
Introduction to ‘Technological infrastructure and international competitiveness’ by Christopher Freeman

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This is an introduction to the publication for the first time of a 20-year-old draft paper by Christopher Freeman, the first paper that uses the concept ‘national system of innovation’. The draft paper illustrates the role played by Christopher Freeman in building innovation research. This brief introduction gives the status of innovation system discourse and research, and relates it to what Freeman wrote more than 20 years ago. It challenges the idea that ‘innovation system is not a theoretical concept’, and shows that current innovation system analysis can still learn from Freeman when it comes to linking together trade policy and national innovation systems.

1. Introduction

Following is the publication for the first time of a more than 20-year-old draft paper by Christopher Freeman, and it is brought in its original form.¹ It is the first text that uses the concept ‘national system of innovation’ (NSI), and it deserves to be read by more than the handful of scholars that have had a chance to see it so far.² It illustrates the key role played by Christopher Freeman in building innovation research.

¹The paper has its own peculiar bibliographic history. Originally it was produced for the OECD Ad-hoc Group on Science Technology and International Competitiveness, chaired by Mr Ingram, with Francois Chesnais as secretary and with a number of country representatives, including myself as representative for the Danish government. The group met several times between 1980 and 1983, and the discussions were extremely stimulating. But in spite of the efforts by Ingram and Chesnais, its final report was never published—the only outcome was a delayed contribution to the DSTI review. The official reason given by the OECD’s top management for not publishing the report was that the printing capacity of OECD was overloaded. Another cause might have been the major conclusion of the group: that the standard analysis of competitiveness with focus only on wages and currency rates was naïve and misleading. As an alternative to the naïve short-term view of competitiveness, the group introduced the concept ‘structural competitiveness’ as reflecting factors having to do with institutions, technologies and human resources. At that time, this was still regarded as a controversial message.

²Thanks goes to Jan Fagerberg, who reminded the guests at Freeman’s anniversary party in Lewes, in September 2001, about the paper. With the acceptance of Freeman, I introduced the paper at the first GLOBELICS conference in Rio de Janeiro, November 2003 (see www.globelics.org) as a symbolic start for this global network on innovation system research.

Freeman is the founder of the Science Policy Research Unit (SPRU), as well as of economics of innovation as a legitimate field of research in Europe (Richard R. Nelson has played a similar role in the USA). He has been a key person in getting the OECD secretariat to bring science and technology policy to the agenda of member states, which started in the 1950s (Lundvall and Borrás, 2004). The following paper gives just one of several examples of how, while building the epistemological community around innovation studies and innovation policy, Freeman has also continuously acted as creative intellectual leader for the community, always ready to open up new intellectual paths, never shying away from challenging the mainstream.³

In this brief introduction I shall give the status of innovation system discourse and research, and relate it to what Freeman wrote more than 20 years ago. Starting from Freeman's paper, I shall challenge the idea that 'innovation system is not a theoretical concept' and show that current innovation system analysis still can learn from him when it comes to linking together trade policy and national innovation systems.

2. The current status of the concept 'national innovation system'

Today it is possible to follow the diffusion of new concepts in time and space by using search machines on the internet. Giving 'Google' the precise formula 'national innovation system', you end up with a total of more than 6000 references. Most of them are recent, some relate to innovation policy efforts at the national level, while others refer to new contributions to social science.

The concept informs policy makers in many countries, including the biggest economies in the world such as the USA, Japan, Russia, Brazil, South Africa, China and India, but also many small countries at different income levels.⁴ This rate of diffusion is quite impressive, taking into account the fact that 15 years ago only a handful of scholars had heard about this concept. The concept has been taken on as a tool by experts in international organizations for economic cooperation, such as OECD, Unctad, the World Bank and the EU Commission.

It has inspired analytical efforts related to different disciplines within social science. In industrial economics it has stimulated the growing analytical efforts to understand the formation and importance of industrial clusters, filières and development

³Perhaps his willingness to challenge the mainstream and his preparedness to be open to disciplines other than economics explains why he and Richard R. Nelson (who shares these characteristics) have not received the Nobel Prize in Economics despite having made the most important contributions to what many people would agree is one of the most important current fields of economic analysis—the economics of innovation.

⁴As far as I know, the prime minister of Finland was the first highly placed politician using the concept in referring to the need to strengthen the Finnish innovation system—he did so at the beginning of the 1990s. Some 10 years later the president of China, in a speech to the Chinese Engineering Academy, made a similar remark in referring to the Chinese innovation system.

blocks—as opposed to the traditional focus on the 'sector' as analytical unit. In economic geography, industrial districts understood as regional knowledge-based networks of firms in economic geography have also been inspired by the systemic approach to innovation processes. In economics, new growth-theorists, such as Paul Romer, have recognized the study of NSI as a useful complement to growth theory.

