

Montresor, Sandro

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Techno globalism and techno nationalism: an interpretative framework

Sandro Montresor
IDSE-CNR, Via Ampere, 56 20131 Milan (Italy)
sandrom@chiostro.univr.it

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Abstract

This paper deals with the globalisation process and with the tensions between national, super-national and sub-national forces it entails. A taxonomy is put forward in order to examine the question at different levels, distinguishing aspects of techno-territoriality, techno-sovereignty, techno-citizenship and techno-nationality, pertaining to, respectively, geographical borders, governance structures and policy making, strategic behaviors and accountability, socio-cultural distances and spaces. The analysis of some of the massive contributions on the issue shows that the first three items have actually reached a global specification, but without completely losing national or even more local characters. A different evaluation instead holds for techno-nationality, as a certain communality of language and culture within a country, along with its historically formed institutional setting, conduce to different technological styles and performances: techno-national systems of innovation therefore still matter.

1 Introduction

It is generally recognised that from the 1980s onwards international economic integration has increased substantially, both at the intensive and at the extensive margin (Chesnais, 1992; Michie & Smith, 1995). On the intensive side, trade flows have expanded both in volume and in spread, and the same

occurred at even higher rates for foreign direct investments. On the extensive side, internationalization has been involving a larger number of economic activities, as firms started conceiving finance, management, corporate strategies and also innovation, besides production and marketing, on a world-wide basis.

Although this new phase of internationalization is commonly referred to as globalization, and identified with quite generally accepted aspects (OECD, 1992, Ch.10, p.211), the research on its actual extension and on its effects is far from conclusive. In particular, it is still unclear which is the outcome of the entailed tension between national, local and global forces, an argument that has been developed with different focuses, methodologies, and conclusions¹.

This is especially true in dealing with technology, as at least two approaches can be identified. On the one hand, there is a dualistic kind of approach, which characterizes techno-globalism and techno-nationalism as two contradictory and mutually exclusive patterns of technological change in which nation (or more local) based factors are, respectively, either already irrelevant or still crucial. The fields in which this dichotomy is investigated are numerous and heterogeneous, so that this approach is unable to reach general conclusions about the prevalence of a global rather than of a national or a local argument². An alternative approach which looks more promising in this last respect is a complementary one, that aims to better qualify some more specific moments and aspects in which techno-globalism might proceed to a different extent and with a different speed³.

¹Out of the numerous volumes on the subject, at least three recent are worthwhile mentioning for their socio-economic breath: Berger & Dore (1996), Boyer & Drache (1996), and Storper (1997).

²Some studies extend to R&D the standard international business approach to multinational corporation (Pearce, 1989; Goshal & Bartlett, 1988; Bartlett & Goshal, 1990; Howells & Wood, 1993), while some other apply to them a technology oriented approach, allocating their innovative outcomes between subsidiaries and parent companies (Patel & Pavitt, 1991; Patel, 1995). Some contributions address nation-specific factors of globalization, such as the national demand or the resource endowment (Porter, 1990; Cantwell, 1995; Moverly & Oxley, 1995), while some other highlight local territorial units, such as small-medium-firms and industrial districts (de la Mothe & Paquet, 1996; Storper, 1993). In some cases the focus is technology-specific, and cross-country sectoral similarities are highlighted (Malerba & Orsenigo, 1995), while in some other it is on the historical, geographical and social context that underpins cross-technology national similarities (Freeman, 1987, 1995; Nelson, 1993; Cohendet et al., 1992).

³The literature that follows this approach is not as much rich but still relevant. In

Following this last approach, in this paper I suggest that the whole question could benefit from a further clarification attempt. A taxonomy is therefore proposed in which techno-territoriality, techno-sovereignty, techno-citizenship, and techno-nationality identify four distinct, although not independent, aspects, with different global, national and local specifications. This scheme reveals particularly useful in organizing existing and further evidence on the topic, as well as in testing the validity of nation-based notions and theories of innovation.

In what follows I will first assign some results one can find in the relevant literature to the proper heading of the taxonomy (Section 2), stressing their pro-global or pro-national character. I will then refer to the most debated nation-based notion of the issue, that of national systems of innovation (NSI), and I will try to show how techno-nationality is, out of the four, the configuration underpinned by its most articulated theoretical conceptualisation (Section 3). In the final section (Section 4) a general balance of the different specifications established within each component of the taxonomy is attempted.

2 Techno-statism versus techno-nationalism

As it is well known, in political sciences *state* and *nation*, two concepts that in economics often go under the same heading of country, are clearly distinct. According to the so called institutional theory of law⁴, the *state* is an institution identified by three constituent elements: (i) territory, that is a geographical space delimited by natural or artificial boundaries; (ii) sovereignty, that is an original kind of power that makes the state independent and superior to other minor legal institutions; (iii) citizens, meant as the community of all those who acquired the relative status, rights and liabilities in a recognised way (not only originally). The *nation* instead refers to a social and ethnic entity, characterised by a certain communality of race, language, culture, habits, traditions, and religion among its components.

some cases the internationalization process is broken down into phases (e.g. commercial, hierarchical, and communicative) depending on the prevalent integrators and media (Grandinetti & Rullani, 1996, Ch.2). In some other techno-globalism is subdivided into components, depending on the focus being on innovative production, distribution and international collaboration (Archibugi & Michie, 1995; 1997).

⁴To this theory can be traced the positions of von Stein, von Gierke, Hauriou, Elrich and Santi Romano, just to quote the most important.

The relationship between the two concepts is quite strict, as the nation pre-exists to the state and represents that sociological basis which guarantees its permanence along the time. On the other hand, the nation does not simply coincide with the citizens of one state, as several plurinational-states reveal⁵.

With the necessary flexibility of every eclectic exercise, the rationale of this general distinction can be extended to the specific domain of technological change, so that techno-statism and techno-nationalism can be taken to account for two different kinds of issues. Pursuing the parallel, *techno-statism* is here used to indicate those techno-economic aspects which relate to one of the three constituent elements of the state, that is: the relevance of the geographical space within which innovations are produced and diffused, and of the physical distance between innovative producers and users (techno-territoriality); the actual domain of different levels of public governance and the efficacy of the relative science and technology (S&T) policies (techno-sovereignty); the degree of accountability and loyalty of the main innovative actors to more or less global centers of power, either public or private (techno-citizenship). *Techno-nationality* as such instead here refers to the innovative role played by the existence of different socio-economic communalities, identified by language, culture and other more specific forms of social sharing, along with the historical roots of their broader institutional setting and social architectures.

Let us consider each of these aspects in turn.

2.1 Techno-territoriality

As the recent upsurge of interest of economists for geography reveals⁶, the actual location of productive activities is extremely important. Although the increasing role of globalizing technologies (e.g. communication and information technologies) makes the incidence of transportation and communication costs less relevant than in the past, another kind of argument sets the question of the physical distance between producers and users (not only innovative) as a crucial one, that of the role of knowledge.

⁵The discussion is indeed very sketchy, but here it suffices to recall the nature of the distinction. For a more detailed historical account of the concepts of nation and of nationality see, for example, Mises (1919, Ch. I; Ed.1994).

⁶Just remind the path-breaking volume of Krugman (1991) and the more recent book of Storper (1997).

In nowadays economic systems knowledge is by far the most relevant factor input (Loasby, 1998; Lundvall & Barras, 1998), the more when it is new knowledge, that is innovation, to be produced and applied. Its inner nature is therefore highly influential in determining the actual specification of the relevant geographical boundaries: this holds in particular for the important distinction between codified (explicit, or formal) and tacit (implicit, or informal) knowledge in the pursuit of science and technology⁷.

It is quite straightforward that physical proximity wouldn't be relevant for the implementation and diffusion of any innovation, if it exclusively or mainly relied on a formal kind of knowledge. As it can be easily de-contextualized, codified and transmitted, the geographical distance between innovative producers and users, either actual or potential, wouldn't enter the feasibility constraints of a certain innovation, while it could instead be relevant for other kinds of reasons, such as, for example, distributive (the commercialization of a new product) or organisational (the implementation of a new productive process). In other words, if this was the case, techno-territoriality would have a global specification.

