

Systems of Innovation for Development

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1. Introductionⁱ

The world environment has gone through significant transformations - encompassing political, productive, technological, organisational, informational, commercial, financial, institutional, social and cultural dimensions - that are dynamically related. These transformations associated to the setting up of a new world order are implying in important adaptations and restructuring that deeply affect general conditions for development and also:

- ❖ political and economic hierarchies of different segments within national and global contexts;
- ❖ different institutions (particularly their role and forms of organisation, articulation and functioning); and
- ❖ people (as workers, consumers and citizens).

One main argument of this paper is that as a result of these transformations, concepts and conditions for development, production and innovation, competitiveness, firms' organisation, management and strategies, Nation state, public and private strategies and policies are being reviewed and new approaches are needed. It is widely recognised that the capacity to generate and use knowledge is the most important element of the sustainable competitiveness growth and development of firms and countries. In fact, as particularly emphasised by the evolutionary approach to innovation, learning - the key source of change - is seen as the most important mechanism for knowledge accumulation, innovation and growth. Of course firms are in the centre of these processes. However, it is increasingly noted that the interactions among them and with a number of other organisations (dealing with education, training, R&D, financing and policy support, etc.) play an important role in the process of knowledge creation and diffusion.

To deal with such complexity the notion of systems of innovation was developed. The main argument sustaining this notion is that innovations (as knowledge) cannot be seen as isolated events; and that technical change is the result of an interactive process, which

both determines and is determined by the institutional environment and which depends on both:

- ❖ radical and incremental innovations;
- ❖ technical, organisational and institutional innovations

Orthodox theory neither conventional neoclassical theory nor the so called "modern growth theory" provide the right kind of analytical framework for this kind of discussion. Neoclassical theory is based upon the idea of the "representative" firm, with perfect information about its future opportunities. Technology is given from outside and it is normally assumed that the firm has perfect knowledge about it. Its production function is "generic", not "firm-specific". Although modern growth theory has successfully modeled endogenous forms of learning, increasing returns to scale, and imperfect competition it does not provide a useful characterization of the institutional environment underlying innovative and technological behaviour.

Evolutionary economics have been precisely concentrating on the behaviour of institutions, on the complex nature of learning processes at the level of the firm and on the ways different societies develops learning and innovation capabilities through time. This systemic character of innovation which is historically determined and location specific which is crucial for the discussion to be taken in this paper is precisely what orthodox theory can not provide. With the additional argument that the analysis of the specificities of different national systems of innovation is fundamental to understand why technological dynamism occurs more rapidly and efficiently in some countries than in others, emphasis to the national character of systems of innovation was given; and the concept of **national systems of innovation** - NSI - was introduced (Lundvall, 1985; Freeman, 1987).

There have been, however, very limited attempts to use the idea of NSIs in less developed countries. In fact, until recently, development theory has focused on comparative wage rates, natural endowments and other related static advantages as necessary preconditions to less developed countries participate in the world market. It is true that a number of authors have emphasised the role of technological change in the growth of developed countries. However, even if a large and important body of literature on technical change and development has recently emerged, industrialisation has not been typically thought of in terms of technical change by development analysts.

The basic aim of this paper is to discuss part of the results of a research project on national and local systems of innovation in Brazil and other Mercosur countries coordinated by the authors. The research project is gathering information of local productive arrangements in order to discuss new possibilities for industrial and technology policies in these countries.ⁱⁱ

Following the steps of the research project, this paper is firstly concerned with understanding how the above mentioned transformations are:

- inducing new forms of development and of insertion of developing countries in the globalised world;

- influencing their systems of production and innovation;
- requiring new industrial and technological development policies.

In order to do that **item 2** will briefly examine the new role of innovation stressing the importance of learning processes and interactions; while **item 3** will present the findings of a research project aiming at understanding how productive arrangement and their innovation systems in Brazil are facing the changes of the 1990s. The final target of the paper is to draw policy implications from this discussion and to explore what would be the main requirements for development and, particularly, the promotion of productive and innovative systems in Brazil and other developing countries (**item 4**).

2. Innovation in the Knowledge/Learning Economy

There is an increasing convergence of visions among different schools of thought when trying to understand the factors underlying a better competitive and innovative performance as well as sustainable and dynamic development of firms, sectors and countries. Interaction among firms and other agents has been recognised as a fundamental source of competitive advantage. This is particularly true in the Knowledge/Learning Era. As a result, investigation about different arrangements, relations between firms and between firms and other institutions and their forms of networking and their local environments has significantly grown during the last two decades.

