

## **Recent changes in the Brazilian national system of innovations – a case of institutional learning?**

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### **ABSTRACT**

This paper begins from the perspective that in order to understand the impact of institutional changes on a country's innovative capacity, it is necessary to take an analytical framework as a reference that recognizes the institutional context as one of its determining factors. The institutional change must also be seen under an evolutionary perspective, happening without interruption and in some cases comes from process of institutional learning. Institutional learning must be understood as the increase in capacity of the entire SNI for the building of individual and collective decisions that are in compliance with the evolutionary environment and which are materialized in a better interaction and cooperation quality amongst all the SNI components, leading them to a higher degree of efficiency and capability to deal with uncertainties that are inherent to economic change, with innovation being the driving factor of such development. In the applied sense, this study investigate the performance of the Brazilian National System of Innovation and intends to accompany its performance during the period from 2000 to 2006, trying to understand how the main changes occurred in the institutionalization of the SNIB, which might or might not be the result of the institutional learning process.

## 1. Introduction

The neoschumpeterian approach has systematically recognized the importance of learning, in all its forms, as being crucial for the launching of innovation groups and that it is these learning processes that furnish the dynamics capable of driving growth and development of nations. It also recognizes that “*almost all learning processes are interactive, influenced, regarding their content, rate and direction, by the institutional set-up of the economy* (JOHNSON, 1992, p. 23). As well as stated by Gertler and Wolfe (2007, p. 06), *institutions are central to the process of learning (...). Learning processes are inherently social and interactive, not just individual, and new knowledge is created through processes that are institutionally embedded.*

Under this perspective, institutions are not taken only as a ‘backdrop’ where economic decisions are taken, but are treated as one of the explanatory components for the differentiated performance of the national system of innovations (SNI) in each country.

The neoschumpeterian literature has been plentiful in treating the learning processes of firms, organizations and individuals – micro level economic agents – evaluating them as interactive processes that constitute the form in which firms and individuals build and organize new knowledge and routines around already consolidated competences, at the same time as they develop higher efficiency thresholds with the building of new competences (NELSON AND WINTER, 1982). Through these optics, learning is considered as the answer to stimulation from the external environment, therefore influenced by the institutional context.

When learning is connected to institutions however, there are few references presented by economic literature. Even so, in the majority of cases, the treatment given is predominantly abstract and the empiric measurement of this ‘*institutional learning*’ is a field of research that has not been sufficiently studied. Considering that the approach taken by the national system of innovation expresses the complexity of institutional arrangements in their various levels and their interaction mechanisms, which interfere in the development of a nation’s innovative capacities’ development (driving it or hindering it), it can be said that institutional learning is a necessary condition for a better performance of the SNI.

The objective of this paper is to investigate the structural changes that have been occurring in the Brazilian National System of Innovation (SNIB) from the beginning of the year 2000 and discuss to what extent such alterations may be considered as ‘*institutional learning*’. This article continues with the performance analysis of the SNIB in the 1980s and 1990s already made by Villaschi (1996 and 2003, respectively). Therefore, it studies the main alterations in the economic, technologic and institutional domains of the Brazilian national system of innovation from 2000 to 2006.

As already discussed in the previous papers, the 80s and 90s were marked by low economic growth and by a sufferable dynamics of the SNIB. This is due, amongst other factors, (i) to the low investment in the central areas of the new techno-economic paradigm (PTE) that was being installed and (ii) to the significant cuts in resources destined to education and R&D. To this is added (iii) the exaggerated attachment to orthodox macroeconomic policies and (iv) the lack of an industrial and technological policy to appraise the decisions of agents of the Brazilian development.

At the end of the 90s, however, institutional changes started to be seen in elements that comprise the SNIB. Even though such signs were discrete in a first moment, attitudes were beginning to appear of awareness that social and economic sustainable development demands profound political and institutional changes, which could not be implemented if the SNIB did not engage in virtual cycles of institutional learning.

In the following item of this introduction the concepts of institutions and institutional learning are examined, as well as the role they play in the national system of innovation. Item three presents the changes undergone by the SNIB in recent years, with emphasis being given to those that may create a more favorable institutional context for investments explicitly destined for innovation. In the final considerations, observations are made regarding public policies (not necessarily or exclusively governmental).

## **2. Institutional Learning and Development of the SNI**

### *a. National System of Innovation and Institutional Learning*

This paper begins from the perspective that in order to understand changes in an economic formation it is necessary to use an analytic framework that recognizes, amongst other aspects, the institutional context as being decisive for its dynamic innovation. It is on this institutional context that the interdependence relations between the economic agents are built (JOHNSON, 1992); it is also this institutional network that supports the various forms of learning (LUNDEVALL *et al*, 2002) and also determines the structure of incentives that guide the agent's behavior. More so this institutional context needs to be understood under an evolutionary perspective and, therefore, not as a mere displacement from one discrete stage to another, but happening without interruption.

The approach of the National System of Innovation - SNI (LUNDEVALL, 1992) is part of this reference since it takes the institutional context and its evolution as the focal point for a country's economic and innovative performance. The concept of innovation itself, crucial for the SNI approach, uses an institutional environment as a requirement for the development of "innovating conditions" for growth. In this sense this approach constitutes a point of convergence that can treat both the questions about innovation, as well as those of institutions in the neoschumpeterian framework (EDQUIST AND JOHNSON, 1997).

Therefore, the SNI must be understood as expressing the articulation complex amongst institutional arrangements in their various levels and interaction mechanisms. This also goes beyond the country's geographical boundaries which, directly or indirectly, interfere in the path and development of the innovative capacities of a certain nation, driving it or hindering it. (VILLASCHI, 1996).

When the SNI concept is used to investigate innovative capacities, it is assumed that innovation is seen as reflecting the cumulateness of learning through interaction amongst all the components of a SNI (JOHNSON, EDQUIST E LUNDEVALL, 2003). This implicates that disorganization among the subsystems that make up the same may compromise the adequate functioning of the SNI.

On one side, due to the fact that it provokes interruptions in the continuity of actions, leading to losses in the results of previous efforts (ALBUQUERQUE, 1997), and on the other, due to the fact that it generates an error in the work's "institutional division", diminishing the possibilities of learning, since the knowledge is prevented from flowing easily to all the participants of the SNI.

Regarding the specificities of lagging socio-economic formations, besides the mentioned factors, the occurrence of an 'institutional hiatus' is common. In this case, the SNI is characterized by the inexistence of some fundamental institution(s) for the innovative process. Therefore, (i) the lack of an articulating entity between the micro and small companies and the financing network of the financial system; and/or (ii) the inexistence of a network of competence formation in the central areas of the techno-economic paradigm in effect would be cases of institutional hiatus that might represent restrictions to the functionality of the SNI.

As Johnson and Lundvall point out,

A development strategy based on an innovation system approach would start by analyzing 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. (JOHNSON E LUNDVALL (2000) apud AROCENA E SUTZ, 2005: 17).

