

Globelics Academy 2008

Ph.D.-School on National Systems of Innovation
and Economic Development

**Factors that determine the impact of innovation-oriented
policies in firms: Conceptual and Methodological Formulation
of Research Project**

(Draft 1)

*Juan Carlos Salazar A.
Bogotá, D.C., Colombia
May 1st 2008*

1. MAIN QUESTION

This is a draft version of a proposal for a conceptual and methodological approach that seeks to answer the question of which are the most important factors that, from a micro-economical standpoint, determine the impact that policy instruments to promote innovation in Colombia have, over the companies that implement them, and how they operate. This seeks to shed some light on what criteria, strategies and measures must be developed as part of a public policy agenda, in order to effectively promote technological development and innovation and, thus, a better performance by implementing firms.

These questions fall into the same line proposed by Lundvall and Borrás (2005):

It is increasingly important to understand better the connection between science and technology on the one hand and economic performance on the other. The rise and fall of the new economy demonstrates that assumptions about simple and direct connections are problematic. [...] This is an issue that remains understudied. In terms of public policy there is a need for innovative thinking about how governments can support the diffusion of good and sustainable practices in cooperation with management and employees. In terms of research opportunities, this link with the importance and need to devote more analytical efforts examining how technical innovation interact with organizational change. [...] and how organizational change affects innovation processes in the economy. (Lundvall and Borrás, 2005:625)

From a more general perspective, the project seeks to contribute to the study and analysis of the theory behind the emergence and development of firms, and to provide analytical elements to answer questions about firm's identity, its evolution and the relationship it has with their development. In other words, it seeks to contribute to the study of the firms' learning dynamics,

and of the factors that, on meso- and especially micro-levels, determine firms' performance in a developing country such as Colombia.

2. MICRO-ECONOMIC FACTORS IN TECHNOLOGICAL-CHANGE POLICIES IN COLOMBIA

Facts about low growth levels in terms of productivity and productive diversification suggest that the impact of the National Innovation System on Colombian economic competitiveness is still not significant, and that the System's capacities are still in their earliest stages.

Evidence about national innovative capacity attests to public policy challenges similar to those that Colombia undertook during the early 1990s with its market-opening processes. At that time, transversal (or functional) policies were developed, that is, policies directed towards both an improvement in market operations, without favoring any specific sectors of the economy, as well as to generate common public goods to productive sectors in the economy, such as: macro-economic and legal stability; physical and services infrastructure; the financial system; or the guarantee to free competition. The National Science and Technology System (SNCT) was also created early during the 1990s.

There is evidence that shows that transversal policies, although necessary to promote an adequate allocation of productive resources and to raise economic productivity as a whole, are not sufficient to allow for the expansion of activities that enjoy comparative advantages, or to facilitate the development of new productive sectors with the potential for exporting and for job creation. Horizontal and sectoral (vertical) policies are also required. The experience in East Asian countries confirms this (Lall and Teubal, 1998).

Fagerberg and Godinho (2005) point out that

“A weakness of much of the existing discussion on catch-up and policy has been an excessive focus on the policy level (government) at the expense of the recipients of these policy initiatives, e.g. the firms of the potential catching-up country. [In this sense] research on the role of firms in innovation and long run economic change commonly stress that, in most cases, firms only have imperfect knowledge of the relevant options in front of them, and that they tend to be myopic, searching in the neighborhood of their existing competence for relevant information, suggestions, and solutions (Nelson and Winter, 1982; Dosi 1988; Fagerberg, 2005, Lam 2005) (Fagerberg and Godinho, 2005: 536).

In that line of thought, there is a need to review the predominant approaches in public policy formulation, directed towards fostering learning and technical changes. On this line, Lall and

Teubal (1998) show how the neo-classical approach, that has been a predominant trend in the analysis of public policies to this end, has made some assumptions which do not accurately reflect the reality of technological development processes. In particular, they draw attention towards the need of adequately understanding the firms' technological and developmental processes on a micro-level and in a more realistic way.

The nature of the learning process, its costs and risks, depend on the context: the initial level of information and skills available to firms, the appropriateness of their past routines and the demands of the particular technologies in question. [...] Given the costs and risks, vertical policies may be required to promote entry into activities with "difficult" technologies, and horizontal policies to encourage the undertaking of complex, new technological functions. (Lall and Teubal, 1998: 1374).