Terms such as synergy, collective efficiency, economies of agglomeration (clustering), associational economy, and learning-by-interaction express the main preoccupations of this debate. Different concepts – such as industrial districts and poles, clusters, ‘milieu’, networks and others – have been used to account for the need of focusing on a specific set of economic activities and interactions. Also new and old approaches have been developed to encompass these activities and agents as well as to allow the exam of the relationship between them, namely: ‘*milieu innovateur*’ and national (local) systems of innovation. It is noteworthy that the main motive of this research effort relates to their policy-making implications and the investigation of new policies and policy tools to stimulate industrial and innovative development.

One argument here is that, far from losing relevance, this research effort focusing on national and local capacities and characteristics will probably increase with the intensification of the globalisation process. The clustering of firms and the collective synergies generated by their interactions, and between them and their environment, make it feasible to innovate, strengthening their chances of survival and growth, which constitute an important source of advantages in the increasingly globalised economy.

It is also worth mentioning that it is not by chance that the concept of national (sub and supra-national) system of innovation was developed in the 1980s as a response to the spread of the idea that the world was going through a process of economic and technological globalisation. One main objective there was to deny the hypothesis that in the “new economy”, local and national specificities would disappear and the role of policies (in general, and technology policies, in particular) would have no relevance.

Therefore, two main arguments of the group of authors working with this framework relates to the understanding that (i) local and national dimensions of innovation and learning processes are even more important with the acceleration of globalisation; and that (ii) the agenda for active innovation policy is extended rather than made obsolete by the new developments.

To summarise: among the main questions contributing for a better understanding of the innovation process of the last few years one can single out the acknowledgement that:

- ⇒ innovation and knowledge are, ever than before, central elements of the growth dynamics and development of nations, regions, sectors and institutions, with the development of learning and innovative capacities becoming even more essential to allow firms to participate in (and make use of) networks and flows of information and knowledge that characterise the present stage of world capitalism.
- ⇒ there are marked differences among agents and their capacities to learn. Innovation - as a process of search and learning and dependent on interactions - is socially determined and strongly influenced by specific institutional and organisational formats. Therefore, far from a trend towards homogenisation, important differences among innovation systems of countries, regions, sectors, organisations, etc. reflect the social, political and institutional context where they are embedded.
- ⇒ if information and codified knowledge present growing conditions of “transferability”— given the efficient diffusion of IT — tacit knowledge (which has a localised character) continues to have a prime role for the innovative success and is still very difficult to be transferred.

Additionally to these considerations, another argument of this paper is that local productive and innovative systems are particularly important for developing countries. The dynamic participation in such organisational format has helped firms of all sizes, but specially micro, small and medium enterprises – MSMEs - to get over growth barriers and to effectively manufacture and commercialise their products. Arrangements of MSMEs are specially important in regions where they mean both employment opportunities and the main (or only) possibility of promoting local development.

3. Local productive arrangements in Brazil in the 1990s

This item starts by summarising some of the main findings of a research project set up with the objective of analysing experiences of selected local productive arrangements and their innovation systems in Brazil, in the 1990s, aiming to design S&T policy propositions at national and regional level. Factors affecting processes of learning, innovation and diffusion strategies of firms, cooperative behaviour and evolution of institutions will be discussed in this item.ⁱⁱⁱ These topics are discussed taking into account the results of a survey covering 26 selected case studies analysed in Brazil from 1998 to 2000.

Table 1 presents a summary of these empirical studies. The classification proposed there focuses on the degree and type of governance that happens in each particular type of arrangement. The first column comprises 15 cases of arrangements of SMEs producing mostly commodities ranging from traditional industries such as shoes and apparel to agroindustrial business such as tropical fruits. Some are geared to the external market, such as the shoe industry in Rio Grande do Sul and tropical fruit in the Northeast while others concentrate their sales in the internal market, such as the shoe industry in Paraíba and the apparel industry in Rio de Janeiro. Some arrangements cater both for the external and the internal market.

The second column comprises 5 cases of arrangements dominated by large firms both of the hub-spoke and industrial platform types. Three of these arrangements are controlled by local affiliates of transnational corporations – TNCs, while two are dominated by recently privatised locally controlled large firms. Four of these arrangements are export-intensive (two locally controlled and two TNC subsidiaries in the agro-business), while the auto industry arrangement concentrates in the internal market. The third column consists of hi-tech firms anchored by a public entity such as a university or a research centre. They contain basically, but not only, locally owned SMEs.

