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AN ANALYTICAL FRAMEWORK FOR UNDERSTANDING THE FINNISH NATIONAL SYSTEM OF INNOVATION**

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ABSTRACT: The paper draws on Freeman, and the Aalborg group's concept of national system of innovation (NSI) in order to build a framework upon which the author wants analyse of the Finnish system of innovation. Since the concept follows a neo-Schumpeterian approach of examining innovation and economic development, the framework that is outlined here addresses both historical and theoretical questions.

Thus, it addresses questions regarding the main features of a system of innovation; the main characteristics of innovation and some alternative taxonomies that have been built for it; the on-going changes in techno-economic paradigm; some relevant aspects of information, knowledge and learning under the ICT techno-economic paradigm; and institutions and social capabilities responses which might be necessary to take place if a NSI is to play an active role in the global innovation processes,

The paper also highlights the major elements of each one of the three domains of the FNSI (technological, economic and institutional) which will be taken into consideration in the analysis of the FNSI.

KEYWORDS: systems of innovation, technical change, technological policy.

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1. INTRODUCTION

If one takes List (1856) as the main inspiration for the national system of innovation (NSI) approach,[1] the best beginning towards the understanding of any country's past achievements, present standing and future perspectives in terms of competence building in socio-economic activities, would be to examine

> … its particular language, its literature, its history, its habits, its laws, its institution, its right to existence, to independence, to progress, to a distinct territory; in a word, its personality and all the rights and duties involved. (ibid., p. X).

Thus, a proper way to examine features of the Finnish national system of innovation (FNSI) would be to pay the right tribute to four sources of the country's identity. According to Lehtonen (1999), these would be natural landscape, Sweden and Swedishness; religion; and institutional assimilation into Europe. As for the first feature, Suikkari (1998), indicates that

> …the Finns like to spend their holidays close to nature, surrounded by green forests, blue lakes, and an idyllic countryside. This is where they gather their physical and emotional stamina for future challenges and achievements. (ibid., p.3).

With respect to the other three features, Lehtinen's arguments are as follows:

(i) Sweden and Swedishness: historical accounts have traditionally been dominated by Finland's political and linguistic break from Sweden. Yet the nineteenth-century Finnish writer and historian Zachris Topelius hit the mark when he said that the Finns owed Sweden an original debt for "the church wall, the courtroom desk, and the school bench";

(ii) Religion: the country has been profoundly influenced by the agrarian peasant work ethic, and by Lutheranism, with its stress on the individual's personal responsibility and direct relationship with God. (…) The Evangelical Lutheran Church, which created a vernacular literature and helped to spread literacy, laying the foundation for later social modernisation. Industrialisation was slow to reach the Nordic Countries, but the high level of basic education facilitated their rather abrupt transformation into modern urban societies;

(iii) Institutional assimilation into Europe: if the story of Finland can be told in terms of the country's cultural, national and economic assimilation into Western Europe from the Middle Ages onwards, the key features of this process, particularly from the current perspective, are the formation of an independent national unit and the traumatic internal and external conflicts in the twentieth century. (…) There is more at stake here than just economic realities and political contingencies: the question of Europe strikes at the very heart of Finnish identity.

Even if these features cannot be correctly and exactly measured, their traces can certainly be found in many aspect of the Finnish national system of innovation – FNSI, whose main features I intend to understand by using the framework which is established in the sections that follows this introduction.[2] That is even more so because in here the system will not be restricted to organisations which foster, support and perform innovation and technological development.[3]

Thus in the sections which follow this introduction, I will present some analytical background which I believe will help me to get a closer approximation to the Finnish system's accomplishment. These accomplishments, though, cannot be restricted to some basic statistics on competitiveness, R&D expenditures, introduction of new products etc.

It must be taken beyond those (which doesn't mean that they are nor relevant, much on the contrary) in order to look at the FNSI through the glass of collective entrepreneurship. This is to be understood in the sense of the 'animal spirit' which is not confined to businesspeople but which are also embedded in people and organisations other than those directly responding to the markets (research, education, government, civil society etc.). In order to have a framework to tackle this task, in the next section, this paper will be dealing with the scope and the content of a system of innovation with the spatial dimension of a country.

Section 3 draws on contributions regarding some characteristics of innovation [Orsenico (1989)] and the taxonomies of innovation that Edquist (2001) and Freeman and Perez (1988) propose. The former because he calls special attention to the growing importance of innovations in 'intangibles'. The latter because of their formulation of techno-economic paradigm which emphasises the importance of 'matching' technological possibilities, economic feasibilities and institutional possibilities.

Section 4 touches briefly on alternative ways to look at the changes we have been going through and which don't seem will be through in the short future. Some of the ideas of Castells (2000), Drucker (2001) and Tuomi (2001) are highlighted in order to have a better approximation to the complexities of the task involved in examining the FNSI at times of fast and increasingly uncertain changes.

Section 5 draws on Johnson and Lundvall (2001), Nokada and Takeuchi (1995) and Kuusi (1999) in order to draw attention to a common theme amongst whoever works or thinks about the emerging society / economy; i.e., knowledge (tacit / explicit) and how it can be acquired. The localised features of both knowledge and the learning processes which enhance it, seem a key aspect which strengthens the NSI approach's argument. And that drives to institutions and social capabilities which are the central theme of section 6.

The last section raises some basic issues concerning the need to adopt arbitrariness in the process the elements which will be considered in each one of the three domains of the FNSI, and the establishment of their boundaries. In order to help the reader, on the one hand, to understand better the framework that I will b using for getting closer to a better understanding of the FNSI; and, on the other hand, to address criticisms to the elements I have chosen.

2. A BRIEF LOOK AT THE SYSTEM'S COMPONENTS AND RELATIONS

Following a tradition which began with Freeman (1987) and Andersen and Lundvall (1988) the major concern here is with interactions which take place amongst all important economic, social and political actors and which strengthen their learning and searching capabilities in such a way that enhances the development, diffusion, and use of innovations in a certain nation.

