From local to national systems of innovation: empirical evidences from the Brazilian case

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1. Introduction:

The purpose of this paper is to discuss Lundvall's concept of national systems of innovation within a different framework from that which worked by one of the authors in the past [Villaschi (1994)]. It focuses primarily on productive arrangements in eight states, all but one in the most developed areas of South and Southeast of Brazil[1]. These arrangements are characterised both by their spatial concentration and the co-operation schemes which take place amongst their main agents (enterprises, research centres, supporting organisations etc.).

The empirical work from which evidence has been brought, aimed to answer two questions. The first one, regarding possible typologies with respect to the major activities which take place in each arrangement investigated; sectors on which there is entrepreneurial concentration; markets; institutional design; dynamic elements and their strategies; learning processes; external economies and economic infra-structure.

The second group of questions looked at the arrangement' trajectories throughout the 1990s and took into consideration the impact of the globalisation process in a context of opening up of the Brazilian economy. The major issues investigated the dynamics of: (i) the learning processes; (ii) the enterprises strategies; (iii) the inflow of foreign capital; (iv) the role and possibilities of policies regarding the

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1 - These are: Shoe Manufacturing, in Paraiba state (Northeast region) [Lemos and Palhano (2000)]; Marble and Granite, in Espírito Santo state [Villaschi and Sabadini (2000)], Metal-mechanics, in Espírito Santo state [Villaschi and Lima (2000)]; Ornamental Stone, in Rio de Janeiro state [Villaschi and Pinto (2000)]; Telecommunications Equipment, in São Paulo state [Porto and Cano (2000)]; Soya, in Parana state [catolin, Meirelles and de Paula (2000)]; Textile and Clothing, in Santa Catarina state [Campos, Cario and Nicolau (2000)]; and Shoe Manufacturing, in Rio Grande do Sul state [Vargas and Alievi (2000)]. In order to do the empirical work involved in this project a grant was obtained from BNDES (the national bank of development) and from FINEP (the federal agency for supporting technological development), under the co-ordenation of Professors Jose Eduardo Cassiolato and Helena Lastres, of the Federal University at Rio de Janeiro state.

promotion of innovation systems, as well as those which are aimed at the financing of competitive upgrading of each productive arrangement.

The relevance of these questions can be found, on the one hand, in the technological bases of world economic development. As it has been pointed out by authors such as Freeman and Perez (1988), at such times emerge special needs for institutional changes which make possible innovation and its diffusion based on available technologies which are economic feasible.

On the other hand, these questions are even more relevant when one takes into consideration some singularities of the Brazilian socio-economic formation. Mainly those regarding policies that have been drawn in the last twenty years in order to address questions such as price stabilisation; ownership of companies in key areas of the IT techno-economic paradigm; liberalisation of capital flows and trade, amongst others.

As it is known, Brazil throughout the nineties followed a pattern of economic policies which has been considered exemplary by orthodox international organisations such as the IMF. As a result, the country has changed from a position it had up to 1979 when the role of government in establishing industrial and technological policies was crucial for the country's continuous leap frogging; to one based on the view that the market mechanisms ensures economic development and stabilisation.

In order to address these two major groups of questions, the empirical work performed used a basic questionnaire which investigated the major agents of the productive arrangements (enterprises, research organisations, government agencies etc.) from a perspective which went beyond their main activities. That is, the major concern was not with internal (to specific agents) capabilities and/or constraints.

Given the central role that is attributed to co-operation schemes that can lead to learning processes which contributes towards innovation capabilities amongst all agents, major emphasis was given to questions that could gather evidence for specific responses to challenges. Amongst these, are economic policies throughout the nineties; the opening up of the Brazilian economy to foreign investments and international trade etc..

It is important to point out that even though public policy in Brazil has been in the opposite direction from that which has been taken by most of the OECD countries[2], the empirical work conducted brings evidence for the existence of dynamic elements in all nine production arrangements which were studied. The reason for that might be found in (i) the way these arrangements interact in the local, in the regional and in the international markets; (ii) the forms through which some MSMEs of the arrangements build up industrial capabilities through their efforts to

[2] - See, for example, OECD (1997), OECD (1999).

supply big exporters of commodities. These aspects are explored in the section that follows this introduction.

In the third section special attention is given to the weakening of policies drawn for the arrangements. Either those specific to some of them; or those which should be of concern for the Brazilian economy as a whole. Two illustrations of the latter are education and financing.

The last section points out basic features of policies that should be drawn in order for the country to become more responsive to the challenges that are common ground on most works concerned with the learning economy (Lundvall and Johnson 2000, for example).

