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Innovation Systems and Developing Countries

by

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Abstract

Connecting the theory of National Systems of Innovation with Development theory offers new insights for a global and interdisciplinary analysis of the current problems of underdevelopment. Some of the main contributions of classical Development thinking are seen to be most relevant. The role of different social actors is highlighted. Attention is driven to concrete processes of interaction., as well as to their economic, political, institutional and cultural contexts.

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Foreword

How can we characterise developing countries? Their heterogeneity seems to make the task impossible but, in the present as well as in the past, it is possible to derive a definition from exclusion. When the transition from agrarian societies to industrial societies framed world history, “developing” countries were those unable to move along industrialisation roads; consequently, the expansion of the industrial West was for them a source of subordination, and so they became in fact not “developing” but underdeveloped countries. Today, when we are living the transition to the knowledge society, the economy of developed countries is solidly based on science, technology, innovation and advanced education. Developing” countries are “the rest”, those unable to use knowledge - its generation, transmission and application - as a fundamental tool for economic growth and social improvement.

In the so-called “golden age” of development - the decades following World War II -, great hopes arose from different strategies proposed for the industrialisation and progress of underdeveloped countries. Those proposals differed on the identification of the “prime motor” of development, but the existence of such a factor was a simplifying common assumption; thus, they can all be seen as “monist” approaches, or models in a strict sense of the term. Disappointment with development, which covered almost all the Third World during the 1980s, came along with a sterilising debate between state and market. The failure of state-centred models was followed by a new failure of market-centred models, while some successful growth processes took place, apparently without following any of those models. In the Latin American social sciences, doubts displaced certainties (Sonntag, 1988). Since the 1990s, questions rather than answers dominate developing thinking at the world scale.

This paper aims to elaborate, in a schematic way and without any pretension of originality, an assertion that we believe to be fundamental: the theory of National Systems of Innovation, NSI,¹ offers a very useful approach for a reconsideration of the problems of Development seen as an integral social transformation. From such a standpoint, some of the classical contributions of Development thinking show new strength.

The NSI theory:

- (i) highlights the relevance of several social actors, thus going beyond the schematic opposition between state and market;
- (ii) focuses not only on economic matters but also on political, institutional and cultural issues;
- (iii) directs our attention to some concrete processes of interactions between actors and organisations, offering a general frame for their study. Those three potentialities of the theory pave the way to a fourth and fundamental one:
- (iv) it is a tool for studying the concrete aspects of innovation activities in underdeveloped countries, thus contributing to a revitalisation of Development thinking, which defining task was the global and interdisciplinary analysis of the specific features of “the peripheral condition”.

This condition and its features were stressed by the classical Latin American conception of Development, shaped and strengthen between the 1950s and the 1970s, but quickly weakened during the 1980s. Another defining feature of that classical Latin American conception of Development seemed also to vanish away during the great crisis of those years - the idea of Development as an integral social transformation.

¹ Lundvall, 1985, 1988, 1992; Freeman, 1987; Nelson, 1993; Edquist, 1997.

Now, such idea is not far away from the notion of Development as Freedom, in the recent and vigorous formulation of Amartya Sen (2000). This notion is characterised by “seeing people as agents rather than patients” (Sen, 2000: 137). The priority given to the expansion of freedoms inspires an “activist” view of Development: “this freedom-centred understanding of economics and of the process of development is very much an agent-oriented view” (Idem: 11).

Thus, the NSI theory and Sen’s vision converge in an actor-centred approach to Development, seen as a multiple ways search for improving the quality of life in the manifold realities moulded by the specific conditions of the “South”.

Beyond monoecconomy

In the early 1980s, Albert Hirschman wrote a famous essay about the evolution of developing theory, explaining some causes of its fast rise and of its even faster decline:

“... development economics started out as a spearhead of an effort that was to bring all-around emancipation from backwardness. If that effort is to fulfill its promise, the challenge posed by dismal politics must be met rather than avoided or evaded. By now it has become quite clear that this cannot be done by economics alone. It is for this reason that the decline of development economics cannot fully reversed: our subdiscipline had achieved its considerable luster and excitement through the implicit idea that it could slay the dragon from backwardness virtually by itself or, at least, that its contribution to this task was central. We now know that this is not so; a consoling thought is that we may have gained in maturity what we have lost in excitement” (Hirschman, 1981: 23).

The essay just quoted opens a volume that aims at “trespassing” disciplinary frontiers, going “from economics to politics and beyond”. Our main assertion can now be reformulated by saying that the NSI theory is precisely, the adequate conceptual tool for such an operation of “trespassing”.

Hirschman’s approach helps to elaborate a point already mentioned. He explains that development economy was shaped by two basic economic assertions:

“By rejection of the monoecconomics claim I mean the view that underdeveloped countries as a group are set apart, through a number of specific economic characteristics common to them, from the advanced industrial countries and that traditional economic analysis, which has concentrated on the industrial countries, must therefore be recast in significant respects when dealing with underdeveloped countries. The mutual-benefit claim is the assertion that economic relations between these two groups of countries could be shaped in such a way as to yield gains for both” (Hirschman, 1981:3)

Orthodox economics assumes the “monoecconomic” approach because it asserts that:

“The orthodox position holds to the following two prepositions: (a) economics consists of a number of simple, yet “powerful” theorems of universal validity: there is only one economics (just as there is only one physics)” (idem :4)

Now, the decline of development theory as a “sub-discipline” of economics, did not open the way to the “trespassing” of disciplinary frontiers that Hirschman asked for, but on the contrary, to the reinforcement of “monoecconomy”. That happened in the context of the “Counter-Revolution in Development Theory and Practice” (Toye, 1987) which, particularly in Latin America, debunked a family of state-centred approaches to Development that were highly original. They were replaced in the foreground of

academy and politics by a market-centred approach, summarised in its recipes by the original and revised versions of the Washington Consensus given by John Williamson (1990, 1997). Although nowadays the World Bank does not endorse such recipes in the same uncritical way as yesterday, the inspiring approach is still very strong in academy and in decision making places. The results of the dominant strategies have been, though, less than impressive.