In summary, as Lall and Teubal put it (1998), the public policy agenda for the promotion of innovation in firms should include a combination of functional, horizontal and vertical policies. Specifically, horizontal policies are those which, throughout the different sectors, support selected activities with no preference for any specific sector or stakeholder, and which are directed towards activities for which no markets exist, or where such markets show significant failures (i.e. the financing of innovation activities or the development of generic technologies). Furthermore, vertical policies must ensure the efficient provision of the specific factors that, at a micro-economic level, condition the capacities, and thus the performance of firms, clusters and sectors in both the domestic and foreign markets. The development of these capacities demands policy measures to promote, in each sector or cluster, learning capacities in firms and facilitate their efficient operation and the economic access to said factors.

3. CONCEPTUAL AND METHODOLOGICAL ASPECTS

Given this context, the scope of this paper is to formulate, for discussion purposes, an initial conceptual and methodological approach to firms' learning processes in the context of the National Innovation System in Colombia. It is based on two visions that are assumed to be complementary: one is based on a body of literature about transaction costs and the firms' learning capacities; and a second one systemic, particularly based on national innovation systems.

1.1. Firms' Capacities and Transaction and Coordination Costs

It is understood that firms, rather than being considered as “contracting nodes”, are institutions that have an “organizational personality”¹ and the potential to develop learning capacities for the individuals that comprise them.

They invest resources in internal coordination processes and transactional interaction “for a general understanding within the company and better commercial relationships with clients, suppliers, etc.” (Hernández, 2007: 40). Technological learning processes comprise not only the incorporation of “machines, licenses or individuals: they have strongly tacit elements, which can only be acquired through experience and personal learning”. (*Ibidem*, p. 7)

In turn, firms' learning processes are closely related to the markets' structures and dynamics. These influence the fostering of the development of new knowledge for economic growth while offering the conditions for a “decentralized and competitive specialization in the generation and processing of information”. (*Ibidem*, p. 20). As a result of this, the nature of the economic problem that we seek to face, from a “Schumpeterian” perspective, is not that of the entrepreneur forced to choose the best possible alternative in terms of production and distribution, on account of a set of alternatives and proper market signals. It is rather an attempt to understand the diversity of behaviors which companies actually assume with regards to these market signals. Therefore, the attempt is to explain the heterogeneity of the results from their different undertakings. There is actually no given set of options and, furthermore, their consequences are unknown (Nelson and Winter, 1982:276).

Therefore, the learning processes to access, master and adapt technologies may represent considerable risks, costs and require a significant amount of time and, in fact, they discourage innovative activities by firms. Actually, learning processes of individuals determine the emergence and the dynamics of transactions costs within the economic system. Throughout firms such cost are internalized. But they imply costs that stem from the need of coordinating human, physical and financial resources. Transaction and coordination costs are endogenous

¹ “Theoreticians of the *entity* such as Freund (1897) and Stauss ‘argue that the enterprise exists independently from its individual members, but cannot work without them’ (Gindis, 2007, p. 23). Companies operate through the real actions of individuals and groups of individuals, and through their internal decision-making structure”. Hernández (2007: 33-34).

within the process of organizational learning. They are closely related to the characteristics of each firm and to the industrial organization. Organizational learning comprises two important components: firstly, the internal learning, which consists of the transmission and extraction of information from individuals or groups within the organization; and secondly, the external learning, that occurs when interactions with agents and individuals outside the organization take place. Therefore, learning is assumed as a social phenomenon.

The market is not, in all cases, the most efficient way in which technological activity is organized and in which good practices and knowledge are distributed. There are other non-market ways, such as public institutions, professional associations and organisms, bureaucracies, hierarchies and networks, in addition to, as happens in the Colombian case, development promotion institutions, universities and research centers, regional productivity centers and technological development centers. Companies also interact and are part of these ways of organization. However, their operation requires policy interventions, as there are, among others, failures in coordination.

Therefore, the means for intervention are determined, to a good extent, by the existence or not of market failures.