2. A general characterisation of the arrangements

The major concern of this section is to identify main features of the arrangements. More important than the technological content of their main products (which vary from telecommunication equipment and cultivares for soya seed production; to shoe making and exploitation of ornamental stones), special emphasis is given to the space scope of the markets which they supply; the size of the firms which comprise them; and the availability of schemes for workers training and for technological services.

Moreover, an attempt is also made in order to identify the major characteristics of the production base of the arrangements and their possible implications for the building up of innovation capabilities amongst their agents. Thus, special attention is given to interactions amongst them and to their sources of innovation.

a . Geographical scope of the markets

The emphasis on the geographical scope of the markets to which the different arrangements sell is due to possible implications for policy making. Thus, if most firms sell at the local market, it is possible to draw policies aimed at increasing interactions between users and producers of innovation. If, on the other hand, the market is mainly national / international, such policies should have as major concern the overcoming of possible barriers[3] to the learning-by-interaction processes that increase innovation capabilities of both users and producers.

(i) *arrangements driven by interactions at the local market*: this is the case of suppliers of Fiat's plant in Minas Gerais state. Most of them were established in the state due to a industrial policy aimed at producing locally as many as possible parts assembled at the car maker's plant. Some of them are also supplying other car assemblers in the neighbouring states of Rio de Janeiro and São Paulo.

[3] - In many cases of cultural content as indicated by Lundvall (1988).

The metal-mechanic arrangement of Espírito Santo is mainly anchored on four local producers of commodities for the international market. These are CVRD and its recently merged Samarco (iron-ore pellets), CST (steel) and Aracruz (paper pulp). Given tight competition, these big users of metal-mechanic services have made explicit efforts in order to improve local suppliers' industrial capabilities (mainly driven at lower costs and improved quality). These capabilities are being used by some of the arrangement' s firms in order to take part on bidding processes to industrial plants in other states.

Even though, the shoe making arrangement of Campina Grande, Paraíba state (in the country's North-eastern region), comprises the major national supplier of low cost rubber sandals, there is no interaction between this big enterprise and other arrangement's firms. The latter are mainly focussed on the local wholesale market which supplies North and North-eastern states. It should be pointed out, though, that some of these firms are targeting specific niches (mainly those of safety apparel) in the more sophisticated markets of the South and South-east, and in neighbour countries such as Argentina, Uruguay and Paraguay.

(ii) *Arrangements with national market scope:* the production of new varieties for seed production in Paraná state is mainly driven for the national market of Soya production. The main concern of producers in this arrangement is to meet the soil and climate specifications of different areas in the country where Soya is produced. These are located in areas where such specifications are quite different such as the North-eastern state of Maranhão; the Western states of Mato Grosso, Mato Grosso do Sul, Goiás and the Federal District, and the neighbour Rio Grande do Sul, in the South, besides its local producers.

The arrangement of telecommunication equipment has its main focus on the national market as well. That is due, on the one hand, to the way it was built in the seventies as part of a policy targeted at building up industrial and innovation capability for the strategic segment of telecommunication services, so considered at the time by the government. On the other hand, as these services have been privatised and sold mainly to foreign companies in the last half of the nineties, there has been no explicit effort to increase any sales abroad.

(iii) *Arrangements aimed at the national / international markets:* 80% of shoe exporting in Brazil (mainly to the United States) is done by the arrangement localised in the Sinos Valley, Rio Grande do Sul. Even though it is to a less degree, about 12% of textile and clothing produced in the arrangement of Itajai Valley, Santa Catarina state, is exported and the American market is one of its major buyer.

The arrangement of marble and granite of Espirito Santo state is the major case of export driven production system. Fourty per cent of what the country exports of these ornamental stones is extracted in this state; the same percentage of what the country exports is from this arrangement; and 50% of the raw material which is sawn, comes from there.

b . Size of the firms that comprise the arrangement:

Another way of grouping the arrangements which were studied is by the size of most of the firms which comprise each one of them. Again, by doing that, the major concern is with the opportunities for policy making. Thus, the main idea is not to go back to the old question 'which size of firms is more innovative' but simply to bring evidence for policy makers which might enable them to draw programmes which differentiate agents in accordance with their financial and/or innovative capabilities.

In most cases, the different arrangements are comprised of firms of heterogeneous sizes. Nevertheless, the dominant sizes are as follows:

(i) *arrangement where there is a majority of micro and small enterprises:* that is the case of shoe making in Campina Grande, Paraiba state. The two big firms which operate in the arrangement have next to none interaction with its other agents. The micro and small scale enterprises that form the core of the productive arrangement have as a whole a quite diversified production base, even though there is a tendency for them individually to specialise in one single product/service.