Despite the new framework for these interactions at times of increasing relations at the world scale, the national dimension is highlighted here in order to capture the spatial-institutional reference for interactions geared towards learning processes which lead to innovation and enhances both enterprises' competitiveness and social capabilities. The idea is to capture this sort of interactions between agents within and beyond a country's geographical boundaries [Villaschi (1992)]. Thus, no matter how intense and extensive economic and social relations are taking place world-wide, the idea is to see a national system of innovation encompassing "… elements and relationships, either located within or rooted inside the borders of a nation state." [Lundvall (1992), p. 2][4]

Thus, this perspective stresses the differences in the rates at which countries exploit the possibilities offered by the technological gap which is opened especially at times of changing techno-economic paradigm or technological trajectories[5] [Freeman and Perez (1988)]. These differences are seen as dependent on each country's ability to mobilize political and financial resources for transforming the technological, institutional and economic structures which comprise its NSI.[6].

As it is stressed in the neo-schumpeterian literature, the trajectories emerging from a techno-economic paradigm are seldom 'naturally' driven by endogenous scientific and technological factors. Economic and socio-political factors are very important in shaping trajectories and determining the way a new technological base for world development is unfolded in different countries. A selection process, then, takes place through the interplay of economic, political and social forces, and the localised scientific, technological, innovative and industrial capabilities.

In order to capture the main characteristics of the interplay that takes place at any country's level, a NSI must be seen from two interconnected and, at the same time, opposite angles. The first is that of the 'disequilibrating' content of the forces which interact within it. This is because changes and transformations are by nature non-equilibrating forces. The second angle through which an NSI must be seen is that of the forces that maintain relatively ordered the configurations of the system and allow a broad consistency between the conditions of material reproduction.

Since the economic, social and political actors that comprise a NSI do not respond to one single logic and the different logic's they respond to are not necessarily convergent, the elements of the FNSI highlighted in this paper will be divided into three self-regulated[7] domains (technological, economic and institutional) which operate according to the following hypotheses [Dosi (1984)]:

(i) regardless of the powerful interactions between them, each of the three domains has a dynamics and a content of its own. The specificities of each domain's dynamics and content shape and constrain their individual impact, and the interactions

amongst them, in such a way that their functional feed-backs can make possible either 'virtuous circles' or 'mismatches;

(ii) 'possible worlds' are limited by the number of configurations under which the three domains can operate in a relatively 'well-regulated' and smooth way;

(iii) imbalance or 'mismatches' between the three domains do not necessarily lead to changes to other, more balanced or 'smoother' configurations,

(iv) the adaptability of the technological system to a given economic and social environment is bounded and limited. Conversely, a relatively limited set of macroeconomic conditions and social relations are 'given' at each stage of the 'technological domain'.

Thus, the system is seen here in a way that it responds to basic features posed by Edquist (2001) . Firstly, it consists of two kinds of entities. One the one hand, there are some kinds of components; on the other, there are relations between these components. Secondly, the reason why an array of components (technological, economic and institutional) and relations (especially those which are mediated by the market) are chosen is because there are evidences that they form a whole. Thirdly, these components and relations are chosen in such a way as to make possible to discriminate the system in relation to the rest of the world; i.e. it must be possible to identify the boundaries of the system. That is, at least one actor of the learning, searching, innovating, producing process is within the country's geo-political boundaries).

3. A CLOSER LOOK INTO INNOVATION

For the purpose of this paper, innovation[8] should be looked at from two perspectives: the characteristics of the innovative process and alternative taxonomies of innovation.

As for the former, it is worth mentioning some of the characteristics highlighted by Orsenico (1989):

(i) innovation is an ubiquitous phenomenon which combines aspects of gradual and cumulative changes (the Schumpeterian 'new combinations' content of innovations) with those of radical breaks with the past (the Marxian and Schumpeterian 'creative destruction' content of technological development),

(ii) the *uncertainties* that come along with innovative processes go beyond a simple lack of information concerning both its technical and its commercial outcomes. This is so because in innovative processes occurs also the lack of knowledge of both the precise cost and outcomes of different alternatives and of what the alternatives are[9];

(iii) there is a *plurality of sources* involving the innovation process. At the same time that innovation increasingly relies on the growth of scientific knowledge, it also involves each time more elements of tacit and specific knowledge that are not and cannot be written down in a 'blueprint' form[10];

(iv) the *cumulativeness* element of technological capabilities and partial appropriability which accompany it creates permanent asymmetries between firms and countries in terms of their innovative competencies.

As for taxonomies of innovation, Edquist (2001) points that "In spite of the name – 'the systems of innovation approach' – a lot of the writing within this 'tradition' was initially focussed on *technological* change, and not on *innovation* in a more general sense." (ibid, p. 6). Thus, he suggests that the complex and heterogeneous category of innovation should distinguish between process and product innovation[11].

Process innovation (*how* goods and services are produced), may be technological or organisational. Whilst product innovation (*what* is being produced) may be goods or services[12]. "In this taxonomy, only goods and technological process innovations are innovations of a 'material' kind. Organisational process innovations and services are 'intangible'. It is crucial to take the intangible innovations into account also, since they are increasingly important for economic growth and employment." (ibid., p. 7)[13].

Another taxonomy[14] of innovation is that put forward by Freeman and Perez(1988) which, on the one hand, relates innovations to their impact on the economic structure. On the other, it takes into consideration different combinations of demand pressures and socio-cultural factors which diversely affect the capability of firms, industries and countries to innovate.