During the 1990s, economic growth in Latin America was higher than in the “lost decade” of the 1980s, but quite irregular, globally insufficient and well below the average of the period 1950-1980. There are more poor people than ever in the continent and the percentage of the population below the poverty line is only a bit less than at the end of the lost decade; social and environmental sustainability is severely challenged (CEPAL, 2000). It is thus urgent to build alternatives to the prevailing “monoeconomy”, by reinvigorating the specific analysis of “the peripheral condition” and by “trespassing” disciplinary frontiers. We need (Sen, 2000: 8-9)

“to investigate the development process in inclusive terms that integrate economic, social and political considerations. A broad approach of this kind permits simultaneous appreciation of the vital roles, in the process of development, of many different institutions, including markets and market-related organisations, governments and local authorities, political parties and other civic institutions, educational arrangements and opportunities of open dialogue and debate (including the role of the media and other means of communication).

Such an approach also allows us to acknowledge the role of social values and prevailing mores, which can influence the freedoms that people enjoy and have reason to treasure. Shared norms can influence social features such as gender equity, the nature of child care, family size and fertility patterns, the treatment of the environment and many other arrangements and outcomes. Prevailing values and social mores also affect the presence or absence of corruption, and the role of trust in economic or social or political relationships. The exercise of freedom is mediated by values, but the values in turn are influenced by public discussions and social interactions, which are themselves influenced by participatory freedoms.”

The Innovation Systems approach

Johnson and Lundvall (2000) point out that, when there is no more a consensus on one “best-practise” or a unique key factor concerning development strategies, “the concept of *innovation systems* is helpful both as an *analytical tool* and as a *guide for policy making*.” In this context, they stress a very important point: both the role of knowledge production and the problem of knowledge transfer have been underestimated in the NSI theory. In particular, not sufficient attention has been paid within this theory to the transformation going on in universities, that albeit not the only actors in the processes of knowledge production are nonetheless key players. The contrast between universality and specificity manifests itself clearly in this aspect. Universities are markedly universal institutions and are everywhere under extra-academic pressures nowadays. However, how universities change, how they interact with other social actors and, finally, how efficient they become as “innovator actors” heavily depend on the historical background and the general configuration of the NSI in which they are inserted (Marceau, 1997, Arocena&Sutz, 2001a).

We would add that the whole issue of endogenous generation of knowledge in underdeveloped countries has been also underestimated, in spite of outstanding contributions, like those of Sabato and Mackenzie (1982), where we can still find relevant guides for facing present day problems. Underdeveloped countries, given the highly specific characteristics of several of the problems they face, will not be able to

find solutions to such problems unless they can count on their own innovation capabilities.

The fact that four different types of capital - production, natural, intellectual and social - are interdependent is, for Johnson and Lundvall, a major reason for promoting the systemic and interdisciplinary approach that is needed for coping with the many sided problems of knowledge and environmental sustainability. They recall that the most fundamental reason for thinking in terms of innovation systems is that innovation is an interactive process, where results depend on the type of relations between different firms, organisations and sectors, as well as on institutional behaviours deeply rooted in each regional or national history. Summing up, the paper we are referring to shows how the innovation systems approach offers an interdisciplinary perspective, that takes into account the interactions between several social actors and the diversity of factors that shape such interactions.

Such “actor-centred vision” comes directly, in the context of the theory of National Systems of Innovation, from the user-producer approach to the theory (Lundvall, 1988), with its stress on the relevant and frequently neglected role of “final users”. Specifically, it is said that, while “the classical actors in innovation studies are individual entrepreneurs and the R&D laboratories of big firms”, with perhaps “secondary parts [...] played by scientists and policy makers” this approach highlights the potential contributions to innovation processes of other actors, as workers, consumers and the public sector as a whole (op. cit.: 365).

Bertelsen and Muller (2001) summarise in a precise way one of the basic features of the systems of innovation approach: “Interdisciplinary combining a structural and an actor oriented approach in a historical perspective.” In our view, that is what development studies need. Such studies and the NSI theory face some relevant common problems.²

The above remarks are closely connected with one of the main conclusions offered by Johnson and Lundvall (2000), when they say that the holistic character of the innovation systems theory, and its focus on learning by doing, using and interacting, ensure that it may be applied to the situation of developing countries, but that for such an application the theory needs to be adapted and extended.

Looking from the South

When the NSI theory is analysed from the perspective of underdevelopment, the following remarks (Arocena & Sutz, 2000a) seem to be relevant.