(ii) *arrangements of mainly small and medium size enterprises*: there are three of the cases which were studied which fall in this classification. It is interesting to notice that two of them are anchored by big enterprises.
This is the case of the chain suppliers of Fiat in Minas Gerais state. Even though both the main assembler and its sub-contractors of first tiers are of medium / big producers and multinationals, the great majority of lower tiers suppliers are local small and medium size firms.
The second anchored arrangement is that of metal-mechanics localised in Espirito Santo state. The anchors are mainly producers of export commodities (iron-ore pellets, steel and paper mill) which must be supplied by firms with low costs, good quality and reliability. Thus, the core of the arrangement comprises mainly local small and medium size firms.
In the same Espirito Santo state, the arrangement of marble and granite there are some big enterprises both in the quarry and in the sawmill parts of the production chain, most of which produce mainly for the foreign market. Despite that, the field work found that most of what is quarried and what is milled takes place in small and medium size enterprise, most of them directing part of their production abroad through foreign (mainly Italians) dealers.

(iii) *Arrangements which comprise mainly medium and large scale enterprises:* this is the case of the shoe making productive arrangement of Rio Grande do Sul state; the textile and clothing one of Santa Catarina state; the one of Soya in Parana state and the telecommunication on of São Paulo state. In the two first ones the majority of the firms still belong to Brazilians, whilst the two former are controlled mainly by foreign capital.
It is also worth to notice that in the cases of the arrangements in Rio Grande do Sul, Santa Catarina and Parana there is quite intensive articulation between the medium size enterprises that form their core, and local MSMEs. In the case of the telecommunication arrangement in São Paulo, however, the idea of global players makes interactions with local firms minimal (when they exist).

c . Availability of technological and training services:

Given the importance that is granted in the theoretical framework which inspired the empirical work carried out, to the innovation capability of each one of the arrangements studied, their grouping according to the availability of technological and training services may be seen as an indication of their competitiveness at times of the learning economy. Thus:

(i) *General technological / training facilities and interactions:* in all the productive arrangements analysed, it is quite diversified the availability of educational, training and technological services facilities. That is so, both in as far as education / training facilities (at all levels, even though at the university one, in many cases the area of engineering is weak); and with respect to organisations that carry research work and/or work on technological / managerial innovation diffusion.

In most cases, however, it is very low the degree of interaction between the entrepreneurial dimension of the arrangements and their technological and training services availabilities. As its is known, from such interactions can emerge greater firms' competitiveness and social capabilities.

The case of Fiat suppliers' network in Minas Gerais is a good illustration. When asked about factors which were taken into consideration at the time of their installation, about 40% of the questionnaire's respondents said that the proximity with universities and research centres was considered either of low or of no importance at all.

(ii) *Specific facilities:* in five of the arrangements studied, explicit efforts were done in the past in order to establish agencies especially designed for contemplating their major training and/or research demands. Thus, in both cases of the shoe making arrangements (that of Paraiba and the one in Rio Grande do Sul), SENAI (a special organisation aimed at trainning workers for manufacturing business) maintains facilities aimed at formal education

and training of the arrangements work force. In both cases, the same organisation also offers infra-structure facilities for responding to specific needs of each one of the local shoe making productive arrangement.

Nevertheless, the ways these facilities are used are quite diverse in each case. On the one hand, in Rio Grande do Sul, there is some degree of integration (not close to what could be considered a good one, though) between the programmes developed by SENAI and the enterprises of the arrangement. On the other, in the case of Paraiba, it is recognised by most of the actors that there exists a gap between the services that are offered and the demand for such services, mainly, by micro and small enterprises.

In a similar way, it is quite diversified the training / educational and technological services which are provided in the productive arrangements of textile/clothing, in Santa Catarina; of Soya, in Parana; and of telecommunications in São Paulo.

Even though in the two former cases there exists recognised innovation capability for products of intensive scientific / technological contents, it is only in the case of Soya that this capability is being used by most of the firms in the arrangement. In the case of telecommunications in São Paulo, recent changes in the ownership structure of the major enterprises of the arrangement, has lowered substantially the degree of use by its major firms of both its available educational (mainly that at the university level) and research facilities.

In the case of the textile / clothing arrangement in Santa Catarina, the disposability of facilities for technological services and for the training of the work force, is an obvious externality for its development. Nevertheless, the major users of services of greater technological content are the bigger enterprises. It is also important to notice that amongst the services offered, it is not available those of product innovation.

In the case of the arrangement of marble and granite in Espirito Santo state, about ten years ago it was established a centre aimed at its technological development. In accordance with its original conceptualisation, that would take place through the matching of potential demand for innovation and the available research facilities at the Federal University one hundred miles away.