Therefore, learning by interaction – the crucial element of a SNI may be impaired by an environment where the learning capacity is not well distributed among the various elements that constitute the system, resulting in a *learning divide* (AROCENA E SUTZ, 2005). The consequence is that the positive externalities of learning are not distributed to the whole group of agents, which may reduce the innovative potential of the system as a whole.

The low possibility of lagging socio-economic formations influencing the direction of the techno-economic paradigm should also be pointed out (FREEMAN E PEREZ, 1988). Due to this, the policies of these formations are turned to the use of 'windows of opportunity' and to the reduction of technological discrepancies in relation to the central countries. This means that in the majority of cases such policies attain a more adaptive rather than a creative character.

#### *b. Institutional learning as a necessary element for development*

Due to the cumulative nature of knowledge of the technical and innovation processes, no institutional arrangement is able to guarantee the continuity of an economy's innovative dynamics, except if it is engaged in the dynamics of institutional learning. This is due to the fact that a certain institutional arrangement may be a driving force of innovation during a certain period and contribute for the hindrance of technical progress in another period. (JOHNSON, 1992). In this manner, institutional learning is a necessary condition for the evolution of the entire national system of innovation and for the economic performance of a country. As pointed out by Johnson (1992, p. 23), "*the capability of national economies to learn, adapt and change their institutional frameworks – to engage in "institutional learning" – is important for the development of their international competitiveness.*

Conceptually, the institutional learning of a SNI needs to be understood as the increase in capacity of the whole system for the structuring of collective decisions that are in agreement with the evolutionary environment and that is materialized in a better quality of interaction and cooperation among all the system's components. This improved interactive and cooperative performance leads the system as a whole to a higher degree of efficiency and qualification to deal with the inherent uncertainties of the innovative process (FELIPE, 2007).

This means that institutional learning necessarily involves a process guided to the consolidation of practices that lead to critical learning and corrective actions through the cooperative involvement between the public and private agents, on all levels. It seems reasonable to hope that the mentioned practices result in the creation of innovative capacity and of new development strategies for the system as a whole or for the majority of its components.

Therefore, the success of institutional learning must be materialized in the structuring of conditions that promote the required adaptation (economic, social, political and institutional) of the behavior of the entire SNI to changes in rules and incentives, leading to a continued improvement of its innovative performance. On the other hand, failure occurs exactly in a situation where new rules and incentives do not provoke active changes in the agents' expectations. On the contrary, they result in reactions deeply embedded in previous behavior standards and which in many cases even create new forms of conflict (between the new and the old) and hindrances to the innovative process (GERTLER E WOLFE, 2007).

Investigation regarding institutional learning, however, has presented a predominantly abstract character and its verification and empiric measurement has scarce literature. In fact, the creation of a consistent methodology that is able to measure the degree of learning in institutions within a certain SNI is still an open field in specialized literature.

Although this paper does not intend to advance in this area, some questions seem to be important for future investigation.

- Is institutional learning alone sufficient to place the National Innovation System – SNI in more adequate functioning conditions?
- Which is the relation between institutional learning and an improved performance of the system as a whole?
- Which indicators would be adequate to analyze the learning degree of the various elements of a SNI?
- Which criteria should be used to distinguish 'institutional changes' from 'institutional learning'?
- Does the institutional learning process also function as trial and error and does it have the same nature as individual or organizational learning?

The methodology used by Villaschi (1996 and 2003) in analyzing the SNIB beginning with technological (which makes innovation possible), economic (ensures feasibility of innovation), institutional (which allows the occurrence of innovation) domains, may be useful to obtain evidence for institutional learning. In this case, so much larger the institutional learning, higher the positive articulation among these system's domains, since this convergence is not a natural nor autonomous process.

More than this, since the self-organization power of institutions is limited, its evolution requires some type of effort that will have to be larger at the time of change in techno-economic paradigms and increasingly dependent on the SNI position in *vis-à-vis* analysis of its equals in other countries.

This heterogeneity of the relative position of national innovation systems and of the manner of institutional learning, explains the inexistence of a sole standard of connection and institutional evolution among the domains of the SNI. In any way, institutional learning and positive articulation among domains should stand out as fundamental characteristics of a national innovation system, mainly due to the existence of continuous cycles of learning and innovation (technical and institutional).

### **3. Recent changes in the Brazilian national system of innovation – a case of institutional learning?**

This paper continues the investigation about the performance of the Brazilian national system of innovation (SNIB) in the 1980s and 1990s, already discussed by Villaschi (1996 and 2003) and will try to identify elements that illustrate the Brazilian institutional learning from the end of the nineties. For Villaschi (2003, p. 02) in the decade of 1980, *“there were strong evidences that the role played by state-owned-enterprises; public run research laboratories in areas at the core of the ICT techno-economic paradigm (telecommunication and informatics); and the way the triple alliance between local, foreign and state-owned enterprises was working, could be a positive indication of possibilities for the Brazilian n.s.i. to take advantage of some 'windows of opportunities' that were being opened by the emerging techno-economic paradigm.”*

The nineties, however, marked the frustration of these expectations. As Villaschi (2003) continues, the change in the institutional and economic structure in the nineties didn't take into consideration the radical transformations that were occurring in worldwide technological development, connected to the information and communication technologies of the PTE. Such political positions caused the SNIB to function with important restrictions.

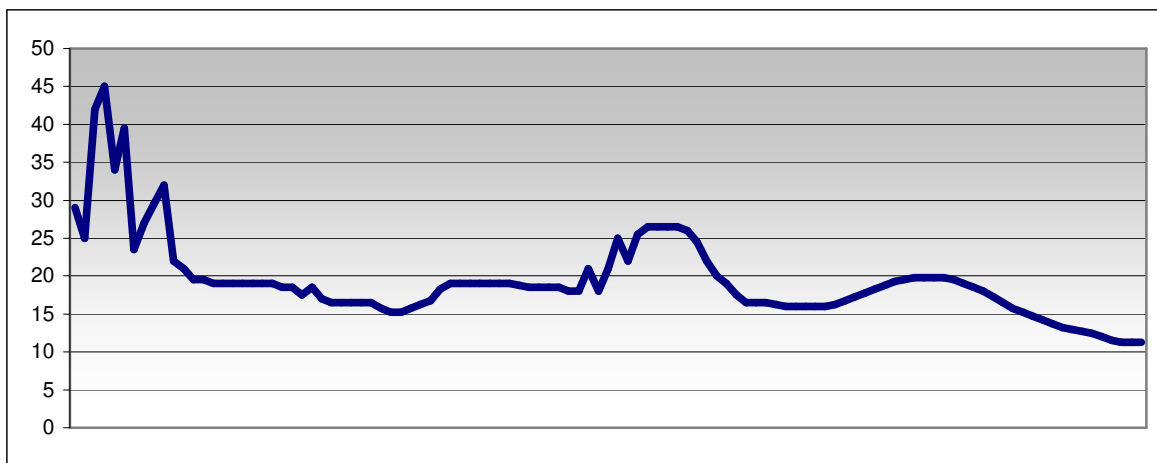
The end of the nineties and the beginning of the 21<sup>st</sup> century, however, are marked by institutional restructuring and changes capable of altering innovative and competitive performance of the Brazilian economy. It is hoped that these changes, which were the result of institutional evolution and learning will bring, in the medium an long term, a greater proximity between the three domains of the SNIB, as well as between the SNIB and its similar entities in other countries. Among the main perceptible changes we may mention:

#### *a – in the economic domain*

The nineties marked what became known as a perverse macroeconomic policy, of a highly restrictive nature, based on the overvaluation of the Real in relation to the dollar, with high interest rates and a mechanism to control inflation, besides a tax policy, also of restrictive nature, characterized by the increase of the tax burden/GNP and with a significant reduction in the government's expenditure, mainly connected to infrastructure and education, science and technology areas.

