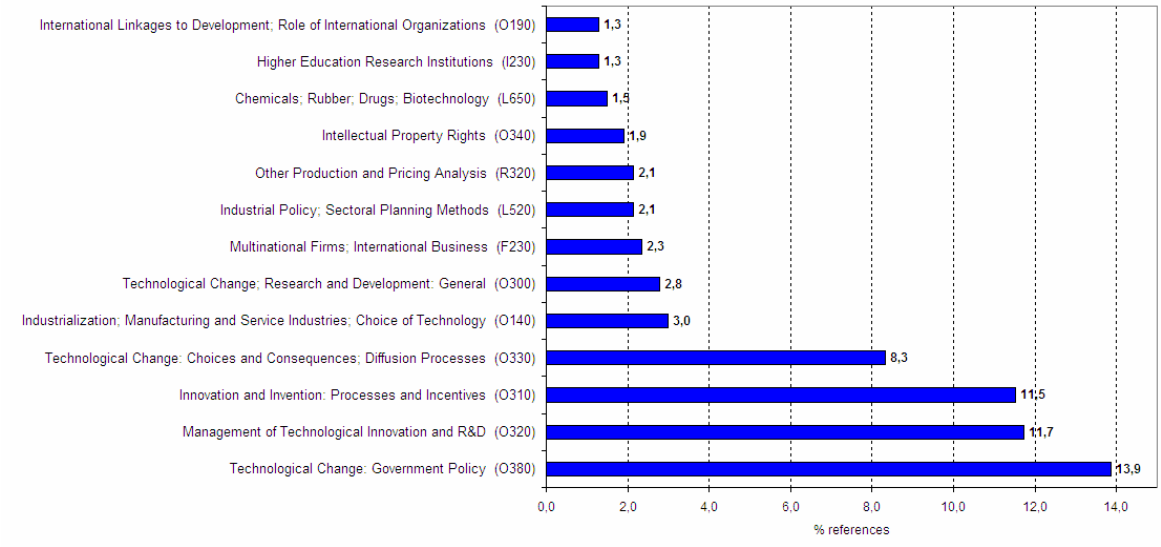

Figure 6: NSI-related articles published in Journals indexed in EconLit, by JEL-code

Analyzing now the articles by keyword (Figure 5) and JEL (Journal of Economic Literature) Code (Figures 6), 'Innovation' and 'Technology' emerge as the most cited keywords, representing together 40% of total references. Given that 'Firms' are at the centre of NSI, one

would expect the relative importance of this keyword to be higher. A finer picture is provided in Figure 6 which was built based on counts of the articles' JEL codes. We counted 99 different JEL codes with a combined number of references of 469. The thirteen JEL codes represented in Figure 6 account for 64% of the total references, and the first four most-cited articles account for 45%. It is possible to conclude that there is a relatively high concentration of articles in a few JEL Codes, namely 'Technological Change, Government Policy', 'Management of Technological Innovation', Innovation and Invention, Processes and Incentives', and 'Technological Change, Choices and Consequences, Diffusion processes'.