- i) “*National System of Innovation*” is an “*ex-post*” concept, that is, it has been built, in the North, on the basis of empirical findings. On the contrary, in the South it is rather an “*ex-ante*” concept, because socio-economic behaviour regarding innovation at national level is, in fact, hardly systemic. That does not mean that innovation is absent. In Latin America, a fundamental problem is that the micro-innovative strengths, that really exist, often remain isolated and encapsulated, thus weakening remarkably their potential contribution to the competitiveness of national economies.

² In a comment to the previous version of this paper, Björn Johnson (private communication) remarked that: “Many of the factors which make people able to be good learners and potential participants in interactive processes of innovation are also constitutive and instrumental parts of development.”

- ii) *The idea of National System of Innovation carries a normative weight.* This is not to postulate the possibility of an optimal design for NSI, which would imply the dismissal of diversity, one of the main characteristic features of such approach. Now, to discard the "ideal system" does not mean that the concept has no reference to what is "good" or what is "bad". For example, the difference in competencies between users and producers lies behind unsatisfactory innovations or the slow path of innovation adoption, particularly regarding the modernisation of mature industries, like textiles and clothing. This has been stressed by Lundvall, who refers approvingly to the way the Japanese MITI directed its efforts to modernise these sectors "as an attempt to compensate for the weak channels of information between producers and science based industries, and to break the inertia built into the traditional user-producer relationships" (Lundvall, 1985: 37, emphasis in the original). A National System of Innovation that takes into account user-producer knowledge asymmetries will probably be more effective in the promotion of useful innovations than one that does not pay attention to this type of problem: it seems then that the NSIs concept carries indeed some normative weight. This is important from a Latin American perspective: to avoid copying or just following the latest policy fashion, some points of reference must be identified, something like a normative guidance, that at least in part will be quite specific.
- iii) *The National System of Innovation concept is "relational":* almost all the literature on the subject stresses the utmost importance of the connections between different types of collective actors. Now, since in Latin America, it is a relatively common task to create organisations to foster innovation, but those organisations seldom operate as bridges between actors, it is worthwhile to underscore the relational nature of the NSIs concept. We shall return to this issue in the next section.
- iv) *National System of Innovation is a policy subject.* This does not mean that the whole shape of the system can be purposefully designed, nor does it mean that whatever policy or policy measure devised can be successfully implemented. But recognising that the NSIs concept is a political concept and that the reality it describes can be submitted to deliberate efforts towards change with a reasonable hope to achieving what is intended is not trivial. This is particularly so in Latin America, where science, technology and innovation have never occupied a high position on the political agenda.
- v) *NSI describe situations in which conflict is present.* Conflict can be found along two dimensions, one within the national system of innovation and the other at a more general, or macro-social, level. "Internal" conflicts have to do mainly with institutional competence and with inter-institutional problems. For instance: what is the relative weight that entrepreneurial organisations, political power and the academia have regarding the setting of the research agendas?; to what extent are the impacts upon national innovation capabilities taken into account in decision making undertaken in ministries, public enterprises and other public spheres? "External" conflicts, on the other side, can be found in different scenarios. Education is one of such scenarios; workers participation on technological decisions at shop floor level is another. NSI are not socially neutral: its configurations affect unequally different social groups, allowing better possibilities for some of them and threatening others, which underlines that conflict is indeed one of its dimensions.

Summing up, when the NSIs concept is looked from the South, thinking about development problems, four aspects of the concept are seen as essential: i) it originated in the central countries as an *ex-post* concept, while in the periphery it is basically an *ex-ante* concept; ii) it carries a normative weight; iii) it is “relational”, iv) it is a policy subject and v) it describes situations in which conflict is present.

The relevance of interactions

Latin American thinking about the issue “science - technology - development - dependency” started to pay attention sometime ago to “the problem of interactions”, facing questions as the following: “¿When, why and how does a society create a demand for science in a given historical situation? ¿What internal and external factors determine the science supply? ¿How do the fluxes of supply and demand move across the different socio-economic circuits? ¿Who profits from the results of scientific and technological research? ¿How do the different actors react to external demands? ¿How and why does the productive structure and the scientific and technological infrastructure alienate from each other? ¿What role corresponds to the state, particularly in developing countries?” (Sabato editor, 1975: 129; our translation). To study such issues and in order to have a guide for building a “virtuous circle” able to put science and technology at the service of development, Jorge Sabato proposed in 1968 “as a model of interactions a triangle with its vertexes representing, respectively, the scientific and technological infrastructure, the productive structure and the government, defined as the fundamental protagonists of those interactions.” (Idem: 130)

Such model, known as “the Sabato triangle”, was described in Sabato and Botana (1968), a paper reproduced in an abridged way as chapter 10 of Sabato editor (1975). The importance of the relations between the protagonists is particularly stressed there: no matter how strong each isolated organisation was, much more important was the strength of the connections between them; in fact the triangle exists at all only if the connections are there.

That pioneering and splendid paper also studies the interactions inside each “vertex” as well as the interactions of the “triangle” as a whole with the external world. Such emphasis in relational issues appears in Sabato’s approach both as an orientation for scientific and technological policies, and as a tool for studying the various concrete innovation processes.

On innovation in Latin America

Although it is difficult to detect in Latin America the existence of NSI in a strict sense, innovation - formal, informal and even interstitial - is part of real life in the continent. A comparison of industrial innovation surveys in several countries leads to some conclusions (Arocena & Sutz, 2000a) that we now summarise.