After the end of that decade, however, the achievement of price stability, added to a consistent policy for the reversion of a perverse macroeconomic environment into a stable and reliable environment, culminated in actions that stimulated economic growth. Among these actions the gradual reduction of the basic interest rate of the Brazilian economy, the SELIC, guaranteeing inflation control is noteworthy

**CHART 01 – BASIC INTEREST RATES – SELIC (JANUARY 1999 TO DECEMBER 2007 – IN %)**



Source: IPEADATA (2007)

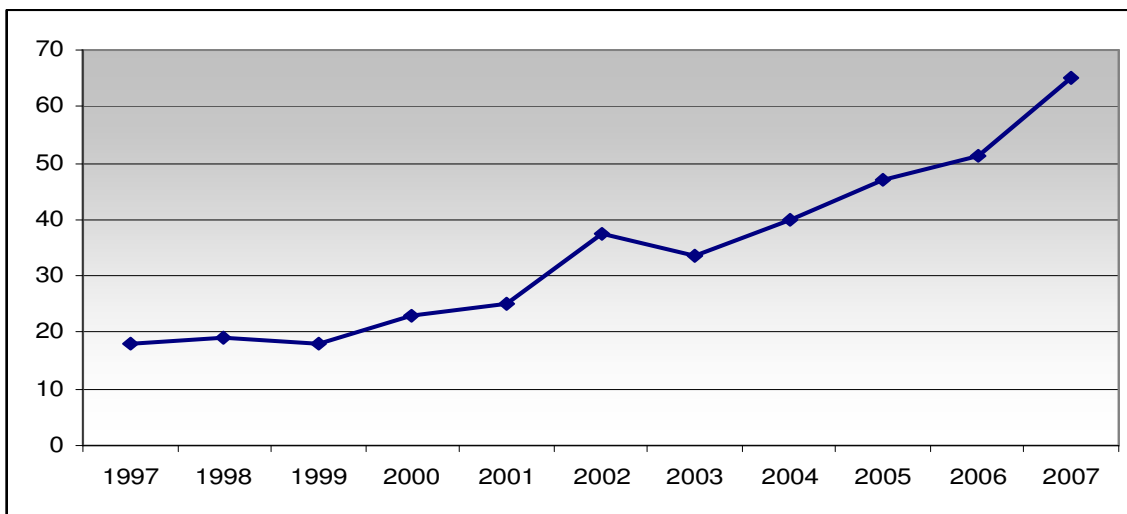
**TABLE 01 – BRAZILIAN RATES OF INFLATION (IPCA) FROM 1999 TO 2006**

<i>1999</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>
8.9	6.0	7.7	12.5	9.3	7.6	5.7	3.14

Source: IBGE and BACEN (2007)

The stimulating environment for investment was also influenced by the volume of financing made to the productive sector. In this aspect, the period from 1999 to 2007 also represents a considerable improvement. Data from the Banco Nacional de Desenvolvimento Econômico e Social (BNDES) show (Chart 02) that the disbursement made by banks to the productive investment projects almost quadruplicated over the last 10 years, going from R\$ 17.9 billion in 1997 to R\$ 64.9 billion in 2007.

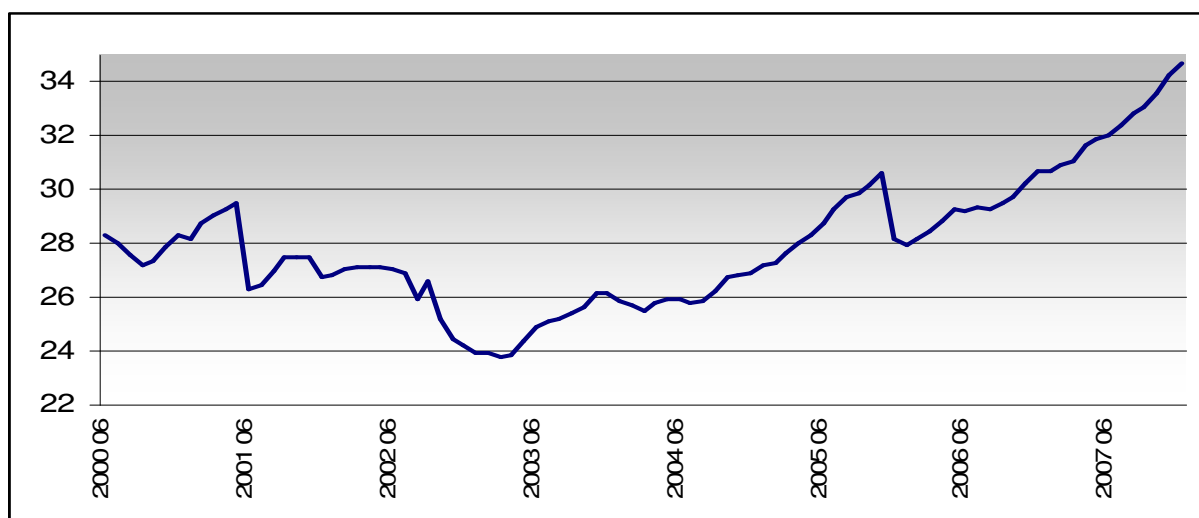
**CHART 02 – DISBURSEMENTS MADE BY BNDES FROM 1997 TO 2007 (IN BILLIONS OF REAIS)**



Source: BNDES (2007)

When the volume of credit operations of the financial system is taken as a whole, an increase in relation to the GDP can be clearly noted, which results in an overcoming (even though partial) of one of the structural bottlenecks occurring in the Brazilian economy during the eighties and nineties.