Recent modification in the polity of the centre have caused major changes changes in the way it is aiming its trajectory. That has been mostly directed towards an international fair which takes place in the core city of the arrangement (Cachoeiro de Itapemirim). No matter how important this yearly event might be for interactions with buyers and suppliers of the arrangement, it is a pity that the potential for research that exists at UFES (mainly those in environmental and production engineering) and which are

so vital to its sustained development, has not been used at all by its firms of all sizes.

3. Elements of recent changes in the arrangements trajectories

The full impact of changes in economic policy that has occurred in Brazil in the last ten years, is still an open issue for long discussions. The assumption that macroeconomic policies aimed at price stabilisation and structural reforms along the prescriptions suggested by the Washington consensus, would generate a virtuous circle of gains in competitiveness following the phase of restructuring through liberalisation of trade, de-regulation and privatisation of state-owned enterprises, cannot be taken for granted for all economic activities in the country. Thus, it should be of no surprise that it has been of diverse content the implications of these policies for the different arrangements studied.

The main sources of differentiation of the impacts of these policies on the arrangements are, on the one hand, the nature of them, mainly in terms of the way they were originated and their evolution the pre-90s period. On the other hand, such a differentiation can be understood also through the means each one of them had for facing the challenges of tightening competition. Be that through the aglomeration advantages that each arrangement had accumulated previously; and /or due to the different strategy followed by the firms for facing these changes.

In the arrangements of greater technological dynamism, one of the main characteristics of their origin was the incentives embedded in the industrial policies which fostered their creation. That took place in the second half of the 1970s, in the case of Fiat in Minas Gerais, and in the 1980s, in the case of telecommunications in Campinas, São Paulo. As a result of the respective policies aimed at their fostering and growth, these arrangements were well established in the beginnings of the 1990s, both in terms of their technological capabilities and as far as their performances (measured in terms of revenue, for instance) were concerned.

Throughout the 1990s, the privatisation process, in the case of the telecommunications arrangement, brought cumulative perverse effects upon R&D investment. As it is known, investments made throughout the 1980s were crucial for fostering technological capabilities which became a major asset accumulated at CPqD (the state-owned telecom's research centre built in Campinas but which supplied subsidiaries in all Brazilian states) [see, for instance, Szapiro (1999)].

In the case of the Fiat's suppliers arrangement, changes in the strategy adopted by its anchor as of 1996 and its consequence – that of an increasing internationalisation of its suppliers – has also transferred off the arrangements boundaries most of the innovative initiatives and capabilities.

As for the Soya arrangement in Parana, two changes have had negative effect on its technological capabilities. First, that in R&D strategies by the main source of innovation (EMBRAPA, state-owned institute for the scientific and technological development of agriculture), which does not allow for co-property of new varieties any more. Second, the modifications in the legislation that regulates the production of new varieties and which ensures private apropriability of innovations through patenting.

These two changes have just about vanished the co-operation system for the recommendation of new varieties which used to make possible EMBRAPA's strategies for the development of seeds through close ties with small and medium sizes producers / co-operatives. It should also be noticed that these changes have taken place at the same time that there has been a substantial entrance of multinational Soya seed producers in Brazil. And here, just as it has been pointed out in the cases of Fiat's suppliers and of telecommunications, that has meant a transference of innovation capabilities towards the multinationals home laboratories.

In the case of the metal-mechanic arrangement in Espirito Santo state, the 1990s have re-enforced ties between local SMEs and the arrangement's anchors. That happened mainly due to new investment programmes that these big enterprises implemented and due to political pressure that was orchestrated by an organisation established for the segment's development (CEDMEC). Such a pressure was directed towards the implementation of local procurements by the big enterprise and the increasing industrial capabilities of the SMEs of the arrangement.

The impacts on the arrangements which produce non-durable consumer goods came from different directions throughout the nineties. Firstly, from exchange variations; secondly, from change in purchasing power.

On the level of the firms which comprise these arrangements, the overvaluation of local currency (specially until 1999), on the one hand, caused fierce competition from abroad which was fuelled by lowered tariffs on imported goods. On the other hand, the exchange devaluation favoured the modernisation of their plants through the import of capital goods at lower relative costs.

In the case of arrangements of shoe making fo Rio Grande do Sul, and that of textile and clothing of Santa Catarina, there was a recovery in the last years of the nineties, which was helped by a devaluation of the currency,is two fold. First, it occurred through the retaking of sector incentive policies; second, in virtue of the adoption of companies re-structuring strategies which modernised the arrangement.