Conventional neoclassical “market failure” analysis alone is not useful, especially at the broader strategic levels. Where information is intrinsically imperfect and markets incomplete and externalities are diffuse, it is not clear that the market failure approach (and conventional tools of cost-benefit analysis) are either plausible or useful. Moreover, *non-market mechanisms* must play a role since strategy involves not only economic but *noneconomic objectives*, and since it requires a high degree of coordination with bureaucratic, professional and political components (market coordination has its limits and cannot encompass all inter- and intrapriority aspects”. (Lall and Teubal, 1998: 1381) [..]

[From a policy making stand point] the use of nonmarket mechanisms is complementary to, not a substitute for, market mechanisms. [It is necessary] explicitly to catalyze market forces and eventually achieve increasing “endogenization” of the activity promoted — an ever-increasing share of promoted activities should be undertaken without government support. This requires that policies promote collective learning and a rapid diffusion of new organizational and management routines. (Lall and Teubal, 1998: 1382)

1.2. Approach from the NIS (National Innovation Systems)

The starting point is the assumption under which innovation is a systemic process of collective learning. The project’s interest focuses, thus, on the structure and specially on the dynamics of the National Innovation System (NIS) in Colombia, understanding it as both the set of relationships and interaction and cooperation mechanisms, as well as the capacities by the public

and private actors that, in one way or another, participate in the financing and execution of activities for technological development, transfer, adaptation and distribution, in order to improve firm performance.

Teubal (2002: 235) suggests assuming that innovation systems comprise five sub-systems or components on a meso-level: the business sector (BS); the supporting structure (SS); the interactions and links; the institutions and markets; and the cultural and social structure. Seeking to simplify the approach to the problem being analyzed, and aligned with the proposal by the author above, this proposal focuses on the first three such components, and makes an explicit distinction between BS and SS.

It is, therefore, assumed that BS is the backbone of the transformation processes in innovation systems, as the companies are those which generate a significant part of economic growth and which develop and leverage on new technologies through market transactions and other relationships. But the BS is, as already indicated, heterogeneous: competences among firms are distributed unevenly, as well as their capacity to adapt to internal and external changes. In fact, companies can be classified depending on whether they are innovative, imitators or laggards behind (Teubal, 2002).

A second element in the system, to be taken into consideration for its analysis, is the SS, which comprises the different organizations that, as opposed to companies, do not follow the market's principles (at least in the strictest sense). This element provides, directly or indirectly, support to companies in their transformation processes with regards to the changes in their surrounding's; thus contributing to the evolution of the innovation system. In the Colombian case, the BS is mainly comprised by national government institutions responsible for the promotion and financing of technological development (ministries, decentralized institutions and public banking), private companies (including commercial banks and the stakeholders in the capital exchange market), as well as all organizations known as "operators", that is, universities, research centers, technological development centers, regional productivity centers and start-up incubators. All of them, in one way or another, assume specific functions within the value chain for projects that seek to increase the productivity or quality of production and distribution of goods, or in the

provision of scientific and technological services, or to develop innovative, market-oriented products.

The third element in the system corresponds to the links and interactions among its actors. These links cover both those non-market links, which are frequently considered to be central to an innovation system, especially within learning process, as well as market-related links, which are equally essential to the different stages of production processes or to the establishment of strategic inter-company alliances directed towards the generation and distribution of generic technologies. To a good extent, even, the interactive learning that takes place outside the market, is related to some extent with the market's relationships or transactions.

There is, then, a direct and dynamic relationship between the way in which the BS changes, and the system's transformation. From an evolutionary perspective, the interesting thing is not so much understanding the operation, but rather, understanding how to make the system adapt to the changing conditions in the international arena, as well as in the domestic environment. Firm's learning processes (such as the adoption or development of new management routines, new organizational forms, or new strategies) as well as the transformation of the system, attest to the presence of systemic effects, that is, there is a circular causality process where the cumulative distribution and the collective learning processes mutually draw on each other. Therefore, changes may stem from either the emergence of new organizations in the EA, or from new activities by the existing institutions or actors. (Teubal, 2002).

After having recognized these distinguishing characteristics of innovation systems, it is desirable, from a public policy standpoint, to promote an adaptative transformation of the system. Considering that there are systemic effects to take into account, this transformation can take place in two ways: Through learning processes within the firms, and through small changes in the architecture of the system.