Although, as it will be clarified later, quite criticizable, this seems to be the implicit perspective undertaken by some recent contributions of international political economy and international relations⁸. These authors maintain that firms would currently be quite footloose and free of choosing the technologies to implement or to adopt, as well as of selecting or rejecting the appropriate organisational forms and the suitable locations⁹.

This global techno-territorial argument is mainly put forward in dealing with multinational corporations (MNCs): as the most relevant information flows between affiliates and parent companies are codified, and what is more in company-specific codes, it is claimed that MNCs would consist of integrated structures, within which innovation might be possibly undertaken

⁷Briefly, the former refers to information and instructions that can be formulated in words and symbols, while the latter refers to those which cannot be completely formulated in an explicit way and are therefore embodied in physical or human capital. Among the several references on the issue, see, for example, the suggestive account provided by MacKenzie & Spinardi (1994) of the invention and diffusion of the earliest nuclear weapons.

⁸See, for example, de la Mothe & Paquet, (1996), Ohmae (1990), and Strange (1988).

⁹Also the extreme idea of virtual companies (and virtual governments), enlarging and shrinking their field of action depending on the opportunity of joining and quitting alliances or partnerships (Davidow & Malone, 1992; de la Mothe & Paquet, 1994), relies on the assumption that firms can be cabled within networks of context-independent information flows.

everywhere, and actually localized on the basis of extra-territorial considerations. Although some empirical evidence seems to confirm this interpretation, suggesting that the subsidiary-parent company distribution of the innovative activities and of the innovative results mainly responds to strategic questions (Ghoshal & Bartlett, 1988; Bartlett & Ghoshal, 1990; Archibugi & Michie, 1995), a narrower characterisation for techno-territoriality can be claimed, although indirectly, also in this multinational context¹⁰. The argument is quite simple and consists of recognizing how the actual innovative corporate structure of a MNC might also be affected by communicative transaction costs, entailed by a relevant distance in geographical terms and in turn overcome by setting a proper organisational kind of distance (Lundvall, 1992b; Kogut & Zander, 1993; Ghoshal & Bartlett, 1990).

The local specification of techno-territoriality however emerges more clearly when the crucial role of tacit knowledge for the innovative process is considered. Unlike explicit knowledge, tacit knowledge cannot be stored or transferred exclusively by impersonal, and context-independent means, such as written documents, or computer files. As person-to-person contacts, practical demonstrations, and physical transactions are instead necessary for its transmission, the spatial dimension entailed by techno-territoriality is inevitably recovered.

According to the latter point, and to related theoretical arguments¹¹, techno-territoriality would therefore rather have a national, or sub-national specification. As for the national characterisation, some environmental/systemic approaches to competitiveness (Hatzichronoglou, 1996) have shown how important virtuous circles can be set-up and fuelled by knowledge sharing and effective feed-backing when the strategic firms of a certain country are correlated and supported by some crucial sectors based in the same national territory (Porter, 1990; Ergas, 1984). The same argument can be scaled-down at a local level when the national context appears so differentiated that it would be misleading to retain it exclusively at an aggregate level: in-

¹⁰For a review of the empirical contributions on this that has become known as the Patel & Pavitt argument, from the seminal work of Patel and Pavitt (1991), see OECD (1992, Ch.10, p.225).

¹¹In particular, such notions as knowledge spillovers, economies of integration, agglomeration and clustering, all concepts that presuppose a certain geographical proximity (especially when informal bits of information are concerned), have been argued to be as much important as economies of scale in locating science and technology (Jaffe, 1989; Jaffe et al., 1993; Feldman, 1993, Cantwell, 1991).

dustrial districts, technology pools, regional systems of innovations and other similar local forums reveal first of all the innovation inducing effects of physical proximity: the fact that this circumscribe the opportunities of sharing a certain cultural and entrepreneurial climate instead pertains to technonationality, and will be therefore discussed later (Brusco, 1982; Beccattini & Rullani, 1996; Cooke et al., 1996)¹².

2.2 Techno-sovereignty

Techno-sovereignty is apparently the most state-concerned component of the taxonomy. Within the nationalism/globalism debate its relevance is twofold as it regards, on the one hand, the balance between national, super-national and sub-national public governance structures engaged in innovation; on the other hand, the scope and the objectives of national and super-national S&T policies.

The former argument is put forward by some international political scientists, who claim that the dissolution of the nation-states into super-national players would be an established global phenomenon¹³. That this hypothesis should be retained very carefully when technology is concerned follows from two quite simple and general considerations. On the one hand, international organizations with decisional power and responsibility for technological questions are often made up of central governments representatives which inevitably express, more or less formally, national needs and interests: accordingly, national innovative institutions do not simply fuse into international ones, and the latter, in turn, often contribute to differentiate the former in a co-evolutive process¹⁴. On the other hand, any attempt at harmonizing the innovative institutional framework at international level, in terms of standards, rules and norms, seems to accentuate, rather than smoothing, the differences between positions and arguments that are conveyed by central

¹²Within such a techno-territorial approach, national and local characterizations are not necessarily contradictory. Although the dominant position in recognizing the relevance of a Dahmenian/Schumpeterian mesoperspective claims a diminishing role of the national context (Paquet, 1996; Storper, 1992, 1993), techno-territoriality helps to understand both the organization of the national context in different local environments, and the nation-specific variety of their relative extension, dimension, internal and external relationships.

¹³See, for example, de la Mothe & Paquet (1996) and Ohmae (1990).

¹⁴Caracostas & Soete (1997) provide several examples of this kind of phenomenon at European level and therefore opt for the significative expression of post-national, rather than super-national innovative institutions.

governments¹⁵. Also the opposite interpretation of a dispersive revolution, which would have dissolved national governance structures into sub-national ones (de la Mothe & Paquet, 1994), should not be taken for granted in evaluating the actual scope of techno-sovereignty. In spite of the present boost to federal systems (Osborne & Gaebler 1992; Davidow & Malone, 1992), the financial and administrative autonomy of the region-states and of other local units in undertaking innovations remains a country-specific and country dependent factor¹⁶.

Coming to the second techno-sovereignty issue, that of S&T policies, two distinct questions should be considered within it. The former refers to the scope that techno-globalism leaves to national S&T policies, the latter concerns the role of S&T policies in facing some undesirable implications of techno-globalism. These two aspects are strictly interdependent: the same international pressures that make it increasingly complex to identify independent national objectives, have also made national policies increasingly necessary for adapting to the resulting new world order¹⁷.

At the outset it should be observed that, although the recent wave of international integration has enlarged the constraint set of the policy makers, the ensuing global (or rather super-national) agreements are not perfect substitutes for national policies. On the contrary, national S&T policies play an important role of co-ordination and often also fill the gaps left by super-national arrangements: in some areas multilateral interventions are less justified than unilateral ones, while in some others they reveal ineffective, as they are not co-ordinated with auxiliary national policies, or even inefficient, as they inaccurately target specific areas where effort duplications with national actors easily occur¹⁸. National S&T policies are also more sub-

¹⁵The case of quality standards is a significant example in this last respect (Barker, 1994). The argument is much more apparent when innovative statistics are considered: particularly explicative is the case of innovations in services (Young, 1996).

¹⁶Cooke et al. (1996) qualify this autonomy as a necessary, although still not sufficient condition for the existence of what they call regional systems of innovation. They provide several examples in which a productive and innovative socio-cultural local base (regionalism approach) is not assisted by the necessary institutional-infrastructure elements (regionalisation approach).

¹⁷This phenomenon has been in general called the contemporary paradox of national policy making (Kozul-Wright, 1995, p.166).

¹⁸This is what emerges, for example, from a critical review carried out by Soete (1994) about the diffusion of innovation in SME in Europe: the creation of EC structural funds without the parallel development of local capabilities, and the support guaranteed to pre-

stantially complementary to the internationalization process, as countries need to constitute a sound absorptive capacity (Cohen & Levinthal, 1989) to benefit from its potential positive effects¹⁹.

