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The Evolving Role of Academic Institutions in Innovation Systems and Development

Brazilian Universities and their Contribution to Innovation and Development

José Manoel Carvalho de Mello
Anne-Marie Maculan
Thiago Borges Renault

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BRAZILIAN UNIVERSITIES AND THEIR CONTRIBUTION TO INNOVATION AND DEVELOPMENT [1]

José Manoel Carvalho de Mello[a*]
Anne-Marie Maculan[b]
Thiago Borges Renault[b]

[a] Federal Fluminense University, Nuclei of Studies in Innovation, Knowledge and Work, Rua Passo da Pátria, 156 Bl E sl 443, 24210-240. Niterói, Rio de Janeiro, Brazil.
[b] Federal University of Rio de Janeiro, COPPE, Bl F, sl, f-109, 21945-970. Rio de Janeiro, RJ, Brazil.

Brazil covers an area of 8.5 million square kilometers, has a population of 187 million and a Gross Domestic Product of US$ 1.067 billion[2]. It is organized as a Federated Republic with 26 states and borders on ten of the twelve countries of South America. A military coup in 1964 led to a military dictatorship. Brazil returned to the constitutional democracy in 1984.

The country has abundant reserves of minerals, Petroleum and gas, an immense river system for generating Energy and transportation of cargo, forest reserves and a rich diversity of fauna and flora. Its population is a mixture of the descendants of the indigenous population with Europeans, African and Asians and has developed a unique and rich cultural heritage. It is the only country in the region that speaks Portuguese.

Exports in 2005 were US$118.3 billion, distributed as follows: 30% primary products, 14% commodities, 55% manufactured goods. Exports amounted to 16% of GDP and 1.13% of total world exports. Imports in 2005 reached US$ 73.5 billion or approximately 10% of GDP and 0.68% of total world imports (IPEADATA, 2006).

The average number of years of schooling for the population is 6.6 years (IBGE, 2004). However, 4.3% of school aged children are not in school. There were less than 100,000 students enrolled in university level courses in 1960 and there were almost 4 million enrolled in 2005.

Brazil has a Gini Index[3] of 0.58 and is ranked 10th in the world among countries that have the poorest distribution of income. The Human Development Index is 0.792 with Brazil ranked 69th in the world (PNUD, 2006).

In 2004, approximately 46% of income was concentrated in 10% of the population, while 50% of the population have only 14% of income. About 34% of the population lives below the poverty line and more than 13% are considered indigent (IPEADATA, 2006).

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* Corresponding author. E-mail addresses: josemello@pq.cnpq.br; amaculan@pep.ufrj.br; thiagorenault@producao.uff.br
[2] Ministry of Foreign Relations, 2006; IBGE, 2008; IPEADATA, 2008.
[3] A value of 0 represents perfect equality of distribution and 1 perfect inequality (PNUD, 2006)

I. INTRODUCTION

Brazil was the last country Latin America to create a higher education system. The first Latin American universities date from the 16th century in Mexico and Peru (1551), the 17th century in Bolivia (1623) and the 19th century in Argentina and Chile.

Brazilian universities have been in existence for less than 100 years. There are some Colleges of medicine, law or engineering that date from the first half of the 19th century, but the first university was created in 1920 by the Federal government. The second, the University of São Paulo, (USP), was created in 1934 by the state of São Paulo with the lofty ambition of competing quickly with the best in the world in terms of the quality of instruction and becoming a instrument of leadership in the field of Brazilian politics. To achieve this objective, USP sought to recruit the best known university professors in Europe, and grew to be the most highly recognized Brazilian institution of higher learning and research.

In the 1950s the creation of new public and private universities began to intensify. By 2005, there were 2,165 institutions of higher learning, of which 176 were classified as Universities. The system of research, a factor that caused various institutions to group together took place primarily among the public universities and in some research institutions linked to specific ministries (Health, Agriculture, Mines and Energy). Public policies for Science and Technology were developed beginning during the 1970s. The difficulties in achieving planned goals for technological autonomy generated great frustration in the academic and scientific community because of the difficulty in achieving the ambitious goals they held[4].

Brazil's industrial capability is relatively recent. The process of industrialization began in the 1950s based on three elements: multinational corporations, the state, and the embryonic national investment. Each of these three factors was assigned a specific role: the first was charged with bringing capital and technology, the second to obtain international financing to compliment insufficient domestic saving and the third was to prepare technologically to develop the domestic market – preferably in association with foreign companies.

The systems of higher education, research and industrial production developed rapidly for three decades but without much interconnection among them, each following its own path. There is considerable controversy among economists and other students of the process of industrialization about the possibility of determining whether or not there is a national system of innovation as defined by Nelson, Freeman or Lundvall.

During the 1980s, the so-called lost decade[5], because of the heavy external debt and the hyperinflation that was not controlled until 1994, these three systems entered into crisis. Beginning in 1990, profound changes were introduced in the economic structure of Brazil: the economy was opened to foreign investment, a number of public service companies were privatized, monetary stabilization was imposed and the organizational structure of large companies was modernized, all tending to increase Brazilian companies' quality of production and ability to compete.

[4] I, II Plan for Scientific and Technological Development (PBDCT), II National Development Plan, (PND).
[5] In the Political Arena, this period coincided with the return to democracy most salient characteristics include indirect election although a civilian present on and the adoption of the new constitution in 1988.

With regard to higher education and the organization of scientific and technological research, new missions and goals were given to the principal actors. As examples the rapid increase in course offerings in higher education by private institutions, and the adoption of a new model for funding research, can be cited. Every government that has come to power since 1994 has viewed the articulation between higher education, research and industry as a major challenge to improve the private sector's ability to innovate, an element that is seen as a key factor in competition.

The object of this study is to analyze the changes that have occurred to provide a context for the current discussions of the new missions of the University, and in particular with regard to its contribution to local economic development, technological training for the business community and for the generation of entrepreneurial opportunities.

The study begins with an analysis of the functions of the university vis-à-vis the characteristics of the process of industrialization, which is presented in the first section. This is followed by a detailed examination of the ability of the university system to meet the demands for the formation of human resources, which speaks essentially to its teaching mission. Later, the development of research activities and their contributions to the process of innovation are examined, with particular emphasis on the discussions of the Innovation Law. Finally, the essential points of the discussion about the social context of university activities are discussed in succinct fashion.

II. THE SOCIO-ECONOMIC CONTEXT

II. 1. Rapid industrialization heavily dependent on foreign technology

Access to technological progress and new production technologies has been the great challenge of the Brazilian economy since the beginning of industrialization. The separation of universities and the business community, between research and innovation, is rooted in the historical characteristics of a delayed process of industrialization.