The first of these alternatives includes learning to: look for market or technology information; identify, filter, evaluate, select and generate new projects; generate or execute R&D projects; recognize and leverage on the importance of marketing strategies and activities; manage

innovation processes, coordinating design processes with production and marketing processes, staffing and budgeting, among others.

Another way in which the system's transformation can take place is through changes in its architecture, which may happen on account of the incorporation of new elements or components, be the firms or institutions in the SS (new laboratories, or new products for financing of innovation); or on account of the appearance of new connections, both national among sub-systems, as well as international. Such is the case where new demands for products and services from the SS emerge in the BS (i.e. financing or training); demands for new relationships or demands for the restructuring of the companies themselves. This is especially relevant for purposes of developing public policies, since, consequently with the fact that there are co-evolution processes, policies are required for the "coordinated growth of supply and demand". (Ibid, 240).

A characteristic of the transformation of the systems is that it is cumulative, and that it comprises the co-evolution of its different elements. In fact, once the transformation has begun, and on account of positive feed-back processes, the learning processes between the elements in the system mutually reinforce each other: growth encourages even more growth. So, for example, interactive learning among start-up companies and recently-created capital funds. Therefore, accumulation processes are directly related with co-evolution processes of the BS and the SS.

4. THE APPROACH FROM COMPLEX SYSTEMS: THE NEW EVOLUTIONARY MICRO-ECONOMICS

As a complement for the methodological approach this project will build on the developments of the new evolutionary microeconomics that Potts propose (2000). Potts proposal stems from the need to bring unity to various questions that heterodox economic schools of thought (for example the Austrian, the behavioral, the evolutionist, the neo-institutional, the Post-Keynesian and the Neo- and Post-Schumpeterian schools) make about the "neo-walrasian" orthodoxy. For him, the unifying element in the heterodoxy questionings and which is translated into concepts such as uncertainty, limited rationality, or imbalance, is the "geometry of the economic space".

This, as opposed to the orthodox assumption, is not one of an integrated space, but rather one of a complex system. In fact, the reality of economic systems contradicts the assumption under which it is an integrated space. Even though the economic system is comprised by elements (such as products, consumers and companies) and connections, no element is connected to all other elements. There are uncertainties and bounded rationality, as well as cognitive, social, organizational, market, space, temporary and heuristic structures that restrict the possibility that all elements in a system may be connected. For Potts, then, the synthesis of the collective of heterodox economy is the study of the connections in the economic system: the connections exist and are incomplete, and this fact determines the structure and dynamics of the economic system.

In presenting his theory – and having explained as how the evolutionist metaphor, when applied to the economic system, may be liberated from its economic base – shows that it is about the study of “information acting on itself”. In the economic context, the problem is no longer only the allocation of resources, but rather the general issue of coordination. “In the context of the evolutionary economics, we refer to the processes by which a complex system, such as an agent or firm, or population of such systems, is able of transform itself by endogenous re-configurations of that information” (Potts, 2000: xi). That is to say: “Connections define information. Changes in connections affect a different structure or organization, or technology, or whatever. Connections by their specificity define systems, and thereby changes in connections constitute the micro-processes of evolution. Hence, evolutionary microeconomics is the study of the micro- and macrodynamics of the connections”. (Ibid, p. xi).

In general, evolutionary microeconomics is built on two ontological premises: a set of elements and a set of connections, that constitute a system. Economy, then, is a system of these systems, whose dynamics take place in a space of connections. And, whenever changes in the connections occur, they also affect the structure of the system.

Therefore, if the application of this metaphor is extended to the description made above of the dynamic and transformation nature of the innovation systems, the results are that the elements would be constituted by the BS and by the SS, and that the connections are given by the relationships and the interactions held by the different comprising elements. “Connections exist in the modalities of technology and in the forms of organization and competition. They exist in

the form of contracts. They exist in the structure of the decision-making rules and in the way in which that information is processed". [Ibid]

Technological change, for example, may occur when the relationships between the elements are changed, or when new relationships are established. Such is the case with a new design concept or product, or with the reconfiguration of an organizational structure, or in the creation of a new distribution network. Institutions change as much as connections change, but these generate new behaviors, routines and social structures. Therefore, the concepts relating to information and coordination are essentially about the geometry of the connections in the economic system. The analysis, then, revolves around open systems and the dynamic coordination, self-organization and self-transformation processes inherent to them.