Thus they distinguish:

(i) *incremental innovations* which are those innovations whose main economic impact refers to the extension of existing demand and an increase in the value added. They improve the efficiency in the use of all factors of production but are not necessarily related to deliberate research and development activities. They are mainly characterised by 'learning-by-doing' and 'learning-by-using' processes and are often the outcome of inventions and improvements suggested by those directly involved in the production process;

(ii) *radical innovations* which comprise new production lines and a partial modification of existing demand. They are characterised by substantial change within existing industries and by the creation of new types of demands. Radical innovations result more and more from deliberate R&D activities in enterprises and/or university and government laboratories. Isolated radical innovations such as nylon or 'the pill' bring structural change but their aggregate economic and social impacts are relatively small and localised. This situation might change if "… a whole cluster of radical innovations are linked together in the rise of new industries and services, such as the synthetic materials industry or the semiconductor industry." (ibid. p.46);

(iii) *changes of 'technology system'* are characterised by major modifications on the demand system and the creation of new industries. They go beyond the combination of radical and incremental innovations to encompass organisational and managerial innovations as well. The example given by Freeman and Perez is the technically and economically interrelated 'constellation' of innovations that took place from the 1920s onwards in synthetic material, petrochemicals, machinery innovations in injection moulding and extrusion;

(iv) *changes in 'techno-economic paradigm'* have a crucial impact throughout the economy with their new demand complexes, their substantial importance for the renewal of existing productive capital, their impact on the skill profile of the labour force, and the chain reaction they carry along which results in the creation of new growth complexes.

Even though the importance of all four 'levels' of innovation is recognised, here the main concern will be with the revolutionary ones. Three aspects of these revolutions are worth emphasising. The first one regards their widespread application and the drastic reduction in costs of many products and services. Beside their technical application in many areas of the economic system, these innovations must imply major and persistent changes in these areas' costs structure.

A second important aspect concerning technological revolutions is their social and political acceptability. This can take longer than the perception regarding the technical advantages of the innovation and its economicity because in many cases such acceptability must be expressed in legislative, educational and regulatory changes.

As I have pointed out earlier [Villaschi (1994)], the institutional content of technological revolutions and the diminishing characteristics of their long term impact on the dynamics of technical and economic accumulation make it reasonable to draw 'impressionistic approximations' between the impact of technological revolutions in economic development and the changes that take place in the natural sciences as a result of switches in scientific paradigm. Broadly defined as "universally recognised scientific achievements that for a time provide model problems and solutions to a community of practitioners" [Kuhn (1970)], scientific paradigms must share two essential characteristics. Firstly, the novelty they achieve must be of such a magnitude that they attract a large and enduring number of adherents. In the second place, they must be sufficiently open-ended to leave different sorts of problems to be resolved by their group of practitioners.

Out of the different ways Kuhn describes paradigm[15], it seems important for the purpose of the present work to emphasise: (i) the way he equates paradigm with a standard, a new way of seeing, with an organising principle governing perception itself, with a map, and with something which determines a large area of reality; (ii) the way he defines paradigm as a universally recognised scientific achievement, as if it were a set of political institutions or an accepted judicial decision; (iii) the way he breaks with the tradition of seeing science as an enterprise which draws constantly to some goal set in advance. "If

we can learn to substitute evolution-from-what-we-do-know for an evolution-towards-what- we –wish-to-know, a number of vexing problems may vanish in the process." (ibid., p. 171).

Table 1: Condensed summary of the Kondratiev waves.

Constellation of technical & organizational innovations	Highly visible, technically successful & profitable innovations	'Carrier' branch & other leading branches of the economy	Core input & other key inputs	Transport & communic. infrastruc.	Managerial & organizational changes	Approx. timing of the 'upswing' (boom)	downswing' (crisis of adjustment)
1. Water-powered mechanization of industry & transport	Arkwright's Cromford Mill (1771) Henry Cort's Puddling' process (1784)	Cotton spinning Iron products Water wheels Bleach	Iron Raw cotton Coal	Canals Turnpike roads Sailing ships	Factory systems Entrepreneurs Partnerships	1780s–1815	1815–1848
2. Steam-powered mechanization of industry & transport	Liverpool to Manchester Railway (1831) Brunel's 'Great Western' Atlantic Steamship (1838)	Railways & railway eq. Steam engines Machine tools Alkali industry	Iron Coal	Railways Telegraph Steam ships	Joint stock companies Sub-contracting to responsible craft workers	1848–1873	1873–1895
3. Electrification of industry, transport & the home	Carnegie's Bessemer Steel Rail Plant (1875) Edison's Pearl St. New York Electric Power Station (1882)	Electrical eq. Heavy engineering Heavy chemicals Steel products	Steel Copper Metal alloys	Steel railways Steel ships Telephone	Specialized professional management systems 'Taylorism' Giant firms	1895–1918	1918–1940
4. Motorization of transport, civil economy & war	Ford's High-land Park Assembly Line (1913) Burton process for cracking heavy oil (1913)	Automobiles, trucks Tractors, tanks Diesel engines Aircraft Refineries	Oil Gas Synthetic materials	Radio Motorways Airports Airlines	Mass production & consumption 'Fordism' Hierarchies	1941–1973	1973–
5. Computerization of entire economy	IBM 1401 & 360 Series (1960s) Intel micro-processor (1972)	Computers Software Telecom eq. Biotechnology	'Chips' (Integrated circuits)	'Information Highways' (Internet)	Networks; internal, local & global	–	–

Source: Freeman and Louçã (2001), p. 141.

Thus, Freeman and Perez's (1988) concept of techno-economic paradigm is a good approximation to Kuhn's elaboration because they relate technological paradigm not just to a particular branch of industry but to the broad tendencies in the economy as a whole. Moreover, they put together the inadequacy of existing institutions to the full develop-

ment of a technological revolution, and the state of crisis that sooner or later emerges from its diminishing revolutionary character. That is, they give some real content to the notion of 'successive industrial revolutions' by interpreting the Kondratiev waves as increasing degrees of 'matches' between the techno-economic system and the socio-institutional framework in the upswing followed by increasing degrees of 'mismatches' between these subsystems in the downswing.

Thus, the approach proposed by Freeman and Perez is centred on a broader interpretation of Marxian and Schumpeterian 'creative destruction' in the sense that in their account of techno-economic paradigms attention is directed at the capacity of capitalism for fundamental reorganisation during periods of crisis. This reorganisation takes place in a sequence of historical constructs formed through the economic, technological and institutional dynamics of the crises. Between these major crises the framework established by the prevailing techno-economic paradigm allows for a range of technological trajectories and institutional arrangements which can take different forms in time and in space.