Nevertheless, in none of the cases such re-structuring has made more dense the localproduction chain. In the case of shoe making in Vale dos Sinos, because it was already wee developed. As for the textile and clothing in Vale do Itajai, the reduced deverticalisation and equipment import have not produced internal effect

which have directly encouraged interactions for innovative learning apart from the incorporation of new technologies.

Particularly, in two specific cases it took place a worsening of conditions for local innovative capabilities in the last few years. The role that has been previously performed by Telebras' CPqD is being significantly altered starting from privatisation of services operated by that company's subsidieries.

Coming from a structure where it was clear the roles performed by the arrangement's dynamic actors - research institutions, equipment producers and service operators - the existing institutional framework for the arrangement has no major concerns for complementarities between these elements.

Since the arrangement's innovative capacity has always been bound to stability and flexibility that the previous framework generated, there are strong indications of deterioration of local innovative capabilities. That is true both for CPqD; and for local research institutes and small and medium local companies

In the Fiat suppliers productive arrangement, there was a similar change. The shift towards closer ties of the anchor with first tier suppliers, decreased local innovation synergies, albeit that has not affected yet companies' industrial performance.

In some cases, there are enhancement evidences in the innovating capacity of local companies/organisations, even if specific and restricted to some elements of the respective arrangement. Those of shoe making in Rio Grande do Sul and of textile and clothing in Vale do Itajaí, as well as the metal mechanic one in Espirito Santo, have been urged to improve their capacity to meet client's short run demands. It should be emphasised that in the majority of cases such qualification was restricted to process innovation, albeit in the metal mechanic case study some innovation has been incorporated to looms produced locally and played an important role in the dynamics of the of marble and granite arrangement.

4. Concluding remarks

The studies carried out show the need to implement policies which could enable a better insertion of each one of them in the growing internationalised economic dynamics. An economy which operates within an economic, political and social context that is steadily influenced by knowledge and undergoes the impact of a rapid diffusion of information technologies.

The general characterisation of such context at international level has been well discussed by Chesnais and Sauviat (2000), Freeman (2000), and Lundvall and Johnson (2000),amongst others. Our purpose here is to make some general remarks for the majority (if not all) of the productive arrangements studied and try to emphasise singularities of each one of them so as to enable a more systemic

action amongst actors. Which must be aimed at higher entrepreneurial/social capabilities.

Several aspects observed are applicable to all arrangements which were studied. Some of them refer to policy objectives; other to their instruments. Above all, they suggest experimental possibilities of public policies in the scope of these arrangements which can be extended latter on to other areas of the country's economy.

A) Human resources qualification:
in the studied arrangements, both at entrepreneurial and labour levels, there is a growing demand for substantial improvement of school level and professional training. In a very significant number of interviewed companies there is a large percentage of employees that have not finished fundamental school and have little participation in training programs. Of course there are some exceptions, especially at the arrangements where labour qualification is an integral part of the segment culture, as it is the case of telecommunications and automobile industry assembling units.

By the same token, entrepreneurial qualification is equally bad, especially that required for permanent innovative processes. Not only due to the schooling but mainly because of low incorporation of management practices which value innovation, human resources, and sustainable use of natural resources, amongst others, as key competitive factors for companies of different size and focus.

In order to improve elementary and secondary educational training, one should set out actions aimed at certification mechanisms which value work force education.
Local programs, such as PRODFOR in the metal-mechanic arrangement of Espirito Santo, have encouraged participating companies to make efforts which have improved the education level of the labour force. It should be also made efforts in order to make compatible the actions geared towards improvement of education and that take place at the different levels of government.

Likewise, management and employees of public institutions which are directly related to the productive arrangements should benefit from a better qualification.
The qualification of the latter, besides making them more effective, efficient and reliable should be such so as to enable them to understand local problems and foster effective solutions. Such importance should be emphasised in situations where the regulation of productive activity is intense, as one can verify in the arrangements of ornamental stones in Rio de Janeiro and that of granite and marble in Espírito Santo.

The study of shoe making arrangement in the Vale dos Sinos suggests that

> "perception over the importance of qualification of human resources as a competitive factor has taken many companies of the arrangement to invest as

> much in the increase of their employees education levels as in the establishment of programs of technical qualifications. The Piccadily is one of the most recent examples that portrays such attitude. Recently this company has installed together with 18 machinery and equipment suppliers a qualification centre for their employees which also operates as trial for new machinery performance test. The centre, that operates since 1998, has already effected the training of more than 3000 shoemakers in the last 3 years. Since such initiative on the company's side is added to the existence of an excellent centre in the arrangement linked to the technical qualification organisation, it is considered that the implementation of policies aimed at the qualification of human resources in the arrangement should involve a larger articulation amongst the efforts are undertaken by government authorities (at the federal, state and municipal levels), companies and institutions that make up arrangement's educational and technological infra-structures. Thus, improvement in investment on formal education by government agencies, should involve, among others, the granting of scholarships and other costs for the engagement of researchers and university technicians as well as centres for local researchers in development of new products and processes."