**CHART 03 – VOLUME OF TOTAL CREDIT OPERATIONS OF THE FINANCIAL SYSTEM IN RELATION TO THE GDP BETWEEN 2000 AND 2007**

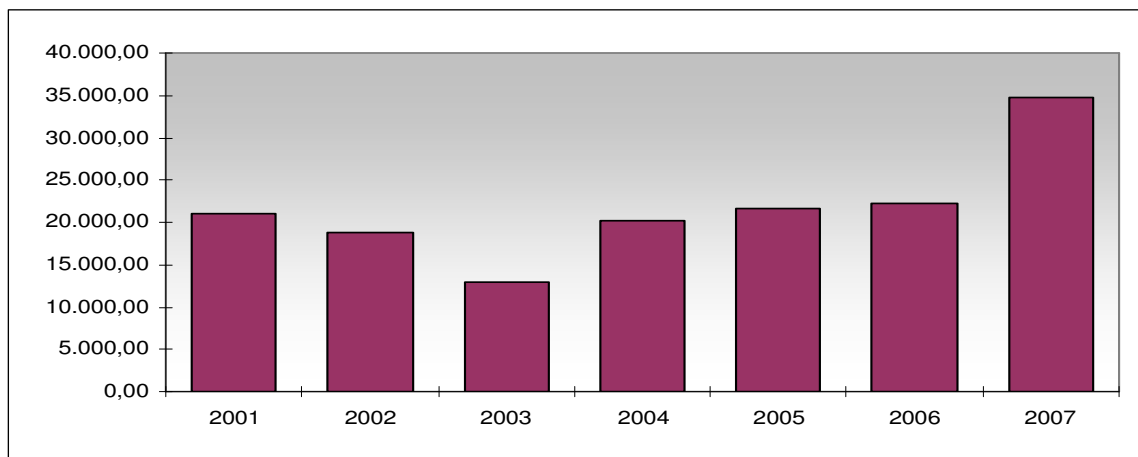


Source: BACEN (2007)

On the other hand, there was an increase in the entry of External Direct Investments, with the record being broken in 2007, overcoming the amounts registered in the half of the nineties, a period marked by large privatizations of state-owned companies.



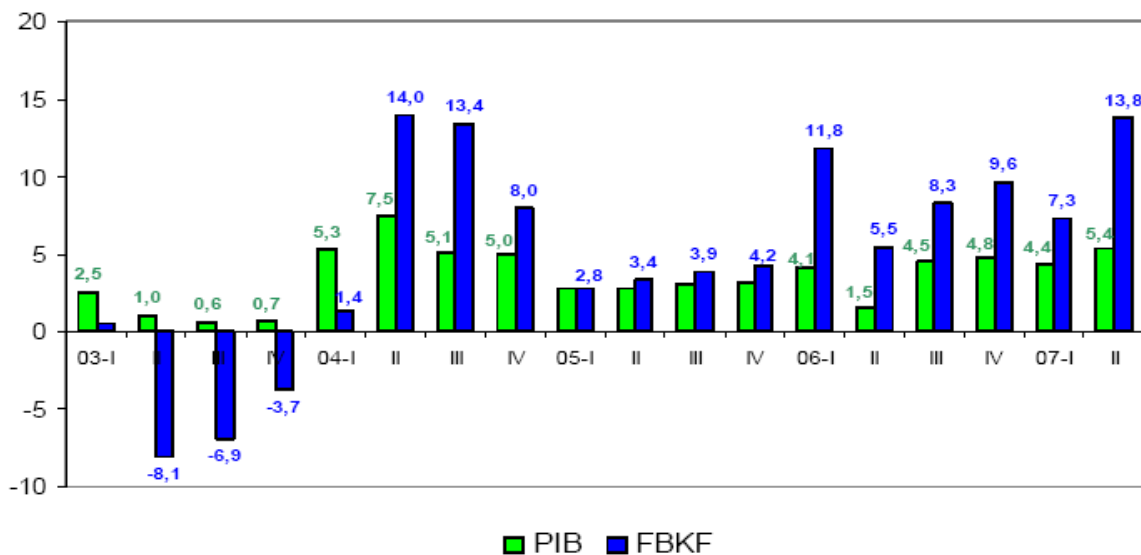
**CHART 04 – ENTRY OF DIRECT EXTERNAL INVESTMENTS (US\$ Bi)**



In this sense it may be said that the analyzed period can be characterized by the reduction in perverse macroeconomic restrictions that were a feature of the previous decade. This is due, as pointed out by literature, to the consolidation of the macroeconomic stability, at the same time as the occurrence of reductions in the interest rates and increases in the financing made to the productive and consumer sectors, and which may contribute to investments in long-term innovative processes.

Emphasis may be given to FBKF in the Brazilian economy. Since it has had a performance superior to the growth of the GDP as of 2004, it may be an indication of potentiality for the country's future development.

**CHART 5 – GROWTH RATE OF THE GDP AND FBKF (%)**



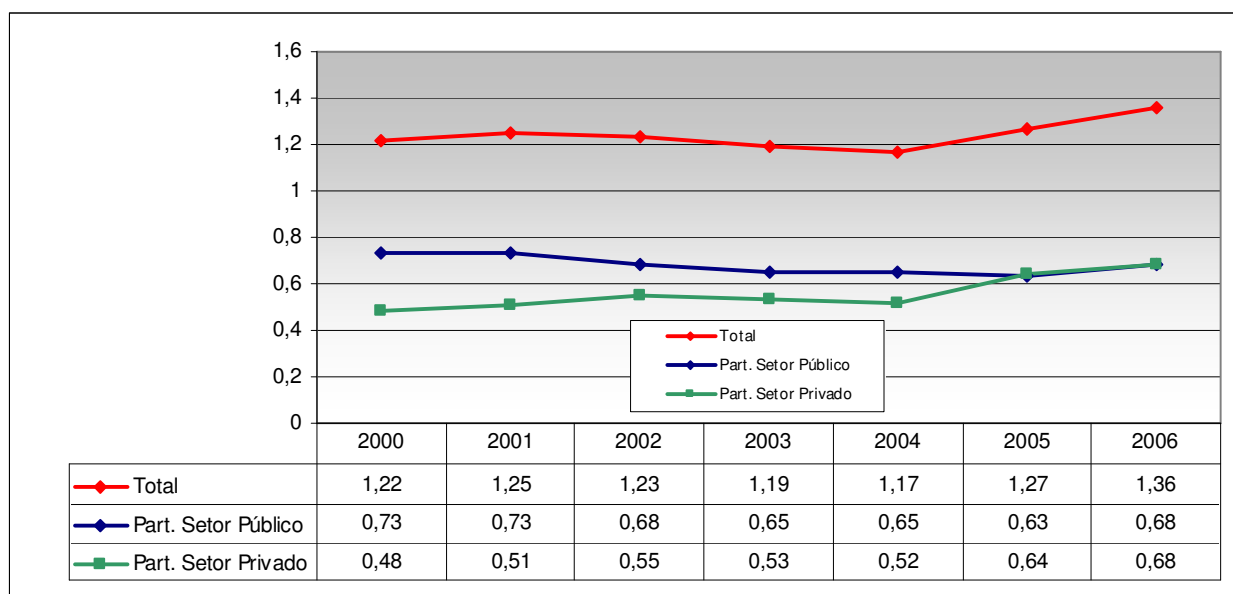
Source: BNDES (2007)

*b - in the technological domain*

In spite of the nineties having been marked by the introduction of national initiative in the computer science area, Internet, programs for the export of software, such initiatives did not have the required flexibility nor stability to promote changes and corrections of direction, in the technological sense, and place the SNIB in alignment with the main characteristics of the PTE that was being installed (VILLASCHI, 2003). The hindrances for these programs were mainly adequate financings and the lack of institutionality that would sustain the required articulations for the programs' continuity and serious study.