This very rapid diffusion reflects some characteristics of the NSI concept. First, it is a synthesis of the most pertinent stylized facts produced by empirical research on innovation in the post war period (innovation as a cumulative, interactive process, with important feedbacks between supply and demand). Second, it makes the nation state level explicit. Especially for less developed economies, the concept can be used to mobilize agents around an agenda that is forward-looking and offensive rather than backward looking and defensive. Finally, for policy makers in all countries it serves as a framework for policy coordination—something that is increasingly needed in a learning economy.

3. A concept with roots far back in history—from List to Freeman

As made clear by the Freeman paper, some of the basic ideas behind the concept 'national systems of innovation' go back to Friedrich List (List, 1841). His concept '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). List argued that the focus should be on the development of productive forces rather than on allocation issues.

In the beginning of the 1980s the idea of a national system of innovation was immanent in the earlier work of several economists working on innovation research. Nelson and other US scholars worked on comparing university–industry links in the USA with patterns in Japan and Europe. The SPRU at Sussex University had, under the leadership of Freeman, pursued several studies comparing industrial development in Germany and the UK, studying, for example, differences in the management of innovation, work practices and engineering education.

The idea of a national system of innovation was immanent also in the research program pursued by the IKE group at Aalborg University (Andersen *et al.*, 1981).⁵ The program was inspired both by French structuralist economists, especially De Bernis and Palloit (see GRESI, 1976), who used the concept 'national system of production' as an analytical tool for explaining economic growth and by the SPRU tradition, with its focus on innovation. In several working papers and publications from the first half of the 1980s we referred to 'the innovative capability of the national system of production'.

⁵It should be mentioned that we had the privilege to interact with Christopher Freeman in several projects in this period and that many of our ideas were shaped in a dialogue with him (see e.g. Freeman, 1981).

But it was Chris Freeman who brought the modern version of the concept 'national innovation system' into the literature. He did so in 1987, in his book on innovation in Japan (Freeman, 1987). The analysis was inclusive taking into account the intra- as well as inter-organizational characteristics of firms, corporate governance, the education system and, not least, the role of government.

When Freeman collaborated with Nelson and others in the major project on technical change and economic theory (Dosi *et al.*, 1988), the outcome was a section on 'national systems of innovation' (Freeman, 1988; Lundvall, 1988; Nelson, 1988). Later, three major edited volumes on the subject (Lundvall, 1992; Nelson, 1993; Edquist, 1997) followed.

4. Different definitions of the 'national innovation system'

It is obvious that different scholars mean different things when referring to a national system of innovation. Authors from the USA with a background in science and technology policy studies tend to focus on 'the innovation system in the narrow sense'. They use the NSI concept as a follow-up and broadening of earlier analyses of national science systems and national technology policies (see e.g. the definition given in Mowery and Oxley, 1995: 80).

The Freeman and 'Aalborg' version of the national innovation system approach (Freeman, 1987; Lundvall, 1985, 1992) aims at understanding 'the innovation system in the broad sense'. First, the definition of 'innovation' is broader. Innovation is defined as a continuous cumulative process involving not only radical and incremental innovation but also the diffusion, absorption and use of innovation. Second, the major source of innovation is not necessarily science. Innovation is seen as reflecting interactive learning taking place in connection with ongoing activities in production and sales.⁶

To a certain degree, these differences in focus reflect the national origin of the analysts. In small countries such as Denmark, as in developing countries—the major concern of Freeman—it is obvious that the competence base most critical for innovation in the economy is not domestic scientific knowledge. This is different in the USA, where economic growth reflects to a higher degree the expansion of science-based sectors.

5. Is the 'national system of innovation' a theoretical concept?

It may be argued that since it takes on different meanings in different contexts, the NSI concept cannot be a 'theoretical' concept. In physics and mathematics it is seen as crucial for scientific progress to agree on universal definitions and on a common terminology with as general applicability as possible. Some scholars in social science,

⁶In a recent case study of the Danish innovation system I have applied an even broader definition of the national innovation system (Lundvall, 2002).

especially economists, argue that the long-term ambition ought to be to transform social science into something that can match natural science in these respects.

A more realistic and fertile approach for social science might be to accept that, by definition, it must remain historical. As already indicated, the components of the economy related to innovation that have the dominant impact upon economic growth and development differ over time and space. To develop 'a general theory' of innovation systems that abstracts from time and space would therefore undermine the utility of the concept both as an analytical tool and as a policy tool.

The OECD paper by Freeman actually takes on the issue of what good theory is. He points out the limitations of quantitative analysis based on abstract models and calls for a method that he characterizes as 'reasoned history'. And he goes on to quote Schumpeter:

It is absurd to think that we can derive the contour lines of our phenomena from our statistical material only. All we could ever prove from it is that no regular contour lines exist . . . We cannot stress this point sufficiently. General history (social, political and cultural), economic history and industrial history are not only indispensable, but really the most important contributors to the understanding of our problem. All other materials and methods, statistical and theoretical, are only subservient to them and worthless without them.