Table 1: Summary of surveyed local productive arrangements in Brazil - 2000

SME arrangements	Arrangements controlled by large firms	Arrangements organised around government institutions
Footwear (RS, MG and PB)	Aircraft (SP)	Telecom (SP, PR)
Apparel (SC, RJ)	Automobile (MG)	Soy (PR)
Tropical Fruits (RN)	Steel (ES)	Software (RJ, SC)
Furniture (SP, RS, MG, SC)	Tobacco (RS)	Biotech (MG)
Wine (RS)	Metal-mechanics (ES)	
Cocoa (BA)		
Ceramics (SC)		
Ornamental Stones (RJ and ES)		

The interviews revealed that, during the 90s, most firms' competitive strategies concentrated on improving production organisation, product quality and modernisation of production processes, normally through equipment imports. There has been an increase in learning capacity of firms, with emphasis on organisational efficiency, skills and production organisation. Most arrangements have centred their efforts on improvements

of their production processes, while only a few decided also to focus on developing new products. As a result of the opening up to unregulated imports of goods, services and capital, most arrangements are moving towards more complex production systems but simultaneously becoming less intensive in the use of local engineering and technological capabilities.

The evolution of learning and innovation capabilities of SMEs have depended very much on the (i) type of relationship they maintain with other firms across the production chain; and (ii) how they could react to changes in the policy regime. This was particularly the case of the arrangements of fruit processing in the Northeast and wine production in the South, which are based on domestically-owned SMEs. For these arrangements, local market is important but exports are becoming more significant. Also State-owned agricultural research centres have had an important role in the development of new plant varieties and in their diffusion to industrial production. Export strategies and – in the case of wine production – the need to compete with foreign products have pushed local producers to strategies that include improvements in their innovative capacity. This progress is associated with continuous experimentation and very little formalisation of activities (such as R&D).

In the hi-tech arrangements, however, the situation is very different. Competition in these sectors is strongly related to the capacity to design, develop and market new products. This type of competition puts intense pressure on firms willing to survive and grow. Interviews confirmed that internal capability, although necessary, is not sufficient to grant firms' survival. Particular emphasis was put mainly on the role of the pattern of competition, policy regime (interest rates, exchange rates, etc.) and the possibilities of networking. In the 90s, with the exception of the biotech arrangement in Minas Gerais, there has been an impressive rate of disappearance of firms, while several have been acquired by TNCs. Those that survived (as well as for those which were acquired) have narrowed the range of intra and inter-firm manufacturing activities and changed significantly the nature of innovation activities performed. Firms decreased those activities with higher innovative intensity (such as R&D and engineering for new products) and increased activities of lower technology intensity. In a related way, there has been a significant decrease in the employment of more specialised personnel. Interviews confirmed that, some of the engineers that remained employed were downgraded in their occupations.

As for the collaborative efforts, in most cases studied collaboration did not increase in the 1990s. In fact, the empirical results show that in all arrangements dominated by subsidiaries of TNCs, technological collaboration significantly decreased during the period. Even in the cases where collaboration increased – basically in arrangements controlled by local firms that target their production to the internal market - a very slow increase in formal cooperation with local institutions and firms was detected. The survey also confirmed that when cooperative relationships occurred, they were mostly based on transfer of tacit knowledge and high level of informality.

Among the analysed cases, it is in the ceramics arrangement where technical cooperation is being pursued further. Interviews showed that one of the most important forms of development or incorporation of new technologies is joint collaboration with input

suppliers. In fact, more than 80% of the interviewed firms declared they maintain monthly, weekly or daily technical contacts with suppliers/clients for activities related development and improvement of products, design of products and technical assistance and to exchange ideas and information. But this case was an exception.

In all surveyed cases there are local institutions which are (or could be) in charge of fostering cooperation among local actors. However, few are really successful in supporting innovation and learning strategies. The constitution of the Brazilian Institute of Wine (IBRAVIN), the Center of Technology in Ceramics – are examples of the joint efforts by local firms for upgrading products and improve quality. It is also worth pointing out that arrangements coordinated by TNC subsidiaries (tobacco, cocoa and auto in Brazil) where innovative capabilities and cooperative behaviour had decreased.^{iv} In these arrangements, organisations were created primarily to coordinate labour relations and to provide a common, organised relationship with suppliers in order to settle prices. Even if such organisations carry out an important role in the maintenance of an integrated production system, they have a very limited role in establishing resource enhancing relations.