Even with the improvement of the macroeconomic conditions as pointed out above, and institutional conditions (covered in the next item), no advances occurred in the technologic domain of the SNIB. The total investment rate in R&D in relation to the GDP went from 1.22% in 2000 and reached 1.36% in 2006. Even though the chart below shows a slight stability with small growth starting in 2004, this rate is not sufficient to diminish the delay in terms of research and development when compared, for example, to countries of the OECD where the average rate of investment in relation to the GDP reached 2.3% in 2006 (OECD, 2007).

**CHART 6 – INVESTMENT IN R&D IN RELATION TO THE GDP (%)**

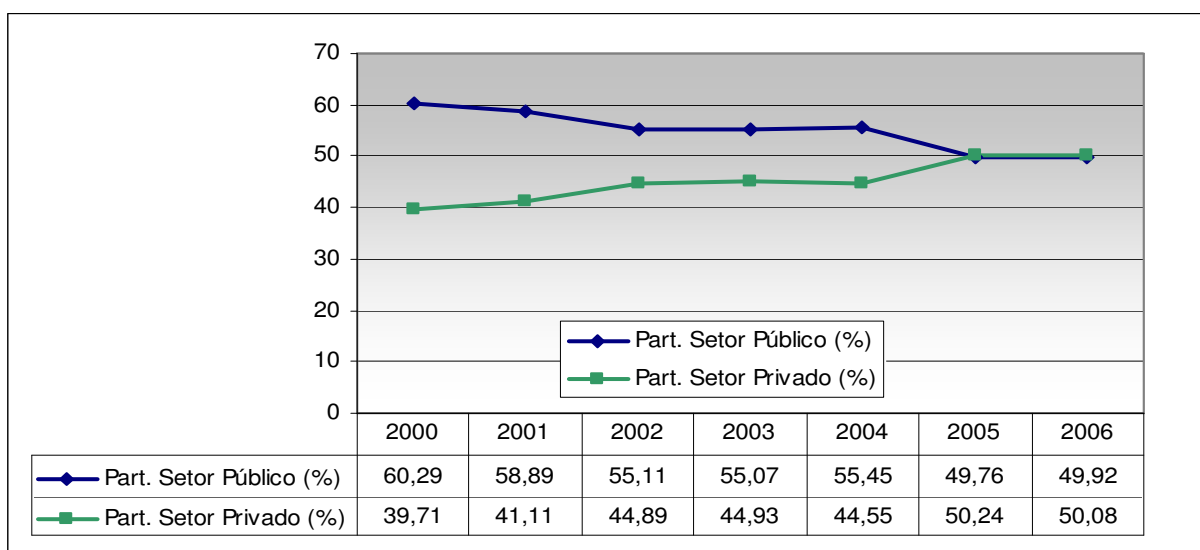


Source: MCT (2007)

On the other hand it is obvious from the chart above that the private expenses when analyzed in relation to the GDP present an increasing tendency which the State's participation tends to diminish. In fact the government's R&D expenses diminished from 0.73% of the GDP in 2000 to 0.68% in 2006, while the investment in the private sector increased from 0.48% to 0.68% in the same period, meaning an increase of 40%.

This tendency is even more evident in the following chart. While the public sector was responsible for 60.29% of investments in 2000, its participation fell to 49.92%, while the private sector increased its participation from 39.71 to 50.08% in the same period. It should be remembered that even considering the total amount it is below the levels required to remove the country from technologic hindrance route, the increase in the participation of the private sector reflects a greater understanding by the enterprises of the requirement to elect innovative capacities as a primary and propelling source of competitiveness.

**CHART 7 – PARTICIPATION OF THE STATE AND PRIVATE SECTOR IN THE TOTAL R&D EXPENSES BETWEEN 2000 AND 2006 (%)**



Source: MCT (2007)

Data analyzed in Villaschi (2003) referring to the technologic formation in graduation courses in the country during the nineties seem to persist in the present decade. Actually, in spite of Brazil having increased its participation in the world scientific production, which reaches 1.8% of the total in 2002 (an amount which is much higher than the 0.5% in 1985), it may be observed that this scientific knowledge has not been transformed in the same proportion in productive applications, due to the low quantity of patents obtained by Brazilian citizens in the United States (LASTRES, 1997; CORBUCCI, 2007).

Regarding this matter, the conclusion reached by Corbucci (2007, p. 10) is that: *“the system of Brazilian technical change may be characterized as predominantly dominated by a technical learning process that is typical of eminently imitating economies, in which the technical change is restricted basically to the absorption and improvement of innovations generated outside the country.”*

On the other hand, as already pointed out by Villaschi (2003), this may also be a consequence of the low participation of engineers in the total of professionals concluding university level courses in Brazil, as shown in the table below, indicating that this tendency still persists in the SNIB.

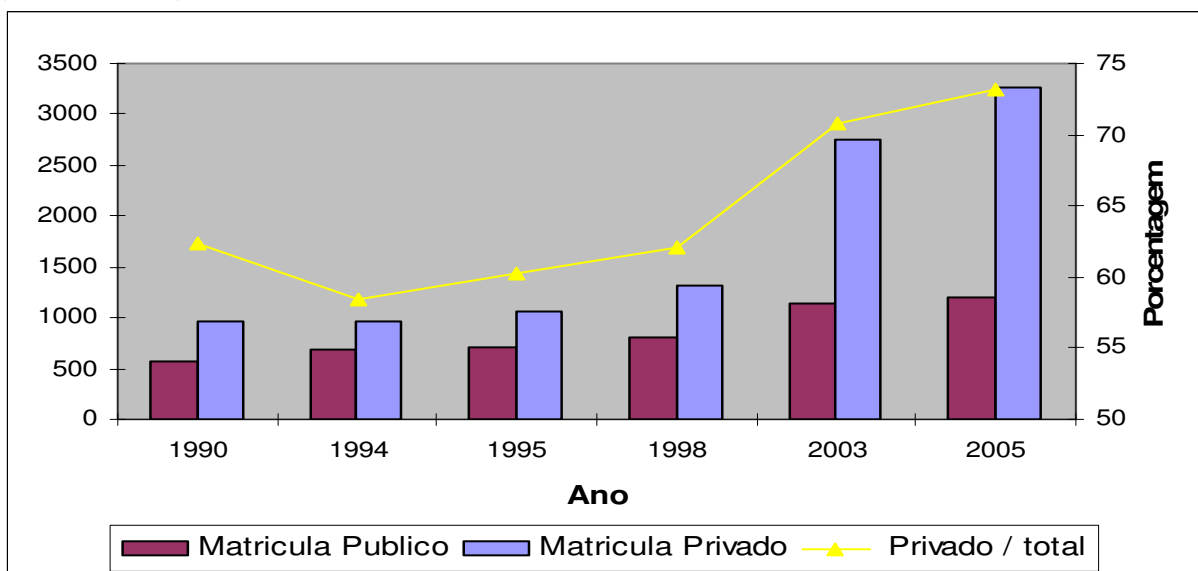
**TABLE 02 – Number of graduation course concluding students, by study area (2004)**

