Woodrow Wilson International Center for Scholars
Brazil Institute

INNOVATION IN BRAZIL:

PUBLIC POLICIES and BUSINESS STRATEGIES

RICARDO SENNES[1]
Managing Partner at Prospectiva Consulting

Woodrow Wilson
International
Center
for Scholars
Brazil Institute

INNOVATION IN BRAZIL:

PUBLIC POLICIES and BUSINESS STRATEGIES

RICARDO SENNES[1]
Managing Partner at Prospectiva Consulting

The Woodrow Wilson International Center for Scholars, established by Congress in 1968 and headquartered in Washington, D.C., is a living national memorial to President Wilson. The Center's mission is to commemorate the ideals and concerns of Woodrow Wilson by providing a link between the worlds of ideas and policy, while fostering research, study, discussion, and collaboration among a broad spectrum of individuals concerned with policy and scholarship in national and international affairs. Supported by public and private funds, the Center is a nonpartisan institution engaged in the study of national and world affairs. It establishes and maintains a neutral forum for free, open, and informed dialogue. Conclusions or opinions expressed in Center publications and programs are those of the authors and speakers and do not necessarily reflect the views of the Center staff, fellows, trustees, advisory groups, or any individuals or organizations that provide financial support to the Center.

The Center is the publisher of *The Wilson Quarterly* and home of Woodrow Wilson Center Press, *dialogue* radio and television, and the monthly news-letter "Centerpoint." For more information about the Center's activities and publications, please visit us on the web at www.wilsoncenter.org.

The Brazil Institute was created in June 2006 out of the conviction that Brazil and the U.S.-Brazilian relationship deserve greater attention within the Washington policy community. Brazil's population, size, and economy, as well as its unique position as a regional leader and global player, justify this attention. Operating as part of the Wilson Center Latin American Program, the Brazil Institute has unique qualities that set it apart from other Washington institutions: an in-depth and comprehensive approach to the issues that policymakers face in Brazil, in the United States, and in various international banks and agencies in Washington; high-quality presentations and publications; a nonpartisan forum for serious discussion; and the capacity to house public policy scholars. Activities include regular public seminars which stimulate nonpartisan reflection on critical issues in Brazilian development, international relations, and economic and political affairs. These seminars present the views of top scholars, high-level policymakers, and business and civil society leaders on the various challenges and opportunities that confront Brazil and U.S.-Brazilian relations. The Brazil Institute enhances the presence of Brazil in Washington by appointing to the Center leading Brazilian and Brazilianist academics, intellectuals, writers, journalists, former diplomats, and government officials to conduct research or to reflect upon their experience in the field. The Institute also organizes and hosts regular meetings of invitation-only groups of high-level policymakers, analysts, private sector leaders, and scholars, elevating the level of discourse and attention given to the country and its issues, and promoting more constructive and informed U.S.-Brazilian relations. The results of the meetings and the studies carried out in preparation for them are widely disseminated in the form of website articles, editorials, policy bulletins, and working papers that are distributed to members of the policymaking community and to Brazilians and Brazilianists active in shaping U.S. perceptions of Brazil. Significant events or programs also lead to volumes published by the Woodrow Wilson Center Press. Additionally, the Brazil Institute maintains a specialized online resource, Portal to Brazil, with regularly updated news and analysis in English and Portuguese on relevant issues.

Paulo Sotero, Diretor
One Woodrow Wilson Plaza
1300 Pennsylvania Avenue NW
Washington, DC 20004-3027

Telephone: 202 691-4271
www.wilsoncenter.org/brazil

Brazil Institute Advisory Council

The Institute's Advisory Council is a committed body of prominent leaders in business, journalism, scholarship, and public life that meets annually to help guide the work of the Institute. The Council gathers annually to discuss the vision and agenda of the Brazil Institute and serves as a vehicle to join leading individuals and institutions interested in Brazil and the Brazil-US relationship.

The Advisory Council is currently co-chaired by **Mr. Alain Belda,** Chairman of the Board, Alcoa Inc., and **Ambassador Anthony Harrington,** President and CEO, Stonebridge International. As of December 2008, Council members are:

Ambassador Luigi R. Einaudi, President, San Giacomo Charitable Trust

Mr. Eduardo Centola, Head of Latin American Mergers at Goldman Sachs

Mr. Horacio Aragones Forjaz, Executive Vice-President of Corporate Affairs, Embraer

Mr. Marcos Sawaya Jank, President, Sugarcane Industry Association (UNICA)

Mr. and Mrs. Robert Mangels, President and CEO, Mangels Industrial

Mr. Paul Moen, Director of International Corporate Affairs, Amgen, Inc.

Mr. David Peebles, Director of U.S. Business Initiatives, ETH Bioenergy

Mr. Mickey Peters, Group Vice President of Regional Operations, Duke Energy

Mr. Andrew Rudman, Senior Vice President for Latin America, PhRMA

Mr. Henrique Rzezinsky, President of Brazil Section, Brazil-U.S. Business Council