The consideration of the global-effects naturally leads to the second argument, that of the policies of defensive nature: as globalization has stimulated the creation of perpetuating, oligopolistic supply structures (Walsh, 1987; Cantwell, 1989; OECD, 1992, Ch.10), suitable national policies are called for in order to face the upsurge of an unbalanced process of international development. Although the question of their most suitable and actual specifications is still open²⁰, there seems to be a certain agreement on the fact that national policies, and S&T policies in particular, should look for a sensible form of cohabitation with MNCs (Chesnais, 1992; Soete, 1994; Michie & Smith, 1995). This does not simply mean picking-up and orienting locally the right MNCs by providing them *ad-hoc* externalities (Dunning, 1991), but rather relying on more substantial national interventions, for example by strengthening the links between finance and industry, or by upgrading the domestic economic activity and its autonomous technological capacity (Chesnais, 1992, pp.194-195): also in a defensive kind of strategy, national absorptive capacity questions are therefore of great relevance.

A final remark is due to about the relationship between techno-sovereignty and the sector-specific characterisation of technology (Malerba & Orsenigo, 1995; Breschi & Malerba, 1997)²¹. Focusing on national technological capacities would be therefore an imprecise policy perspective. It would instead be more appropriate to refer to different sectoral technology-support-systems (Metcalf, 1995), as different technologies are promoted by different accumulation systems, also across different countries, so that a super-national perspective is simultaneously involved. The clash between the latter sectoral

competitive R&D within already integrated R&D systems are two areas where the need of a complementary approach is pointed out.

¹⁹This idea of a national absorptive capacity is discussed and illustrated through several examples by Mowery & Oxley (1995), especially with respect to the massive wave of technology transfers which characterize the globalization process and to countries at an early stage of development (Dahlman & Brimble, 1990; Nelson, 1993).

²⁰For an overview of the main positions see in particular Kozul-Wright (1995) and Panic (1993).

²¹The underlying idea is that of technological regime, originally developed by Winter (1984), according to which technologies differ in their opportunity and appropriability conditions, and in the cumulativeness, nature and means of transmission of the relevant knowledge. See also Nelson & Winter (1982).

and supranational specifications, on the one hand, and the national one discussed above, on the other hand, is however only apparent, and it can be solved when one only recognizes that technology policies can be addressed to different issues (Metcalf, 1995, p.38). In general terms, technology policy can focus on technology as such, that is on the content of a certain innovation, or on different stages of the innovation process, and in this latter respect the technology-support-system argument indeed holds. But technology policy can also focus on those institutions that develop and support technology, and in this case the national specification of techno-sovereignty holds as well, possibly to the above mentioned arguments.

2.3 Techno-citizenship

Techno-citizenship is here meant broadly and refers to the actual degree of accountability of the goals, strategies, and performances of the innovative agents to those of the countries of their formal belonging²².

Although in principle relevant for all the organizations with a certain degree of international openness, the question is particularly important in dealing with MNCs, the most apparent example of an organization involved in the economy and in the institutional setting of different countries. In this last respect, the strategic relationships between the parent and the affiliate companies can be retained a proxy of the entailed techno-citizenship: the role attributed to the different business units of a MNC, along with their relationships, can be in fact maintained as the organisational acknowledgment of the relevance of differentiated national contexts in providing technological and managerial resources and significant innovation opportunities. Organization and management business studies with a global concern are therefore extremely pertinent in disentangling the actual specification of this techno-component.

In the relevant literature²³ at least three configurations have been identified and applied to the analysis of multinational technological activities (Bartlett & Ghoshal, 1989; 1990). Given their implications for the present

²²The citizenship of inventors and scientists, or the statutory reference of firms and other innovative organizations to their establishment locus, or again the juridical status of their stakeholders, management or members, are not greatly affected by globalization. For this reason, rather than on formal citizenship the focus is on its different country-specific characterizations, and on its different relationships with the correspondent nationality.

²³For a critical survey see, for example, Grandinetti & Rullani (1996, Ch.4).

issue it is useful to briefly restate their basic features.

In the first model (*multidomestic model*), the foreign activities are run by independent firms, to which the parent company decentralizes resources, responsibilities and decisional power, relying on external controls rather than on more integrated communicative forms. The inherent technological strategy is local-for-local, as reactivity and flexibility to local instances are the most important strategic competence: accordingly, those MNCs operating with this model can be said to have a multiple and dispersed kind of techno-citizenship.

In the second model (*global model*), the foreign activities are considered as mere logistic appendices of the parent company, which retains central resources and decisional power, and exerts a strict formal control over the affiliates. The typical strategy is centre-for-global, with the exploitation of global economies of scale as the ideal strategic competence: the relative MNCs have therefore a unique, central techno-citizenship, that of their base-country.

Finally, the third model (*international model*) is in fact a weaker version of the second in which resources, responsibilities and decisional power are transferred to the foreign activities to make of them intelligent contributors to the learning capabilities of the centre, while the relative controls are formally planned but less strict. Given the functional role of the affiliates, the matching strategy is local-for-global: however, the MNCs of this model have a global, rather than a central citizenship, as both the affiliates and the parent company are equally important - although only through a unidirectional centre-periphery transfer - for the entailed strategic competence, that is developing a world-wide learning capacity.

Which of these and possibly other forms of techno-citizenship MNCs are more prone to assume facing the recent techno-global wave is not yet an established result. On the one hand, following those who have argued for the current convergence towards an integrated international production system (Doz, 1986; Dunning, 1992), the dominant specification would be global²⁴. On the other hand, some other scholars (Bartlett & Ghoshal, 1990) claim that more respondent to the new international order would be a further model, which refers to more strategic competencies simultaneously, and with poses greater emphasis on international learning capabilities. According to this

²⁴The relevant model would therefore be one which determines a co-ordinated federation, rather than an extremely decentralized federation or a centralized control (Grandinetti & Rullani, 1996, Ch.4)

fourth (*transnational*) model, the parent company does not centralize or decentralize once and for all, but rather diversifies its conduct among the foreign activities, integrating them in an internal network, characterised by diffused co-operative relationships. In turn, the selective differentiation between the business units depends only partially on the resources and competencies of which they are provided within the network, but also, and especially, on the national context where they operate, and on its role within the international chain of value: in this respect, a further multiple specification of techno-citizenship, this time more genuinely national, rather than dispersed, would be the most suitable to the present global scenario.

Although the last argument looks the most prominent, equally plausible is the hypothesis according to which there wouldn't be a unique, dominant form of techno-citizenship, while all the above mentioned (and other) configurations would be potentially relevant and selected according to specific considerations²⁵.

These are the main elements of the argument with respect to MNCs. Techno-citizenship has been much less debated in the case of national firms, governments and other public institutions (mainly universities and research institutes) that, although retaining a national formal citizenship, are more and more involved in international innovative partnerships, joint-ventures and co-operative agreements. Although this kind of collaboration, aimed at sharing and transferring know-how between national and foreign partners, might be thought as functional to a knowledge augmenting, global strategy, national references are apparent both in the public and in the business sphere.

As for the former case, although governments and public institutions are usually deemed to be more prone to disclose their innovative results, it is also true that they often compete to achieve the leadership in some fields of science and technology, especially in those which have a strategic value²⁶. Moreover, in general terms, as these institutions are constituent parts of the state apparatus, they are inevitably more accountable to their actual citizens than firms that are owned by a capital that is often internationally dispersed.

As for national firms, and other non public organizations, the argument of a multiple, national techno-citizenship holds again when the recent ten-

²⁵In this direction moves, for example, that recent strand of empirical literature that tries to link the MNC model of specializations with the comparative advantages of the home and the foreign countries (Cantwell, 1993; 1995; Cantwell & Sanna-Randaccio, 1992).

²⁶This is of course the case of knowledge and technologies with direct military applications (Pianta, 1988).

dency of establishing co-operative, external networks is considered (Ghoshal & Bartlett, 1990). In such cases, it is the identity of the partners, along with the main determinants of the collaboration that provides some hints to establish which form of techno-citizenship is the most consistent with the present patterns of internationalization. In this respect, a recent body of research on newly provided databases (Hagedoorn & Schakenraad, 1990; 1993) seems not to favour the hypothesis of global techno-citizenship (Archibugi & Michie, 1995).