<i>Study Area</i>	<i>2004</i>	<i>% do Total</i>
Agriculture and Veterinary Medicine	10,256	1.6
Science, mathematics and computer science	48,667	7.8
Social science, business and law	237,891	38.0
Health Sciences	77,868	12.4
Education	182,189	29.1
Engineering, production and construction	33,148	5.3
Humanities and arts	21,042	3.4
Services	15,546	2.5
<b>Total</b>	<b>626,617</b>	<b>100</b>

Source: Corbucci (2007)

Another movement that also continues in the second half of the nineties (VILLASCHI, 2003), is the increased number of enrolments in private universities. It should be pointed out that the enrolment of students in higher education and in private universities was aided by the PROUNI (a program created by the federal government in 2003) that granted in 2005, 113 thousand scholarships for students enrolled in private institutions (INEP/MEC, 2007). The evolution of the enrolment in universities and the participation of the private sector may be seen in the chart below.

**CHART 08 – ENROLMENT IN GRADUATION COURSES, PER TEACHING SYSTEM (1990 to 2005)**



Source: Corbucci (2007)

However, three cases of success should be pointed out in the technological domain of the SNIB. First, the consolidation of Petrobrás as the world leader in oil prospection in deep waters.

Even though the Brazilian decision to start oil prospection dates back to the first half of the 20<sup>th</sup> century, it was only after the oil crisis of the seventies (and the consequent increase in the prices of the barrel) that the country started to destine resources for the prospection and production of the mineral under difficult exploration conditions. It is within this context that the Brazilian geological conditions favored (and still favor) the reserves in sea fields, which represented 91.6% of the total reserves in 2006 (IBP, 2007).

As emphasized by Ortiz Neto (2006), the discovery of large reserves in the Campos Basin – RJ at depths superior to those that could be prospected by imported technologies – even with adaptations – presented challenges to the company's capacity for production expansion. Due to the lack of technology on the world market that could operate under the conditions found in the discovered fields, in 1986 Petrobrás created the Qualification Program in Oil Prospection Technology in Deep Waters (PROCAP), in order to promote the adaptation and generation of technologies that could visualize, in a technical and economic manner, the production of oil in deep waters.

The 1986 program was launched with an aim of reaching a prospection in a depth of 1,000 meters. With the first program's success, the PROCAP 2000 was created in 1993, with the objective of exploring fields with depths of up to 2,000 meters. As of 2000, the third phase of the program was launched, the PROCAP 3000, with the basic objective of prospecting fields of up to 3,000 meters depth.

The PROCAP 1000, 2000 and 3000 required the creation of competences and knowledge that were still scarce (including worldwide), which made the company take considerable efforts in R&D, creation of interaction networks and in the formation of specific qualifications to this end. Due to the positive results of this strategy, Brazil achieved world leadership in the prospection and production of oil in deep and extra deep waters, establishing various world records.

The second case to be pointed out is that of EMBRAER. As shown by Suzigan e Furtado (2006), the company was created in 1969 and until the end of 1980 was still considered by many to be an enterprise placed between failure and success that was very costly to the public sector. The success of Embraer in the nineties, however, marks the result of a persistent investment strategy in learning that allowed the conquering of an ever more sophisticated technologic base. As the authors point out, the success of Embraer is connected to the creation, still in the fifties, of the ITA – Air Force Technologic Institute.

Lastly, the third case that deserves to be emphasized is the Brazilian fuel production from renewable sources: ethanol. The recognition of the technological advances that this industry has gone through has opened the possibility of using 'sugar cane' not only to produce sugar and ethanol, which already occurs since the seventies, but also for bioelectricity and bioplastics. Since Brazil has already consolidated its worldwide leadership in the production and export of ethanol, this position is also reinforced by the verification that the fuel and energy production from renewable sources, including biomass, contributes to the sustainability of environmental conditions, occasioning the reduction of greenhouse effect gas emissions and in the fight against the effects of climate change.

The investments in technologic progress during the last decades have allowed progress in the use of cane pulp and cane ends to generate electricity, on a short-term, and of cellulosic ethanol on a medium-term basis (ÚNICA, 2007).

In spite of this, other challenges still need to be overcome. It is necessary to consolidate ethanol as a global *energetic commodity* in the fuel area, by means of increasing the product's production, consumption and international trade. Anyhow, the results of the adoption of a vigorous and decisive energetic, industrial, commercial and technological policy centered on ethanol and other biofuels in order to maintain the Brazilian vanguard position in this industry are clear.

*c – in the institutional domain*

As pointed out in neoschumpeterian literature (notably FREEMAN AND PEREZ, 1988, PEREZ, 2002), technological advances and economic possibilities of a techno-economic paradigm cannot reach complete development within an institutional structure that does not comply with its nature.

As mentioned previously, while developed countries have institutional frameworks that adapt faster to challenges brought by PTE evolution of information and communication technologies (TIV), countries under development tend to present institutional structures that still have features from passed models, which impose restrictions to current requirements. The leap in institutional learning required in such cases makes one believe that such an undertaking cannot be made simply by laws and decrees.

On the contrary, the installation of ethical principles of cooperation and social cohesion should be established, which may only be molded by the building of collective solutions for the correction of institutional routes, elimination of inefficient practices and establishing those that are more favorable to development (FUKUYAMA, 1996).

In the Brazilian case, the requirement for institutional learning is even more justified by the delay to which the SNIB was subjected in the eighties and nineties, when compared with matters that were already being dealt with in countries of the Triple Alliance and some emergent countries.

In fact, as pointed out by Villaschi (1996) the Brazilian institutional structure in the eighties was fundamentally marked by the “*primary intention of creating political institutions that might reduce the hiatus between the authoritarian regime [that ended in that decade] and so long waited for democracy.*” (p. 228) and “*the basic debate was concentrated in forms to conciliate the state and society during the transition from authoritarianism to democracy and in alternative ways of forming a ‘nexus’ between capital and work that might integrate the policy of masses and economic development*” (p. 234). Even though there was already a concern – mainly from some of the state techno-bureaucrats – with the questions of technical progress and appearance of new technologies connected to TICs, the lack of synchrony between economy, the society and institutional structure considerably diminished the possibility for firmer and more consistent actions of adaptation of that structure to the new nature of PTE that was being installed.

The nineties can be characterized by the implementation of structural changes in the Brazilian institutionality that did not take into account the transformations that were happening in the world technological core. On the contrary, the many changes made were “*connected to competitiveness in the allotment of factors (mainly in natural resources and cheap labor)*” (VILLASHI, 2005, p. 12) and the SNIB’s low performance in the nineties is not surprising, as well as that little was done regarding those ‘windows of opportunity’ opened by the new PTE of the TICs.