- i) National spending in innovation is quite low; in the great majority of the countries, investing in R&D is below the threshold of 1% of GDP that UNESCO considered as a minimum three decades ago.
- ii) Innovative firms are characterised by performing indoors R&D, so analysing how Latin American industrial firms do R&D becomes a central element for the study of really existing innovation.

- iii) Industrial innovation is highly informal; even if a fair proportion of industrial firms perform both product and process innovation, R&D activities are not clearly and formally articulated with the enterprise strategy.
- iv) In spite of the above, entrepreneurial innovation is not necessarily of a low level of complexity; for example, the proportion of professionals in R&D is consistently higher than in other firm activities.
- v) Innovative firms have a comparatively important number of qualified technicians; their number and their salaries are, besides size, the only indicators related to level of innovation performance that the surveys show.
- vi) Firms need qualified personnel to be able to innovate, a result that even if reasonably expected, stems with remarkable accuracy from empirical findings.
- vii) The lack of qualified personnel in medium and small enterprises is not compensated by external advice. Some studies suggest that, among such firms, those that establish relations with universities and research institutes are the firms with highly qualified personnel, well related with their colleagues in academy: even to know what to ask and how to ask it, some level of training is necessary. It is more than possible, then, that the small firms asking for advice detected in the surveys are not precisely the ones that need to compensate their technical weakness through external help.
- viii) Firms consider the ideas for innovation as well as the concrete implementation of innovations mainly as an internal affair.
- ix) Concerning external relations of the firms, the less important organisations are universities and public research centres, which belong to the national set of institutions, while innovation in national firms is frequently based on ties with foreign firms.
- x) The acquisition of capital goods for innovation from other firms, if we include it as an “external relationship”, appears to be the strongest for all countries. This is also valid regarding the future: augmenting the investment in machinery and equipment was by far the most frequent answer to the question about plans for future innovation. In all cases, machinery and equipment for innovation were overwhelmingly foreign.

Summing up: low spending on R&D, low reliance on local knowledge institutions, high reliance on foreign embodied science and technology.

The picture is completed by the outstanding importance of recent foreign direct investment by multinational corporations

The last remark is closely related with the assumption that Latin American NSI are moulded by an insertion, in the international economy, that is characterised by specialisation on production based on natural resources, with comparatively low and mainly imported technological added value. Several features previously considered are connected with this type of international specialisation that fosters the emergence of what we could call **neo-peripheral systems of innovation**. We shall return to this issue after some brief remarks concerning present day relations between “centres” and “peripheries”.

Underdevelopment and learning divides

At present, several trends are shaping a “globalising learning economy” (Lundvall and Borrás, 1997). Nevertheless, we are not witnessing a generalised convergence of socio-economic processes, of patterns of growth or of levels of well

being. As it has been shown by many different studies, the recent evolution of our world includes the persistence and even the accentuation of several types of heterogeneity and asymmetry.

Strictly speaking, it is not the clash between “convergent” and “divergent” trends what is taking place, but the social and geographic differentiation of the consequences of one “globalising” process, that impacts almost every human being, but in very different ways.

From the point of view of development problems, the similarities with the process started by the Industrial Revolution are quite evident. The whole world was impacted by industrialisation. In the countries that started their transition towards industrial societies, some common features appeared, including the emergence of new social divides. In the rest of the world, some similarities stemmed from the expansion of new techniques and new relations of production, but above all from the subordination to the “centres” of the new industry-driven economy; in the “peripheries”, that remained basically agrarian societies for a long period, new divides also appeared. But the main divide, that started growing at the beginning of the 19th century - as the fundamental studies of Paul Bairoch have shown - was the “gap” between the productive capabilities of the “centres” and the “peripheries”. The last were always far away from homogeneity, but the divide between development and underdevelopment has not for that been less real.

In a quickly changing world, the more or less “central” or “peripheral” character of a nation or region does not keep still. In general, the most relevant phenomenon is the transformation of the factors that shape the gap between centres and peripheries: what we are interested in stressing here is that at present the fundamental influence stems from the “learning divide” (Arocena and Sutz, 2000b).

Lundvall and Johnson (1994: 26) state that:

“...we regard the contemporary first world, capitalist economies not only as knowledge-based economies but also as ‘learning economies’. In a way all economies are learning economies, in the sense that economic life always forms a basis for some processes of interactive learning, which results in the production and introduction of new knowledge. But in the modern learning economy, technical and organisational change has become increasingly endogenous. Learning processes have been institutionalised and feed-back loops for knowledge accumulation have been built in so that the economy as a whole, including both its production and consumption spheres, is ‘learning by doing’ and ‘learning by using’.”

In some nations and regions, an important proportion of the population and a great number of organisations are involved, in a more or less permanent way, in activities that demand formal and tacit knowledge, require an advanced level of education and offer multiple possibilities for improving people’s capabilities, by participating in several interaction processes, specially those related with innovation seen as problem-solving. Those are the “learning societies”; they constitute the developed world of our time, the “North”. Its characterisation proves by itself that its emergence is taking place in a small part of the globe, essentially the countries of the “triad” Western Europe - USA - Japan, and a few else. In those countries, generation, transmission and utilisation of advanced knowledge have a central role, by means of several processes where creation of capabilities and opportunities for using them in innovative ways reinforce each other.