2.4 Techno-nationality

Following a broad interpretation, this component refers to the technological relevance of the cohesion typically provided by a common nationality, but also granted by other less formal and more peculiar sharing situations of the same kind (communality of knowledge, culture and ideology) between the innovative agents²⁷.

Focusing on techno-economic aspects, at least two sets of issues fall under the present heading.

First of all, as the kind of communality to which it refers gets forged and evolves during quite long times, dealing with techno-nationality entails that history matters. Innovative processes and outcomes can be traced back to the history of their main actors and institutions, inducing phenomena of what has been called by technology historians path-dependence and lock-inness (Arthur, 1989; David, 1985). Secondly, as the same kind of common background is conducive of socio-economic relationships that are extremely important for the innovative process, techno-nationality also refers to what technology sociologists have called the social-shaping of technology (Bijker et al., 1987). In both these respects innovation comes to be interpreted broadly, as a process that involve institutions that not only do, but also support and permit innovation, while the interactions among them are as much important as their singular behaviour: in other words, in terms of innovation-systems.

As for the former techno-national aspect, that innovative systems establish and evolve under a contingent and local set of techno-economic cir-

²⁷The narrow interpretation that innovative agents of different formal nationalities reveal different technological capabilities entails a genetic, exogenous approach that has been questioned in political sciences (see, for example, Mises, 1919) and that is not very appropriate in any endogenous explanation of technological idiosyncrasies.

cumstances is largely documented. In general terms, the constitution of the modern nation-states, and in particular the solutions given to their external and internal conflicts, have spurred the perception of different national innovative priorities. Also the implementation of specific innovative structures, such as R&D departments, and the achievement of specific innovative performances is strongly historically rooted²⁸. To be sure, one has also to recognize that history is made up of emulation (catching-up) of other external contexts that are deemed superior, and of absolute and relative convergence towards the world frontier²⁹. However, even in those cases in which they reveal successful, such attempts usually call for a certain degree of adaptation to a historically rooted national context (Abromovitz, 1989).

As for the latter aspect, that of the social shaping of technology, its techno-national relevance is manifold as different are the variants it encompasses (Williams & Edge, 1996).

First of all, techno-nationality seems to show its natural, national specification when the reference is to the social construction variant (Pinch & Bijker, 1984; Bijker et al. 1987). The relevant social groups of potential users (Pinch & Bijker, 1984, p.414) that, according to this strand of literature, shape fundamentally the choice of a certain technological configuration, among a set of alternatives, are first of all located in a historically formed context which models their interrelationships with the technologies they face (Russel, 1986, p.334-335): in other words, the social-milieu of those groups which close situations of interpretative flexibility has also a national configuration.

A different specification seems instead to fit the labour process variant of the social shaping literature. This approach focuses on the relationships and power structures that characterise different industrial organizations and investigates their influence in stimulating or hampering evolving productive technologies (Braverman, 1974; Wood, 1982). As strictly organisational questions, such as, for example, the technological performances of the capitalistic workplace, are mainly considered, (techno) national elements are not maintained to convey significant elements of differentiation.

²⁸For an extended discussion of these nation specific technological histories see the classical book of Landes (1969) and Part I of the most recent edition of Freeman & Soete (1997). For more specific cases, see also Freeman (1987; 1992; 1995).

²⁹Several examples of national institutional convergence are provided in Nelson (1993). See in particular the discussion of the catch-up of the United States and Germany with respect to the United Kingdom (Walker, 1993).

The social shaping of technology reveals a more direct connection with techno-nationality in a third, wider variant that explicitly considers the broader institutional context that characterizes a society's technology ensemble (Russel and Williams, 1988, p.11)³⁰. Several aspects are addressed within this strand, and at least three are worthwhile mentioning in their techno-national specifications: the intrinsic shaping function of institutions; their cognitive role; and the institutional nature of the market.

The first point is a typical argument of the institutional theory³¹, according to which institutions and organizations, in particular those involved in innovation, have two peculiar features: on the one hand, they do not rise in a vacuum, being shaped by the presence of a cultural, possibly national, environment (North, 1990); on the other hand, they do not reduce to constraints, but are also enablers, as they mould the preferences and the choice set of the economic (innovative) agents (Edquist & Johnson, 1997). These arguments have recently inspired the debate on the existence of different models of capitalism (Albert, 1991; Dore, 1992), a great part of which is devoted to their technological implications, as revealed by the idea of different national systems of innovation, discussed later³².

As for the second point, recognizing that institutions have a cognitive dimension is also related to the cultural homogeneity caught by techno-nationality. The basic argument is quite simple: given that information collecting and elaborating abilities are limited, individuals (and more innovators-entrepreneurs) must resort in their perception and processing activities to established cognitive frameworks (Hodgson, 1988, p.119). As they are learnt and acquired from specific social surroundings and national cultures, these

³⁰The reference is here to those scholars who adopted such a broad perspective in dealing with technology policy issues and to those who adhered to the recent neo-Schumpeterian and evolutionary approach to innovation.

³¹More precisely, the reference is here to those contributions which are inspired by the old, Veblenian, rather than by the new, Williamsonian institutionalism. For a detailed discussion of this issue see Hodgson (1988, 1993).

³²The core hypothesis of this debate is that the advent of capitalism in culturally differentiated contexts would have implied different specifications of a set of fundamental socio-economic values and ideologies (such as, for example, solidarity, participation, short-termism, speculation, etc.); the latter, in turn, would have shaped the internal organizational styles, the external institutional connections, the objectives and the performances of the relevant productive, financial, educational and also innovative organizations. For a specific illustration of the technological implications of the debate see Leoncini & Montresor (1998).

cognitive frameworks end up to be highly differentiated and induce also different cultural styles of technical problem solutions (Farmer & Matthews, 1991, p.108).

Finally, coming to the third point, considering the market as a social institution, and not as an institution-free state of the nature (Dosi, 1988; Hodgson, 1988; Lowry, 1976), makes the economic shaping of technology one of the relevant forms of social shaping. The idea here is that the dominating set of formal and informal social rules affects the economic calculus undertaken in implementing any economic decision, and *a fortiori*, that related to the introduction and diffusion of an innovation. Although a cost-benefit analysis of particular design decisions and technical choices has to be undertaken in all societies, the form taken by this reckoning is extremely variable, mainly because of those kinds of socio-cultural and socio-political aspects addressed by techno-nationality (MacKenzie & Wajcman, 1985, p.15).

3 Techno-nationalism and national systems of innovation

The concept of system of innovation has become quite standard in the economics of technological change, as it is recognised that the innovative process does not follow a linear, isolated path, but rather occurs within specific institutional contexts of interactive relationships between different organizations (Edquist, 1997). Less clear is which is the most relevant specification of its boundaries: techno-globalism has put the national specification, the first to be proposed (Freeman, 1988; Nelson, 1988; Lundvall, 1988) under discussion, and spurred other super-national and sub-national specifications (Edquist, 1997a). The reference to the framework discussed above might be of some help in clarifying this issue.

Although the concept of NSI has originated with an empirical concern³³, and lacks an unambiguous definition and a coherent general theory³⁴, a

³³This and other similar concepts refer to what has been called an appreciative kind of theorizing, distinct from a formal one because of its empirical concern (Nelson & Winter, 1982).

³⁴For a discussion of the origin of the notion see Freeman (1987, 1988, 1995). For an analysis of its several variants see McKelvey (1991) and Humbert (1994). For a wide set of empirical applications of the same concept see Nelson (1993) and Cohendet et al. (1992). For some more recent developments see Patel & Pavitt (1994) and Edquist (1997).

strictly theoretical treatment of the topic is provided within Part I of the book edited by Lundvall (1992), to which it is convenient to refer also for a discussion of its national domain.