Mr. Ronaldo Veirano, Founding Partner, Veirano Advogados

Mr. Carlos Eduardo Lins da Silva, Ombudsman, Folha de São Paulo

Dra. Maria Hermina Tavares de Almeida, Professor, Universidade de São Paulo

Dr. Leslie Bethell, Emeritus Professor, Universidade de Londres

Dr. Luis Bitencourt, Professor, National Defense University

Dr. Thomas E. Lovejoy, Biodiversity Chair, The Heinz Center

CONTENTS

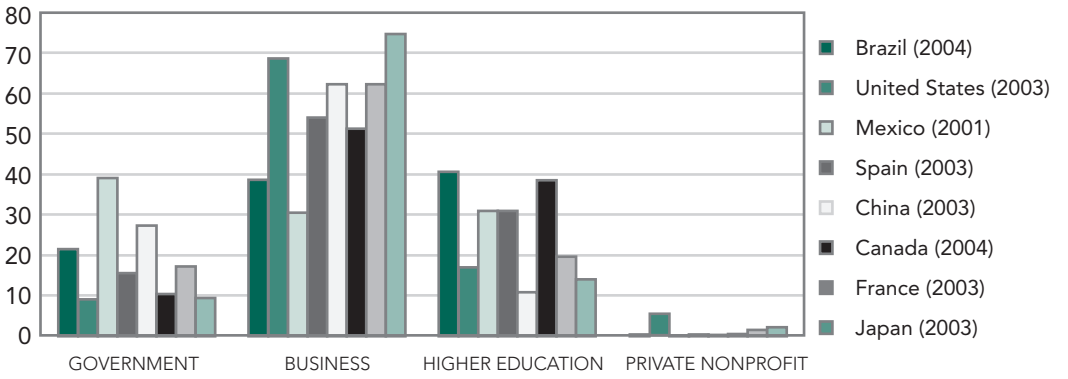
FOREWORD

Future historians interested in understanding the transformation of Brazil from the perpetual underperforming Latin American nation into a relevant regional and global player will likely look for evidence of substantive change in the country's development in the first quarter of the twenty first century. Assuming that the premise of Brazil's ascension will be confirmed by facts in the years to come, they are bound to find evidence of the country's rise in public policy decisions adopted with one aim in sight: to foster Brazil's capacity to create and apply knowledge in the development, production and marketing of new, useful and necessary goods, processes and services. This process, known as innovation, is often referenced but not always explained or understood for what it is–an essentially qualitative evolution that successful nations achieve on their way to prosperity.

Guided by the hope and conviction that democracy and economic stability have set Brazil on the path of such a historic transformation, in mid-2007 the Brazil Institute of the Woodrow Wilson International Center for Scholars launched a series of seminars to promote awareness of this important process in Washington and foster dialogue between Brazilian and American experts. We found a willing partner in Prospectiva, a São Paulo-based international consulting firm with a solid record of work in the field of innovation. Four seminars, held both in São Paulo and Washington D.C., followed the inaugural conference, which took place two years ago at the Wilson Center. The Center's Program on Science, Technology, America and the Global Economy and its director Kent Hughes were a key partner in the first two seminars.

Innovation in Brazil: Public Policies and Business Strategies is the product of our joint effort. Prepared by a team led by Ricardo Sennes, a Political Science professor at the Pontifical Catholic University of São Paulo and Managing-Partner at Prospectiva, the report offers a comprehensive summary of the discussions and main conclusions on changes under way and challenges and opportunities ahead. The modest presence of high-tech products among Brazil's exports (less than 13 per cent in 2007, concentrated in a few companies, which compares with over 40 per cent represented by commodities and 20 per cent by goods of average technological intensity) is a clear indication of the need for the adoption of public poli-

R&D Research Spending (Percent of Total by Sector)



Source: http://www.mct.gov.br/index.php/content/view/8377.html

cies that will make it easier for Brazilian companies to invest more in innovation in order to increase the aggregate value of products it has to offer at home and abroad.

Sennes notes that the new context created by the simultaneous internationalization of both Brazilian companies and of research and development offers unique opportunities and incentives for a nation such as Brazil, with a proven capacity to attract foreign investment and act globally. The country faces in this area, however, a major challenge of improving the quality of human resources, due to the limited number of researchers working in industry and the small percentage of graduates in science and engineering that it produces when compared to OECD and the other BRIC countries. As Brazil's government and companies move forward to establish and implement official policies and business strategies to achieve improved levels of development and foster science, technology and innovation, another issue related to the internationalization of R&D highlighted in the report is the imperative for coordination of national and international policies,on key issues such as intellectual property protection.

Government agencies, academic institutions and private sector organizations and companies of both countries contributed their time and expertise to this seminar. Participants and their affiliation are recognized by name on pages 4 to 6 of the report. These include the Brazilian Industrial Development Agency (ABDI), the National Industrial Property Institute (INPE), the State of São Paulo Research Foundation (FAPESP), the Brazilian Center for Analysis and Planning (CEBRAP), the Institute of Economy at the Federal University of Rio de Janeiro,

the Creative and Innovative Economy Center at George Washington University's Law School, the Innovation Agency Inova at the University of Campinas, and the National Science Foundation of the United States. A special note of gratitude is due to the University of São Paulo, which hosted two seminars at the Polytechnic School of Engineering and the Institute for Advanced Studies and made available experts from two of its entities dedicated to foster innovation: the Laboratory on Innovation and Competitiveness and the Technological Company Incubator Center (CIETEC).

The Center for American Studies at Fundação Armando Álvares Penteado and its director, ambassador Sergio S. Amaral, have our gratitude for hosting the seminar to launch this report.

The task of planning, organizing and holding the series was greatly facilitated by Ricardo Mendes, the executive director of Prospectiva Consulting. Anselmo Takaki, a research assistant at Prospectiva, and Alan Wright, the Brazil Institute program assistant from May 2007 to May 2009, worked hard in the logistics of each event and collaborated in the publication of the seminar summaries, available online at the Wilson Center website. Ana Janaina Nelson, the Brazil Institute program assistant in the Summer of 2009, revised the report in English. Lianne Hepler, who leads the Wilson Center's graphic design unit, designed this publication and managed its production. To all, a sincere thank you!