To sum up, the main conclusions of the research project on local productive and innovative systems in Brazil have provided evidence that, in the 1990s, with few exceptions, instead of being reinforced:

- ⇒ productive and innovative efforts are decreasing and this of course affects both firms' core capabilities as well as their learning processes;
- ⇒ productive and innovative networks are being disarticulated (and there is no new significant articulation between the new investments and local agents);
- ⇒ the level of employment of specialised personnel has decreased (and this has been followed by the downgrading of the occupations of some of the specialists who remained employed).

In Brazil these trends were particularly observed in the case of the high-tech arrangements (especially ICTs), despite the important role they have played - and are expected to play - as promoters and diffusers of technical progress to other sectors and activities. The research showed that the most successful arrangements in the 1990s were those dealing with traditional technologies and in particular those natural resources intensive.^v Of course it was very important to learn how these arrangements were positively responding to the new challenges of the 1990s. However, the disarticulation of important high-tech arrangements that had accumulated both productive and innovative capabilities and the fact that Brazil's share of world exports of hi-tech products decreased from 0.6% in 1985, to 0.26% in 1991 and 0.19% in 1995^{vi} assume particular importance in the new era entitled as Knowledge Era.

It is also important to stress the influence of the macroeconomic environment on the innovative propensity of local firms. Many of them, seeking primarily to survive, have abandoned most long-run concerns. Above all, the predominance of short term financial objectives (both in public and private strategies) associated to high levels of instability,

high exchange and interest rates impose important restrictions to any policy aiming at promoting industrial and technological development. Instead of fostering local capabilities, the 'competitive insertion' model, adopted in Brazil, assumed that:

- the opening of the economies and the attraction of foreign investment would be the best way to improve the form and degree of integration of these economies in the world market;
- technology, innovation and knowledge can be globalised; and like a commodity, could be acquired internationally under market conditions.

Attempts to accelerate the integration of Latin America into the global economy by attracting foreign capital resulted in an effective increase of FDI. The flows of foreign investment increased from US\$ 8 billion in 1990 to US\$ 67.3 billion in 1998, and the stock of FDI grew 60% in the period. Although inflows in the 1990s are approximately 13 times of what was observed during the 1970s, economic growth has been 50% lower. It is worth noting that FDI in the 1990s was mostly directed to mergers and acquisitions of existing firms (and their accumulated capabilities) rather than 'greenfield' investment. Also, and contrarily to what was planned, these new investments are basically import-intensive and are not geared to exports, targeting mostly local markets. An additional great concern relates to the sustainability of this situation.^{vii}

Therefore, the appropriateness and effectiveness of the policies adopted in the region can be questioned in many points, including their very basic target: the increase of international competitiveness and an effective insertion in the globalisation process. In the case of the Mercosur economies, although the export profile has evolved in such a way that industrialised goods are increasingly important, their insertion in the international market is still characterised by the exports of *commodities* that are intensive in natural resources and/or energy and in low wage. These *commodities* have shown a tendency to low dynamism, excess supply and price stagnation.

More important than that is the loss of world market shares. Export growth of these countries has been much slower than the increase in world trade. Even worse than this poor and negative economic results is the deterioration of social conditions in Latin America. A recent CEPAL report (Stallings and Perez, 2000) conclude that the reforms had negative impacts not only on the level of employment and of the posts offered, but also on the income distribution of the region.

4. Conclusion

Regarding the main conclusion of the research project about local productive and innovative systems in Brazil, three interrelated points are mobilising the discussion on the need of new forms of industrial and technological policies. One refers to the challenge of transforming productive arrangements in dynamic and innovative systems. That is how to foster and support an agglomeration of firms and other institutions into its process of becoming an articulated group of agents that can collaborate in production, innovation, design, marketing, commercialisation, etc. The second relates to the need to create

conditions to promote the development of new productive systems. In this case the challenge is also to give them conditions to grow and sustain their growth. Lastly and more importantly, there is a need to establish adequate macroeconomic conditions, not only to allow these two targets to be fulfilled, but also to revert the situation of destruction of existing local productive and innovative capacities, that have been previously accumulated, as documented in the Brazilian case.