First of all, the main distinction of the present paper is explicitly stated among the premises: a national dimension, defined by cultural, ethnical and linguistic characteristics (i.e. techno-nationality), is actually opposed to an *étatist*-political one, defined by one single geographical space controlled by one central state authority (i.e. techno-territoriality and techno-sovereignty) (Lundvall, 1992a, p.2). Although the latter is also discussed in several places of the book, the dimension which receives more attention within the three bits which constitute the theoretical foundation of the notion (correspondent to Chapters 2, 3 and 4) is for sure the former.

The first bit of the NSI theoretical construction recognizes two basic facts discussed above (Johnson, 1992). On the one hand, institutions shape innovation by allowing those forms of human interaction on which learning (by-interacting) is mainly based³⁵. On the other hand, the prevailing economic structure and productive relationships affect that more isolated learning (by-doing or by-using) which emanates from routine activities. Both the institutional set-up and the production structure are in turn highly diversified, at different levels, and this explains different forms of learning and innovation: their typical organizations have different internal structures (first order diversity), different routine generation and selection mechanisms (second order diversity), and, overall, operate within different nation specific forms of cultures and ideologies:

As long as we can identify *national cultures*, we should expect national differences in production and innovation. Culture makes nations with the same kind of economic system [...] different from each other, and cultural systems are governed by rules and rules about rules, including rules for breaking and changing rules. [...] Many of the rules supporting production differ between countries and since communication within a common culture is easier than between different cultures, we should expect the differences between national cultures to have considerable staying power. *National ideologies* may also be important. [...] (A) nation often has

³⁵This holds to a different extent, depending on its goal orientation: in this respect learning is actually different from searching and exploring.

a rather stable, common ideology. [...] (T)here are ideological differences between nations [...]. Such national ideologies influence communication, interaction and learning at all levels of society. (Johnson, 1992, p.39, original emphasis).

The second bit of the NSI theoretical foundation follows up the previous one and deals more specifically with innovative user-producer relationships (Lundvall, 1992b). The issue is deemed crucial as innovations, specifically product innovations, entail such a degree of uncertainty and of asymmetric information between producers and users to call for organised markets, in turn relying on durable and selective relationships between professional innovative units³⁶. These organised markets are (techno) national at least in two respects.

First of all, techno-nationality is regarded as an essential producer-user distance, as the cultural space becomes progressively more important with respect to others (i.e. economic, organisational and geographical) in moving from a quite stationary to a highly innovative environment³⁷.

Complex and ever changing messages, combining explicit information with tacit assumptions regarding mutual obligations, will often be required in interactions involving innovative activities. Here cultural differences between user and producer may block the interaction.

This is one reason why nations still play an important role, as economic entities, with a relative autonomy. (Lundvall, 1992b, p.56) .

A second techno-national argument follows from the theoretical assumption that user-production interactions within organised markets can't occur between fully opportunistic agents (Williamson, 1975), as this would otherwise rise prohibitive transaction costs inducing complete vertical integration. User-producer relationships are instead often inspired by co-operation and

³⁶Organized markets are considered intermediate between pure markets and vertically integrated relationships, conducive of, respectively, stationary technology (or at best process innovations), and radical change (or even technological revolutions).

³⁷These different kinds of distance affect the character of the resulting technological change, on a scale that ranges from stationary technology to technological revolutions, passing through incremental and radical innovations (Freeman & Perez, 1988).

other social agreements and values (such as, for example, loyalty, mutual trust, respect, etc.) which are different among nations, inducing different forms of cultural based rationality (Kornai, 1971; Allen, 1988; Lester & Crocker, 1987). This is, in turn, responsible for a different impact of the transaction costs sustained in innovating and for a more or less developed learning capability:

There are several (other) documented, interesting, international differences between agents which are rooted in national social norms and culture. The time horizon might be short or long term, and their attention might be directed towards either financial variables or use-value aspects of production. [...] In the real world, the dominance of either honesty or opportunism at the national level will reflect historical, and perhaps even an heritage from pre-capitalist developments. (Lundvall, 1992b, p. 61-62)³⁸.

The last bit of the NSI theoretical construction specifically refers to the structure of production and of productive linkages (Andersen, 1992) in affecting both unintentional and deliberate innovative activities. Also here national specifications are extremely relevant, with a meaning that keeps referring to techno-nationality both with respect to simple (by-doing and by-using) and interacting learning.

First of all, simple learning takes place within a search (and selection) space (Nelson & Winter, 1982, p.229) that entails stochastic outcomes and path-dependence for the involved firms, as suggested by the evolutionary theory, but whose topology is also affected by the relative aggregate production structure, as from the classical Arrow argument. The synthesis of these two approaches mainly explains sector-specific diversities among firms which hold across different countries. However, another kind of localized learning and lock-in-ness can be figured out which is more related to techno-nationality:

By localised we mean national and more or less industry-specific. This kind of localised search may help to conserve national idiosyncrasies in the pattern of specialisation. In this case we are

³⁸The argument also holds when international user-producer relationships, involving heterogeneous rationality specifications, are considered: a variety of solutions for some important questions about techno-globalism (such as, for example, the role of MNCs, of SMEs, of standardization, etc.) follow accordingly.

not dealing with a global lock-in-ness into specific technology (as discussed by David [...] and Arthur [...]) but with a lock-in of national firms/industries due to, for example asset specificity and the difficulties of entering well-established industries where an especially huge amount of tacit knowledge becomes a major barrier to entry. (Andersen, 1992, p.80-81).

Secondly, national systems of production and techno-nationality intertwine also when production-dependent interactive learning is considered. Following again a structuralist-evolutionary synthesis, seller-buyer relationships are locked-in in flexible, footloose specifications only as long as products are fully standardized, while they shift to a more structural, informal and information-intensive, typically techno-national interface when a proto-commodity is introduced and gradually transformed into a well defined commodity :

The relevance of intranational (and techno-national) relationships in the early stages of the commodification process is therefore at least threefold:

[...] (1) (S)emi-formal and informal information [...] transfer is not as strongly filtered and disturbed in intranational as in international channels. (2) [...] The creation of new channels of the innovative type is easiest between members of a national production system [...]. (3) [...] Differences with respect to the character and amount of national linkages between producers and lead-users lead to differences in the overall competitiveness of nations [...]. (Andersen, 1992, p.85)³⁹.

From all these briefly sketched theoretical arguments⁴⁰ it clearly turns out that the national specification of the national system of innovation is closely related (as in the case of the production and productive linkages argument), and sometimes even coincident (as in the case of institutional learning), with that particular component that has been previously identified with the term of techno-nationality.

³⁹The list is only a sub-sample of the original one compiled by Andersen, so that the numeration has been fitted accordingly.

⁴⁰Although the reference is to Lundvall's user-producer approach, similar insights can be also drawn from Nelson & Rosenberg (1993).

On the other hand, this is also true for many pieces of empirical work which try to disentangle the actual specification of the main sub-systems within a system of innovation: studies on management systems and work organization principles, either arguing for the intra- firm transposition of different national cultural values (Kogut, 1991; Hofstede, 1980), or for the globalizing effect of organisational learning (Johnson & Lundvall, 1992); studies on inter firm networking, either pointing to different national industrial structures (Hakansson, 1989), or recognizing their regional structure (Brusco, 1982; Russo, 1985); studies on financial systems, either stressing different socio-cultural styles of innovation financing (Tylecote & Demirag, 1991; Zysman, 1983; Christensen, 1991), or suggesting the advent of a full financial globalization (Franks & Mayer, 1990; Zysman, 1990); studies on pure technological leadership and catching-up between nations, either highlighting the role of nation-specific institutions (Freeman, 1992) social capabilities (Abramovitz, 1989) and skills formation process (Ashton & Green, 1996, Ch. 5,6, and 7), or addressing the scope of globalizing technologies and worldwide institutions⁴¹. Although more specific conclusions are obviously dependent on the precise issue, in general terms the former techno-national option seems to prevail on the latter techno-global one, so that it is plausible to conclude that techno-national systems of innovation still matter.

4 Conclusions

Extending the political sciences distinction between nation and state, in this paper four dimensions have been identified to deal with globalization in technology (i.e. techno-globalism): techno-territoriality, techno-sovereignty, techno-citizenship and techno-nationality as such.