B) Cooperation schemes toward innovative capabilities – In the majority of cases, the productive arrangement already have organisations which, if articulated amongst themselves, may improve their respective innovative capabilities. The table taken from the paper on the marble and granite arrangement illustrate such situation. As one may observe, for the majority of identified bottlenecks in the production chain there are organisations which could help to overcome them.

That does not take place, mainly, because, on the one hand they act in an unarticulated way. On the other hand, they do not offer stable and flexible conditions required for the innovative processes, as it is understood by this paper's theoretical framework.

Activities, technological areas and knowledge network

1. Activity (stages on the production chain)	2. Knowledge involved / innovation possibilities	3. Actors already involved in innovation processes
EXTRACTION	Geological engineering, chemistry and environmental; geographical mapping; bed potentiality; technology of material; research on the extracted material (type, colour, market, quality); technology of human resources (technical qualification, courses, training, remuneration and social benefits – transportation vouchers, meal-vouchers, earnings and profit sharing); prevention on occupational accident; mapping of affected environment area; project for environment recovery; extraction technology (material to be used: mortar, explosives, others); block framing (cutting them in the right dimensions for sawdust, avoiding thus, loss and waste); transport technology; logistics (production flow – highway and/or rail transport and/or, warehousing).	SEAMA, SENAI, SEBRAE, UFES, others universities in the Geology area, CETEMAG, SINDIROCHAS, SINDIMÁRMORE, Extracting companies
SAWDUST	Mechanical engineering (machine physical structure and its productive capacity); human resources technology (technical qualification, courses, training, social benefits and remuneration – transportation vouchers, meal vouchers, earnings and profit sharing participation); machinery automation/information; logistics; material technology; measurement technology and trials; better use of input in accordance to the material to be sawdust – composition of adequate whitewash and sand shot; blade to be used should be in accordance to the stone geological resistance and composition; reclamation of scrap (abrasive mud).	UFES, SEAMA, Suppliers of Machinery and Equipment, input manufactures, CETEMAG, SINDIROCHAS, SINDIMÁRMORE, SENAI, SEBRAE, Companies (sawmills)
FINAL IMPROVEMENT (cutting and polishing)	Mechanical engineering (machine physical structure and its productive capacity); human resources technology (technical qualification, courses, trainings, social benefits and remuneration – transportation vouchers, meal vouchers, earnings and profit sharing participation); polishing technology (follow polishing stages for a better gloss/shine); waste minimization; resistance and adaptation of cutting disks to type of material to be cut; use of abrasives in accordance geological composition of stone; transport technology; logistics (warehousing, packing, transportation); business administration (company lay-out, administrative routines, attendance, production programming, delivery timetable, quality control); consumer attendance; design; marketing.	UFES, SENAI, SEBRAE, Machinery and equipment manufacturers, CETEMAG, SINDIROCHAS, SINDIMÁRMORE, companies (marble shops)

MARKET	Sociology; Economics; Informatics; Accounting; Administration; Foreign Trade.	UFES, Colleges, SENAI, SINDIROCHAS, SINDIMÁRMORE, CETEMAG.

Source: Villaschi and Sabadini (2000)

That, however, should not lead to naive ideas over issues that involve the conceptualisation and implementation of policies aimed at increasing co-operation and learning processes schemes amongst actors of the same arrangement. The following table, taken from the study on the shoe making arrangement of Rio Grande do Sul, illustrates that. There is a reasonable heterogeneity of situations within the same arrangement, which indicates the urge for a more accurate examination of the specificities of each case. An important implication of this is that one should avoid very generic policies.

Interactive learning Strategies in the shoe making arrangement - Vale dos Sinos/RS

Actor/segment	Internal sources of information and knowledge	Internal sources of information and knowledge	Type of Learning Strategy
Shoe manufacturing Companies functioning in higher quality and price markets	Own qualification in design and commercialisation, local manufacturers of machines and components, commercial fairs in the country	International competitors, manufacturers of machinery abroad and international commercial fairs	Active and based in knowledge and information resources both locally and outside the arrangement
Shoe manufacturing companies functioning at lower price markets	Large shoe manufacturing companies in the arrangement	Exporting Agents and international clients	Passive and based primarily on external sources of information and knowledge
Machinery and equipment suppliers	R&D Institutes and local training, commercial fairs in the country	International Competitors, International equipment fairs	Active and based primarily on external sources of information and knowledge
Tanning	R&D Institutes and local trainings	Joint ventures with international competitors	Passive and based on local sources of information and knowledge

Source: Vargas and Alievi (2000)

The characteristics of arrangement articulations may guide forms of incentives to co-operative interactions amongst its agents. In the case of companies that act as anchors in an arrangement (as it is the case of Fiat suppliers network and the metal mechanics arrangement), could have their respective access to financing

agencies partially conditioned to the transfer of funds obtained for the productive and innovative qualification of their local suppliers.