Besides breaking with different degrees of mono causal economic determinism, the techno-economic paradigm approach can be seen as an important move towards a more unified theory of growth, crisis and change. This heterodox approach seems more adequate than the vicious circle of mainstream social sciences where, on the one hand sociologists and political scientists try to explain weak social motivations, political apathy and political crisis in terms of economic trends. And, on the other hand, economists try to explain economic crisis tendencies as the result of the politicisation of the economy on motivations and incentives.

Table 2: Changes in the techno-economic paradigm: from 'cheap energy' to chips.

'Fordist' (Old)	ICT (New)
Technology features	
Functionality & 'better' products	Knowledge & communication linked with human mind
Place-to-place connectivity	Person-to-person connectivity
People as 'users',' consumers', 'workers'	Personal, physical & psychological sustainability
Economic features	
Energy-intensive	Information intensive
Design & engineering in 'drawing' offices	Computer-aided designs
Sequential design & production	Concurrent engineering
Automation	Systemation
Single firm	Networks
Product with service	Service with product
Centralization	Distributed intelligence
Specialized skills	Multi-skilling
Institutional features	
Government control & sometimes ownership	Government information, co-ordination & regulation
'Planning'	'Vision'
Welfare state' & 'warfare state'	Regulation' of strategic ICT infrastructure
Pax Americana': U.S. economic & military dominance	Multi-polarity', Regional blocs
U.S. dominated int'l financial & trade regimes (GATT, IMF, World Bank)	Problems of developing appropriate int'l institutions capable of regulating global finance

Source: Adapted from Freeman & Perez (1988), Freeman & Loucã (2001), & Tuomi (2001).

This heterodox approach is even more important when one wants to deal with the ongoing change in techno-economic paradigm. Even if one can trace its scientific and technological roots as far back as the XVII Century[16], the so-called information and communi-

cation technology (ICT) techno-economic paradigm only became a part of the economic agenda after the 1970s. Moreover, its institutional implications only came to the open public debate in the 1990s.

No matter when each one of these three dimensions of the ICT techno-economic paradigm has surfaced in academic and/or public debate[17], it is important to bear in mind that one should avoid the pitfall of single-factor determinism, whether cultural, economic, political, scientific, or technological determinist [Freeman and Loucã (2001)].

4. SOME ALTERNATIVE PERSPECTIVES FOR THE ON-GOING CHANGE IN TECHNO-ECONOMIC PARADIGM

Given the revolutionary content of change in techno-economic paradigm, it should be of no surprise the different interpretations and the different attempts that have been made to understand its main features. In here, some of these will be briefly mentioned in such a way as to stress the need to look at this transition period as times for looking not only to the availability of technologies and the feasibility of the economic uses.

It has become each time more clear that for a techno-economic paradigm to fulfil its technological potentials and its economic perspectives it has to be embedded in institutions which are flexible to make change feasible and stable in order to make routines possible. As emphasised by Johnson (1992), institutions make society possible because they make it unnecessary to start life from scratch every day by being widely accepted as guideline for social life, regardless of whether each member of society accepts them ideologically or politically.

Some of the needs for institutional changes can be better understood when some alternative features of the ICT techno-economic paradigm are highlighted. Thus, Castells (2000), on the one hand, stresses that in *the information society*, the basic unit of economic organisation is no longer an entrepreneur, a family, a corporation, or the state, but a network composed of a variety of organisations. According to that author, the institutions that hold these networks together is the 'spirit of information' itself – a 'cultural code' of the ephemeral, which both informs and enforces powerful economic decisions at every moment in the life of the network.

On the other hand, Drucker (2001), stresses that in the *next society* knowledge will be all, where there will be the need to learn how to live with an ageing population, with knowledge workers as the new capitalists, with manufacturing paradox of getting far more output with far fewer workers, and with a new organisational concept for corporations where control doesn't take place through ownership but through management.

Tuomi (2001), points to three waves on the understanding of *knowledge society*. The first one – which began roughly in the beginning of 1970s and went until the beginning of the 1990s – was associated with an anticipated 'ICT revolution'; which was expected to lead to convergence of television and telecommunications. The second wave focused on competitiveness, economic growth, access, regulation, privacy, security, and intellectual property rights. Quoting Ducatel et al. (2000), Tuomi (ibid.) points that the key difference from the first wave was the emerging concern about information haves and have-nots.

He identifies Ducatel and his colleagues, perhaps, as representatives of a third wave: "The relationship between technological change and social transformation is now acknowledged to be a complex one, and the simple notion of technological changes having social effects, which in turn can be simply controlled by appropriate policies, has now been shown to be false… This brings an added complexity to policy making: it is not enough to develop and implement appropriate technology policies in isolation. Technology policies and social policies have to be developed in a complementary way and strive for complementary objectives. It is necessary, if we want the 'society' in information society to be more than a rhetorical device, to develop a more sophisticated appreciation of these social issues." [Ducatel et al. (2000, p 9), quoted in Tuomi(2001, p.8).

As we can see, the content of the emerging techno-economic paradigm, on the one hand, inspire different interpretations amongst different authors. The different stresses that is given to the many features identified, on the other hand, inspire different policies which search for legitimacy of both, technological prospects and their economic implications.

Since, as pointed out above, a major characteristics of innovations in general, but especially of those with a paradigmatic content such as ICT, is uncertainty it seems worth repeating Freeman and Loucã(2001)'s quotation of Charles Dickens, in his *Tale of Two Cities:* "It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us".

They finish their book saying that the fundamental thing is to choose. I have chosen to highlight the interactions that take place within certain socio-cultural-historical-economic boundaries (in this particular case the ones that shape Finland), amongst elements in three autonomous and interdependent domains. The technological (which makes technology available), the economic (which assures it is feasible and sustainable) and the institutional (which makes it possible).

In here, there will be no concern with which one comes first. In what follows, the major focus will be on two features which is common in every list of features of the emerging era: knowledge and institutions. If it were for nothing else, it should be because the main difference between previous waves / revolutions / societies / ages and the one we are living in is that today there are new/faster forms and new contents (social, political, economic etc) for collecting, treating, transmitting and receiving all sorts of information anywhere and everywhere[18].