Paulo Sotero
Director, Brazil Institute
June 2009

INTRODUCTION

Innovation is rapidly gaining importance as a theme in both Brazil's public policy agenda and in the development of business strategies. A similar process can be seen in other countries. There is a significant correlation between a country's level of investment in innovation and the degree of exposure and integration of its companies in international markets. With the opening of new markets and the capacity to expand participation in existing markets, innovation is considered a strategic tool in a firm's competitiveness.

As countries strive to increase their international competitiveness, governments from several countries create stimulus policies to strengthen the innovative capacity of national companies. In Brazil, there is now consensus in both the academy and in the business community regarding the vital role of private enterprise. Business is understood to be the locus of innovation. A good combination of government policies and business strategies is central to the creation of an environment propitious to generate innovation—as evidenced in numerous countries and regions.

Within this context, new strategies and policies to foment innovation are being established in Brazil. Since the beginning of this decade, with the return of industrial policies, innovation has assumed a role in the Brazilian government's program and policy agenda. The federal government, through several agencies like FINEP, BNDES, MCT, has substantially increased programs and investments in innovation. This is also true of state governments, especially the state of São Paulo. The result has been an increase in business dynamics in this field and interaction between universities and companies, although in a much smaller scale than initially projected.

The purpose of this paper is to conduct a brief study of the main stimulus policies for innovation in Brazil and the strategies of companies established in the country in response to government efforts and market forces. In brief, it synthesizes the presentations and discussions from a five-part seminar series coordinated by Prospectiva Consultoria Brasileira de Assuntos Internacionais, the Brazil Institute and the Program on Science, Technology, America and the Global Economy of the Woodrow Wilson International Center for Scholars. Hosted in alternating succession both in the United States and in Brazil, the four events sought to assess "the challenge of innovation in Brazil."

The objective of the seminars was to analyze current policies and challenges to develop a comprehensive, advanced national innovation system in Brazil. The two main forms of analysis were business strategies and government policies in relation to innovation in the country. The seminars addressed the issue of intellectual property (IP), innovation strategies in different countries, business strategies and government policies in Brazil and the challenges facing Brazilian development. Government and business sector representatives, researchers and analysts from Brazil and the United States participated in the numerous panel sessions. The events were attended by representatives of national and multinational companies from diverse sectors, state-owned companies, Brazilian and American government entities, class associations and support institutions, Brazilian and foreign researchers and teachers as well as the national and international press.

The first seminar was held in Washington, D.C., in June 2007. Seven speakers discussed how public policies, government institutions and the adoption of intellectual property rights affect the effectiveness and use of innovation in the Brazilian economy. The participants also analyzed the dynamics of business models based on knowledge and the role of the capital markets in advancing development strategies geared towards innovation. The speakers at this meeting included Jorge Ávila, president of the National Industrial Property Institute; José Goldenberg, professor and former dean at the University of São Paulo; Christopher T. Hill, professor of public policy at George Mason University, Robert Atkinson president of Information Technology and Innovation Foundation (ITIF); Ricardo Camargo Mendes, director of Prospectiva Consultoria; Flávio Grynzpan, director of the National Research, Development and Engineering Association for Innovative Companies (ANPEI) and former president of Motorola Brazil; William Marandola, executive manager of the Brazilian Consortium of Pharmaceutical Companies (COINFAR).

The University of São Paulo Politécnica School of Engineering hosted the second seminar in November 2007. The conference focused on three main themes: how to improve and advance Brazilian innovation policies and public-private partnerships; international perspectives on innovation and an assessment of business strategies from the perspective of national and multinational companies. The presentations were carried out by thirteen speakers who explained and debated the critical role of business in the innovation process and evaluated different strategies available for governments that seek to promote innovation from a domestic and international perspective. Paulo Sotero, director of the Brazil Institute; Carlos Américo Pacheco, assistant secretary of development of the state of São Paulo; Carlos Henrique Brito Cruz, scientific director at the State of São Paulo Research Foundation (FAPESP); Sérgio Risola, general coordinator of the Technological Company Incubator Center at the University of São Paulo (CIETEC–USP); Ricardo Sennes, partner/director of Prospectiva Consultoria; Stephen Merrill, executive director of the United States National Academy of Science's Board on Science, Technology and Economic Policy (STEP); Kent Hughes, direc-

tor of the Program on Science, Technology, America and the Global Economy of the Woodrow Wilson Center; Fernando Reinach, executive director of Votorantim Ventures; Sonia Tuccori, manager of research and development at Natura; Maurício Mendonça, executive manager of CNI's Industrial Competitiveness Unit; Alexander Triebnigg, president of Novartis Brazil; Mauro Assano, research executive at IBM Brazil and Olívio Ávila, executive director at ANPEI were among those present.

The third seminar was held on April 2008 at the University of São Paulo Institute for Advanced Studies, in collaboration with USP's Observatory for Innovation and Competitiveness. It marked the release of a comparative study of innovation strategies in seven countries (USA, France, Canada, Ireland, United Kingdom, Finland, Japan and Brazil). The *Brazilian Mobilization for Technological Innovation (MOBIT)* was produced by the Brazilian Center for Analysis and Planning (CEBRAP) with financial support from Brazilian Industrial Development Agency (ABDI). Presented by its principal author, USP's professor Glauco Arbix, the study is guided by the notion that innovation be perceived and treated as an essential element to help the country achieve two major national objectives: higher and sustained economic growth and a dynamic insertion in the international scene. Participants included Carlos Henrique Brito Cruz, scientific director at FAPESP; David Kupfer, professor of the Economy Institute at the Federal University of Rio de Janeiro and coordinator of the Industry and Competitiveness Group (GIC-IE/UFRJ); Mario Salerno, professor at the USP Polytechnic School and executive coordinator of the Innovation and Competitiveness Observatory; Ricardo Sennes, partner/director of Prospectiva Consultoria; Paulo Sotero, director of the Brazil Institute; César Ades, director of IEA/USP; Evando Mirra, director of ABDI; Glauco Arbix, professor at USP, general coordinator of the Innovation and Competitiveness Observatory, and former president of the Institute of Applied Economic Research (IPEA) from 2003-2006.