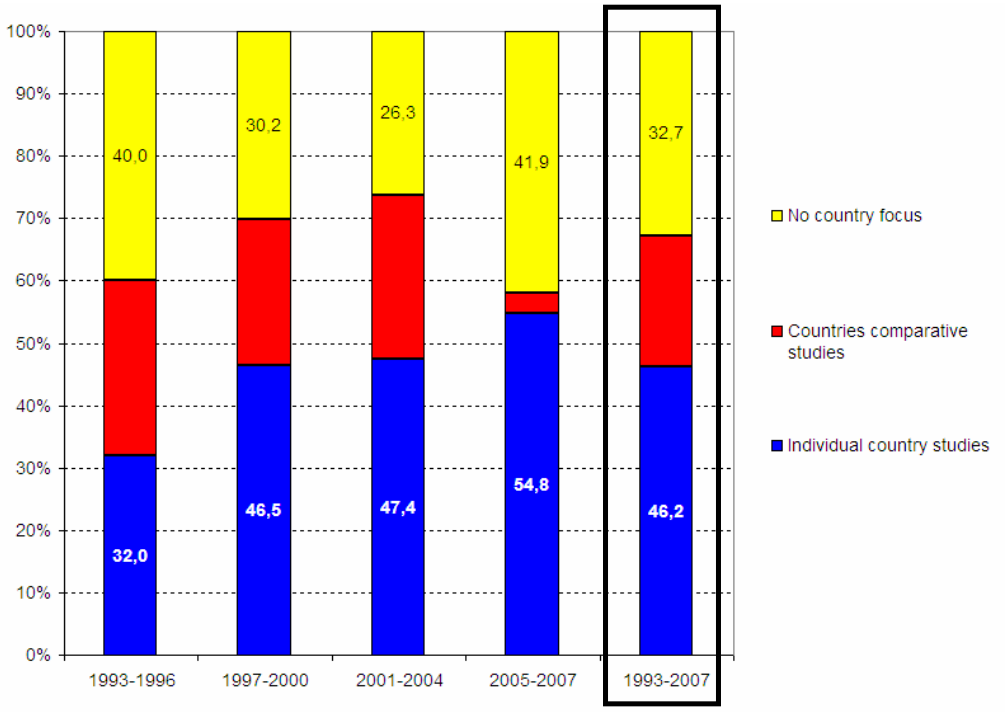

Figure 7: NSI-related articles published in Journals indexed in EconLit, by country focus

Despite the pressing need for comparative studies on countries' NSI (see Edquist, 2005; Lundvall, 2007a,b), the bulk of the studies focus on one single country (46% for the period 1993-2007) (Figure 7). Moreover, and more preoccupying, studies involving more than one country are almost negligible in the more recent period (2005-2007).

This, however, may not necessarily reflect a 'bad' trend. In fact, in order to perform the so-desired rigorous, historical, and systemic analysis of countries' NSI, a substantial amount of detailed and (often) idiosyncratic statistical and qualitative information is required. Thus, in a first stage, single-country analyses are likely to be advisable. Afterwards, as evidence on single countries emerge, we should them expect richer comparative country analyses.

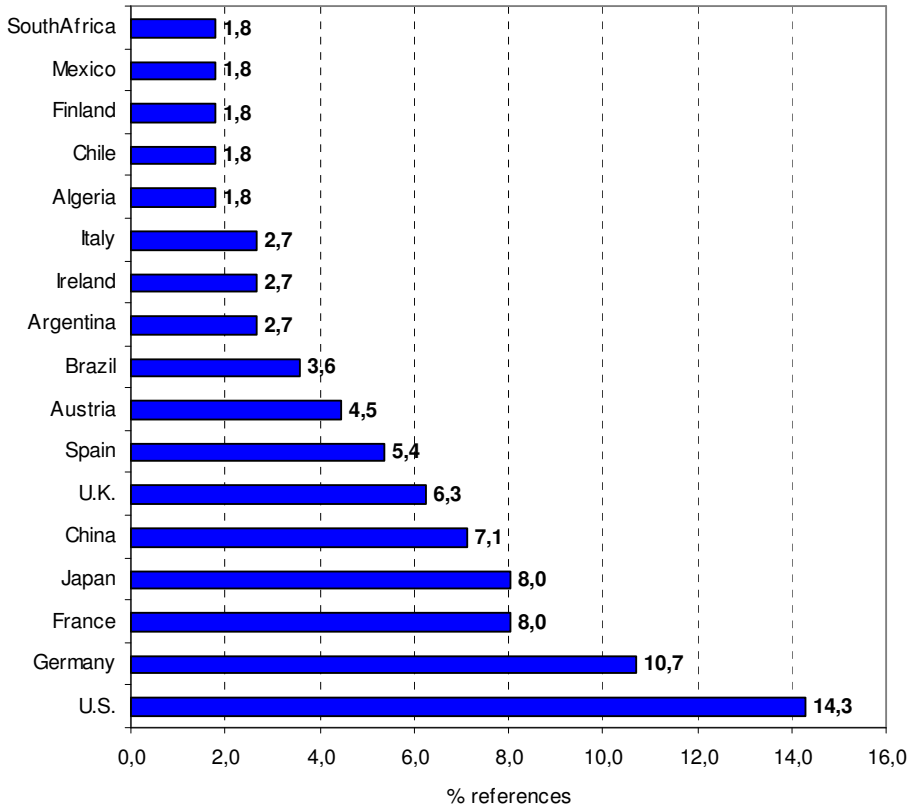

Figure 8: NSI-related articles published in Journals indexed in EconLit, by country

Among those (112) articles that explicitly compared or analyzed countries, 14.3% focused on the US and 10.7% on Germany (Figure 8). That comes as no big surprise since these economies are frequently taken as benchmarks in international comparative studies. Moreover, the first empirical studies on NSI focused on the US economy (Nelson, 1993).