Again it is necessary to remember that attempts to implement programs aiming at adapting the country to the nature of the new PTE were made, such as the Brazilian Program of Information Society, in spite of the majority of actions being isolated and discontinued. As pointed out by Villaschi (2005, p. 13), “*in spite of the minister’s good intentions [of C&T] and those of some of his colleagues in various government spheres, of the academic and business worlds, the late launching of a program focused on information society in Brazil had the same destiny as others related to the previously exalted “Avança Brasil”: lack of appropriate financing and continuity, due to the low political commitment in the government spheres in which decisions are taken.*”

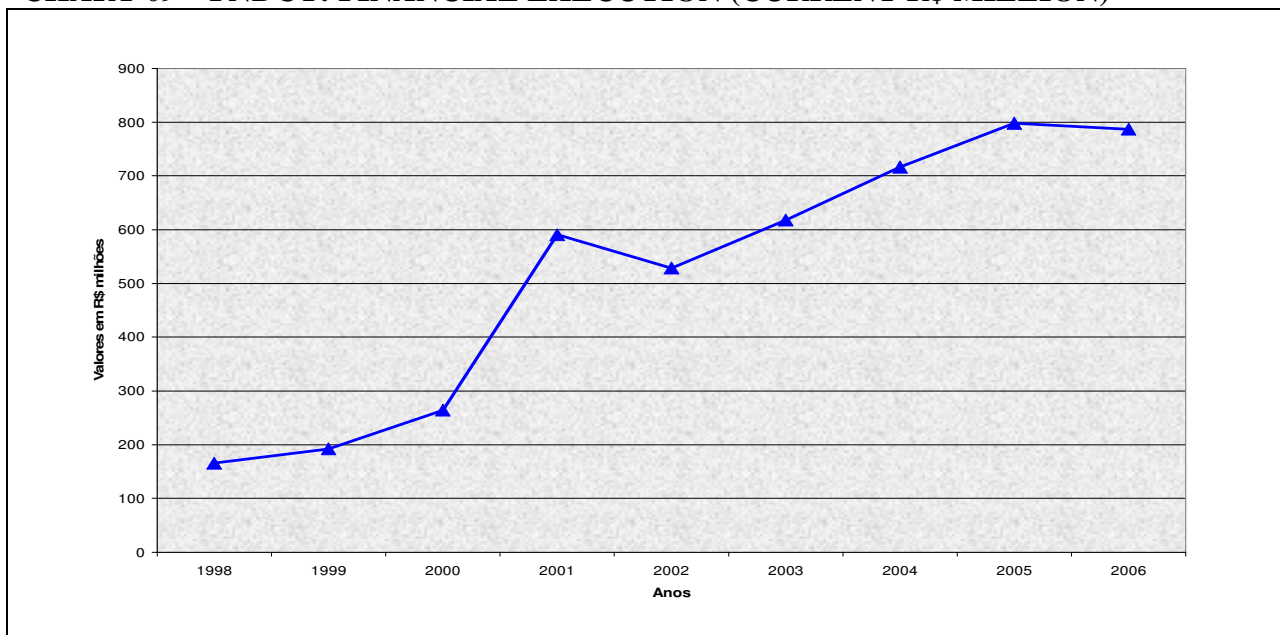
However, after the end of the nineties, there was considerable progress in terms of these transformations that tend to create institutional environments that are more aligned with the nature of the PTE in effect and that comply with crucial elements for the country’s innovative capacity. Among these the following are noteworthy:

(i) Creation of sectorial funds for the financing of innovation and research.

The difficulties generated by the reduction in resources to finance and improve the R&D in the country during the nineties generated, in technicians connected to organizations developing R&D in the country, a reaction in order to overcome the chronic instability in the allotment of resources for their financing. As a result of this reaction, in 1997 the ‘sectorial funds’ started to be administered. These funds are made up by the collection of income deriving in some cases from financial compensation paid for the exploration of natural resources; in others, by the creation of contributions from state interventions in the economic domain; in some cases connected to the creation of regulatory agencies in privatized economic sectors and/or submitted to exploration by private enterprises granted through government concession contracts.

This paper considers the creation of these funds as a positive result of institutional learning by people and organizations that had already incorporated the idea that investment in innovation is a critical factor in the building of the necessary conditions for the country’s development.

**CHART 09 – FNDCT: FINANCIAL EXECUTION (CURRENT R\$ MILLION)**



Source: FINEP (2006)

The chart above shows the financial execution of Sectorial Funds that go from R\$ 160 Million in 1998 to R\$ 787 Million in 2006. This new financing mechanism for Research, Development and Innovation in the country, even though presenting some deficiencies that need to be corrected, means the recovery of importance of the FNDCT – National Fund for Scientific and Technologic Development, where the resources of the Sectorial Funds are allocated. In spite of the considerable increase in resources available for R&D, they are still lower than those available in the seventies.

#### (ii) A new Industrial Policy and the Innovation Law

The release in 2003 of the Industrial and Foreign Trade Policy (PITCE) in itself represents a maturing process of the Brazilian institution, since it represents the overcoming of an anti-political inclination (or not political while political) that was predominant from the beginning of the eighties. Even though its formulation and implementation are far from coping with the large range of difficulties that were accumulated during the entire period, the PITCE indicates a development strategy centered on innovation and that is profoundly geared by the impacts of technological transformations, which makes it converge with the neoschumpeterian principles.

In this manner it is remarkable that innovation occupied a space in the economic policy. The main points of the PITCE are: the purpose, the focus on innovation and, to a certain extent, the recognition of the requirement for a new institutional organization to carry out the policy's coordination.

With priority being given to scientific and technologic development, propagation sectors of technologies and innovation were selected – semiconductors, software and capital goods – areas that the PITCE denominates as ‘bearers of the future’ (SUZIGAN & FURTADO, 2006).



However, the PICTE is facing difficulties in transforming the policy's guidelines into concrete results. The main difficulties are comprised in two pillars. The first refers to the already old problem of lack of coordination among the governmental institution that define the guidelines and finance the innovation programs and the private companies that implement and incur in the risks of the innovation process. The second is the absence of coordination between the objectives and results of the macroeconomic policy adopted and the objective of the policies that involve industry, commerce, technology and the SNIB.

In 2006 the Innovation Law was approved with the purpose of supplying assistance for the transmission of knowledge generated by basic research, mainly deriving from universities and public research institutes for the technologic development in companies. This was strengthened by the initiative of the BNDES of creating specific loans for companies that desire to increase their expenditures in R&D, for the introduction of new products or productive processes.

### (iii) New treatment for Micro and Small Companies

The General Law for the Micro and Small Companies of 2006 creates new conditions for the growth of a significant group of enterprises in Brazil. The law foresees (a) the reduction of tax load, (b) agility and ease in obtaining long-term financings, (c) participation through consortiums, in government bidding and purchases, ensuring scale gains, (d) reduction in time and bureaucracy for the registration of companies, (e) incentive to exports, with elimination of taxes and possibility of creation of consortiums of micro and small companies for export.