5. INFORMATION, KNOWLEDGE AND LEARNING

Modern economics is more than ever aware of the importance of knowledge and learning[19]. Within the field of innovation studies and technological changes, Nelson and Winter (1982) , for instance, have made extensive use of the distinction between tacit and codified knowledge[20]; Arrow (1962), Rosenberg (1976), and Lundvall (1985) raise specific questions regarding learning and innovation. The major difference between these contributions is that whilst the first two are more concerned with learning within the firm (by-doing and by-using, respectively), Lundvall's learning-by-interacting brings to the fore front of the discussion innovation capabilities which emerge when users and producers search together for a new product/process.

However, the understanding of knowledge and learning still remains narrow, despite new insights that emerge from historical and empirical research programmes on institutional economics, evolutionary economics, socio-economic research and the economics of innovation[21]. It must be credited to them the better grasp we have today on how innovation takes place in different parts of the economy. But, when it comes to the other aspect of knowledge production, i.e. competence building, learning and mediation of knowledge, research is only now beginning to raise fundamental questions about who learns what and how learning takes place in the context of economic development [Johnson and Lundvall (2001].

In order to contribute to a better understanding of these issues, Johnson and Lundvall (2001) divide it into four categories. Individual[22] knowledge consists of

(i) *know what:* refers to knowledge about 'facts'. The number of people living in New York, what the ingredients in pancakes are, and when the battle of Waterloo took place are examples of the kind of knowledge which is close to what is commonly called information. Above all, it can be broken down into bits and communicated as data;

(ii) *know why:* refers to knowledge about principles and laws of motion in nature, in the human mind and in society. This kind of knowledge has been extremely important for technological development in certain science-based areas, such as the chemical and electric/electronic industries. The access to it will often make advances in technology more rapid and reduce the frequency of errors in procedures involving trial and error;

(iii) *know how:* refers to skills – i.e. the ability to do something. It may be related to the skills of artisan and production workers, but, actually, it plays a key role in all important economic activities. The businessman judging the market prospects for a new product or the personnel manager selecting and training staff use their know-how. It would be misleading to characterise know-how as practical rather than theoretical. Even finding the solution to complex mathematical problems is based on intuition and on skills related to pattern recognition which are rooted in experience-based learning rather than on the carrying out a series of distinct logical operations.

(iv) *know who*: involves both information about who knows what and who knows what to do, and the social ability to co-operate and communicate with different kinds of people and experts. It has become increasingly important because there is a general

trend towards a more composite knowledge base, with new products typically combining many technologies, each rooted in several different scientific disciplines. That makes access to many different sources of knowledge more essential.

According to Johnson and Lundvall (2001), very little knowledge is 'perfectly public'. Even information of the know-what type may be unavailable to those who are not connected to the right telecommunications or social networks[23]. Even if and when scientific or other types of complex knowledge is perfectly accessible, for accessing it the user must have invested in building absorptive capabilities[24]. They illustrate their point with the following considerations:

(i) despite the fact that information technology has greatly extended the information at the disposal of individual agents, *knowing what* increasingly depends on selection of what is relevant. Even with the most recent advances in this area, access to this kind of knowledge is still far from perfect and the most effective medium for obtaining pertinent facts may be through the *know who* channel, i.e., contacting an outstanding expert in the field to obtain direction on where to look for a specific piece of information;

(ii) scientific work aims at producing theoretical model of the *know-why* type, and some of this work is placed in the public domain. That, though, doesn't mean public access since it often takes enormous investments in learning before the information one might obtain through the Internet or other forms has any meaning. Again, *know who,* directed towards academia, can help the amateur obtain a 'translation' into something more generally comprehensible[25]. This is one strong motivation for companies' presence in academic environments and sometimes even engaging in basic research. Some big companies contribute to basic research and they tend to take over functions of 'technical universities'. This close connection between science and the exploitation of new ideas by business in fields such as biotechnology, though, can undermine the open exchange that should continue to characterise academic knowledge production[26];

(iii) in fields characterised by intense technological competition, technical solutions are often ahead of academic *know-why*. This is the case when technology can solve problems of perform function without a clear scientific understanding of why it works. Here, knowledge is more *know-how* than *know-why.*

Having addressed these different forms and contents of knowledge and their blurred public/private boundaries, Johnson and Lundvall (2001) come to another fundamental question specially for those concerned with the production, circulation and distribution of goods and services, i.e., how can different aspects of knowledge be mediated. In this respect, they add:

(i) since tacit knowledge in the form of *know-how* or competence cannot be separated from the person or organisation containing it, mediation may take the form of the purchase by the customer of the services of the person or the firm rather than the competence itself. The importance in this sort of mediation (and the problems it involves) can be noticed by the increasing relevance that has been acquired by knowledge intensive business services (KIBS)[27];

(ii) tacit knowledge can also be mediated[28] through interactive learning between the one which needs it and its carrier. This may be a conscious choice, for example when an apprentice enters into a contract with a master, or it may be a side-effect of co-operation between people and organisations to solve shared problems.

Mediation of knowledge is not necessarily easier when its content can be made explicit and it can be separated from its carrier. On the one hand, determining the value of the information for the uses before the transaction takes place is not always an easy take.

For obvious reasons, the user wants to know something in advance about the knowledge and the seller does not want to give information away for free.

On the other hand, it is difficult both for the seller to restrict the use of the information once it has been sold; and for the buyer to restrict its further distribution by the seller.

> Despite these difficulties, a large growing amount of knowledge is the object of transactions in something that looks like a market (there is a buyer, a seller and a price). One reason why markets work is that formal and informal institutions – including legal protection in terms of patents, licences and copyright – support transactions. Another, even more fundamental, reason is that many markets for knowledge transactions are not pure but rather *organised markets*. Long-term relationships with elements of experienced-based *trust* often play a major role in knowledge markets [Lundvall (1988), p. 16, italics added].