A fourth event took place in Washington, D.C. in July 2008. The main themes and areas Brazil must face to create a political and business environment that drives innovation were discussed. What Brazil has done to reduce the gap relative to highly innovative countries was underscored whether dealing with public policies or the business environment. The speakers at the seminar were: Paulo Sotero, director of the Brazil Institute, Ricardo Sennes, partner/director of Prospectiva Consultoria; Roberto Castelo Branco, former general vice-director at World Intellectual Property Organization, consultant for the Brazilian Agricultural Research Company (Embrapa); Stephen Merrill, executive director of the United States National Academy of Science's Board on STEP; Katia Ramos Moreira Leite, partner at the Genoa Biotecnologia Group and president of the Genoa Group's technical and scientific committee; Diogenes Feldhaus, director of partnerships at the Innovation Agency for the State University of Campinas (Inova-Unicamp); Michael Ryan, director of Creative and Innovative Economy Center, George Washington University

Law School; Rahim Rezaie, PhD candidate at McLaughlin-Rotman Centre for Global Health, University of Toronto.

The series concluded with a fifth seminar focused on Biotechnology and Innovation in Brazil, held in Washington in November 2008. AmGen and the Brazilian chapter of the Brazil-US Business Council co-sponsored the event. Speakers included Cathleen Davies, president and CEO, BIOTECH Primer; Collins Jones, coordinator, Biotechnology Program at Montgomery College and co-Founder, TechnoVisions; Michael Ryan, director, Creative and Innovative Economy Center, George Washington University Law School, and Kent Hughes, director , program on Science, Technology, America and the Global Economy (STAGE), Woodrow Wilson Center.

Three key concepts on innovation permeate this cycle of discussions: (a) a broad concept of innovation, not restricted to applied research activities; (b) the importance of interaction and complementariness between public policies and private strategies, and (c) the fact that innovation is an activity related to the international dynamics of markets and competitive differentials, and not an activity referenced on national issues.

There was strong consensus with regard to the concept of innovation, broadly defined. According to Arbix (April 2008), "innovation is no longer understood simply as research and development (R&D) and science and technology. That is not to say that science, technology, and research investment are relegated to some ´secondary plane´; along with education, each of these factors are essential parts of a country's development plan. Innovation, however, is now viewed in a much broader sense. It is seen as the development of new products, technologies, services, processes, business models, logistical and organizational structures, and strategies. Moreover, innovation is no longer treated as merely one additional component of economic development and business competitiveness. Rather, it is seen as the central point through which all government actions (including "traditional" policies such as those focused on infrastructure) and business efforts converge."

The MOBIT project concluded that several countries have been making innovation the main focus in their search for economic development. All seven countries studied have innovation as their core focus in public policies and development and economic growth strategies. According to Glauco Arbix (April 2008), "there is an undeniable consensus in and among each nation that innovation is at the heart of their strategies of growth and competitiveness."

On the issue of public-private interaction, Carlos Pacheco (November 2007) explained that globalization has increased the competitiveness of countries and corporations integrated into the world economy, which, in turn, has sharpened the need for innovation—making it a central pillar for any public policy aimed at economic development and industrialization. Global competition forces companies to perform at a higher level; to produce better products and services, businesses must invest in training and education programs that create a more skilled workforce.

While firms are the principal engines of innovation and policymaking is "still grounded in economic considerations," countries with the most dynamic economies are those that have developed a "national system of innovation" where the increased number of actors—companies, governmental institutions and research centers—fluidly interact within a cohesive network (Pacheco, November 2007). In other words, businesses are not the only agents of innovation. A favorable environment is also needed to encourage innovative activities. It is of no value for companies to have innovative strategies and to yearn for their development if the business climate restricts and hinders their actions. Laws, public policies, government programs, available financing and actions of science and technology agencies, suppliers, clients and competitors directly affect companies' innovative capacity. The literature on competitiveness and innovation refers to this environment as "national systems of innovation." National systems of innovation are governed through incentives for innovation and are where interactions are facilitated by linguistic and cultural similarity, expanding the capacity to transmit tacit knowledge among individuals. This space also includes national institutions[2] that will determine the levels and direction of innovative activities (Lundvall *et al*., 2002).

Both government and companies are important players for investment in innovative activities. Their actions, however, differ in relation to the conditions that affect this investment. The government will invest in segments, activities and sectors of interest to society and with less regard to variations in the economic environment. On the other hand, private companies invest in activities that are in demand and capable of generating profits. Furthermore, these companies are much more sensitive to surrounding environment conditions, significantly reducing investments in times of crisis, instability or scarce financing. Thus, business strategies and government policies are an important element of analysis in reference to the development and challenges of each country's innovation policy.