China is the country revealing the most marked increase in studies focusing on its NSI. The set of (17) countries depicted in Figure 8 represent 85% of the total references to countries, with the first five countries – US, Germany, France and China – covering almost half of the total references.

Sadly, no article (published in a journal indexed in EconLit) exists on the Portuguese NSI, which might suggest an interesting (although troublesome) potential research project.[10]

[10] To our best knowledge there exists only one published study (book chapter), by Godinho (2006), which analyses Portuguese NSI. Such assessment is based on a quantitative methodology for measuring and mapping different countries NSI developed by the author and his co-authors (Godinho et al., 2004).

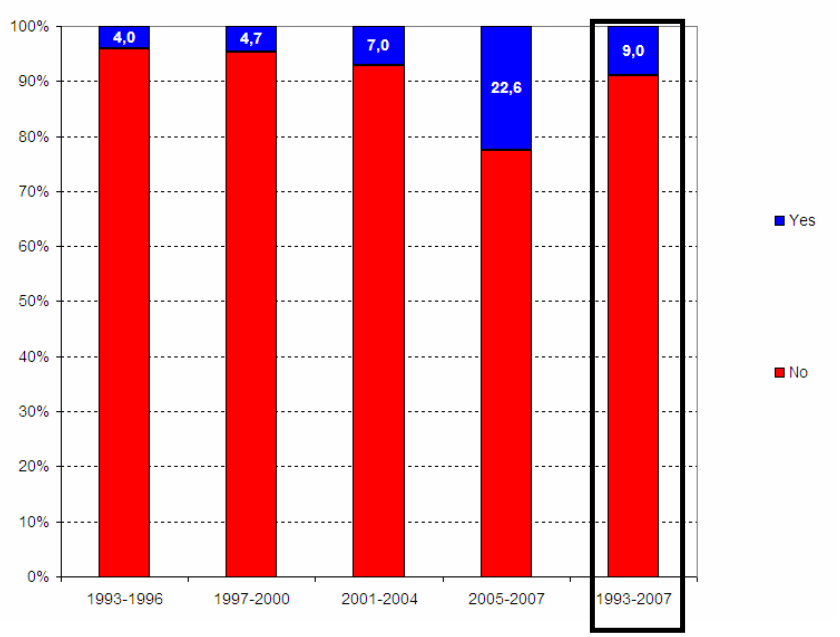

Figure 9: NSI-related articles published in Journals indexed in EconLit, by University-related research focus

Another apparently 'hot' topic is University-Firm relationships or the role of Universities in the countries' NSI. Although in the 1990s University-related research was negligible, in the most recent years, especially in the last two years, it has received a major boost (Figure 9). This is in part related to the more widespread acceptance of NSI's 'competitive' concepts/approaches, namely the Triple Helix Model (Etzkowitz and Leydesdorff, 1997), and the increasing bearing of local public authorities which see universities as engines of 'regional' development (Teixeira and Costa, 2006; Fritsch and Slavtchev, 2007).

This trend has spurred an interesting 'conceptual' debate on the extent to which such an increase in the role of universities in NSI-related research is associated to 'commodification' and a 'colonizing of academic of knowledge' (Lundvall, 2007b). In a knowledge-based economy, Lundvall (2007b: 33) argues that "there is a need to think about the implications for the role of universities of the fact that knowledge becomes more and more fundamental for the economy as for society as a whole. The historical role of universities has been an institution that 'validates' knowledge. It has been an institution that, while aiming at the full truth of matters, at least systematically tries to establish what 'reasonably reliable knowledge' is. This is also one reason why it has been an institution with a relative autonomy in relation to the state as well as in relation to economic interests. This function is even more important in a knowledge-based society."