In any case, it has been increasing the importance of R&D-expenditure as a means of facilitating the mediation of knowledge. On the one hand, because even to pursue reverse engineering takes a minimum of scientific competence which requires certain investment in R&D. On the other hand, since both the rate of change and the complexity of knowledge have been growing quite fast, no single organisation can master all the elements of the knowledge base[29]. In order to engage in any kind of R&D collaboration scheme, the same minimum scientific competence must be available in any of the organisations which want to engage in this type of knowledge mediation.

It is important to notice that even when knowledge is embodied into products, it might be necessary some kind of mediation for the transference of tacit knowledge in order for it be fully and/or properly used. This is the reason why suppliers of complex process equipment may offer training to the personnel of the customer organisation[30].

In all cases that have been presented by Johnson and Lundvall (2001) it is quite clear that at times of changing techno-economic paradigm, any attempt to have clear cut division between tacit and codified (or codifiable) knowledge is unfruitful. Thus, it becomes increasingly important to understand how these two forms of knowledge can establish virtuous circles of interaction.

The SECI (socialisation- externalisation-combination-internalisation) model proposed by Nonaka and Takeuchi (1995) is based on the idea that knowledge is created in a continuous process where the socialisation of tacit and unarticulated knowledge transforms it into a knowledge which can be codified / transferred. The combination of different externalised knowledge increases the tacit knowledge which is internalised into the individuals or the participating organisations. A virtuous circle is established when this new tacit knowledge is socialised.

Given that virtuous circles in many cases don't take place as a result of formal settings but are based on learning which is base on informal networks, more attention should be paid to 'learning communities'. The concept of 'learning community' is a way to describe basic actors and institutions interacting and build different types of networks for learning. The defining functions of a learning community are its common knowledge management or knowledge logistics activities resulting in the adoption or in the production of innovations [Kuusi (1999)].

A quick look at this model will be a strong argument for Johnson and Lundvall (2001)'s alert towards the need of better understanding the connections between different forms of knowledge, their public/private content and the different forms for their mediation. It will also serve for strengthening the context implication of tacit knowledge. That is, we need "… to think harder and more carefully about how tacit knowledge and context are *produced* before we can say anything intelligent about the conditions under which tacit knowledge can most readily be shared – that is, when 'proximity' is important: what types and why [Gertler (2001), p. 17][31].

6. INSTITUTIONS AND SOCIAL CAPABILITIES

As a point in an earlier work [Villaschi (1994), the concept of institutions has been defined in many ways. They regulate the competition for power (political institutions), they are concerned with the production, circulation and distribution of goods and services (economic institutions); they deal with the religious, artistic, and expressive activities and traditions in the society (cultural institutions); and they focus on the questions of marriage and the family and on the rearing of the young (kinship institutions). Consisting of both informal constraints (taboos, sanctions, custom, traditions, and codes of conduct) and formal rules (constitutions, laws, property rights), institutions in general terms "are humanly devised constraints that structure political, economic and social interactions." [North (1991), p. 97].

A basic feature of institutions is that they are informational devices drawn to reduce uncertainties. By reducing the amount of information needed for individual and collective action, institutions make society possible and are a fundamental building block in all societies. From an economic point of view, the institutionalist tradition has stressed the *time* and *place* dimensions that characterise regularities of social behaviour. Economic behaviour is instituted, then, not because of some universal human characteristics, but rather through a process of enculturation. Moreover, by identifying *learning* and *innovation* with 'habits of thought' Veblen (1919) emphasised the role of institutions in shaping them both.

In a world characterised by innovative activities (centred on different forms and contents of knowledge which is acquired through diverse sources and means of learning), uncertainty is an important aspect of economic life, and the existence of institutional setups at the different levels (of a specific firm, of a group of firms or of a country as a whole) become a central component of a system of innovation. In such a world then, institutions move beyond the above mentioned characteristics of routines, and guiding every day life in order to work also as a framework for change.

Given these configurations of institutions, it should be of no surprise that in all the approaches that have been mentioned above both for characterising the socio-cultural-political-economic changes we are going through and for a better understanding of a key factor of these changes – knowledge, they always emerge as a key element to be looked at. As highlighted by Freeman and Perez (1988), at times of changing techno-economic paradigms challenges emerge to the old institutional framework. The core resources, technologies, organisational arrangements, and market structures of the new paradigm cannot reach their full development potential within the old institutional framework.

If it were for nothing else, the old institutional setting was drawn (formally or informally) in order to match the socio-economic-technological needs and preferences of its time. Thus, as new socio-economic-technological needs emerge a new institution setting must come to place or a 'mismatch' occurs between the different domains described above.

Such a 'mismatch' can be seen from a perspective of the way agents (individual, groups, organisations) perceive the changes that are taking place. According to Hämäläinen (1999):

(i) there are those which develop a new attitude that better reflects the new techno-economic realities of the world, but are unsatisfied with the slow adjustment of social norms, formal institutions, and collective behavior;
(ii) others are satisfied with their old mental paradigm, but not with the way the economy and technologies are changing the world around them;
(iii) still others which feel losses from the rapid structural change brought about by the techno-economic paradigm shift and cannot understand what went wrong with the society; and
(iv) there are also those which do realise that changes are inevitable but given their vested interests on the old paradigm (usually connected to human capital and physical assets) voice their protests against possible changes.

Due to these different perceptions and alternative behaviours, Perez (1997) points out that:

(i) the long transition phase between the old and new socio-institutional paradigms tends to be a turbulent period of increasing social tensions, rising moral and religious fundamentalism, proliferation of new 'clans' and extreme movements, strong leaders with simple ideologies, and even wars and revolutions[32];
(ii) the adjustment of society[33]'s legal and regulatory framework can be a very slow process due to the resistance of many special interest groups and the complex nature of the political process;
(iii) the institutional adjustment process influences collective behaviour. Public sector organisations and old special interest groups tend to be the last strongholds of the old institutional arrangement since they do not face direct competition and have strong interest in maintaining the old regime.

By now it should be clear that a system of innovation cannot rely only on economic relations which can be mediated by the market or whose governance can take place through hierarchies. Let alone on economic relations only.