Finally, the third concept refers to the dynamics of innovation as a process with international scope and parameters. As stated by Mendes, at present it makes no sense to define strategies in the field of innovation—whether public policies or business related—if it is not comparative in scope, taking into account what other countries and markets have done. He explained that "No one innovates thinking of the domestic market." High investments and meticulous selection of innovation projects, given the scale and risks involved are only justified from an economic perspective and the search for excellence, using the international market and large networks of innovation found around the world as a reference. Moreover, there are two fundamental variables that make innovation possible only within an international context. First, for products to be truly innovative (in the sense that they produce entirely new products or services and not simply imitations or incremental improvements), the project requires a substantial (expected) scale of return. Second, "breakthrough innovation" necessitates a high degree of specialization in niche fields. In both cases, this is only possible within the international arena.

The subsequent sections of this paper are divided into two parts. The first section introduces the public policies and governmental strategies to support and stimulate innovation in Brazil. The second section describes and analyzes the search for innovation, looking specifically at business strategies of several public and private Brazilian companies.

PUBLIC POLICIES

The search for innovation is a volatile activity that involves high costs and risks, but it can bring about great returns and benefits for the company, industry and country. For this reason, this type of activity is among those that are generally approved for receiving government incentives through public policies. However, for these policies to generate real effects, they need to articulate different forms of government action and the regulatory framework. Otherwise, besides wasting resources, there is the risk for some government initiatives to be neutralized by other policies that have the opposite effect. As we will see ahead, several countries have policies for innovation, but few have achieved significant results.

In the second seminar, Pacheco underscored that to truly succeed as an international competitor the "complexity of the entire innovation paradigm" requires governments to adopt a more holistic approach to public policy. That means increasing capital and labor mobility, public and private sector cooperation, as well as provisions of public goods like "technological infrastructure". It also means providing direct incentives for businesses (especially medium- and small-businesses) to enhance innovation and encourage risk-takers (angel investors, venture capitalists, etc.) to commit seed-capital to start-up companies; establishing tech-parks and business incubator programs; stimulating cooperation between businesses and universities; and promoting the commercialization of intellectual property. Moreover, he affirmed that a coordinated national strategy that integrates these different policies into one cohesive framework should therefore be a top-priority for the Brazilian government.

In that sense, support for the development of only science or technology, is not sufficient to create a virtuous circle of innovation. Thus, the linear technology-push and demand-pull models are considered insufficient today for stimulating innovation. On the other hand, the systemic view of innovation consists of a more comprehensive approach that focuses on learning processes as endogenous factors, based on an interdisciplinary and evolutionary perspective of innovative processes—more interdependent than linear in nature—where innovation-supporting institutions are influential factors in this process (Edquist, 2005). This systemic perspective is similar to Kline and Rosenberg's (1986) chain-linked model where the innovative process requires constant interaction among the players.

Under this approach, public policies should aim to create environments that are favorable for interaction between players, with a vision for long-term investments that manage both the high costs and risks involved in the innovation process. The most important public policies can be separated into five separate categories. (a) Industrial and sectoral policies that aim at promoting "productive activity, directed at development stages that are longer than pre-existing ones" (Ferraz, Paula and Kupfer, 2000, p. 545). (b) Foreign trade policies, with import policies used to protect nascent industries, and export policies that help increase the competitiveness of national industry against international competitors. (c) Promotional and financing policies that enable long term investments and the development of new technologies with research and development (R&D) expenses. R& D investments have a high-degree of uncertainty and are normally left out of the private financing system's scope. Thus, there is room for governments to work through non-reimbursable financing at low interest rates (without subsidies). (d) Policies for competition and regulation that aim at creating and maintaining a competitive economic environment in critical areas for innovation, including intellectual property policies. (e) Policies to support micro-, small- and mid-sized enterprises (SMEs) that have been able to play a significant role in innovative economies. And last but not least, (f) education policies to train skilled labor and in the fields of science, technology and innovation that promote and stimulate the generation of knowledge in society by supporting academic and scientific research.

Besides all these policies more directly tied to stimulating innovation, it is also important for macroeconomic, fiscal and monetary policies to harmonize with this objective—instead of factors that limit the application and development of innovative policies. These public policies to stimulate innovation are increasingly common and necessary for countries to create a favorable environment for long-term investment, R&D, the quest for innovation and the development of new products. For some years now, countries like the United States, Japan and European Union nations have expanded the range of their science and technology policies to include innovation. However, there is no single model. In every country, the combination of these policies occurs in a specific manner.

Public policies to support innovation generally focus on economic growth and international competitiveness, that is, on innovation linked to the development of business sectors. However, a number of countries are broadening their range of innovation policies to solve social issues like inequality, urbanism and poverty, as well as environmental issues like reducing pollution and improving energy use and generation (Lundvall and Borrás, 2005).

While this change is more recent in Latin American and Asian countries, it still reveals significant and positive effects. According to Carlos Pacheco (November, 2007), after 2001, governmental agencies responsible for advancing scientific knowledge in Brazil have followed international patterns and broadened their focus from science and technology to encompass innovation. Moreover, the Brazilian government has also fo-

cused on strategies to enable economic growth and development through innovation. International indexes reveal the country's improvement in terms of competitiveness. In the World Competitiveness Yearbook of 2008 (IMD, 2008)—an index of 55 countries that compares a host of indicators such as economic performance, governmental efficiency, business efficiency and infrastructure—Brazil is ranked 43rd. Although it trails countries like Chile, India, Peru and Colombia, it represents an improvement of six positions compared to 2007 (49th place), possibly as a consequence of the positive effects from actions being carried out in Brazil.