Before the Second World War, Brazil was essentially an agricultural country. The 1950s marked the beginning of a policy of delayed but intense industrialization. Under the influence of the studies of unbalanced economic growth done by the Economic Commission for Latin America (ECLA), Brazil opted to pursue a process of industrialization known as "import substitution". The development of the more dynamic industrial sectors would be left to the large multinational corporations that brought capital and technology[6]. State companies were concentrated in sectors like generation and distribution of electric power, telecommunications services, mining and production of basic industrial goods, (steel, petrochemicals, etc.). Funding for these activities would be guaranteed by the State and companies would rely on contracts for the transfer of technology and know-how to organize their productive activities. Other sectors were left to local companies, with limited financial capacity and precarious and limited access to

[6] Automobile, pharmaceutical, capital goods and equipment and cement industries.

technology. This industrial policy, guided by the development of the domestic market would come with strong protectionist orientation.

From 1952 to 1980 Brazil followed an import substitution industrialization strategy with a large presence of state-owned companies in primary sector industries (steel, mining and petrochemical) and in concessions for public services. There was also growing participation by multinational companies in the consumer goods sector. The industrial sector developed behind high tariff and non tariff barriers that protected domestic, state and multinational companies from international competition.

During the military regime, between 1964 and 1980, a succession of governments intensely pursued a policy of industrial and technological self-sufficiency through State companies that served a dual purpose: to guarantee the production of primary raw material and industrial inputs (steel, minerals, hydroelectric power); and to create centers of Research and Development to spread specific technological advances to strategic sectors (nuclear power, aviation, data processing). There are numerous examples: Petrobras, Eletrobrás, Telebrás, Nuclebras and Embraer. An important role was also played by the Brazilian Agricultural Research Company (Embrapa) in the development of Brazilian agriculture and whose research projects were designed to improve seeds and livestock the as well as protection against plant and animal diseases. The results of these projects were rapidly disseminated though industrial agriculture and are at the root of the substantial increase in the grain harvests and the extraordinary performance of agribusiness exports during the last ten years.

The 1950 – 1980 period is when Brazil's industrial base was formed, with high rates of growth and a considerable degree of diversification. During the years 1970 - 1979 Brazil experienced an average annual rate of growth in GDP of around 8.4%. But this rate of growth was not linked with technological development of the same magnitude. The desired articulation between industrial autonomy, through import substitution, and technological autonomy, through the substitution of imported technology with endogenous technology simply did not occur.

During the decade of the 1980s, a crisis occurred in the Brazilian economy as it began to confront two negative effects of the growth model it had adopted: the rapid growth of external debt that helped to feed extremely high levels of inflation on the one hand, and low levels of productivity that left Brazilian industry unable to compete in international markets on the other. The 1980s are referred to as the lost decade. Inflation was not brought under control until 1994[7]. It was a decade marked as well by a significant reduction in government funding for science and technology.

II. 2. Research and training human resources: the dual mission of the University

The most significant feature of the policy of industrialization and technological development was revealed in the ambitious plan for training human resources at the graduate level linked to the implementation of institutional Research activities. This was

[7] Between 1980 and 1994 the annual rate was above 100% with rates greater than 1000% per year between 1988 and 1994 and reaching 2700% in 1993 (see www.ipea.gov.br/ipeadata, accessed 21/11/2006).

an attempt to integrate university research with the training of highly qualified human resources for the production sector.

	Features of Industrialization	University Functions
1920-1950	Heterogeneous industrialization, with offshore technology incorporated in imported equipment, and the immigration of foreign technicians.	Scarcity of Institutions of higher learning (schools of engineering)
1950-1970	Industrialization based on import substitution, with the creation of subsidiary companies for production by multinational corporations and state-owned companies in primary sectors and public services	Training of human resources (engineering) as part of the process of industrialization
1970-1990	Diversification of the industrial base. Leading edge Industries based on endogenous technology and the increasing number of Brazilian employees at the managerial levels of multinational corporations	Training of specialized human resources and research scientists for the apprenticeship process

Board 1 - The Process of Industrialization and University Functions
Source: Maculan (1996)

This view was based on a linear conception of the process of innovation and the belief that there would be a natural overflow of research to companies. While the utopian ideal of technological autonomy failed to materialize, and domestic companies proved to be technologically passive, there was, however, a real process of learning that was marked by the progressive mastery of the technology of production that took place in a manner much like that described by Bell and Pavitt (1993).

Public policy for science and technology (S&T) during the 1970s was characterized by the adoption of programs directed to the creation of an infrastructure for research with a reasonable degree of installed capacity and important human resources. The principal policy instrument was the creation of the National Fund for Scientific and Technological Development (FNDCT) created in 1969[8]. The fund had significant resources compared to the size of the scientific community.

A portion of public funding was made available to the productive sector for innovation; but the impact was limited to because of the lack of demand on the part of

[8] According to Decree Law nº 719 of July 31, 1969

companies that rather than investing in internal Research, gave priority to the transfer of technology from abroad - the standard option at the time. The internal funding allocated by private companies for R&D did not amount to more than 3% of total government funding available and was concentrated in a few State-owned companies.

The availability of public funding at the time was nearly always associated with the "developmentista" policy of imports substitution. Moreover, there were various external loans coming from the Inter-American Development Bank, devoted specifically to scientific and technological development or to higher education. During the 1970s, a growing volume of government funding became available. The Fund was created and conceived to be quite flexible, and could use budgetary resources, based on loans from financial institutions or other organizations, tax incentives, from contributions and donations from public and private organizations and from other sources. By the beginning of the 1980s an important loan was being negotiated with the World Bank for the area of S&T – the PADCT[9], signed in 1983.

The most visible sign of the role of the FNDCT in the process of the institutionalization of scientific and technological research during the 1970s, was the growth in the number of post-graduate courses which increased from 125 in 1969 to 974 in 1979. A complex institutional system was created around the federal agencies promoting post graduate and research activities, that allowed the creation and financing of laboratories for post graduate education, and the creation of scholarships for students the at the M.A. and Ph.D. level, and to the evaluation of the quality of these courses. This system – unique among the countries of South America in the 1970s and 1980s – attracted numerous researchers and students from neighboring countries, particularly from Argentina and Chile.

During the decade of the 1980s, because of the imbalance in public accounts, difficulties with servicing the foreign debt and the reduction in direct foreign investment in productive activities, the FNDCT suffered a violent reduction an amount of available funding for the most important research projects as well as in the importance of S&T in general in governmental policy. The model for the institutionalization of academic research began to collapse. New guidelines began to appear that placed pressure to reduce the financing of basic scientific research and shift it to research in applied technology (Guimarães 1995) that was more in tune with the objectives of III PBDCT (1980-85).