But that is not the situation in most nations, which are deeply affected by the new role of knowledge but are not evolving towards learning societies. So, in spite of

all the differences between them, they constitute the underdeveloped world of today, the “South”.

The divide between those two types of societies - the emergent “learning societies” and the rest - can be partially gauged by means of different indicators. For example, the simultaneous consideration of tertiary enrolment (the proportion of the population between 18 and 24 years old that attends university type education) and the level of investment in R&D (as a percentage of GDP) offers a good “proxy” to the notion “existing capabilities and opportunities for using them creatively”. A telling representation of the “learning divide” stems from locating each country in a diagram along those two dimensions.

It is important to stress that this notion is different, and in our opinion much more relevant, than the widely commented “digital divide”. Concerning this issue, it is worthwhile quoting a recent conference given by Manuel Castells³:

“The third point of the analysis I am presenting is the one related with the digital divide, that is, the idea that Internet is creating a world divided between those who have and those who do not have Internet. ¿What do we know about this? On one side, it is true that there is a great difference of connectivity, and we observe that those persons who do not access Internet have a growing weakness in the labour market. We observe also that territories not connected to Internet lose international economic competitiveness and, consequently, they become growing spaces of poverty, unable to incorporate to the new development model. But, on the other side, what we also observe is substantial growth of connectivity. I insist, the rates of growth of Internet are very high everywhere, and what today is called in the US the digital divide, that is, fundamentally, the lack of connectivity in our type of societies, that is different from the Third World, is ceasing to be a problem. [...] Thus, connectivity as an element of social divide is quickly losing relevance. But what is in fact observed in those persons that are connected, particularly students and children, is that a second element of social divide appears, much more important than technical connectivity, that is the social and cultural capability for using Internet. Once that all information is in the web [...], the coded knowledge, but not the tacit knowledge that is needed for what one wants to do, the issue is to know where the information is, how to search, process and transform it in specific knowledge [...]. That capability of learning to learn, to know what to do with what one learns, that capability is socially unequal and is related to social and family background, to cultural and educational level. That is the place, empirically talking, of the digital divide at this moment.”

Summing up, what matters is the capability of learning to learn, that stems both from education and from participation in activities that, at the same time, demand and generate advanced capabilities. Consequently, from the point of view of social and regional differentiation, what matters is the learning divide.

Interactive learning spaces and neo-peripheral insertion

The systemic approach to innovation and the emphasis on learning by interacting lead naturally to propose the concept of “interactive learning spaces” (Arocena & Sutz, 2000b), to denote the more or less stable situations in which some actors have opportunities to strength their capacities to learn, while interacting in the search for solutions to given problems. They may involve very different organisations and persons, and can emerge in a variety of contexts. Examples include the many concrete cases of sustained co-operation between producers and researchers, in the course of which the perspective of both change and their capabilities grow, while they

³ Inaugural lesson of the doctoral program on information and knowledge society, Open University of Cataluña (our translation).

learn to collaborate between them and often with other actors, educational institutions, public organisms, NGOs, etc.⁴

Different types of economic growth have very different consequences concerning the generation of interactive learning spaces. Conversely, the relevance of the last greatly influences the type of growth and, especially, the extent to which it is based on knowledge and driven by innovation. As a “stylised fact”, we may say that developed countries and dynamically integrated social groups everywhere are “interactive learning spaces rich”, while underdeveloped countries and disfavoured social groups everywhere are “interactive learning spaces poor”. This is a main dimension of learning divides.

Latin America is not rich from that point of view; moreover, some aspects of the prevailing type of growth tend to inhibit or even destroy some of those learning spaces. Concerning this issue, it is worth noting the following features of the structural change that is taking place (Katz, 1999):

- (i) the trend to replace locally produced equipment by imported capital goods, thus diminishing national production of such goods;
- (ii) the weakening of in-house engineering aimed to extending the life-cycle of equipment and, more generally, the diminishing role of in-house engineering departments of several industrial firms;
- (iii) the dismantling of the R&D laboratories of public firms that frequently happens after they are privatised. Katz suggests that we are probably witnessing the emergence of a new style of technological development, less “domestically intensive” than during the period of the Industrialisation by Import Substitution.

A similar picture stems from a study (Alcorta and Peres, 1998) of the innovative behaviour of the Latin American and Caribbean (LAC) countries by means of the “Index of technological specialisation”, which measures the relation of a country’s exports market shares in high and low technology. Those authors assert that, excepting Mexico, that index for the LAC countries has remained essentially at the same level between 1977 and 1995. It was similar at the beginning of the period to the index of the group that encompasses China, Indonesia, Malaysia and Thailand, which at the end was six times bigger. The same paper (Alcorta and Peres, 1998: 876-878) includes assertions as the following. Main technological efforts of LAC countries, that in the late 1970s addressed high-tech products, showed in the mid-1990s (again excepting Mexico) a predominance of medium-tech products. “Except for the Mexican export processing zones and vehicle and mechanical engineering industry, LAC has very little more to show in terms of technological upgrading and international competitive high-tech industries.” Its trade specialisation pattern is based, again, on “primary products and low-tech manufactured goods.”