At the organisations' level, it is each time more recognised the importance of social capital, i.e., their inter- and intra-organisational relationships which play important roles in their production / innovation processes. At the level of firms networks, attempts have been made in order to quantify these relationships through the decomposition of social capital into three factors, namely social interaction, trust and the quality of information [Ali-Yrkkö (2001)]

Since "social capital is assumed to be proportional to the density of relationships among citizens and specific weight is given to the frequency of participation in organisations (…) [Lundvall (1998), it becomes clear that these relationships are embedded in social attributes / capabilities[34] which are ever harder to be measured and even defined.

If one follows Coleman (2000), social attributes / capabilities can be understood as institutional relationships between people. Under Putman's (1993) terms, they should be related to social networks, the norms of society and trust. Whilst using Fukyama's (1995) contribution one could argue that social attributes / capabilities include the ability of people to work with one another for the common good.

Whichever is the level at which one wants to understand common good, these social capabilities are of fundamental importance if a NSI is to cope adequately with scientific, technological, economic and institutional challenges and take full advantages of the windows of opportunities which emerge at times of changing techno-economic paradigm [Perez and Soete (1988)]. That is ever more so because societies differ with respect to the accumulated social capital and that has an impact on their capability to produce intellectual capital and to engage in innovation activities [Schienstock and Hämäläinen (2001)].

7. FINAL COMMENTS

The general theoretical framework that was established here will be used in working papers which will follow this one, in order to have a closer look at the interactions which take place within and between elements of the technological (makes technology available), the economic (makes innovations feasible) and institutional (makes innovation possible) domains of the Finnish national system of innovation – FNSI.

As it has been indicated elsewhere [Villaschi (1994)] the boundaries between these domains are not always clear. Neither is straightforward the choices that have to be made regarding what are the chosen elements in each one of these domains.

Thus a certain degree of arbitrariness will be used in order to 'select' different elements of the FNSI. One criterion, though, they must fulfil; i.e., they all have to have qualities to lead a shift in the degree of disequilibrium of the system as a whole, thus starting a sequence of structural tensions and their partial resolutions. That is, they must be capable of creating social and economic networks which can lead to opportunities for the Finnish economy and society in the new era of knowledge and learning under the possibilities which are opened by ICT techno-economic paradigm and by the globalisation process that it fuels.

The preliminary choices are for[35]:

(a) *In the economic domain*: [it is the ground test for innovation feasibility. The main focus will be on co-operation (beyond production and circulation) amongst firms and between them and organisations in the other domains that lead to learning which enables innovation and technological development that enhances both firms / clusters competitiveness and social capabilities]

- Emphasis on *two clusters* (besides a general description of the successful path creation by the clusters programme): ICT; and well being;
- *SMEs*; *KIBS*; *Start-ups* and *incubation* (not necessarily in technology intensive industries but stressing constraints and opportunities that are faced / opened to newcomers and to business of the 'old economy';
- *Regional features* (the experience of Oulu with knowledge intensive industries as a strategy for regional development);
- *Financing of innovation and technological development* (main features of the Finnish finance system regarding start ups and innovation both in knowledge intensive and in 'old economy' enterprises): seed-money, venture capital; business angels;

(b) *In the technological domain*: (make innovation available. The main focus will be on interactions amongst organisations within the domain and between them and those in the other domains, which leads / facilitates the creation and the circulation of tacit and explicit knowledge)

- *Universities* / *Polytechnics* / *VET*: teaching, basic research and R&D
- *Centres of excellence*: regional innovation / technological capabilities;
- *Sectoral research institutes*;
- *Co-operation agreements abroad*;
- *VTT*: structural changes in history and to come.
- *Private*: Nokia laboratories, HP Platform;
- *Content*: Information society programmes;
- *Funding*: Public ad private sources:
- *Cross-border*;

(c) *In the institutional domain*: (make innovation possible. The main focus will be on institutional building which facilitates path-creation towards innovation focused on social capabilities and economic competitiveness)

- Historical and organisations features of S&T policies: STPC, Sitra, AKA, TEKES;
- People on the move: university / government / industry;
- Trust and equality;
- Labour's perspective;
- Information society / learning economy: public debate / parliament's discussions;
- EU / OECD: policies / recommendations.

From a cultural and political perspective one should also expect that these elements, on the one hand, strengthen the country's identities which were highlighted in the first section of this paper. And on the other hand, that they contribute for the addition of new identities and roles of Finland in a world which every one would like to be culturally inter-connected / connectable.

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ENDNOTES

[1] - As founding fathers of the approach, Freeman and members of the IKE Group have different points of view on where the basic inspiration came from. In Freeman(2001) points that in his book, List "…deals with almost all the main features of the modern NSI literature." (ibid., page 115), whilst Lundvall et al. (2001) say that "… the direct inspiration came via Burenstam Linder who is a liberal economist and a former conservative minister in the Swedish government (Linder 1961) rather than directly from List." (ibid., page 4).

[2] - It should be stressed that there is no intention to present elements of the FNSI which contradict the approaches used by Castells and Himanen (2001) or by Schienstock and Hämäläinen (2001). Emphasis to what is discussed in those two works might be given or taken away in here. But the main purpose is to add more elements to the analysis of the world wide recognised accomplishments of the Finnish system in the past twenty years.

[3] - Which is the main concern of Nelson's (1988) approach to national system of innovation. That can also be identified with the 'triple helix model' whose main concerns is the relationship among science, industry and government creating the conditions for future innovation. See Leydesdorff(2001)] for a critical appraisal of the (neo-) evolutionary model of a triple helix of university-industry-government.

[4] -- To further support the 'localised argument' (be it at the national, regional or local levels), it is worth mentioning that Whitley(1996) emphasises factors such as trust and the capacity to build extra-family collective loyalties as important when characterising national business systems.

[5] - To be discussed in the following section.

[6] - For a review of different aspects of the innovation systems approach, see Lundvall et al. (2001), Edquist (1997). For critical comments on the approach, see Edquist (2001). Miettinen (2001) highlights criticisms to the concept, mainly with respect to the ways it has been incorporated in the Finnish technological policy discourse.