II. 3. Technological Training, University-Business sector interaction and the capacity for innovation

Beginning in the 1990s, the Brazilian economy was subjected to a series of profound changes that changed its growth path. The new directions for the economy were the result of the interaction of various factors: deregulation (telecommunications, water, electric power distribution), the privatization of the large state mining companies, and the opening of various industries to foreign investment of (energy, petroleum, finance). New management models and a new wave of organizational innovation and modernization spread through Brazilian companies as they adapted to new standards of performance that were essential to their participation in globalized economy.

[9] (Guimarães, 1995)

Successive governments redefined the goals of industrial policy emphasizing the need to increase the competitiveness but Brazilian companies, especially so that they would be able to integrate with the offshore market. The use of new technologies (particularly data processing technology) was considered essential and spread throughout Brazilian industrial companies. Training in technology was now understood to include the ability to find, use and master new technology and became the principal goal of industrial and technological policy.

The challenge was to get companies to engage in the effort of modernization and assume innovation as a central part of their strategy. The process of technological training and the acquisition of the ability to innovate were now seen as the goals of industrial policy, but to achieve them required the cooperation of the universities. There was an urgent need to shed the passive acceptance of technology of the recent past. Various policy instruments were used. But with the economy still plagued by instability, although with inflation almost under control, investment and productive modernization took time to reach a significant volume. The new model of Development, however, was unable to return to the rates of growth of the earlier period, and remained at an average annual level of 1.7% between 1990 and 1999.

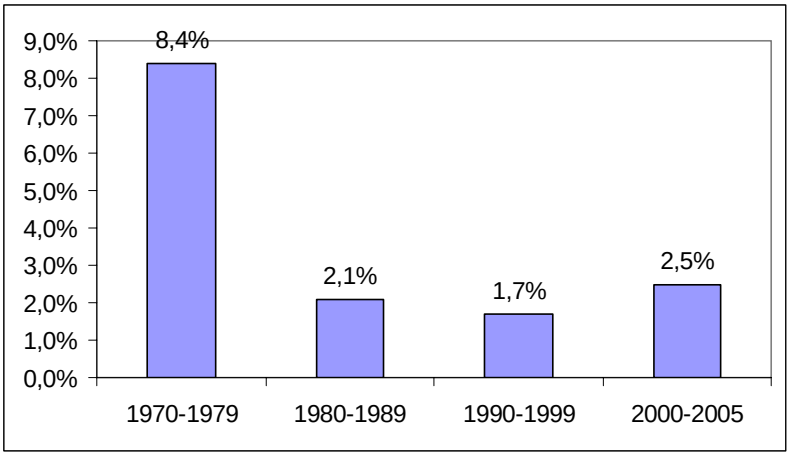

Chart 1 – Annual GDP growth average
Source: IPEADATA 2006

The broader objective of technological education began to replace the goals of expansion of production capacity and the search for technological autonomy. But government funding for science and technology, although slightly higher than during the previous decade, did not reach the levels obtained in the 1970s. The FNDCT in particular remained at a very low level. The new development model was not able to provide technological dynamism to Brazilian industry. The introduction and incorporation of new technology, and the modernization all business technology after the "opening" of the economy was much less than had been expected.

The lack of technological dynamism and the limited capacity for innovation can be clearly seen in two reports, PINTEC[10] for the years 2000, 2003 and 2005 (IBGE 2002,

[10] PINTEC is the Brazilian Technological Innovation Survey.

2005, 2007). The latest edition of the survey analyzed the nature of innovative activities in 93,301 companies with more than 10 employees, most of them from industrial sector (91,055), but for the first time it also included companies from the service sector: telecommunications (393), computer science (3.811) and R&D (42). The surveys show the differences in innovative behavior according to sector and size [11]. The first observation is that about one-third (34.4%) of the companies surveyed developed products and or implemented processes that were technologically new or substantially improved during the period from 2003 to 2005. Lack of technological dynamism continued to characterize Brazil's industrial base. Innovation was not widely practiced. Of the total, 20% of the companies surveyed developed innovations in product, 40% innovations in process the and other 40% produced innovations and product and process. Innovative activities were characterized essentially by the acquisition of machinery and equipment, of which the largest part was imported. The preference for mature technology, tested and incorporated in capital goods, remained strong. The predominance of this idea is confirmed by the trajectory of Brazilian industry which continued to be heavily dependent on external sources of technology. Brazilian companies continued to be essentially receivers of technologies developed by others, generally outside the domestic production system (Maculan 2005).

In general, the innovations that took place resulted in a modest improvement in the technology of the production processes. Important changes in the technology of production were rare and innovations in products were even rarer. The lack (or insufficiency) of demand for new products appears to have originated outside the decision making of the individual Company. It was a characteristic of the domestic economic environment that was still unable to fully understand that technological education, innovation and knowledge were the new parameters of competition.

Companies invested very little in internal R&D the activities, collaborated infrequently with universities or research institutions, and rarely purchased the results of research performed by other institutions. In the survey, 6,168 companies said that they invested in internal R&D activities, 58.6% of these performing R&D activities on a continuous basis and 86% of these were large companies. The survey also showed that 1.3% (83.944 people) of employees work with R&D activities in full-time (1.7%) and part-time (0.38%) regimes.

The effects of the lack of technological dynamism in industry during this period can also be seen in the low productivity of the labor force and by the composition of exports. Industrial productivity, which grew rapidly during the 1960s and 1970s, remained essentially stagnant during the following decades, in sharp contrast to what occurred in countries like Korea and Taiwan, which also industrialized during this time. Productivity in Brazil which reached a high of 35% of American productivity today corresponds to 25%. Brazil, like Mexico, and different from the Asian countries, appears not to have been able to expend the effort to learn and assimilate the technology it received from abroad (Viotti *et al*. 2005). The broadening research base appears to have had little impact on the process of absorption, mastery and improvement of technology.

[11] According to the Survey of Business (Cadastro Central de Empresas) by the IBGE, in 2004, Brazil had 5,371,291 active businesses; that is private businesses, government agencies and other private not-for-profit entities. Of this total, 9.2% correspond to transformation industries.

The composition of the exports is another indicator of the lack of Brazilian technological dynamism. In 2005, Brazilian exports were US$ 118.3 billions, among these US$ 34.4 billions of primary products and US$ 81.1 billions of manufactured products (IPEADATA, 2006). However, those manufactured products are dominated by medium technological intensity products. As it is showed in Table 1, Brazilian exports are characterized by primary products and commodities (40.4%) and medium technological intensity products (20.7%). Moreover, there is a small share of high technological intensity products (12.8%). The data also shows the difference among the kind of products exported by Latin America countries – Chile, Argentina and Brazil – and the most developed countries – top 25 Europeans, Japan and USA. The three less developed countries have their exports based on primary products, which require a relatively low technology level. The other developed countries with high technology dynamism export few primary products and a lot of medium and high technological intensity products.