By allocating the results of some representative contributions on technology and globalization to the most pertinent heading of this taxonomy, and trying to establish accordingly their global, national or sub-national specification, interesting results have emerged.

⁴¹The above referred sub-systems are those discussed in the second part of Lundvall's book (1992, Part II: A Closer Look at National Systems of Innovation), with two notable exceptions: the omission of Chapter 7, dealing with the pacemaker role of the public sector, which better fits the techno-sovereignty component; the inclusion of the educational and training sub-system, highly shaped by techno-national considerations and not included in Lundvall (1992) for scope constraints.

First of all, apart from techno-nationality, all the elements of the taxonomy do not admit a unique specification. As for techno-territoriality, the need of a certain geographical proximity, and thus the relevance of a local specification (either national or sub-national), is the more plausible, the more crucial is the role of tacit and implicit knowledge, while the same component has a global specification in multinational contexts, where explicit knowledge dominates. As for techno-sovereignty, national specifications dominate in those sectors that are more related to the security, to the competitiveness, and to the technological idiosyncrasies of one country, while global specifications are not purely substitutive for the national, but leave to national governmental structures the scope for supporting and accommodating their implementation. Finally, in dealing with techno-citizenship, global (or central) and dispersed (or local) specifications are two opposite, extreme strategies which fit a scenario where production is the most internationally integrated economic activity. A national specification however prevails once one recognizes the present dominance of an international division of the cognitive work within which the international chain of knowledge is the main strategic rationale.

Quite different conclusions hold for techno-nationality, whose natural, national specification is confirmed by looking at several aspects: the role of history and of institutional shaping in forming different innovation systems, the national underpinning of the social construction of technology, the cultural base of the cognitive role of institutions, and the institutional nature of the market. Indeed, this is the unique component of the taxonomy whose specification is quite unambiguous.

In trying to determine which of the identified techno-components is the most implicit in the notion of national system of innovation, techno-nationalism has emerged as another important element, along with techno-sovereignty: such questions as institutional learning, innovative producer-user relationships and productive (linkages) structure, that is the three interrelated building blocks of the most articulated theoretical construction of the concept (Freeman, 1994), along with several related pieces of empirical evidence, actually convey different elements of techno-nationality, either directly or indirectly.

References

- [1] Abramovitz, M. (1989), *Thinking about growth*, Cambridge, Cambridge University Press.
- [2] Albert, M. (1991), *Capitalisme contre capitalisme*, Paris, Editions du Seuil.
- [3] Allen, P. (1988), Evolution, innovation and economics, in Dosi, G. et al. (eds.), *Technical Change and Economic Theory*, London, Pinter Publishers, pp. 95-119.
- [4] Andersen, E.S. (1992) Approaching national systems of innovation, in Lundvall, B.A. (ed.), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers, pp. 68-92.
- [5] Archibugi, D. & Michie, J. (1995), The globalisation of technology: a new taxonomy, *Cambridge Journal of Economics*, vol. 19, pp. 121-140.
- [6] Archibugi, D. & Michie, J. (1997), Technological globalisation and national systems of innovation: an introduction, in Archibugi, D. & Michie, J. (eds.), *Technology, Globalisation and Economics*, Cambridge, Cambridge University Press, pp. 1-23.
- [7] Arthur, B.W. (1989), Competing technologies, increasing returns, and lock-in by historical events, *Economic Journal*, vol.99, pp. 116-131.
- [8] Ashton, D. & Green, F. (1996), *Education, Training and the Global Economy*, Aldershot, Edward Elgar.
- [9] Barker, B. (ed.), *Quality Promotion in Europe*, Aldershot, Gower Publishing.
- [10] Bartlett, C.A. & Ghoshal, S. (1989), *Managing across Borders: The Transnational Solution*, Boston, Harvard Business School.
- [11] Bartlett, C.A. & Ghoshal, S. (1990), Managing Innovation in Transnational Corporations, in Bartlett, C.A., Doz, Y. & Hedlund, G. (eds.), *Managing the Global Firm*, London, Routledge, pp. 215-55.

- [12] Beccattini, G. & Rullani, E. (1996), Local systems and global connections: the role of knowledge, in Cossentino, F., Pyke, F, & Sengenberger, W. (eds.), *Local and Regional Response to Global Pressure: the Case of Italy and its Industrial Districts*, Geneva, International Institute for Labour Studies, pp. 159-174.
- [13] Berger, S. & Dore, R. (eds.) (1996), *National Diversity and Global Capitalism*, Ithaca, Cornell University Press.
- [14] Bijker, W., Hughes, T. & Pinch, T. (eds.) (1987), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, MA, MIT Press.
- [15] Bijker, W. & Law, J. (eds.) (1992), *Shaping Technology/Building Society: Studies in Socio-technical Change*, Cambridge (MA), MIT Press.
- [16] Boyer, R. & Drache, D. (eds.) (1996), *State Against Markets: the Limits of Globalization*, London, Routledge.
- [17] Braverman, H. (1974), *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century*, New York, Monthly Review Press.
- [18] Breschi, S. e Malerba, F. (1997), Sectoral innovation systems: technological regimes, Schumpeterian dynamics, and spatial boundaries, in Edquist, C. (eds.), *Systems of Innovation. Technologies, Institutions and Organisations*, London, Pinter Publishers, pp.130-156.
- [19] Brusco, S. (1982), The Emilian model: productive decentralisation and social integration, *Cambridge Journal of Economics*, vol.6, pp.167-184.
- [20] Cantwell, J.A. (1989), *Technological Innovation and Multinational Corporations*, Oxford, Blackwell.
- [21] Cantwell, J.A. (1991), The international agglomeration of R&D, in Casson, M.C. (ed.), *Global Research Strategy and International Competitiveness*, Oxford, Basil Blackwell, pp. 104-132.
- [22] Cantwell, J.A. (1993), Corporate technological specialisation in international industries, in Casson, M.C. & Creedy, J. (eds.), *Industrial Concentration and Economic Inequality*, Aldershot, Edward Elgar.

- [23] Cantwell, J.A. (1995), The globalisation of technology: what remains of the product cycle model?, *Cambridge Journal of Economics*, vol. 19, pp. 155-174.
- [24] Cantwell, J.A. & Sanna-Randaccio, F. (1992), Intra-industry direct investment in the European Community: oligopolistic rivalry and technological competition, in Cantwell, J.A. (ed.), *Multinational Investment in Modern Europe*, Aldershot, Edward Elgar, pp. 71-106.
- [25] Caracostas, P. & Soete, L. (1997), The building of cross-border institutions in Europe: towards a European system of innovation, in Edquist, C. (eds.), *Systems of Innovation. Technologies, Institutions and Organisations*, London, Pinter Publishers, pp.395-419.
- [26] Chesnais, F. (1988), Technical co-operation agreements between firms, *STI Review*, vol.4, pp. 51-119.
- [27] Chesnais, F. (1992), National systems of innovation, foreign direct investment and the operations of multinational enterprises, in Lundvall, B.A. (ed.), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers, pp. 265-295.
- [28] Christensen, J. (1991), Financial systems, internationalization and corporate finance, Paper for the Conference on EC Business and Integration, Gilleleje 18-30 August.
- [29] Cohen, W.M. & Levinthal, D.A. (1989), Innovation and learning: the two faces of R&D, *Economic Journal*, vol.99, pp. 569-596.
- [30] Cohendet, P., Llerena, P. & Sorge, A. (1992), Technological diversity and coherence in Europe: an analytical overview, *Revue d'Economie Industrielle*, n.59(1), pp. 9-26.
- [31] Cooke, P., Gomez-Uranga, M. e Etxebarria, G. (1997), Regional innovation systems: institutional and organisational dimensions, *Research Policy*, n.26, pp.475-491.
- [32] Dahlman, C.J. & Brimble, P. (1990), Technology strategy and policy for industrial competition: a case study in Thailand, *World Bank Industry and Energy Department Industry Series, Working Paper*, n.24.