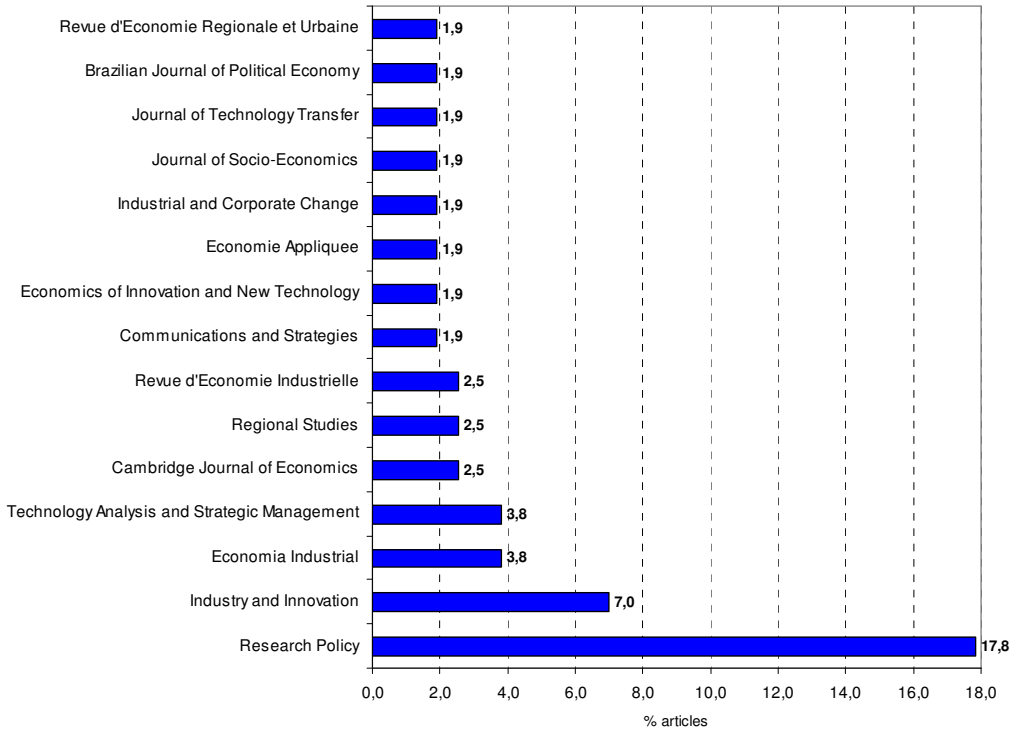

Figure 10: NSI-related articles published in Journals indexed in EconLit, by Journal

NSI research is significantly spread out among different outlets (Figure 10). The 156 articles were published in 72 journals, where the most important is *Research Policy,* with almost 18% of the NSI-related published articles. It should be noted that this journal originated in Freeman's research institute, SPRU,[11] and Freeman himself is its founding editor. This providential coincidence does to a large extent reflect the existence of the so-called 'epistemic communities' in this field of research (Haas, 1990, 1992; Adler and Haas, 1992).

Although, as could be expected, none of the mainstream journals appear amongst those mentioned in NSI-related research (Figure 10), there are important and renowned journals publishing in this area, namely (beside Research Policy), the *Cambridge Journal of Economics*, *Regional Studies*, and *Industrial and Corporate Change*. These are, in general, considered 'heterodox' journals as the bulk of articles published there are often very critical of mainstream economics. This further stresses the issue detailed in Section 3, where it was argued that the NSI's conceptual roots go deep into evolutionary economics.

[11] Freeman was in fact the founder of SPRU, whose offices today are located in the 'Freeman Centre' at the University of Sussex (UK).

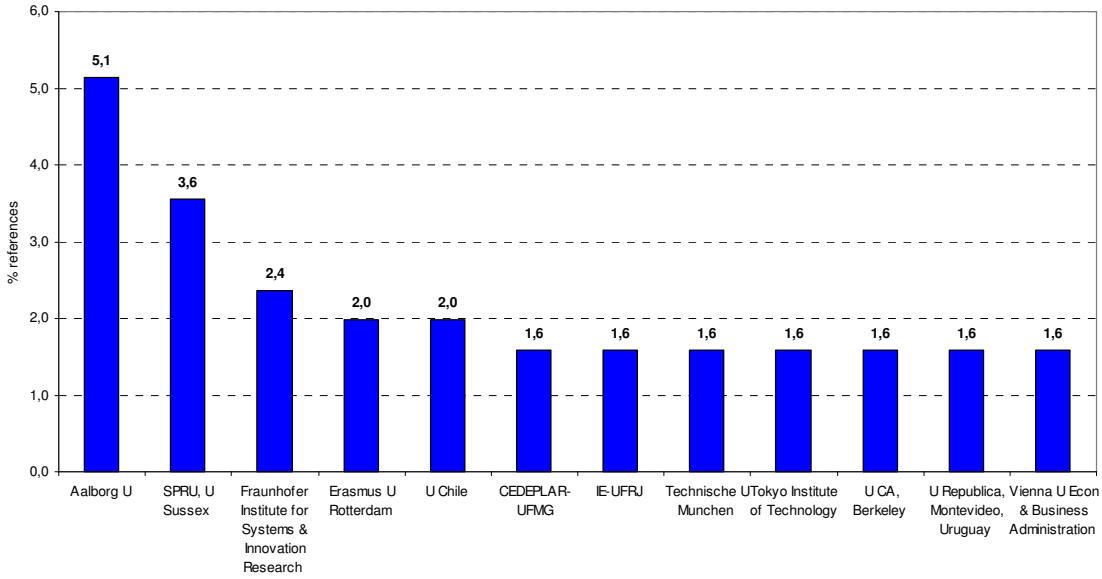

Figure 11: NSI-related articles published in Journals indexed in EconLit, by author's affiliation