	Chile	Argentina	Brazil	EU-25	Japan	USA
High technological intensity products	5,6	9,2	12,8	30,6	31,6	37,6
Medium technological intensity products	1,9	12,5	20,7	32,2	45,5	29,4
Low technological intensity products	2,2	3,4	9,8	6,9	9,6	4,2
Natural resources and labor intensity products	3,5	5,3	9,5	10,8	3,5	6,7
Primary products	81,3	50,8	40,4	8,1	2,8	11,8
No classified	5,4	18,8	6,9	11,4	7	10,4
Total	100	100	100	100	100	100

Table 1: Exports classified by technological intensity (2005) – in percentage
Source: MCT, 2007.

The reason for the Brazilian and Latin American low technology exports is the lack on the industrial structure. It is based on the use of the existing capacity, with low propensity to the development of new products, processes, brands and international distribution system. According to Industrial National Confederation (CNI) data[12], see Table 2 bellow, only 1.7% of Brazilian industrial companies innovated in an attempt to differentiate their products. Moreover, 20.3% were specialized in standardized products and 78% neither differentiated their products nor managed an increase in productivity. It also shows that the big companies (more than 500 employees) are the exporter and innovative companies, but they appear in a much smaller number than the others (1.200 companies).

Type of company	Characteristics	Number of companies (thousand)	Number of employees (average)	Average turnover - US$(1)
A	exporter and innovative	1.2 (1.7%)	545	78.8 millons
B	standardized products exporter	15.3 (20.3%)	158	15 millions
C	low productivity and does not differenciate products	55 (78%)	34	0.760 million

(1) Exchange rate R$ 1,71 in 05/04/2008.

[12] The publication refers to a study of the Institute of Applied Economic Research (IPEA) with 72 thousand industrial companies with more than 10 employees.

Table 2: Brazilian industrial structure classification
Source: CNI, 2005.

III. THE UNIVERSITY SYSTEM AND THE TEACHING MISSION

The system of higher education, although relatively new, grew rapidly. But this expansion occurred in an unorganized manner, accumulating countless problems and distortions. Today the image of the whole is filled with contrasts. The institutions of higher learning, are classified in three categories according to their organization and academic prerogatives: universities; university centers or colleges (MEC 2004). All have to be certified by the National Education Council, an autonomous regulatory agency, after being approved by the Ministry of Education. These institutions may be public (created, maintained and managed by public authorities) or private (managed by private individuals or corporations).

Universities should generally have a poly-disciplinary structure, with a regular offering of at least 12 undergraduate courses in at least three different disciplines all recognized and having a positive evaluation from the Ministry of Education; graduate programs with at least three fields of study at the Masters level and one course at the PhD. level all evaluated by the Ministry of Education; institutional extension programs; at least 33% of the teaching faculty working full-time, and of least 50% of the academic faculty with a Masters' or Ph.D. degree. University Centers should have a poly-disciplinary structure, regularly offering at least six undergraduate courses in at least two specific fields of knowledge, an institutional extension program, and 25% of the teaching faculty working full-time and of least 33% of the academic faculty with a Masters' or Ph.D. degree. Colleges should offer and least one undergraduate course on a regular basis and should have prior approval of the teaching conditions.

However, it is important to note that only the institutions of higher learning considered to be universities are required to develop research activities. Of the 2,165 institutions of higher learning only 10% (176) were considered to be universities. The most important are public – federal or state[13]. These are the institutions that supported the second mission – Research – and were able to act in more effective manner to support local Economic Development.

Finally, it should be noted that the ethnic and income inequalities of society are reflected with an even greater degree of distortion in access to higher education: enrollments correspond to only 10% of the population aged 18 to 24 years. The regional distribution of these institutions is also highly unequal: the Southeast region has more than half of the institutions.

First we will present a retrospective of the origins of the University System in Brazil after which we will comment on some of the features of the system and the questions raised by the reform that is currently in progress.

[13] See Sinopse da Educação Superior – 2004 (INEP 2004).

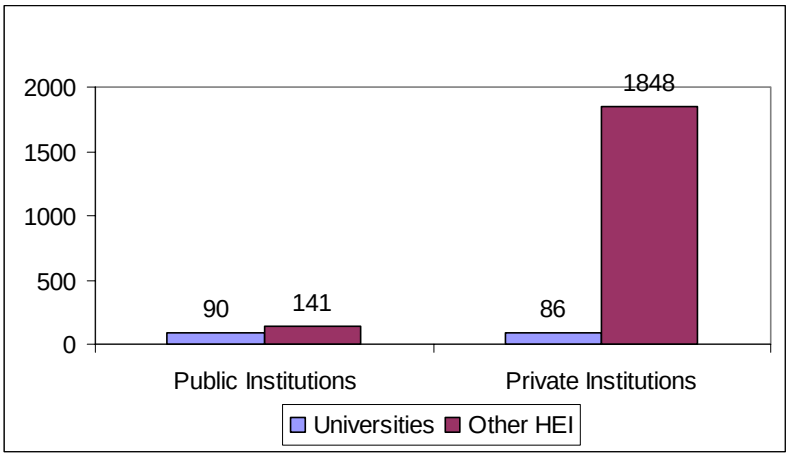

Chart 2 – Institutions of Higher Education: Brazil 2005
Source: Inep (2006)

III. 1. History: Delayed appearance but rapid growth

Some institutions of higher learning were created in the form of professional schools and institutes, during the second half of the 19th century and work closely associated with the vision of a Brazil that was modern and Republican[14]. Creation of universities only occurred in the first half of the twentieth century, initially because of the fusion of schools and institutes. The first attempt to organize higher education and universities dates to 1931, during the first government of Getulio Vargas, as evidenced in the "Statutes of Brazilian Universities". The objective was to "raise the level of general culture; encourage scientific investigation in any area and facilitate the exercise of activities that require higher technical and scientific training". This goal could be the responsibility of the University system as well as isolated institutes. In addition to legislative teaching activities at the undergraduate level, the Statute anticipated extension activities that would take the form of courses and conferences of an educational or utilitarian nature in order to aid the spread of knowledge that was useful to individual and community life, solutions to social problems and the spread of ideas and principals that support higher national interests.

In 1920 the first university in Brazil was created that brought together in an artificial way three autonomous colleges; law, medicine and engineering. During the following years several State and federal universities were created, among these was the University of São Paulo that distinguished itself by pursuing excellence according to the standards of European universities. But the 1920 and 2006, 55 Federal universities were created with widely divergent origins and profiles; either through the merger of public, State or municipal and private institutions, or completely new universities. Beginning in 1950, the majority of state universities were federalized.

By the decade of the 1950s, universities and individual institutions of higher learning were exclusively involved in the preparation of human capital at the undergraduate level. The demand of the productive sector for skilled human resources was quite modest, in a manner consistent with the lack of industrial development that had

[14] The National School of Engineering was created during the time of the Empire.

been achieved by that time. A limited number of research activities were performed by isolated researchers in institutions like the National Institute of Technology, the Butantã Institute or the Oswaldo Cruz Institute.