- [33] David, P.A. (1985), Clio and the economics of QWERTY, *American Economic Review. Papers and Proceedings*, vol.75, pp. 332-337.
- [34] Davidow, W.H. & Malone, M.S. (1992), *The Virtual Corporation*, New York, HarperBusiness.
- [35] de la Mothe, J. & Paquet, G. (1994), The dispersive revolution, *Optimum*, vol.25, pp. 42-48
- [36] de la Mothe, J. & Paquet, G. (1996), In search of a new international political economy, in de la Mothe, J. & Paquet, G. (eds.), *Evolutionary Economics and the New International Political Economy*, London, Pinter, pp. 35-57.
- [37] Dore, R. (1992), Japanese capitalism, Anglo-Saxon capitalism. How will the Darwinian contest turn out?, *Centre for Economic Performance, Occasional paper*, n.4..
- [38] Dosi, G. (1988), Institutions and markets in a dynamic world, *The Manchester School*, vol.56, pp. 119-146.
- [39] Doz, Y. (1986), *Strategic Management in Multinational Companies*, Oxford, Pergamon.
- [40] Dunning, J.H. (1991), Governments, economic organisations and international competitiveness, in Mattson, L.G. & Stymme, B. (eds.), *Corporate and Industry Strategies for Europe*, Amsterdam, Elsevier Science Publishers.
- [41] Dunning, J.H. (1992), *Multinational Enterprises and the Global Economy*, Wokingham, Addison-Wesley.
- [42] Edquist, C. (eds) (1997), *Systems of Innovation. Technologies, Institutions and Organisations*, London, Pinter Publishers.
- [43] Edquist, C. (1997a), Systems of innovation approaches - their emergence and characteristics, in Edquist, C. (eds.), *Systems of Innovation. Technologies, Institutions and Organisations*, London, Pinter Publishers, pp.1-35.

- [44] Edquist, C. e Johnson, B. (1997), Institutions and organisations in systems of innovation, in Edquist, C. (eds.), *Systems of Innovation. Technologies, Institutions and Organisations*, London, Pinter Publishers, pp.41-63.
- [45] Ergas, H. (1984), Why do some countries innovate more than others?, Centre for European Policy Studies (CEPS), Brussels, Working Paper n.5.
- [46] Farmer, M.K. & Matthews, M.L. (1991), Cultural differences and subjective rationality: where sociology connects with economics of technological choice, in Hodgson, G.M. & Screpanti, E. (eds.), *Rethinking Economics. Markets, Technology and Economic Evolution*, Aldershot, Edward Elgar, pp. 103-115.
- [47] Feldman, M.P. (1993), An examination of the geography of innovation, *Industrial and Corporate Change*, vol.2, 451-470.
- [48] Franks, J. & Mayer, C. (1990), Capital markets and corporate control: a study of France, Germany and the UK, *Economic Policy*, n.10, pp.189-231.
- [49] Freeman, C. (1987), *Technical Change and Economic Performance: Lessons from Japan*, London, Frances Pinter.
- [50] Freeman, C. (1988), Japan: a new national system of innovation?, in Dosi, G. et al. (eds.), *Technical Change and Economic Theory*, London, Pinter Publishers, pp. 330-348.
- [51] Freeman, C. (1992), Formal scientific and technical institutions in the national system of innovation, in Lundvall, B.A. (ed.) *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers, pp. 169-187.
- [52] Freeman, C. (1994), The economics of technical change, *Cambridge Journal of Economics*, vol.18, pp. 463-514.
- [53] Freeman, C. (1995), The National System of Innovation in historical perspective, *Cambridge Journal of Economics*, vol. 19, pp. 5-24.

- [54] Freeman, C. & Perez, C. (1986), Business cycles, long waves, investment behaviour and technological changes, SPRU, mimeo.
- [55] Freeman, C. & Soete, L. (1997), *The Economics of Industrial Innovation* (III Ed.), London, Pinter.
- [56] Goshal, S. & Bartlett, C.A. (1988), Creation, adoption and diffusion of innovations by subsidiaries of multinational corporations, *Journal of International Business Studies*, vol. 19, pp. 365-388.
- [57] Goshal, S. & Bartlett, C.A. (1990), The multinational corporation as an interorganizational network, *Academy of Management Review*, vol. 15, pp. 603-625.
- [58] Grandinetti, R. & Rullani, E. (1996), *Impresa Transnazionale ed Economia Globale*, Rome, NIS.
- [59] Hagedoorn, J. & Schakenraad, J. (1990), Inter- firm partnerships and co-operative strategies in core technologies, in Freeman, C. & Soete, L. (eds.), *New Explorations in the Economics of Technical Change*, London, Pinter, pp. 3-28.
- [60] Hagedoorn, J. & Soete, L. (1991), The internationalisation of science and technology policy: how do national systems cope? in *Science and Technology Policy Research*, National Institute for Science and Technology Policy, Tokyo, Mita Press.
- [61] Hagedoorn, J. & Schakenraad, J. (1993), Strategic technology partnering and international corporate strategies, in Hughes, K. (ed.), *European Competitiveness*, Cambridge, Cambridge University Press, pp. 60-86.
- [62] Hakansson, H. (1989), *Corporate Technological Behaviour - Cooperation and Networks*, London, Routledge.
- [63] Hatzichronoglou, T. (1996), Globalisation and competitiveness: relevant indicators, *STI Working Papers*, 1996/5.
- [64] Hodgson, G.M. (1988), *Economics and Institutions: A Manifesto for a Modern Institutional Economics*, Cambridge, Polity Press.
- [65] Hodgson, G.M. (1993), Institutional economics: surveying the old and the new, *Metroeconomica*, vol.44, pp. 1-28.

- [66] Hofstede, G. (1980), *Culture's Consequences: International Differences in Work Related Values*, Beverly Hills, Sage Publications.
- [67] Howells, J. & Wood, M. (1993), *The Globalisation of Production and Technology*, London, Belhaven Press.
- [68] Hughes, T.P. (1989), The evolution of large technological systems, in Bijker, W., et al. (eds.) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, MA, MIT Press, pp. 51-82.
- [69] Humbert, M. (1994), The globalisation of technology as a challenge for a national innovation system, EAEPE Conference, Copenhagen, 28-30 September.
- [70] Jaffe, A.B. (1989), Real effects of academic research, *American Economic Review*, vol.79, pp. 957-970.
- [71] Jaffe, A.B., Trajtenberg, M. & Henderson, R. (1993), Geographical localization of knowledge spillovers as evidenced by patent citations, *Quarterly Journal of Economics*, vol.108, pp. 577-598.
- [72] Johnson, B. (1992), Institutional learning, in Lundvall, B.A. (ed.), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers, pp. 23-44.
- [73] Johnson, B. & Lundvall, B.A. (1992), Closing the institutional gap?, *Revue d'Economie Industrielle*, n.59(1), pp. 111-123.
- [74] Kogut, B. (1991), Country capabilities and the permeability of borders, *Strategic Management Journal*, vol.12, pp. 33-47.
- [75] Kogut, B. & Zander, U. (1993), Knowledge of the firm and the evolutionary theory of the multinational corporation, *Journal of International Business Studies*, n.4, pp. 625-646.
- [76] Kornai, J. (1971), *Anti-equilibrium*, Amsterdam, North-Holland.
- [77] Kozul-Wright, R. (1995), Transnational Corporations and the Nation State, in Michie, J. & Smith, G.J. (eds.), *Managing the Global Economy*, Oxford, Oxford University Press, pp. 135-171.