That could benefit smaller supplying firms in two ways. On the one hand, they have better access to cheaper and more appropriate financial sources of funds. On the other hand, that could be seen as an efficient way to organise their demand for innovation and to articulate it with local suppliers of technological services.

In arrangements where small and medium companies are predominant, the co-operation may be stimulated through the fostering of co-operative network made up of companies and other institutions that would have a central co-ordination so that Individual efforts of each of them may be upgraded through collective actions. The objectives would be the use of the available infra-structure and the attainment of better performance on input and equipment procurement; on the sharing of higher cost equipment; and on strategies of combined action for product marketing, design and development.

In general, the main purposes should be to stimulate information flows between different elements of the arrangement; to improve their management skills; to create / enhance technological infra-structure and make wider its use. In other words, make an effective leap forward product, process and organisation innovation.

It also urges to expand the scope of existing technological institutions in order to make explicit their action on monitoring progress on these three aspects of innovations. That should create a more appropriate environment for interactions amongst firms and suppliers of technology, as there would extra motivation for more frequent encounters between the arrangements actors.

Interaction for learning processes are related as much to the profile of studied arrangement productive segment as to their respective production chain density; their companies competitive strategies; as well as to their specific environment characteristics with respect to trust relations developed through time. With that in mind, the analysis of learning processes in these nine productive arrangements has made evident the potentialities for these processes to be enlarged as well as some of their shortcomings that maybe corrected.

One way to accomplish that would be the development of specialisations amongst the arrangement actors in order to foster complementarities which may generate local externalities and may provide co-operative relations aimed at technological learning processes.

One should bear in mind that, in most cases, such results depend on the agents own strategy. But, what is important to point out is that due to the existence of cultural ties within each arrangement, it is possible to stimulate them and to enable the adoption of strategies based on trust and co-operation schemes. Such actions

depend basically on the co-ordination capabilities of existing of institutions to foster links between its components besides and beyond those set by market conditionalities.

C) S&T policies: there have been quite substantial changes in the in the last fifteen years both in form and in content of S&T financing in Brazil. That has caused in one's best judgment a substantial reduction of research institutions' capacity to respond to the sophistication and ever increasing demands for scientific and technological knowledge.

Since part of the innovative qualification effort that must be made in order to strength the studied arrangements is highly dependent on a lesser or greater degree, on technological and scientific knowledge, it is imperative the recovery of investments priority for the construction / enlargement / maintenance of laboratory infra-structure in the majority of research institutions that give or may give support to the dynamics of these arrangements.

Similarly, efforts should also be made in order to recover the dynamics of human resources development aimed at technological and scientific S&T activities. Past efforts, primarily between the sixties and eighties have had their results minimized through the nineties. That has been due to federal government policies which, on the one hand, have motivated precocious retirement of members of faculty and researcher groups. On the other hand, they have not given any incentive to the formulation of medium and long term projects by R&D institutions.

In such conditions, in an increasing number of cases, the country is losing its capability for the technological dialog due to discontinuities on S&T qualification projects. As a result, deficiencies have sprung on the conditions under which demand coming from business is met by R&D elements of the different arrangments.

Even if there is potentiality for technological policies directed specifically for each of the studied arrangements, regardless of their respective technological basis complexity, there exist opportunities for projects, for which one can foresee results in te short run. An illustration of that is the recommendations which were made for the case of FIAT suppliers arrangement and that reflects a generalised situation for the Brazilian auto parts segment as a whole:

- The three agreements for the automotive system should include an amendment to explicitly include the sector's R&D policy taking into consideration that the only related existing articles (11th and 12th articles of Second Agreement) are generic and do not contribute to this purpose;

- The sector's R&D policy should be part of the required reciprocities of automotive assembling units and spare parts companies which are beneficiaries of such agreements. Thus, the nationalisation rate of spare parts and components of vehicles should be added to R&D internalisation rate. Such rate could take into consideration the innovation effort that made both

in-house and between companies, in such a way as to go beyond quality certification tests and adaptation aspects of local conditions ("meeting specific tropical conditions");

- Co-operation schemes with local research institutions (universities, institutes and technological centres) should be drawn with explicit aim of incorporating that R&D internalisation effort;

- in the R&D expenditures it should also be included the technological effort of engineering design that would go beyond basic design of products and processes that involve local processes of co-design amongst automotive assembling units and their local suppliers;

- it is also necessary to involvement of local research institutions – in the case of Minas Gerais state, UFMG, UCMG and CETEC – which could have a deeper involvement in the arrangement through co-operation agreements on specific R&D projects.