In 1962, when the Federal University of Brasília was created, the importance of the relationship between higher education and research was recognized. In the following years, the need for Brazilian universities concerned with graduate studies and research activities to have a new organizational and legal framework became clear. In 1968, the federal government sanctioned this new organization up universities in the so-called University Reform Law (Law 5.540), to meet the new demands in terms of the training of skilled human resources and the generation of scientific and technical knowledge imposed by the process of industrialization. Graduate studies and research completed the triad, (undergraduate, graduate studies and extension services) and research. Extension activities were reaffirmed in this Law as a way of providing services to society. Based on this "Sucupira Opinion"[15] universities were given this mission, in addition to teaching, research that was being done in graduate courses, and at a national level, in the broader areas of knowledge. The university administrations were structured around Undergraduate, Graduate, Research and Extension activities.

III. 2. A system marked by contrasts

The Brazilian universities have evolved in an uncoordinated manner with each of these core activities – teaching, research and extension - following its own path pulled by various interests and different variable over time. The possible contributions of the University to society can be examined from the perspective of the development of these different paths.

The growth in the University system occurred in a chaotic manner with no clear policy orientation. The increase in the number of students between 1960 in 2004 was substantial, but was much less than desirable. The number of students enrolled increased in absolute terms in the last ten years, but the percentage the (10%) of youths between 18 and 24 years remained unchanged. Ambitious goals for the expansion of higher indication described in the National Education Plan[16], forecast reaching 30%, which would mean a system with 20 million students or more, but this is a percentage far less that of the OECD countries which is on the order of 60%.

The number of universities increased by more than 300%, from 39 in 1964 to 176 in 2005. The majority of enrollments are concentrated in these universities (58.2%)[17]. Furthermore, it should be noted that the rapid expansion of enrollments in private institutions the account for 74.4% of the total in 1994 and for 89% in 2005. During the same period, enrollments in public institutions declined from 25.6% to 11%. This shows the unquestionable dominance of the private sector. Out of a total of 1,661,034 students registered in undergraduate courses in 1994, 41.64% were enrolled in public institutions and 58.4% in private institutions. This percentage increased considerably and by 2005 it

[15] Opinion nº 977/65, C.E.Su, approved. December 3, 1965. Definitions of graduate Courses published 03/12/1965.
[16] Law 10172 of 09/01/2001. Approved during the Administration of Fernando Henrique Cardoso.
[17] There was also a splintering of institutions of higher education in that more than 44% of these institutions have less than 500 students.

reached 74% of undergraduate students were enrolled in private institutions and only 26% in public universities. However, most of private HEIs are non-universities institutions (1,848), a number 13 times bigger than public non-universities institutions, whilst the number of universities is almost the same, 49% are private and 51% are public universities.

In terms of performance, graduate programs show dynamism and quality. In 2006, to the University system provided 2,437 programs in graduate studies (masters and doctorate), 86% were in public institutions of and 14% in private institutions (INEP 2004). The public segment is responsible for 82% of the master courses and 90% of the doctoral courses (CAPES 2004b). But universities in the private segment increased their offerings of graduate courses, from 87 courses to 346 courses in the master degree program and from 44 courses to 96 courses in doctoral programs between 1996 and 2004.

In almost twenty years, **the number of enrollments in master degree programs increased three times and the enrollments in Ph.D. programs increased almost five times.** In 2006, those numbers were 42,220 and 10,559 enrollments, respectively. The number of master degrees increased by 785% and Ph.D. degrees by 979% from 1987 to 2006, achieving the level of 32,280 Masters and 9,366 Ph.D. degrees in the last year. Despite the large increasing, in 2006 Brazil was graduating only five Ph.D. degrees per 100,000 inhabitants[18] (CAPES 2007).

Enrollments in undergraduate courses were heavily concentrated in certain areas of learning: 69% in social sciences and the humanities, and only 11% in engineering and technological areas. At the graduate level, the level at which most research activities take place, this trend is even more apparent. In 2003, 41.6% of the students receiving advanced degrees were concentrated in applied social sciences, the humanities, linguistics, and arts and letters. 31.6% of the students received degrees in the exact sciences, biology and engineering. The distortions in the distribution by area of knowledge are directly related to the predominance of private, for profit, institutions offering a number of course openings that require little investment in equipment are concentrated.

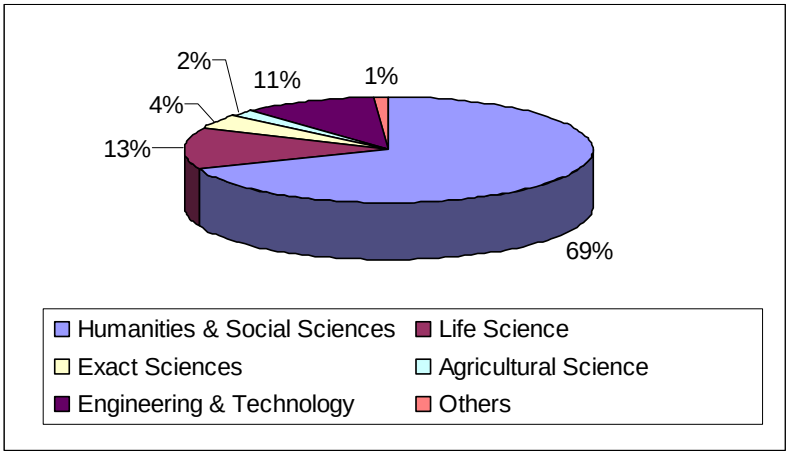

Chart 3 – Undergraduate students' enrolment per field of knowledge

[18] A rate much lower than that of Germany which graduates an average of 30 Ph.D.s per 100,000 population, South Korea with 13.6 or Japan with 12.1. In 2003, the number for South Korea was three times that of Brazil.

Source: Cavalcante (2005)

The evolution of the system of higher education in Brazil has reinforced regional, social and racial inequalities. Inequalities are reflected in the distribution of universities and IHLs in the macro regions of Brazil. Half of the IHLs are located in the southeastern region. In terms of gender, most of the enrollments are female: 2,193,246 as opposed to 1,693,776 males. But the gender inequality is reversed in the concentration by area of knowledge is considered: in engineering and the exact sciences 80% of the students are males.