This paper argues that one of the main problems facing Brazil and other Latin American countries, in the turn of the millennium, results in part from a very poor understanding of the nature and consequences of the present transformations the world economy and society is going through. Policies adopted by most Latin American countries reflect these misunderstandings. Therefore, it points to the need of advancing towards an adequate understanding of the permanent characteristics and impacts of the new socio-techno-economic pattern of accumulation, the role of information technologies and their diffusion, the new forms of innovation and learning processes, etc. In this effort it is essential the understanding that:

- ⇒ far from being an integrated and borderless world, the so-called globalisation requires the attaining of local, national and regional specificities;
- ⇒ traditional visions that define competitiveness in terms of prices, costs (particularly labour costs) and exchange rates have become obsolete;^{viii}
- ⇒ sustainable forms of industrial and technological partnership require levels of qualification and capabilities that are much higher than in the past;
- ⇒ local learning processes are fundamentally based on dynamically improving human resources and stimulating different forms of articulation among agents;
- ⇒ the stronger the human resources base, the greater is the possibility of accelerating learning processes, the stronger the potential for innovation and the broader the chances of the system to face competitive pressures.

All of this requires the design and implementation of more sophisticated forms of promoting industrial and technological development taking into account the present transformations, local and national conditions for development and also the changes associated with new forms of governance at world level

The implications of the discussion above are important for developing countries for three related reasons. First because policies that are being pursued in these countries, are based on the idea that technology and knowledge have become 'global' and that like a commodity, they could be acquired internationally under market conditions. Of course one could argue that moving to testing and quality control from previous commitment to product innovation should be viewed as a positive, important achievement, as a necessary way to integrate into the world economy. In fact, in a globalised economy it is impossible for firms to be isolated and not linked to international sources of technology. Evidently, opening up to international trade implies that not every production technology should be

developed locally. The point here, is that, the capacity to use the technology is intrinsically related to the capacity to understand and absorb it.

On the whole the results of our research project suggest, firstly, that a simple exposure to international competition is not at all sufficient to foster firms to increase their innovative activities and their competitiveness. The few success stories analysed highlight, in particular, the importance of continuous public and private policies and efforts aiming at promoting the capacity to acquire and use knowledge and to innovate. They also show that these policies and efforts should be based on strengthening local resources, organisations and institutions, as well as on the quality and intensity of their interactions. Both these cases and those where local innovation systems were negatively affected by the changes of the 1990s suggest that the setting up of local systems of innovation in development conditions in a globalised world requires a type of intervention that should be much more sophisticated than a simple attraction of foreign direct investment.

Secondly, this discussion is important for the understanding of national systems of innovation in developing countries since the very idea of NSIs implies different roles for firms according to their capital ownership, innovation strategies and links with local arrangements. However, it is recognised that, not even in the case of developed countries, this issue is very much debated.

Thirdly and as pointed out by a number of Latin-American and Caribbean authors, the evolutionary literature on innovation systems tend to give little attention to problems related to the instability and vulnerability of the macroeconomic, political, institutional and financial environment, which have been a marked characteristic of less developed countries. Additionally, some of them point to problems such as hyperinflation, high external debt and high interest rates as common important constraints to technological (and productive) development in these countries.^{ix}

Considering the broader research agenda in this area, further emphasis should be given to the role of localisation (understood as 'societalisation'), geopolitics and the linkages between the macro-economic and micro-economic environments which determine success, cohesion and longevity of these systems. And of course much more empirical analysis should be done focusing **National and Local Systems of Innovation** in the context of development.

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ⁱ This paper is based on Local Systems of Innovation in Mercosur Facing the Challenges of the 1990s and Innovation Policies in the Knowledge Era: a South American perspective by both authors.

ⁱⁱ The project involves a network of researchers of more than 50 people in Brazil, Argentina and Uruguay. The reports produced for the first phase of this project were published in Cassiolato and Lastres, 1999. All papers of the project are available in www.ie.ufrj.br/redesist.

ⁱⁱⁱ See Cassiolato and Lastres, 1999 and the technical notes of the project in www.ie.ufrj.br/redesist.

^{iv} In fact, this pattern, seems to be a common feature of the Latin American experience in the 1990s. As suggested by Katz, 1999, TNC “subsidiaries changed significantly their innovation strategies, as they increased the import content of their products. They have discontinued local engineering activities that they undertake in order to adapt or improve product and process technologies” (p. 24-5).

^v This finding is also in agreement with the observed trend towards the specialisation of most Latin American economies in natural resources (Katz, 1999).

^{vi} Argentina’s share decreased from 0.08% in 1985 to 0.04% in 1995. In both cases, the relative decline was accompanied by an absolute one, while total exports of these goods more than doubled during the period. For more details see Cassiolato and Lastres, 2000.

^{vii} For more details see Cassiolato, 2000

^{viii} See the concept of ‘spurious competitiveness’ introduced by Fajnzilber, 1988.

^{ix} See, among others, Villaschi, 1993; Melo, 1996; Girvan, 1996, Katz, 1999, Arocena and Sutz, 2000.