A new OECD report, "Science, Technology and Industry Outlook 2008," compares science and technology data from member and non-member countries (South Africa, Brazil, Chile, China, India, Israel and Russia) measuring the level of and trends in innovation throughout the world (IEDI, 2008). The main trends identified by the study in relation to research, technology and innovation were: i) innovation is increasingly driven by knowledge; ii) rapid change in the organization of research, made possible by advances in computer technology, is based on collaboration and shared knowledge; iii) with the acceleration in globalization, there has been rapid improvement in connectivity and in the development of technological platforms and standards; and iv) changes in competitive markets, technology and environment.

Comparing Brazilian data with those from other BRICS countries (Brazil, Russia, India, China and South Africa) and OECD member countries, several interesting conclusions can be drawn from the article. The first is R&D's low intensity[3] in Brazil: 1.02% in 2006, compared with the OECD average of 2.26%. China, which competes for attraction of FDI with Brazil, expanded its R&D intensity from 0.95%, in 2001, to 1.42%, in 2006, and its goal is to reach 2% of GDP in 2010. Brazil's goal established in the GAP for science, technology and innovation is 1.5%. The report cites some of the obstacles encountered by companies to generate innovation identified in Pintec (cost, economic risk and shortage of qualified personnel) and underscores that the enactment of the Innovation Law should help resolve these problems and consequently expand investments in innovative activities.

A study conducted by Glauco Arbix, cited in the June 2007 meeting by Christopher Hill, corroborate these data. It compared 1200 Brazilian companies with Argentine and Mexican companies, showing that Brazilian companies have become more competitive in the international export market for mid- and high-technology goods.

The government's role for the country to achieve positive results like those presented in the above paragraph is quite significant. Presenting the Mobit results at the April 2008 seminar, Arbix emphasized that through its institutions, policy instruments and planners, the state was a key player in the "elaboration, implementation and sustainability of innovation policies." Arbix enumerated how the state performs these functions. Most significantly, the state helps to enable, articulate and structure cooperation with the private sector. Even in countries such as the United States and the United Kingdom, where there is a strong orientation towards free market principles

and decentralized federal structures (generally considered less conducive to state involvement), governments are actively involved in the development of "pro-active policies to stimulate innovation and assist the restructuring of enterprises" to align with the shifting patterns of globalization. In developing countries, the role played by the state in generating innovation is even more relevant and direct.

Several successful cases exist where direct state action contributed to the innovation process. Successful government action focused on addressing concrete market needs, especially international ones, and in partnership with private companies. In Brazil, for example, some state-owned and hybrid companies capably managed innovation in a systemic and sustainable manner. The three major companies that stand out in this field are Petrobras (Brazilian Petroleum Corporation), Embrapa (Brazilian Agricultural Research Corporation) and Fiocruz (Oswaldo Cruz Foundation).

Between 1990 and 2006, Petrobras (the second largest Brazilian patent holder) filed for 733 national and international patents—securing 216 of these patents to date. The company is among the leading R&D investors in the world; while much of the company's R&D efforts are carried out in its research center (Leopoldo Américo Miguez de Mello Research and Development Center - Cenpes), it maintains many partnerships with universities and outside research institutes. Cenpes receives nearly 1% of the company's earnings, has about 1800 researchers, about 30% holding Master's and PhD degrees (Takaki *et al*., 2008).

Embrapa, in turn, is a research institute linked to the Ministry of Agriculture, Livestock and Food Supply (MAPA), with headquarters in Brasília and 41 offices around the country and four abroad. The company researches agriculture, livestock and food in total collaboration with producer and population demand. Between 1990 and 2006, Embrapa filed for 229 patents and received 27 patents nationally[4]. Besides the research conducted at its units, Embrapa also works in partnership with national and international universities, private companies and other research institutes. It has about 2,300 high-skilled researchers: 53% have doctorate degrees, 45% Master's degrees and 2% Bachelor's (Takaki *et al*., 2008; Castelo Branco, July, 2008).

Fiocruz is a public foundation, created in 1900. Today, it carries out the following activities: (a) research, providing of hospital and out-patient services, (b) manufacturing of vaccines, medications, reagents and diagnostic kits, and (c) teaching and training of human resources in the health area. It has 13 technical-scientific units, mainly specialized in technological development of health inputs. Fiocruz deposited 169 requests for national and international patents between 1990 and 2006, and to date, has been granted 62 of these patents. In addition to its in-house research, the foundation also maintains partnerships with universities and research institutes for conducting R&D activities (Takaki *et al*. 2008).

The Brazilian government efforts go beyond its involvement with these companies; since the beginning of this decade, new governmental policies and programs spurred a new scenario more conducive for generating innovation in Brazil. According to

Mendes (April 2008), there have been considerable efforts on the part of the Brazilian government to institute a greater focus on innovation. Despite institutional deficiencies and imperfections of existing laws and policies, Brazil's matured and modernized legal and institutional tools have made it possible for the country to design and execute innovation-oriented development strategies.

In the early 2000s, Brazil witnessed a return to strong industrial policies, with a new focus on innovation and its systemic processes. The government stimulated increased competition of domestic companies by opening markets to trade, pushing for economic reform and encouraging privatization.

It is also important to note the great advances in intellectual property rights during the 1990s. After the Uruguay Round in 1994, when the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement was signed, which established regulation for all trade related to intellectual property and established sectoral nondiscrimination in granting patents in member countries, the Brazil enacted the Intellectual Property Law (9.279/1996). A study carried out by Takaki et al. (2008) shows the significant increase in the number of patents filed after 1996 in Brazil. Although the TRIPS agreement granted countries like Brazil a 10-year period to internalize their resolutions, the country opted to quickly move forward with this issue. The result: the legal framework of intellectual property in Brazil is very complex and reliable, positioning the country with one of the best regulations in the sector around the world.