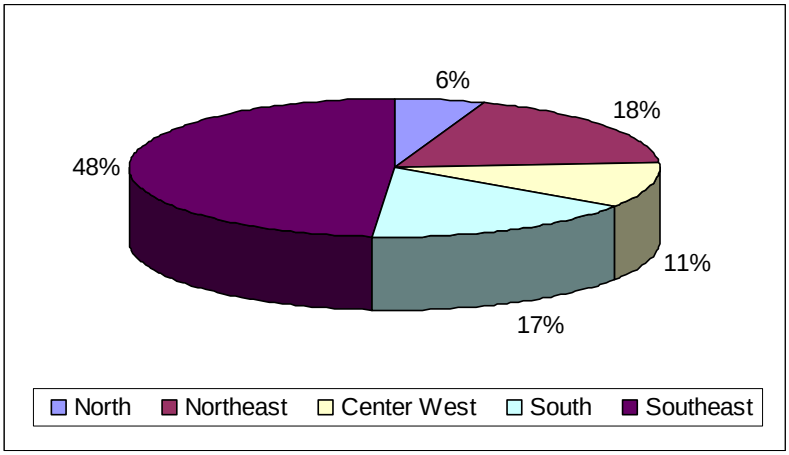

Chart 4 – Number of HEI by region
Source: INEP (2006)

Data from the Ministry of Education show that the percentage of blacks, whites and mixed races in institutions of higher learning is different from the society that large (see Chart below).

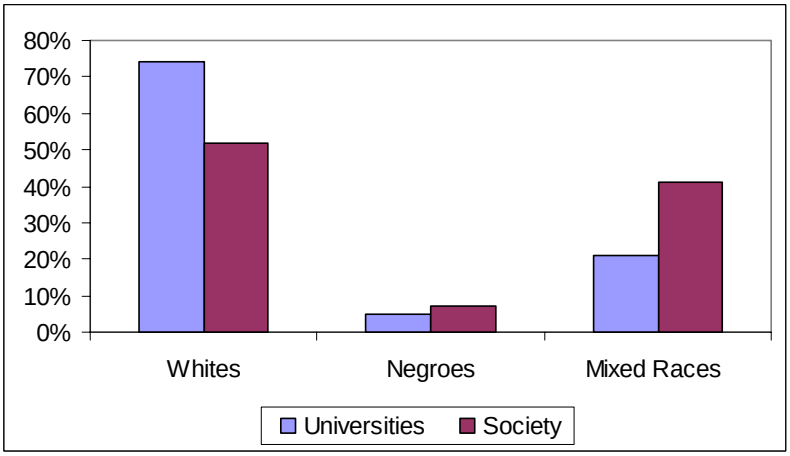

Chart 5 – Ethnic groups in universities (2005)
Source: MEC (2005)

III. 3. Discussions of reform

The system of higher education developed very rapidly, but without following a clear government strategy and without explicit social objectives. Expansion took place in a laissez-faire context under the influence of the market interests of private groups. It became essential to correct the most obvious distortions and create conditions to promote social inclusion, reducing social inequalities and expanding the through-put capacity of the system. The University Reform Law of 1968 was based on adapting the system to the demand for an educated labor force to support the process of industrialization – and the chosen path was the development of graduate studies and academic Research.

The government that took office in 2003[19] attempted to reduce Brazil's social deficit with citizens without access to universities and whose exclusion was based on ethnic and social characteristics. The proposals for university reform, like other complimentary measures, were designed to promote the expansion of a democratic, multi-ethnic and poly-cultural university. The reforms were based on the need to adapt the system of higher education to the needs of a sovereign democratic country, able to foster social emancipation with a view of a radical modernization that would allow the entrance of wide segments of the population that had heretofore been excluded from the university population and higher education in general.

Two measures in particular should to be discussed in view of the controversy that surrounded them. One was the offer to provide scholarships for students that did not have the ability to pay the tuition and student fees. The other was the saving, or "earmarking" of positions in public universities for students with ethnic or social characteristics or based on the primary and secondary schools that the candidates attended.

The issue of social inclusion and "positive" racial discrimination

The Ministry of Education created a program called University for Everyone (ProUni) to assist low-income students. ProUni[20] provides scholarships for students that were educated in the public school system, those with physical disabilities than those who declare themselves to be black, brown or of Indian descent. The percentage of scholarships by state is determined by the percentage of the population black, brown or of Indian descent shown in the IBGE census for each state. The first year ProUni offered 112,000 scholarships in 1,142 institutions of higher education. In the next four years 400,000 new scholarships will become available. The implementation of ProUni, combined with the creation of 10 new federal universities the and 42 new campuses significantly increases the number of openings in higher education, completes a system of free public education, reducing regional inequality and allowing greater integration of new universities with regional social and economic realities.

The measures adopted revived heated debates and the assumption of opposing positions. In the society at large, there is a consensus recognition that a large part of the population of indigenous or African descent is in fact marginalized in all segments of social life. But the ProUni program was criticized because it reserves space for

[19] The Government of Luiz Inácio Lula da Silva, was inaugurated in 2003 and re-elected in 2006.
[20] Laws nº. 213/2004 and nº. 11.096 January 13, 2005

individuals that *declare themselves* to be black, brown or of Indian descent, using the argument that this introduces criteria that are explicitly racial in direct opposition to the supposition of the equality of rights of the individual.

The academic community disagreed with the policy of reserving space for students coming from lower levels of society who studied in public schools arguing that this would represent a threat to the recognized quality of instruction in public universities. In fact, basic public education for the least favored social classes is considered to be totally insufficient in quality. The students who are trained in this system are unable to qualify for public universities that are the leaders in terms of quality higher education. They only qualify for enrollment in private institutions where education is expensive and of limited quality. Students who are socially disadvantaged do not attend public universities because they cannot qualify through the selection process, and do not enroll in private universities because they cannot afford to pay for it.

The academic community argues that facilitating the enrollment of the students will have a negative impact on the quality of public higher education and research. Since the basis of exclusion is the quality of primary instruction, it is there that governmental action should be invested in the improvement of teaching and teachers. The former Minister of Education Cristovam Buarque, points out that selection for study in the university system was always intended for a smaller, select group of persons, since the majority of the population has not even completed high school (Buarque 2003).

The Brazilian Academy of Science believes that the manifestations of racial prejudice that exist in Brazilian society can not be overcome using criteria based on race as a substitute for an objective basis. This could leave space for distortions and a worsening of tensions that would be prejudicial to university life. The central issue is social inequality, a situation that affects individuals coming from with a wide variety of ethnic and cultural groups. The important question, therefore, is how can institutions of higher learning alleviate social exclusion and increase the social diversity of the student body without affecting the quality of instruction.

An important group the well-known members of the university community, particularly anthropologists and sociologists, made a public declaration that rejected selection based on racial characteristics, even when used as an instrument of “positive” discrimination. In addition to ignoring constitutional issues, this would have the perverse effect of creating “legal” racism. Despite obvious differences in opportunity that affect the poorer population specifically those of African descent problems would arise in applying these rules to admissions given the lack of clear racial categories in the Brazilian population. Finally, racial distinctions are difficult in a country whose population is the result of an historic mixture of multiple miscegenation (indigenous, European, African and Asian).