5. CONCLUSION

An answer to the question formulated at the beginning of this essay will be attempted based on the conceptual elements herein proposed. The development of the analytical methodology will be based, in principle, in Teubal's (2002) and Pott's (2000) proposals, from which the purpose will be to understand which factors act simultaneously as the logical cause for the interactions that take place on the micro-level. This way, the purpose will be to describe and analyze the structure of the NIS in terms of the underlying dynamics in the connections among their elements. To this end, it will also be necessary to study the internal structure of the agents, the evolutionist dynamics of the technology and the institutions that the agents create, the structure of the companies and other complex agents, as well as the interactions – both market-related and non-market – that take place among the agents that comprise the System's dynamic networks.

Considering that the project's interest is mainly on the effects that policies have over firms, non-market operations will have to be treated centrally as part of the project's development. The idea is to take advantage of the strategy proposed by Potts in order to merge several of the contributions from the heterodox schools and filter them through the theory of complex systems, the graph theory and the theory of networks.

As an instrument for analysis, it is necessary to develop simulation models. For this, and as proposed by Potts (2000), descriptions will be used, of the concept of complex systems, based on

the graph theory, “which is a branch of mathematics that recognizes the existence of elements (vertices) and connections (edges) as two distinct sets. This defines, for each possible combination, a *graph* as an ontologically complex object”. (Potts, 2000: 8).

Therefore, a complex system can be used to estimate certain types of simulations that represent micro-economic events, that are the basis for economic evolution. Finally, an attempt to apply the algorithmic models from the economic agents model proposed by Potts – *hetero economicus* – to the Colombian environment, which have been thought of as artificial agents that learn and interact. These agents may be individuals, companies, supporting institutions or public institutions, that have preferences and that access, develop, adapt and use technologies and information for their own self-organization and self-transformation.

6. BIBLIOGRAPHY

- Cantwell, John (2005) “Innovation and Competitiveness”, in Fagerberg *et al* (2005)
- Edquist, Charles (2005) “Systems of Innovation. Perspectives and Challenges””, in Fagerberg *et al* (Eds) (2005)
- Fagerberg, Jan and Godinho Manuel (2005) “Innovation and Catching-up” in Fagerberg *et al* (Eds) (2005)
- Fagerberg, Jan (2005). “Innovation: A Guide to the Literature” in Fagerberg *et al* (Eds.) (2005)
- Fagerberg, Jan; David Mowery and Richard Nelson. Eds (2005). *The Oxford Handbook of Innovation*. Oxford University Press 2005.
- Hausmann, Ricardo and Bailey Klinger (2007) *Achieving Export-Led Growth in Colombia*.
- Hernández, Iván et al (2008) *Empresa, Innovación y Desarrollo*. Universidad Nacional de Colombia.
- Lall, Sanjaya and Morris Teubal (1998). ““Market-Stimulating” Technology Policies in Developing Countries: A framework with Example from East Asia”, en *World Development* Vol. 26, N° 8, pp. 1369-1385.
- Lundvall, Bengt-Åke and Susana Borrás “Science, Technology, and Innovation Policy”, en Fagerberg *et al* (Eds) (2005).
- Nelson, Richard (2006) “Economic Development from the Perspective of Evolutionary Economic Theory” en *Working Papers in Technology Governance and Economic Dynamics* N° 2. The Other Canon Foundation; Tallinn University of Technology.
- Nelson, R. and Sidney Winter (1982). *An Evolutionary Theory of Economic Change*. Harvard College.

Nooteboom, Bart (2000) *Learning and Innovation in Organizations and Economies*. Oxford University Press

Potts, Jason D. (2000) *The new evolutionary microeconomics: complexity, competence, and adaptive behaviour*. Edward Elgar Publishing Limited. Cheltenham, UK.

Teubal, Morris (2002) "What is the systems perspective to Innovation and Technology Policy (ITP) and how can we apply it to developing and newly industrialized economies?". In *Journal of Evolutionary Economics* (2002) 12: 233-257

Teubal, M., Esben Andersen (2000) "Enterprise Restructuring an Embeddedness: A Policy and Systems Perspective". At *Industrial and Corporate Change*. Volume 9. Number 1. 2000