Such conclusions, and several others of similar type, can be based in the results of a wide scope study of Local Systems of Innovation in the MERCOSUR (Cassiolato and Lastres, 2000). That study explains the influence, in the actual economic dynamics, of the natural resource - intensive production, particularly *commodities*, and in general of the goods and services with little endogenously generated intellectual value added. Moreover, such study stresses the outward oriented change of technological demand, by giving several examples of high-tech Brazilian firms that, after being bought by

⁴ Björn Johnson (private communication, previously mentioned) asserts that: “A ‘national system of innovation and competence building’ includes at least

(1) individual and group ‘learning capabilities’

(2) ‘learning spaces’

(3) ‘learning efforts’ or utilisation of learning potentials.”

multinational firms, have abandoned the more complex and sophisticated activities previously cultivated. Clearly, such events are not helpful for the expansion of “interactive learning spaces”.

Mortimer and Peres (2001: 47, our translation) assert that “an important process of transnationalisation took place in Latin America and transnational firms became the dominant economic agents during the nineties.” Those authors analyse how different conditions have promoted two predominant styles of external insertion. One of them is seen in Mexico and the Caribbean basin. It is characterised by the exports of assembled manufactured goods to the US markets, their profitability being closely related with the wage differentials. Those goods are produced by transnational firms which keep their activities of higher added value outside the region; important progress has been made in terms of international competitiveness but without being able to extend that dynamism to the rest of the economy. The other style of international insertion is shown by South America, where the production and elaboration of natural resources predominates, based on their abundance and using mostly mature technologies. In the continent as a whole, structural heterogeneity and polarisation of productive activities are greater than in the past; foreign trade has grown but several endogenous productive chains have been dismantled, and the growth of exports did not generate a process of export-led economic development (idem: 56-57).

The analysis offered by Cimoli and Katz (2001), of how structural reforms in Latin America have modified the patterns of product specialisation and external insertion, shows that knowledge intensive industries have lost ground. Those authors stress that the new patterns are strongly biased against employing very qualified people and doing Research and Development activities, so structural unemployment of highly qualified persons has become common. In our view, that is a major factor in the deepening of learning divides.

In a very broad sketch, it can be said that the types of growth actually prevailing in Latin America are based on the intensive and frequently damaging use of natural resources and / or in assembling activities (*maquila*), as well as in low salaries and weak social and environmental regulations. In most cases, knowledge, innovation and advanced learning play a marginal role. This shapes external relations and types of insertion in the international economy that may be labelled as “neo-peripheral”. In such context, Innovation Systems look more fragmented than systemic, show a low density of national innovative relations, and depend essentially on innovation coming from abroad.

Learning and inequality

Johnson and Lundvall say, “there is a clear and strong tendency toward polarisation built into the learning economy”. In the last decades, inequality has grown between highly and poorly qualified people, and between rich and poor countries. The reports of international organisations converge in that sense.

So learning divides are deepening. Surely, the process is not ineluctable. Freeman (2000) asserts that widening inequalities is characteristic of the initial stages of a new techno-economic paradigm, while opposing trends emerge when that paradigm comes to its mature stage.

From another point of view, analysing what he calls the informational global capitalism, Castells (1998: 82) focuses his attention in the social and economic exclusion and concludes:

“Thus, overall, *the ascent of informational, global capitalism is indeed characterised by simultaneous economic development and underdevelopment, social inclusion and social exclusion*, in a process very roughly reflected in comparative statistics. There is a polarisation in the distribution of wealth at the global level, differential evolution of intra-country income inequality, and substantial growth of poverty and misery in the world at large, and in most countries, both developed and developing.”

In the same book, further on, he says (Castells, 1998: 162, italics in the original, as before):

“This widespread, multiform process of social exclusion leads to the constitution of what I call, taking the liberty of a cosmic metaphor, the *black holes of informational capitalism*. These are regions of society from which, statistically speaking, there is no escape from the pain and destruction inflicted on the human condition for those who, in one way or another, enter these social landscapes.”

In any case, the tightening connection between inequality and capability-building is a major issue of our time. Of course, differences in knowledge have always influenced social stratification, and the last, today as yesterday, does not depend of only one factor. But the growing influence of learning processes in the distribution of social power and related benefits, reinforces inequality as a generator of inequality. In fact, concerning individual and collective progress, each day we can see the greater importance of the capability to keep learning, during the whole active life and at an advanced level. In turn, the possibility to do so depends heavily on the access to high quality tertiary education and to jobs related with interactive learning spaces. Those who are able to do so have good possibilities of systematically bettering their situation, while those who are excluded from such opportunities will probably face very serious difficulties.

All this issue deserves very special attention in Latin America, where in the midst of so many discussions and conflicts, an absolute consensus can be detected: it is the most unequal region in the world. In fact, high inequality, subordination and exclusion (Emmerij, 1997; Thorp, 1998) have historically marked prevailing patterns of Latin American socio-economic evolution. That indeed does not contribute to the consolidation of co-operation networks, shared norms and trust relations. In this way we meet again the issue of “social capital”, the importance of which for the NSI approach has been stressed by Johnson and Lundvall.

Attitudes towards change and social capital

Motivating a renewed attention to some of the central ideas of the pioneers in development theory is, from our point of view, one of the potential contributions of the NSI theory. The emphasis of the latter on innovation as a distributed and interactive phenomenon carries our attention to the need of making a better use of multiple capabilities, as it was stressed in a classical book, originally published in 1958, where it is said that:

“...development depends not so much on finding optimal combinations for given resources and factors of productions as on calling forth and enlisting for development purposes resources and abilities that are hidden, scattered, or badly utilized” (Hirschman, 1958, p.5).