D) Use of fiscal, public credit and financing – for those companies that are focusing on international markets or are facing external competition in the domestic market, the isonomy on fiscal and public credit conditions, is an important competitive factor. The idea widely spread amongst business people interviewed by the different empirical work upon which this paper is based, is that mechanisms should be sought in order to enable tributary conditions and credit/financing conditions similar to those granted to foreign companies which compete with arrangements' companies both domestically and abroad.

In the case of small companies, it is important to make feasible the transfer of funds under new conditions from fostering agencies and/or special funds. One of the mechanisms suggested by interviewed businessmen is the transfer through credit unions which are prepared to charge lower spreads in view of lower risks they take for knowing the borrowers better than commercial banks. The latter usually take decision based on information from balance sheets, which practically make unfeasible the financing to smaller companies since they use of the mechanism declaring less revenues in order to avoid taxes.

The remarks made by one businessman from the shoe making arrangement of Campina Grande clearly express such possibilities: "the focus of policies for fostering MSMEs development has always been the single firm individual companies, through programs of financing which are inadequate to our needs. This is due mainly to the fact that several of the financing agencies and fund managers still do not have practice to deal with small size companies particularly because of inherent difficulties of their size."

Some changes are taking place towards a focus on dealing collectively with small firms, in such a way as to make their financing feasible and possible. The few cases that can be identified in Brazil with a more collective approach to financing and innovation in SMEs have already proved that it may promotes more synergy amongst companies that share collective financing commitments and learning towards innovation.[4]

[4] See Mytelka (2000) for some ideas on cluster banking.

In relation to isonomy on tax buden and on public credit, it could be exemplified with the shoe making arrangement of Vale dos Sinos, where the exemption of shoe exports represents today, one of the main claims of shoe companies in the arrangement. Abicalçados, one of the main class association that integrate the arrangement, searches tributary exemption over exports of at least 10%. They argue that excessive tax burden on shoes has damaged their competitiveness abroad.

Another example for the need of isonomy on tax burden and on public credit, is that of capital goods producers (such as the one which supply the marble and granite arrangement in Espirito Santo). Their main difficulty to compete comes from existing financing conditions that are offered to manufactures abroad through international financing institutions. In this case, an important factor of support to the segment's development involves the creation of differentiated lines of credit for the acquisition of material and domestic equipment so as to enable isonomy in relation to what is offered to foreign manufacturers.

Summing up, this paper has brought evidence from nine local production arrangements which operate under quite different conditions. Some of them reflect major issues regarding the Brazilian economy in general, and its system of innovation in particular. Amongst these, two need to be stressed. The first one regards the low work force level of formal education. In the majority of studied arrangements 60% of the workers have attended school for a maximum of eight years.

The tacit knowledge in the processes of building up innovation capabilities has a key constituent when these findings are put into perspective. Such element is education and this is what is missing in the Brazilian system of innovation.

The funding both for production and innovation capabilities would be the second item which was focused on this paper. More than half of the investigated arrangements are financed with the firm's own resources That is, macroeconomic policies regarding inflation targets and foreign capital inflows pays bad service to the NSI with high interest rates and poor funding of innovation and production activities. Even more important, this happens when experiments concerning new ways of financing production and innovation occur out of the established financial system (Mytelka 2000)..

An overview of the arrangements which were studied show deficient articulation of the elements in each and in all of them. This stems from the way policies regarding production and technological capabilities have been built disconnected from each other in Brazil. And, in many cases, contrary to each other.

That has resulted in a situation where, despite the existence of financial, human and physical resources in different organisations (enterprises, universities, training centres etc.) which constitute dynamic elements of a production arrangement, very small space has been left for co-operation amongst them. In many cases (such as

the soya arrangement in Paraná state, telecommunications in São Paulo, and Fiat network in Minas Gerais), recent changes in industrial policy (privatisation, opening up of the internal market) and in macroeconomic policies (high interest rates, budget control) have resulted in the strengthening of multinational firms (with very few links with local research groups) and in poor competitive conditions for the local ones.

The policies that emerge from the analysis of these production arrangements can be seen as going beyond them and the localised co-operation schemes which foster learning processes which may favour innovation and increasing social capabilities. They are pointed out as a way of strengthening the Brazilian national system of innovation at times of increasing competition in the knowledge and learning economy.

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