- [78] Krugman, P. (1991), *Geography and Trade*, Massachusetts, The MIT University Press.
- [79] Landes, D.S. (1969), *The Unbound Prometheus. Technical Change and Industrial Development in Western Europe from 1750 to Present*, Cambridge, Cambridge University Press.
- [80] Leoncini, R. & Montresor, S. (1998), *Classifying technological systems: an empirical application to 8 OECD countries*, IDSE-CNR, Milan, mimeo.
- [81] Lester, R.K. & Crocker, M.B. (1987), *The economic organisation of nuclear plant projects: some cross-national comparisons*, Centre for Energy Policy Research, MIT.
- [82] Loasby, B.J. (1998), *Knowledge, Institutions and Evolution* (forthcoming).
- [83] Lowry, S.T. (1976), *Bargain and contract theory in law and economics*, *Journal of Economic Issues*, Vol.10, pp. 1-22.
- [84] Lundvall, B.A. (1988), *Innovation as an interactive process: from user-producer interaction to the national system of innovation*, in Dosi, G. et al. (eds.), *Technical Change and Economic Theory*, London, Pinter Publishers, pp. 349-369.
- [85] Lundvall, B.A. (ed.), (1992), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers.
- [86] Lundvall, B.A. (1992a), *National systems of innovation: introduction*, in Lundvall, B.A. (ed.), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers, p. 1-19.
- [87] Lundvall, B.A. (1992b), *User-producer relationships, national systems of innovation and internalisation*, in Lundvall, B.A. (ed.) *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers, pp. 45-67.

- [88] Lundvall, B.A. & Barras, S. (eds.) (1998), *The Globalising Learning Economy. Challenge for Innovation Policy* (Report based on contributions from 7 projects under the TSER Programme), Brussels, DG XII.
- [89] MacKenzie, D. & Wajcman, J. (eds.) (1985), *The Social Shaping of Technology*, Milton Keynes, Open University Press.
- [90] MacKenzie, D. & Spinardi, G. (1994), Tacit knowledge, weapons design, and the uninvention of nuclear weapons, mimeo.
- [91] Malerba, F. & Orsenigo, L. (1995), Schumpeterian patterns of innovation, *Cambridge Journal of Economics*, vol. 19, pp. 47-65.
- [92] McKelvey, M. (1991), How do national systems of innovation differ? A critical analysis of Porter, Freeman, Lundvall and Nelson, in Hodgson, G.M. & Screpanti, E. (eds.), *Rethinking Economics. Markets, Technology and Economic Evolution*, Aldershot, Edward Elgar, pp.117-137.
- [93] Metcalfe, J.S. (1995), Technology systems and technology policy in an evolutionary framework, *Cambridge Journal of Economics*, vol.19, pp. 25-46.
- [94] Michie, J. & Smith, G.J. (eds.), (1995), *Managing the Global Economy*, Oxford, Oxford University Press.
- [95] Mises, L. (1919), *Nation, Staat und Wirtschaft. Beiträge zur Politik und Geschichte der Zeit*, Wien, Manzsche Verlags, translated as *Stato, Nazione ed Economia*, (1994), Turin, Bollati Boringhieri.
- [96] Molina, A. (1989), *The Social Basis of the Microelectronics Revolution*, Edinburgh, Edinburgh University Press.
- [97] Moverly, D.C. & Oxley, J.E. (1995), Inward technology transfer and competitiveness: the role of national innovation systems, *Cambridge Journal of Economics*, vol. 19, pp. 67-93.
- [98] Nelson, R.R. (1988), Institutions supporting technical change in the United States, in Dosi, G. et al. (eds.), *Technical Change and Economic Theory*, London, Pinter Publishers, pp. 312-329.
- [99] Nelson, R.R. (ed.) (1993), *National Innovation Systems. A Comparative Analysis*, Oxford, Oxford University Press.

- [100] Nelson, R. & Winter, S. (1982), *An Evolutionary Theory of Economic Change*, Cambridge (MA), Harvard University Press.
- [101] Nelson, R.R. e Rosenberg, N. (1993), Technical innovation and national systems in Nelson, R.R. (eds.) *National Innovation Systems. A Comparative Analysis*, Oxford, Oxford University Press, pp.3-21.
- [102] North, D.C. (1990), *Institutions, Institutional Change and Economic Performance*, Cambridge, Cambridge University Press.
- [103] OECD, (1992), *Technology and the Economy. The Key Relationships*, Paris, OECD.
- [104] Ohmae, K. (1990), *The Borderless World: Management Lessons in the New Logic of the Global Market Place*, London, Collins.
- [105] Osborne, D. & Gaebler, T. (1992), *Reinventing Government*, New York, Addison-Wesley.
- [106] Panic, M. (1993), The state as an agent of change, paper presented at WIDER conference on the State and Economic Development, University of Cambridge.
- [107] Paquet, G. (1996), Technonationalism and meso innovation systems, PRIME, <http://iir1.uwaterloo.ca/MOTW96/Summer96/GillesPaquet.html>, pp. 1-13.
- [108] Patel, P. (1995), Localised production of technology for global markets, *Cambridge Journal of Economics*, vol. 19, pp. 141-153.
- [109] Patel, P. & Pavitt, K. (1991), Large firms in the production of the world's technology: an important case of non-globalisation, *Journal of International Business Studies*, vol. 22, pp. 1-21.
- [110] Patel, P. & Pavitt, K. (1994), The nature and economic importance of national innovations systems, *STI Review*, n.14, pp. 9-32.
- [111] Pearce, R.D. (1989), *The Internationalisation of Research and Development by Multinational Enterprises*, Houndmills, Macmillan.

- [112] Pianta, M. (1988), Hight technology programmes: for the military or for the economy?, *Bullettin of Peace Proposals*, n.1, pp.53-79.
- [113] Pinch, T. & Bijker, W. (1984), The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might bene t each other, *Social Studies of Science*, vol.14, pp. 399-441.
- [114] Porter, M. (1990), *The Competitive Advantage of Nations*, London, Macmillan.
- [115] Russel, S. (1986), The social construction of artefacts: a response to Pinch and Bijker, *Social Studies of Science*, vol.16, pp. 331-346.
- [116] Russel, S. & Williams, R. (1988), *Opening the black-box and closing behind you: on micro-sociology in the social analysis of technology*, Edinburgh PICT, Working Paper No.3, Edinburgh University.
- [117] Russo, M. (1985), Technical change and the industrial district: the role of inter rm relations in the growth and transformation of ceramic tile production in Italy, *Reserach Policy*, vol.14, pp. 329-343.
- [118] Soete, L. (1994), *European Comparative Innovation Systems*, paper presented at the Transnational Institute on Innovation, Competitiveness and Sustainability, Centre for Policy Reserach on Science and Technology, Whistler, B.C., Simon Fraser University, (<http://edie.cprost.sfu.ca/summer/paper/luc-soete.html>).
- [119] Storper, M. (1992), The limits of globalization: technology districts and international trade, *Economic Geography*, vol.61, pp. 260-282.
- [120] Storper, M. (1993), *Regional worlds of production: learning and innovation in the technology districts of France, Italy and the USA*, *Regional Studies*, vol.27, pp. 433-455.
- [121] Storper, M. (1997), *The Regional World: Territorial Development in a Global Economy*, New York, Guilford.
- [122] Strange, S. (1988), *States and Markets*, London, Pinter Publishers.

- [123] Tylecote, A. & Demirag, I. (1991), Short-termism: culture and structures as factors in technological innovation, Research Project on Performances Pressures and Technological Progress in British Industry, mimeo.
- [124] Walker, W. (1993), National innovation systems: Britain, in Nelson, R.R. (eds.), National Innovation Systems. A Comparative Analysis, Oxford, Oxford University Press, pp. 158-191.
- [125] Walsh, V. (1987), Technology, competitiveness and the special problems of small countries, STI Review, vol.2, pp. 81-133.
- [126] Winter, S.G. (1984) Schumpeterian competition in alternative technological regimes, Journal of Economic Behaviour and Organizations, vol.5, pp.287-320.
- [127] Williams, R. & Edge, D. (1996), The social shaping of technology, Research Policy, vol.25, pp. 865-899.
- [128] Williamson, O.E. (1975), Markets and Hierarchies: Analysis and Anti-trust Implications, New York, The Free Press.
- [129] Wood, S. (ed.) (1982), The Degradation of Work? Skill, Deskilling and the Labour Process, London, Hutchinson.
- [130] Young, A. (1996), Measuring R&D in the services, STI Working Papers, No.1996/7, Paris, OECD.
- [131] Zysman, J. (1983), Governments, Markets and Growth - Financial Systems and the Politics of Industrial Change, Oxford, Martin Robertson.
- [132] Zysman, J. (1990), Trade, technology and national competition, Paper for the OECD Conference, Paris, 24-27 June.