The existence of a regulatory standard, however, did not immediately guarantee the effectiveness of the Brazilian Trademark and Patent Registry office (the National Institute for Industrial Property—INPI), or even full compliance with this law in DVD and software areas. Nonetheless, in terms of the intellectual property mechanism for research activities and innovation, the law did have an important impact.

In the June 2007 seminar, Christopher Hill emphasized that an effective IP system must balance between IP protection on the one hand and dissemination of knowledge on the other; ensuring that consumers and future producers have access to advancements in innovation is as important as rewarding innovators with patent protections. Ricardo Mendes (June, 2007) underscored Hill's opinion and warned that if Brazil wants to be considered a player within the global IP industry it must be more responsive to international IP regulations, improve IP-oriented institutions, encourage technology transfer (both internally and from abroad), as well as work towards the harmonization of regional and international IP standards. Mendes observed that the Brazilian government has taken positive steps to promote innovation throughout the economy by legislating (US–style) innovation laws that protect property rights. Additionally, Brazil has expanded and created new government agencies tasked with coordinating the disparate IP applications—although a welcomed initiative, these agencies have yet to connect and harmonize Brazil's national IP strategy. Nonetheless, Brazil's national strategy still suffers from contradictory

and inconsistent policies, inefficient allocation of resources and an unconsolidated regulatory framework.

At the same event, Jorge Ávila defended Brazil's intellectual property policy, pointing out that the INPI has established IP as the central mechanism to promote innovation and innovation policies within the economy. Furthermore, the institution also coordinates national networking by developing joint initiatives and guiding other institutions to value IP as a positive growth strategy and conducts seminars and leads research programs on IP through the Academy of Intellectual Property and Development. Àvila also stated that within the new INPI strategies for promoting innovation in Brazil, the institution began to work on three fronts: a) helping government and business build a strong IP system that fosters innovation and competitiveness throughout the economy by improving IP rules in international agreements and strengthening domestic IP-related laws and regulation; b) promoting the IP system by making it well-known to potential beneficiaries; and c) operating the IP system itself, ensuring the system's efficiency, efficacy and quality. The INPI president also recognized the need for businesses to actively pursue product differentiation and patent protection; more innovative firms need to consolidate in order to expand resources and better utilize economies of scale. He concluded that firms need to diversify their IP portfolios; increase R&D investments, seek to partner with other firms, and develop new products through cross-licensing.

The Sectoral Funds for Science and Technology was created in 1999. Sectoral Funds are financing tools for research, development and innovation projects. They work as complementary resources for developing strategic sectors, stimulating the generation of knowledge and ensuring that such knowledge is transfered to companies. The Funds are administered by the Research and Projects Funder (FINEP), which is subordinate to the Ministry of Science and Technology (MCT). At present, there are fourteen specific sectoral funds: Aeronautics, Agribusiness, Amazon, Waterway, Biotechnology, Energy, Space, Water Resources, Information Technology, Mineral, Oil and Natural Gas, Health, Land Transportation, Telecommunications. Additionally, there are three cross-sectional funds: Green-Yellow Funds, geared towards university-business interaction; Infrastructure, for supporting improvements in science and technology institution infrastructure; and Audiovisual, for developing cinematographic and audiovisual activities in consonance with federal government programs. Funding for these projects comes from the National Fund for the Development of Science and Technology (FNDCT). The two exceptions are the fund for the technological development of telecommunications (Funttel), which receives resources from the Ministry of Communications, and the Audiovisual Fund, which receives resources from the Contribution for the Development of the National Film Industry (Condecine) and the Telecommunications Inspection Fund (Fistel) (FINEP, 2008).

These funds have guidelines and budgets defined by managing committees with representatives from productive, academic and governmental sectors. However, since

these are non-reimbursable resources, only science and technology institutions, that is, universities and research institutes, can receive the funds. Until 2002, the contingencies established for Sectoral Funds was a great obstacle to the program's success. In 2003, the government began to address this problem. Before 2002, only about 40% of the authorized resources were actually distributed, after 2003 this percentage increased to over 90% (MCT, 2008).

The year of 2003 was very significant for industrial development to reassume its prominence in Brazil and for the use of industrial policies as important tools for this development, after a long period of indifference regarding these strategies, especially in the 1990s. Enactment of the Industrial, Technological and Foreign Trade Policy (PITCE) was the first step taken by Luis Inácio Lula da Silva's government (who began his first term that year, being reelected in 2006 for a new term until 2010) in the process of retaking the country's growth and development. Its objective was to induce a change in the competitive level of Brazilian industry, seeking greater innovation and differentiation in products and services, resulting in greater competitiveness of Brazilian products in the international market. PITCE established four priority sectors (pharmaceuticals and medications, semiconductors, software and capital goods) and it gave innovation a more systematic connotation, mainly stimulating interaction between the productive and academic sectors. Since then, new laws and programs have been launched aimed at strengthening the national system of Brazilian innovation.[5]

The following year, the Innovation Law (10.973/2004) was enacted which maintains and expands support for university-business partnerships, the participation of universities and research centers in the innovative process and the transfer of university knowledge to companies mainly by means of the obligatory creation of Technological Innovation Nuclei (TIN) at universities and the release of laboratories and equipment to be shared between science and technology institutions (STI) and companies. Furthermore, the law makes room for technological research and the generation of innovation in the private sector, permitting, for the first time in the country, non-reimbursable public resources to be offered to companies to share the costs and risks of innovative activities. Enactment of this law thus permits the creation of the Economic Subsidy program, in 2006, coordinated by FINEP, and which aims at providing resources for research and development (R&D) activities at the company. Between 2006 and 2008, about R$ 800 million (Bahruth, 2008) were provided in this program for projects that support the insertion of researchers with Master and PhD degrees in technological activities at companies and for innovative product and process projects at companies, through the national public announcement on strategic themes, the PAPPE subsidy, for micro and small companies, and the recently launched PRIME, for recently-created companies.