The issue of autonomy of the universities

ProUni was also criticized as a threat to the autonomy of the universities. The academic community believes that both reforms by the Federal Government as well as the “affirmative actions” of the states in defining quotas for specific social groups in

public universities[21], clash head on with the principle of universities' autonomy in the definition of their means of selection.

The second controversial aspect with regard to autonomy is financing. There is a consensus regarding the role of the state in financing and consequently its right to establish goals for the public universities. But the question arises of whether the State is to be the sole supporter of the universities or if the universities should be encouraged to generate their own revenues, offering paid MBA-type courses or based on payment for services rendered, more closely approximating the model of corporate administration.

Administrative autonomy has been guaranteed to public universities since the 1990s but few have shown serious interest in fully developing this potential. In fact, many have expressed the concern that autonomy might mean the suspension of government financing.

The issue of teaching quality

The subject of teaching and research quality is also addressed in the reforms. The disorganized growth of private higher education, which for many years was facilitated by the lack of clear criteria for regulation by the state, seems to have reached its limit. Several institutions are facing financial difficulties and a trend of mergers and consolidations, in addition to the participation of private international institutions[22], should probably take place. One of the consequences of this process is the questioning of the quality of the teaching offered. The result has been a commercialization without quality in higher education, an increase in supply that does not meet the needs of those who cannot pay and that does not meet the economic or social requirement for preparing human resources. Courses in management, administration and education, law and accounting sciences prevail. With a few exceptions, private institutions offer limited quality education and do not carry out research.

In reviewing this situation, the Brazilian Academy of Science – ABC - says that "the current panorama of higher education requires effective measures to improve teaching quality, encourage production of new knowledge and new academic models, control the autonomy and financing of federal institutions of higher education, and the expansion of education in areas important for the development of the Country. These objectives will only be reached by reinforcing and expanding public sector education which is where the largest number of enrollments in higher education is concentrated in all developed countries".

The government confirmed the need to evaluate the quality of teaching using several measures for this purpose, depending on the level of the teaching considered. There was significant resistance, but the practice is becoming established. A recent survey by the Ministry of Education found that 70% of the students want more rigorous evaluation of the teaching quality.

IV. THE UNIVERSITY SYSTEM AND INNOVATION

[21] The State University of Rio de Janeiro was one of the first to introduce reservation of vacancies for black students.
[22] A multiplication of corporate universities established by major corporations or banks is also occurring.

In the context of reform, the ability of academic research to contribute to innovation and competitiveness of domestic companies and corporations is also in question. The National Post-Graduate Education Plan[23] prepared by the Ministry of Education – MEC – states that the educational system is a strategic factor in the process of socioeconomic and cultural development and represents an indispensable institutional reference for the formation of highly qualified human resources and invigoration of the national scientific-technological potential. The training of professionals capable of participating in different sectors of society and contributing to the modernization process of Brazil is a task that required graduate studies, since it is in the National Graduate Education System that essentially all of Brazil's scientific and technological research takes place.

Two other bottlenecks have been identified: an inadequate system of financing that still gives preference to the desires of individual researchers who work "over the counter" as opposed to the practices of scientific research through collaboration and networking, an organizational model indispensable for the generation of cutting-edge knowledge. The second bottleneck is the disparities in the level of scientific development among different states. From the perspective of the demands and the economic potential of a continental country like Brazil, scientific research needs a national policy for integrating the measures that would promote the structuring of research activities to meet the specific demands generated by the local economic development. The recent opening of new universities, of new campuses and advanced technical schools (CEFET) reflects the efforts of the current government to respond to these needs.

However it is worth noting that in this set of measures to reform the higher education system, the efficiency of the generation and dissemination models for new knowledge in society and especially in the economy, or the lack thereof, was often overlooked. The reference model continued to be almost exclusively the formation of human resources, with little attention given to the subject of research and the generation of knowledge as input for the technological training of the companies and innovation.

IV. 1. University - private sector relations

After the expansion of the graduate education system the university is poised to move in the direction of an alliance with the corporate community through the formation of highly qualified human resources and knowledge generation. In the 1990s, the most active universities in research initiated new institutional policies for the dissemination of research results and the transfer of technology. Several initiatives are undertaken to facilitate the creation of companies of the spin-off type around academic research projects. "Company incubators", offices for technology transfer and technological parks have multiplied. The first company incubators were created at the end of the 1980s[24]. By 2003, 70 university incubators were in operation.

In the 1990s, the importance of patenting the knowledge generated at the university increased, mainly after enactment of the new intellectual property law in 1997.

[23] CAPES 2004b.
[24] At the University of São Carlos in the State of São Paulo and at the Federal University of Santa Catarina.

The objective was to attract the interest of the companies for licensing of the patents of the universities that would allow them to obtain supplementary resources. Technology transfer offices deal with the offer of technological services, negotiation of contracts, patenting, technology commercialization, training of human resources and technological diffusion. A recent analysis showed that there were 30 such offices in operation in the university system (Lahorgue, Ritter, Mello, 2005). The performance of those new forms of action by the universities still needs careful evaluation.

The Innovation Law passed in December 2004 strengthened those options and forced the universities to create a specific administrative structure - Offices for Technological Innovation – NITs – to manage the activities for the commercialization of knowledge. In 2006 the National Forum of Managers of Innovation and Technology Transfer (Fortec) comprises 60 NITs from universities and research institutes was created.

On the other hand, the business community has shown limited interest in the university initiatives. The efforts and investments by the universities do not appear to be sufficient to open the way for a more systematic interaction with companies that would lead to a more intense efforts innovation. It is probable that the companies still lack sufficient internal capacity to absorb and to benefit from the knowledge generated in the universities.

It has been noted that the generation of Brazilian patents is quite limited and that companies file for fewer patents than universities. Data from the National Institute of Intellectual Property (INPI) clearly reveals the lack of innovative activities on the part of Brazilian companies. Between 1999 and 2003, the largest number of patent applications came from the University of Campinas (UNICAMP) and of the twenty largest patenting institutions, five were universities and two were development agencies (Carvalho 2006). At the US patent office[25], 106 patents were granted to Brazil in 2004, representing 0.6% of the patents registered[26] that year (Rezende 2005) while Brazil's share in the world production of scientific articles was 3 times greater.

These data confirm the strong scientific production of universities, the lack of innovative capacity of industry and the fact that there is little interaction between research institutions and the productive sector within the innovation system. That situation seems to still be characterized by the characteristics of the industrialization process presented in the first section. According to Viotti (2006, p. 9), "the vast majority of Brazilian companies do not seem to have accumulated sufficient technological training to change into an active agent of the absorption process and generation of innovations."