Social attitudes concerning global transformations belong to those issues that deserve special attention in Hirschman's approach:

"Our diagnosis is simply that countries fail to take advantage of their development potential because, for reasons largely related to their image of change, they find it difficult to take decisions needed for development in the required number and at the required speed" (Hirschman, 1958 :25).

Consequently, we think that the characterisation of a given National System of Innovation should include the analysis of collective attitudes. It can be shown that such widely used tools as opinion surveys give a very rich information about the relations between, on one side, collective images of change and innovation, and on the other side, educational and socio-economic levels, age, occupational insertion, etc. (Arocena & Sutz, 2000a).

The study of those elements suggests something fundamental for every systemic approach with emphasis on institutions: institutional systems formally similar or even identical can show completely different performances. That is a recurrent lesson of Development studies, where once and again it is seen that "imported institutions" work in a much less satisfactory way than where they were originally created.

The last remark is closely connected with a Putnam's celebrated study, concerning the fundamental influence of the Italian civic traditions in the different performance of the Italian regional government. In that study the attention is focused on "social capital", a notion that refers to some features of social organisation, as trust levels, norms effectively respected and interaction networks, "that can improve the efficiency of society by facilitating co-ordinated actions" and, in particular, spontaneous co-ordination (Putnam, 1993: 167). It can be said that an important part of social capital is constituted by those networks that we have called "interactive learning spaces".

"Stocks of social capital, such as trusts, norms, and networks, tend to be self-reinforcing and cumulative. Virtuous circles result in social equilibria with high levels of co-operation, trust, reciprocity, civic engagement, and collective well-being. These traits define the civic community. Conversely, the absence of these traits in the *uncivic* community is also self-reinforcing." (Putnam, 1993: 177)

Although it raises several problems, the approach is most appealing. Here we only want to point out that it offers new evidence of the self-reinforcement of inequality in unequal societies.

Concerning the last remark, we refer to the results of a study of the distribution of social capital, in Chile, which paid special attention to association strengths of the different social strata, because, as it follows from Putnam's work, those strengths foster the expansion of social capita. That research done in Chile led to the following conclusions:

"...the distribution of social capital tends to accentuate social inequalities. People with higher income and education accumulate more of that capital. On the contrary, lower levels of education and incomes are associated with less social trust and a weaker sentiment of reciprocity. From that, it follows a relevant conclusion for development strategies: the accumulation of social capital may deepen existing inequalities." (Lechner, 2000; our translation)

The last assertion confirms rather than challenges Putnam's findings, because the last show how regional inequalities concerning social capital, that are deeply rooted in Italian history, tend to reinforce inequalities concerning actual development levels. But the conclusion is even more relevant in the underdeveloped world, where dual

societies can be seen almost in every country, and where in the same region living conditions are often extremely asymmetric, as it can be seen all through Latin America. In fact, a long series of studies concerning the geographic distribution of innovation capabilities in Italy shows that Putnam's "civic community" is innovation-rich, while "the uncivic community" is innovation-poor. The Chilean study suggests that, in dual societies, a very asymmetric distribution of social capital have major consequences on the distribution of innovation capabilities.

So once more we see that the complex relations between (in)equality and innovation constitute a problematic central node of development issues, specially in Latin America (Arocena & Sutz, 2001b).

Building Innovation Systems in underdeveloped countries

As was previously said, the NSI highlights several of the most fruitful ideas of development thinking. One of them is the notion of *linkages*, proposed by Hirschman based on his deep understanding of the Latin American situation.

"The linkages capture much of the development story for a reason that has already been given; development is essentially the record of how one things leads to another, and the linkages are that record, from a specific point of view. They focus on certain characteristics inherent in the productive activities already in process at a certain time. These ongoing activities, because of their characteristics, push or, more, modestly, invite some operators to take up new activities" (Hirschman, 1981 :75).

It is important to stress that linkages are true inductors of innovation:

"A linkage exists whenever an ongoing activity gives raise to economic or other pressures that lead to the taking up of a new activity" (idem :76).

Examples of linkages are the "innovative circuits" (Arocena & Sutz, 2000a). They are defined as processes in which pressing problems of production are solved by the encounter of actors having the problem with "knowledge" actors - be they faculty teams, public laboratories or high-tech firms -, thus leading to joint work on related problems, in a sort of growing or virtuous spiral. "Interactive learning spaces" are situations - or stable networks - that favour the emergence of "innovative circuits"; conversely, these virtuous circles contribute to the consolidation of such learning spaces, and often open the way to the creation of new ones.

The study of NSI can be enriched by the analysis of such innovative circuits, of how and why they appear, succeed and multiply, or disappear. The capability of profiting from them is a measure of development, considered, in Hirschman's sense, as a process where one thing takes to another or, in an equivalent formulation, where the attention to needs and problems links activities previously disconnected thus generating new combinations and activities.

In innovative circuits we often witness the relevant role of "technological tailors", that is, teams or firms capable of elaborating a knowledge-intensive solution "tailored" to the specific aspects of the problem under consideration, its scale and available resources. Solutions of this type, particularly when the problems are posed in small peripheral countries are not usually available in the international technological market. Consequently, those problems may induce innovations and learning processes with a strong national dimension.