If we follow the Norwegian sociologist Lars Mjøset (Mjøset, 2001, 2002, 2003), we can go further along these lines and point to the type of historical and comparative case-based approach that typically is inspired by the innovation system concept as exemplary for what social science can and should do in order to promote theory building. Defining 'theory' as 'accumulated knowledge, organized by the human mind, to be used for purposes of explanation', Mjøset characterizes attempts to establish 'general theory' as well as sociological 'grand theories' that neglect historical context as falling outside this definition—no accumulation of knowledge takes place since the explanatory scheme remains frozen once and for all.

6. National systems in the international division of labor

Freeman starts his paper with references to some of the most recent contributions on how technology affects trade and international competitiveness. These issues have become less central in most of the following literature on national innovation systems. There are works that involve international comparisons and works that reflect on the internationalization of processes of innovation but much less on international specialization in trade (Carlsson, 2003). The focus has become more oriented toward the domestic institutional set-up and national innovation policy and less toward the impact on trade and the role of trade policy.

But there are exceptions. The contribution on technology and trade by Dosi and

Soete (1988) refers to national systems of innovation not explicitly but indirectly, by pointing to how 'absolute advantages' emanate from 'country-specific conditions of technological learning and accumulation'. There have also been a few, more recent, important contributions on how innovation and technology are linked to trade, foreign direct investments and globalization of technology.

The contributions on the role of the home market when it comes to promote innovation and deepen specialization by Jan Fagerberg (1995) may be seen as a kind of modern follow-up of the Listian idea of linking the national production system to trade performance. His work on how different factors affect the competitiveness in different sectors gives another important insight (Fagerberg, 1996). What is interesting about Fagerberg's work is that it gives strong and updated empirical evidence for some of the relationships that Freeman presents in the paper below. Archibugi and Pianta (1992) gave an important descriptive contribution by showing a high degree of correlation between specialization in trade and specialization in the national knowledge base (using patent data to map the knowledge base).

Another issue that has been addressed to a much higher degree is how far national systems remain important when it comes to understand innovation in an era of globalization and multinational firms. Archibugi and Michie (1997) and Pavitt and Patel (1999) go further in analyzing how far globalization has undermined the function of national systems.

Fagerberg's studies tend to support the assumptions made by Freeman that domestic technology infrastructure has a major impact on trade specialization and international competitiveness. The work by Pavitt, Patel and Archibugi shows that while internationalization implies that national systems tend to become more open, the national roots remain of major importance also for patterns of innovation. The national level remains important both for political and analytical reasons.

7. Freeman as pilot and innovator

The richness of the context in which the NSI concept appears in the Freeman paper is remarkable. It raises many of the points that current research on innovation systems is focused upon and it gives a first glimpse of the contours of the full-blown concept. But some of the ideas remain in a preliminary form in this early draft paper.

Early on, a chain of links between different empirical and theoretical contributions is established and this may help us to understand how Freeman developed his version of the innovation system-perspective. The paper starts from the work by Pavitt and Soete (1980) on how R&D and patenting affect international specialization, and links this work to the competitiveness of national economies. It then goes on to point to a much broader set of factors, such as financial markets, education systems and work organization, that bolster competitiveness, thereby already signaling the broad definition of the innovation system. It brings into the analysis a long time perspective

by showing how 'catching-up' can be understood in the context of long waves, new technological systems and national innovation systems.

The paper is rich and controversial also in terms of its policy conclusions. It starts from List's criticism of Adam Smith, and shows that the most important contribution by List was not his protectionist proposals but rather the emphasis on governmental initiatives to build 'infrastructure' and invest in 'mental capital'. The brief conclusion also gives direction for policy as well as for future research. At the international level it foresees the very limited effect of currency rate policy aiming at getting prices right (cf. the recent drastic shifts from a weak to a strong euro versus the dollar). At the national level it emphasizes the importance of inter-firm networking and clustering, as well as the importance of 'coupling' between firms and knowledge institutions.

The Freeman paper opens up what certainly was (and remains) a controversial idea for mainstream economists in the OECD secretariat that free trade might not always be to the advantage of all countries. This critical approach to the free trade doctrine has almost disappeared from the analysis of national innovation systems. The experience of Brazil and other Latin American countries where the opening up of home markets for foreign multinationals has destroyed the most promising competence-based activities and the more aggressive approach of WTO in relation to intellectual property rights and public sector activities may be seen as signals that there is a need to bring critical perspectives on trade policy back into the analysis.

It would be somewhat depressing if we were to conclude that Freeman said it all 20 years ago, and it would not be correct to end up with such a conclusion. Today we are much better prepared to take an explicit confrontation with standard economics, and to develop a criticism of its incapacity to grasp processes of innovation and competence building. Freeman has laid much of the foundation by organizing a body of research pointing toward a different kind of economics than the one thriving at most economics departments. It is my gut feeling that we are now much closer to opening up the paths he has indicated and broadening them into new avenues. The 'national innovation system' could be seen as one tool helping us to do just that.

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