[7] - "The self-organisational approach to dynamic modelling proceeds from the observation that complex interdependent dynamical systems unfolding in historical, i.e. irreversible time, economic (political and social, my addition) agents, who have to make decisions today, the correctness of which will only be revealed considerably later, are confronted with irreducible uncertainty and holistic interaction between each other and with aggregate variables." [Silveberg et al. (1988), p.1036].

[8] - The traditional way of seeing innovation in Schumpeter's original terms ('doing new things or old things in a new way'), perhaps should be replaced by looking at innovation in an economy as a question of creation and exchange of knowledge amongst relevant actors.

[9] - As Nelson and Winter (!982) state there is "…a simple distinction between organizational activity directed to innovation (or problem-solving more generally) and the *results* of such activity. The fundamental uncertainty surrounding innovative activity is uncertainty about its results." (ibid., p. 132).

[10] - The existence of a global bank of blueprints from which anybody can get a copy to be used for starting up production, is a simplifying assumption made by neo classical theory of production and economic growth . As Johnson and Lundvall (1999) stress, this ignores the fact that most accessible knowledge can only be used by skilled agents and that skills differ and are not easily transformed in blueprints.

[11] - He also suggests that one can distinguish, too, between development, diffusion and use/production of new processes and products; as well as between innovations in low, medium and high technology sectors of production.

[12] - Edquist (2001) points out that some product innovations are transformed into process innovations in a 'second incarnation'. That is mainly the case of 'investment products' - such as an industrial robot which are a product when they are produced and a process when they are used in the production process.

[13] - The importance of intangibles has increased as it becomes each time more recognised that knowledge-intensive business services – KIBS can play a major role in the diffusion of innovations to firms of different sizes.

[14] - Archibugi and Michie (1995) proposes a taxonomy which helps to understand better the political economy of innovation at a time of intensified and modified internationalisation of economic relations.

[15] - See Masterman (1970) for a discussion of the twenty-one different ways Kuhn describes a paradigm, her grouping them into metaphysical paradigms, or metaparadigms; sociological paradigms and artefact paradigms or construct paradigms.

[16] - See, for example, Cortada (2000).

[17] - Freeman and Loucã (2001) remind us that even the Chairman of the United States Federal Reserve, Alan Greenspan, "… has spoken frequently of the 'new paradigm', referring specifically to computers,, telecommunications, and te Internet as the source of the remarkable spurt of growth in the US economy in the 1990s." (ibid., p.301).

[18] - Compare with Tuomi (2001)'s "… the ongoing socio-economic transformation is based on three interrelated processes of increasing informationalization, changing communications and interdependence structures, and changing processes of knowledge creation and utilisation.

[19] Johnson and Lundvall (2001) reminds us that knowledge has been at the centre of analytical interest from the very beginning of civilisation. Aristotle distinguished between: *Epistèmè:* knowledge that is universal and theoretical. *Technè:* knowledge that is instrumental, context specific and practice related. *Phronesis:* Knowledge that is normative, experience-based, context-specific and related to common sente: "practical wisdom" (ibid., p. 12).

[20] - According to Gertler (2001) philosopher of knowledge such as Ryle (1949) and Polanyi (1958, 1966) anticipated later developments in social constructivist thought by enunciating what was for them a crucial distinction

between knowledge that could be effectively expressed using symbolic forms of representation – explicit or codified – and other forms of knowledge which defied such representation – tacit knowledge.

[21] - It is important to have in mind, however, that in theories that form the core of standard economics, it is assumed that rational agents make choices on the basis of a given amount of information. The only kind of learning allowed for is agents' access to new bodies of information.

[22] - According to these authors, on the organisational level the four categories correspond to 'shared information – data bases', 'shared models of interpretation (including company stories)', 'shared routines', and 'shared networks'. On the regional level they are identified as 'people', 'culture', 'institutions' and 'networks'.

[23] - That should be a matter of great concern for those who are working on the prospect of a new international order at ICT times. Since information and knowledge refers more than ever to power relationships, the 'haves' and 'have nots' in both inter and intra-country spheres cannot be considered a side subject for those who are investigating opportunities and constraints in the new/ next society/economy/paradigm.

[24] - "Know-how is never fully transferable since how a person does things reflects that individual's personality (even organisations have a 'personality' in this sense)" (ibid., p.15).

[25] - In this context the Finnish *Centre of Expertise Programme* can be seen as a model in terms of facilitating access to *who knows* where to find what is relevant and how to translate what is found in a way meaningful to business.

[26] - Johnson and Lundvall (2001) also stress that, contrary to the free 'spill-overs' which is assumed by standard economics, access to scientific *know why*, under all circumstances, depends upon investment in R&D activities and in science.

[27] - For an interesting appraisal of the situation of KIBS in the FNSI, see Leiponen (2001).

[28] - Johnson and Lundvall (2001) point out that tacit knowledge can also be mediated through the hiring of the expert as employee or through the taking over of the organisation controlling the knowledge.

[29] - That is true both of high-tech areas such as biotechnology (see evidence presented by Walter Powel at workshop sponsored by Advanced Technology Policy Group/Minister of Industry and Trade, on 13/XII/01) as well as more mature fields such as the forest industry [see Hazley (2000)].

[30] - In the context of developing countries that is essential even when one is not dealing with complex process equipment. Low educated labour force implies that in those cases, this training is crucial if embodied knowledge is going to have any economic impact at all.

[31] - Which can be seen as an additional argument in favour of the NSI approach and a good reason to go to Karl Polanyi [Polanyi (1944)] for a better understanding of the origins of tacit knowledge and context.

[32] - The events that took place before September 11, 2001 and the reactions afterwards illustrate this interpretation very well.

[33] - Here to be understood on different scales of space (local, regional, national, supranational) and other forms of social gathering (ethnic, religious, professional etc.).

[34] - Attributes and capabilities are here used in order to differentiate social constructs at a more general social spectrum than those under which organisational inter-intra-relations take place.

[35] - I will be grateful for all and every comment that can be made by the readers of this working paper.

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