Hirschman's strategy for development converges with the one proposed by Johnson y Lundvall (2000):

“A development strategy based on an innovation system approach would start by analysing all parts of the economy that contribute to competence building and innovation. It would focus on the *linkages and synergies* between the parts that form the system as a whole and, especially, it would try to identify the nodal points and crucial learning stimulating linkages. It would also try to identify the missing linkages and interactions, the interactions which for different reasons do not occur thereby reducing the innovation performance of the economy.”

Thus, a strategy is sketched for building Innovation Systems in underdeveloped countries that begins with the analysis of the specific features of learning processes and of what really happens at that level. From our point of view, the strategy is based on an actors perspective, stressing the relevance of existing or missing interactions; thus, the results of concrete policies will crucially depend on the attention given to the interests, needs and possibilities of the different actors potentially involved in innovation processes. The strategy is also based on a “bottom-up” perspective. Indeed, the starting point is given by the links, synergies or innovative circuits that really exist, which are considered as lessons, stemming from society itself, as to how to cope with innovation problems in the usually less than friendly context of underdevelopment. They deserve the care a gardener gives to his flowers. Since “interactive learning spaces” can be seen as the “cells” of the innovative tissue, their multiplication and interconnection creates the Innovation Systems from below. Thus, detecting, protecting and promoting such germinal spaces seems a central chapter of “gardener type” innovation policies in underdevelopment contexts.

Self Sustainable Human Development

How do we see the development issue at the beginning of the 21st century?

We should emphasize first, once again, the ethical dimension. What matters is to make a contribution to the betterment of the quality of human life, understood in a broad sense, as Amartya Sen does when he says that the aim should be the expansion of freedom. Such approach is encompassed in the well known concept of *Human Development*.

During the last decades of the 20th century, the notion of *Sustainable Development* was elaborated. By now, it is also well known; it stresses the environmental dimension of the issue, and seeks to avoid that the actions of today damage the possibilities of development in the future.

The environmental point of view leads to a profound reconsideration of styles of growth and of its eventual limits. From such point of view, energy and material are limiting factors, while knowledge is an enabling factor, that is increased rather than used up in the production process. Consumer and productive learning, technological as well as institutional, may open the way to styles of growth more sustainable than those predominant today. (Johnson, 1998: 94, 99, 100)

In such context, Segura-Bonilla (2000: 1, 80, 87) proposes a combination of two approaches, the Ecological Economics approach and the Systems of Innovation approach; he discusses when the Systems can be considered Sustainable, and he relates the issue with “eco-innovations”. He asserts, in particular, that the first of those two approaches emphasises the need to learn from economics as well as from natural

sciences. Such remark directly relates the subject with the interactive approaches in the field “Science, Technology and Society.”

It has become usual, then, to speak of Human Sustainable Development. We think that it is still necessary to call attention to an additional dimension: the self-sustainability of development, that is, the capability for building today the basis of the development of tomorrow. This dimension is obviously linked with the instrumental aspect that Sen stresses once and again, of freedoms as tools for development. It is also clear that future possibilities will greatly depend on what is done today to expand learning and innovation capabilities.

Let us summarise: the theory of National Systems of Innovation is, potentially, a great conceptual tool for searching ways towards *Human Self Sustainable Development*, something that Latin America urgently needs.

Epilogue: small peripheral countries

Rich and early exponents of the NSI theory are given by several of the papers collected in a volume about the problems of small countries facing the technological revolution (Freeman & Lundvall edit., 1988). It is showed there that, among so many disadvantages, the potential advantages of small countries could be the fluid character of the relations between different actors and the flexibility of their organisational structures. Such conclusion stems from studies of “central” countries, but points in the same direction than a pioneering and almost forgotten essay of Real de Azúa (1977), that was focused on the small peripheral countries.

For us, for obvious reasons, such issues are fundamental and we have written some articles related to them, after studying the inspiring collective volume previously mentioned.

We want to finish by saying that the NSI approach seems to be remarkably useful for the study of development problems in small countries, where the institutional fabric is most relevant and where systemic policies for innovation, that are above all articulation instruments, may be specially rewarding.

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Danish Research Unit for Industrial Dynamics

The Research Programme

The DRUID-research programme is organised in 3 different research themes:

- *The firm as a learning organisation*
- *Competence building and inter-firm dynamics*
- *The learning economy and the competitiveness of systems of innovation*

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

Theme A: The firm as a learning organisation

The theoretical perspective confronts and combines the resource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human resources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

The Ph.D.-programme

There are at present more than 10 Ph.D.-students working in close connection to the DRUID research programme. DRUID organises regularly specific Ph.D-activities such as workshops, seminars and courses, often in a co-operation with other Danish or international institutes. Also important is the role of DRUID as an environment which stimulates the Ph.D.-students to become creative and effective. This involves several elements:

- access to the international network in the form of visiting fellows and visits at the sister institutions
- participation in research projects
- access to supervision of theses
- access to databases

Each year DRUID welcomes a limited number of foreign Ph.D.-students who want to work on subjects and projects close to the core of the DRUID-research programme.

External projects

DRUID-members are involved in projects with external support. One major project which covers several of the elements of the research programme is DISKO; a comparative analysis of the Danish Innovation System; and there are several projects involving international co-operation within EU's 4th Framework Programme. DRUID is open to host other projects as far as they fall within its research profile. Special attention is given to the communication of research results from such projects to a wide set of social actors and policy makers.

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