In spite of being aimed at micro and small companies, the differentiated treatment which is given to smaller sized companies may be seen as a further encouragement for the appearance and consolidation of *spin-offs* with a technologic core and small innovating companies. When helping these companies to obtain access to government purchases and long-term financing, the new Law responds to the natural hostility of market forces to smaller scale enterprises.

### (iv) Universities' Renovation

The Support Program for Restructuring and Expansion Plans of Federal Universities – REUNI has the purpose of giving federal universities the required conditions to enlarge access and permanence in higher education and unites efforts to consolidate a national policy for the expansion and improvement of quality of public university level education. It is hoped that a better and more significant performance of the federal public universities will occur, which will be evaluated by quality indicators to verify the REUNI's achievements.

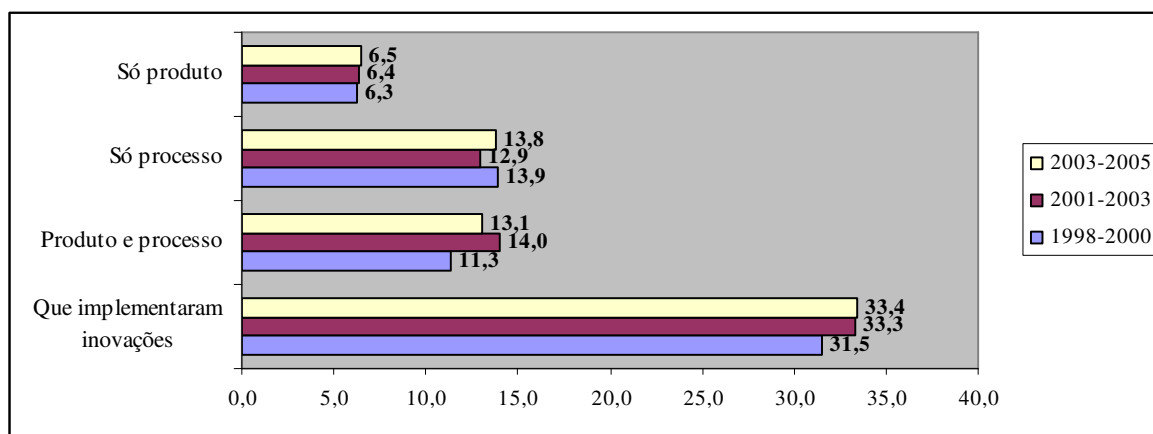
It should be noted that REUNI creates incentives for a greater proximity of public universities (and its researchers) to private organizations and the civil society. Even though, as shown by Lundvall (2002), this is not a guarantee of greater integration between these important elements of the SNI, the attempt to ease (or overcome bureaucratic hindrances) this integration may be seen as a step forward for the SNIB to become more contemporary in its own time.

Even though evidence exists of evolution in the building of an environment that is favorable to innovation within the SNIB, which is the result of the institutional learning process that was characterized herein, the conformation of the results of institutional learning is neither automatic nor immediate. This is the result of the recognized slow character of the effects of institutional changes and the requirement for continuity of actions to make results occur.

In the Brazilian case, evidence exists that this hiatus between learning and results must be taken into account. Among them, the following are noteworthy:

- According to data from the PINTEC – Technological Innovation Research, of the Brazilian Institute of Geography and Statistics (IBGE), the percentage of companies that make innovations in products or processes in Brazil has not altered significantly during the period from 1998 to 2005, as may be seen by the chart below.

**CHART 10 – PERCENTUAL PARTICIPATION OF THE NUMBER OF INDUSTRIAL ENTERPRISES THAT IMPLEMENTED INNOVATION – BRAZIL, 1998-2000, 2001-2003 AND 2003-2005.**



Source: PINTEC/IBGE.

- Another information presented in the PINTEC is that due to the concentration of innovating capacity in a few agents of the SNIB, the results of institutional learning varies significantly between companies according to their size. While in the total of companies the participation of those that promote innovation remains practically unaltered between 2001-2003 (33.3%) and 2003-2005 (33.4%), in companies with 100 to 249 occupied persons, this percentage increased from 43.8% to 55.5%. In companies with 250 to 499 and with more than 500 occupied persons, this percentage increased from 48.0% to 65.2% and from 72.5% to 79.2%, respectively. On the other hand, in smaller companies, those that employ from 10 to 49 persons, the percentage was reduced from 31.1% to 28.9%, indicating that (i) the micro and small companies' capacity to take over more favorable institutional conditions is smaller than that of a medium or large company and ii) the change in the institutionality directed to these companies does not rapidly alter the expectation state of these agents.

**TABLE 03 – Number of companies and percentile participation of the number of companies industries that had implemented innovations**

Number of employees	n. companies		n. innovation companies		Tax (%)		New product to national market		New process to sector in Brazil	
	2001-2003	2003-2005	2001-2003	2003-2005	2001-2003	2003-2005	2001-2003	2003-2005	2001-2003	2003-2005
Total	84.262	91.055	28.036	30.377	33,3	33,4	2,7	3,2	1,2	1,7
From 10 to 49	67.165	72.300	20.894	20.923	31,1	28,9	2,1	2,1	0,7	0,9
From 50 to 99	9.157	10.036	3.200	4.076	34,9	40,6	2,3	3,7	0,8	1,2
From 250 to 499	4.881	5.338	2.140	2.962	43,8	55,5	3,9	6,5	1,7	3,8
From 100 to 249	1.695	1.843	813	1.201	48,0	65,2	5,8	9,4	3,4	6,1
From 250 to 499	1.364	1.537	989	1.216	72,5	79,2	26,7	33,4	24,1	27,1

#### **4. FINAL COMMENTS**

Institutional learning may be placed in terms of, for example, the ability of institutions of eliminating inefficient social practices and substituting them for those that help the economic change process and social adaptation to the evolutionary environment, aligning the institutional, technologic and economic domains to the nature of the PTE in effect.

In this manner, institutional learning is a process which derives from the internalization in the institutions' routines and from the experiences extracted from their evolution. The learning efforts and joint and convergent building of solutions, in all institutions and spheres of the SNIB, are profoundly necessary.

The speed of global transformation creates an environment that favors the concentration of benefits in countries with SNI that are capable of (i) learning quickly and (ii) minimizing internal conflicts through a process of institutional evolution.

As stated by Edquist and Johnson (1997), the ability of an economy of generating sustainable growth depends on its ability to learn and diminish institutional conflicts, so that the specific actions of economic policy point to changes that promote an environment which is more favorable to activities and innovative capacities (including institutional). Within this process, it should be pointed out that in many cases the process of 'unlearning' to operate according to institutional prevailing optics in the previous techno-economic paradigm (Fordism) is so or more important than learning to operate according to the logic of what emerges (in the present case, the TICs).

The reasons for attachment to institutional rules of the previous paradigm are many, as pointed out by Perez (2001). To explain and recognize them may be the first and important step for the required institutional leaning to make the SNI contemporary in its own time.

Although the SNIB still has a long road ahead of it, the last years represent a considerable improvement in the building of this favorable environment. How much of this progress is derived from institution learning and how much may be credited to the required unlearning of past forms and contents is something that must be more profoundly studied.

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