According to PINTEC 2005 (IBGE 2007), only 34.4% of the Brazilian industrial companies made innovations between 2003 and 2005 and of this total 34.122% engaged in R&D activity. It should be emphasized that the large companies are the more innovative but they represent only 1.71% of the companies surveyed.

To increase the capacity of the companies to do research and generate innovation, incentives must come from the companies and not in the universities. After all, the main actor of the innovation is the company and the initiative should [therefore] start there.

[25] USPTO – United States Patent and trademark Office
[26] The same proportion of the beginning of the nineties

Universities should merely participate as partners of this process. Of the 93,000 surveyed companies, 19.6% indicate the universities and the research institutes as important partners for innovation. But it is important to note that 60% of the companies that interact in R&D with the universities seek the accomplishment of tests or product tests and 40% other cooperation activities (IBGE, 2007).

The haphazard process of industrialization, mainly based on multinational companies did not promote conditions for generation of adaptive or incremental technologies for the companies. This process failure did not allow the national system of innovation to be developed in a complete and effective way, and was classified as an immature system (Albuquerque and Sicsú, 2000) based on passive learning, and the low propensity to transform knowledge into innovation (Viotti, 2002). Brazil, like Mexico and different from Korea or Taiwan, has a system of innovation that rewards the passive absorption of technology and underestimates the importance of the learning processes and adaptive innovations. Companies act in isolated fashion and have difficulty developing partnerships and cooperation, whether among themselves or with research institutions. As a result of this culture, the production and innovation systems show little synergy and interactions among the actors are insufficient to generate innovation. Very few of the results obtained by R&D institutes are able to flow directly into the productive sector, which remains removed from scientific and technological development (Rezende 2005). In other words, there is a serious lack of interaction between the productive structure and the scientific structure.

IV. 2. The debate about the Innovation Law

The form version of the Innovation Law[27] adopted in 2004 was delivered after an ample debate with the civil society, coordinated by the Ministry of Science and Technology. That law is designed to legalize several initiatives of the universities regarding commercialization of research results, including the rendering of services, the formation of partnerships with companies in research projects, the creation of technological companies and technology patenting and licensing.

The Ministry of Science and Technology based its proposal on the assertion that the commercialization and licensing of technology is an "important collective interest, because its purpose is to provide society with the products and processes that guarantee improvement in the quality of life of the population. The productive sector... is the most interested party in the implementation of the measures..... since it will be directly benefited by the possibility of exploring economically products and processes resulting from research lines"[28]. Commercialization is not directly related to the primary activity of the universities, but [is however], related to a secondary result from research activities and the economical exploration proper."

The industrial associations declared themselves in favor of the proposal, though clearly noting the restrictive nature of the law. In fact the bill as voted is limited to regulating the activities of the academic sector, while an innovation law should actually

[27] Law No. 10.973, enacted in December 2004
[28] From the statement of reasons for the draft of Law 2001.

focus on the business sector. The extensive debate in the scientific community was focused on the measures that break with the traditional view of academic research.

The Brazilian Association for the Progress of Science - SBPC - believes that turning the university into an institution to enter the market for technological development [is] a certain contradiction. “All indications are that one of the purposes of that project is to lead the university to self-sustainability based on the competition for investment in technological development… [with] the collateral effect of a decrease in its capacity to think about society [as a whole]” .

Among the most controversial aspects is the proposed legal change to permit the creation of “start-up businesses” through an incubation process in the universities. The law authorizes the shared use of university laboratories, equipment, material and facilities for small businesses and companies in activities to promote technological innovation. The universities may authorize their researchers to form a company with the objective of developing innovations.

Another controversial issue concerns the legal system for the transfer or licensing of technologies developed at the university which is authorized “to enter contracts for technology transfer and licensing granting the right to use or exploit the creation developed there” with private companies. For that purpose, the universities will have to “provide a nucleus for technological innovation, whether own property or in association with other institutions of Science and Technology with the purpose of managing its innovation policy.”

V. THE SOCIAL DIMENSION OF THE UNIVERSITY

To complete the analysis of the mission of the universities for the development of the Brazilian society, extension activities need to be presented in summary fashion’. Referred to in the Academic Reform Law of 1968 as services rendered to the community, separate from the undergraduate and graduate education and research activities and more connected to participation of the teaching corps, extension services are taken to a new level, by force of the Constitution of 1988. The extension services are raised to the same level as teaching and research activities and all three are considered to be inseparable missions.

The Administrative Deans responsible for extension activities in public universities[29] want to redefine the content of that mission. Extension activities are traditionally understood to mean services provided for disadvantaged social groups. They are supposed to represent the commitment of the university to overcoming situations of inequality and social exclusion. Today they seek to integrate those actions with areas of knowledge (Communication, Culture, Human Rights, Education, Environment; Health; Technology and Work) in the form of offers for training or economic opportunities.

In the last census done by the Ministry in 2004, extension services continued to be seen from the point of view of services rendered to the community. The importance of the services rendered to the citizens is worthwhile recording: 180 million patients were

[29] FORPROEX – Public Universities Extension Pro-rectors Forum.

treated in academic health units, and 350,000 cases of legal assistance were provided by academic juridical units.

The experience of the Federal University of Rio de Janeiro in the incubation of technology-based companies is what motivated the movement "Citizen Actions Against Hunger and Poverty and for Life" in this same university, the first Incubator for Popular Cooperatives in 1995. In 2005, 34 universities (public and not for profit institutions) already had incubators of popular cooperatives, totaling 350 incubated cooperatives generating a total of 8.000 direct jobs (Etzkowitz *et al*. 2005).

VI CONCLUSIONS

Brazil has arrived at the 21st century with a complex productive structure and a reasonable research system, either with regard to the number of masters and Ph.D. graduates or to its share in international scientific publications. However those two systems continue to be quite far apart from one another. Companies continue to describe themselves as having a poor capacity to absorb and to improve technology and develop innovations.

The use of the research infrastructure mainly installed in public universities to raise the technological training level of the companies became the greater objective of the recent political changes. The universities are being strongly encouraged to economically exploit the results of their research, to protect their creations, to patent the technologies developed, to provide support to the process of entrepreneurship and the generation of companies of technological basis.

In the examination of those initiatives some issues stand out. On the one hand, there are initiatives that fit into the university environment, but do not focus directly on companies. The contribution of the university continues to be limited to technological training and the innovative performance of the companies.

On the other hand, the expressed economic value of research, and the patenting and licensing policy of the universities, as expressed in the recent Innovation Law, continues to cause concern in the part of a significant portion of the academic world.

Continuous monitoring and evaluation activities to determine how the universities are implementing these activities would seem to be useful, even indispensable. The Academic Reform Law, still under discussion in the Congress, is designed precisely to address these issues. But outside of graduate studies and research policies in the universities, the same political will is not present in relation to undergraduate teaching which continues to be characterized by serious shortcomings.

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