The organizations that are the building blocks of the NSI approach/concept – SPRU and Aalborg University (see Figure 1) – stand at the forefront in terms of the percentage of references to the authors' affiliation associated with the published articles. The Fraunhofer Institute, SPRU and Aalborg have long-standing cooperation relations in innovation areas, which further underpins the argument for the existence of 'epistemic communities' in this area of research. Note (Figure 11) that some Latin American Universities are quite active in this field – the University of Chile, Universidade Federal de Minas Gerais (UFMG), Universidade Federal do Rio de Janeiro (UFRJ), and Universidad de la República Montevideo. The importance of these organizations reflects the emergence of a new field within NSI-related research, the Developing/Transition studies on NSI.

6. Conclusions

Early studies on NSI have typically given verbal descriptions of national innovation patterns, involving a reduced number of indicators of innovative activity. Moreover, they usually concentrated on one country in order to thoroughly describe the functioning of the innovation system under consideration. Due to large extent the lack of a formalized methodology to conduct such studies the set-up of NSI studies has varied considerably. In face of this, several efforts were undertaken to carry out system-level comparisons as well as to formalize the NSI concept, leading to the introduction of descriptive frameworks and to the development of analytical models.

In this paper we sought to provide a *quantitative* appraisal of the problematic of the National Systems of Innovations. We offer a complementary, 'quantitative', description of the state-of-the-art in the literature resorting to bibliometric methods.

Our exercise showed that the time evolution of articles published was quite irregular, receiving a first major boost with the 1995 *Cambridge Journal of Economics'* special issue on NSI, and that the NSI contributions have not converged to an integrated framework.

In concrete, considering the whole period (1993-2007), we find that 'Performance Assessment-oriented Descriptive Studies on NSI' comprise the most representative category (almost 30%), followed by 'Conceptual/critical meta literature on NSI' (approximately 20%). Both the 'Formalized/Analytical Models of NSI' and 'General Description of NSI' are underrepresented. Corroborating our 'qualitative' survey, the bibliometric exercise evidenced that historically detailed descriptions on NSI à la Freeman are rare, and analysis using more rigorous and diversified quantitative methodologies for assessing the performance of NSI are on demand. At a first glance surprisingly, the 'Policy-oriented Studies on NSI' category involves a rather small share (less than 13%), which might be to a large extent explained by the fact that our analysis relies on published indexed (in Econlit) articles, rather than (edited) books or reports where such category is likely to be overrepresented.

In a context where there is an increasing dissatisfaction among original proponents of the NSI concept on its (ab)use, it came with no surprise that the share of 'Conceptual/critical meta-literature on NSI' category increased by almost 10 points between 2001-2004 and 2005-2007 periods. Such trend reflects the conceptual dynamism and methodological-analytical challenges faced by NSI approach, which still leaves much room for development, both in terms of its theoretical grounding and its empirical application.

Empirically, and despite the need for additional comparative studies on countries' NSI, a substantial percentage (46% for the period 1993-2007) of studies focus on one single country, and in the last period in analysis (2005-2007) the share of studies involving more than one country is tiny (less than 3%). The US and Germany are the most cited countries for NSI analysis, gathering respectively 14.3% and 10.7% of the corresponding total (112 articles).

The theoretical – evolutionary - roots of the NSI approach is reflected by the fact that the most important outlets of NSI related research are quite fundamental 'heterodox' journals, namely the *Research Policy* (18% of published papers), the *Cambridge Journal of Economics*, *Regional Studies*, and *Industrial and Corporate Change*. The importance of such outlets

stresses even further the holistic and interdisciplinary perspective of NSI approach, encompassing a wide array of the important determinants of innovation, allowing for the inclusion of organizational, social, and political factors, as well as economic ones, and absorbing perspectives from different (social science) disciplines, including economic history, economics, sociology, regional studies.

Even though innovation processes increasingly entail other dimensions, namely, international, the concept of *National* Systems of Innovation will for sure enjoy continuing popularity. Indeed, the *systemic approach* to innovation in general – regardless of the analytically selected boundary of the system – has been established and proved as a useful framework to study technical change and its determinants.

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