Law 11.196 was enacted in 2005 to reinforce advances of the Innovation Law. It was replaced in 2007 by Law 11.487, which became known as the Good Law. This Law authorizes the automatic use of fiscal benefits for companies that invest in R&D

and are within requirements, without any need for a formal request. This speeds up and expands incentives for investments in innovative activities. The special tax regime and fiscal incentives for companies created by the Law stipulate, among others: deductions from income tax and social contributions on net profits from expenses on R&D (60% - 100%), reduction in the tax on industrial products for purchasing machines and equipment for R&D (50%), economic subsidy through scholarships for researchers in companies and exemption from the Contribution for Intervention in the Economic Domain (CIDE) for paying for patent deposits.

Giving continuity to the objective of changing the Brazilian technological level, in 2007, the Growth Acceleration Plan for Science, Technology and Innovation (GAP for STI) was launched with actions to be carried out and objectives to be reached between 2007 and 2010. The objective of the plan is to articulate five policies and programs (Growth Acceleration Plan and Infrastructure, PITCE, Agricultural Development Policy, Health Development Policy and Education Development Policy) that will establish economic policy and economic growth in the country. Its goals include expanding investments in R&D from 1.02% of Gross Domestic Product (GDP), in 2006, to 1.5% in 2010, with an expansion of private expenses to 0.65%. The plan has four general strategic priorities, sub-divided into 21 lines of action: a) Expansion and consolidation of the National S, T & I System: includes actions for institutional consolidation, training and empowerment of human resources and infrastructure and fomenting research in science and technology (S&T); b) Promotion of technological innovation in companies: aims at creating tools to stimulate, finance and support differentiated technological innovation according to the specific needs of large, mid-sized and small companies and start-ups at incubators and technological parks; c) Research, Development and Innovation (RD&I) in strategic areas: establishes 12 strategic areas for national development that will receive large incentives for research; d) ST&I for social development: aims at stimulating the insertion and dissemination of S&T in society with improvements in teaching, popularizing ST&I in society and using technologies for social development.

In 2008, a new industrial policy was launched in Brazil, the Production Development Policy (PDP), with the objective of providing sustainability for economic growth, increasing productive investments and economic growth rates. Twenty-five priority sectors and three large support programs were established for these sectors: a) Programs to strengthen competitiveness: Standardized Capital Goods, Customized Capital Goods, Automotive Complex, Service Complex, Civil Construction, Leather, Footwear and Artifacts, Aeronautical Industry, Naval Industry, Wood and Furniture, Plastics, Agroindustrial System, Personal Hygiene, Perfumery and Cosmetics; b) Mobilization programs in strategic areas: Nanotechnology, Biotechnology, Defense Complex, Health Industry Complex, Energy, Information Technologies and Communication; and c) Programs to consolidate and expand leadership: Cellulose, Mining, Steel, Textile Industry, Apparel and Meat.

The PDPs main challenges are to expand supply capacity in the country, preserve the robustness of the trade balance, increase the capacity for innovation and strengthen micro and small enterprises (SMEs). Four macro goals were established to be achieved by 2010: increase investment rates; expand the participation of Brazilian exports in global trade; increase expenses in R&D and grow the number of exporting SMEs. Goals for specific programs were also set. The PDP's actions are subdivided into three levels of operation: a) Systemic actions: focused on factors that generate positive externalities for the production structure as a whole; b) Strategic highlights: public policy issues deliberately chosen due to their importance for the country's production development in the long term, and which are regionalization, SMEs, exports, integration with Latin America and Africa and sustainable production; and c) Structural programs for production systems: guided by strategic objectives and based on the diversity of the domestic production structure.

Besides the policies and programs initiated in the beginning of the 2000s, the creation of two government entities reinforces actions geared towards the country's industrial development and innovation. The first entity, founded in 2004, is the Brazilian Agency for Industrial Development (ABDI), tied to the Ministry of Development, Industry and Foreign Trade (MDIC), with the mission of promoting Brazilian industrial and technological development by increasing competitiveness and innovation. In general, its objective is to articulate and promote the carrying out of Industrial Policy in interaction with the diverse public entities and private enterprise. It operates as the Executive Secretary of the National Council of Industrial Development (CNDI)[6] and the National Committee on Biotechnology[7]. It also develops five macro programs that mobilize and gather promotional, representative, academic, private and governmental entities, contributing towards the definition of strategies that increase the level of industry competitiveness through innovation, with a focus on the cross-sectional dissemination of new technologies and the international insertion of Brazilian companies. ABDI has six operational axes: public-private articulation, strategic sectoral programs, competitive intelligence, strategic and future options, mobilization and empowerment for innovation and industrial development and insertion abroad (ABDI, 2008, Mirra, April, 2008).

The second entity is the Center for Management and Strategic Studies (CGEE), which promotes and conducts studies and prospective research in S&T and its relations with productive sectors; evaluates strategies and economic and social impacts of scientific and technological policies, programs and projects; disseminates information, experiments and projects for society; promotes interlocution, articulation and interaction of S&T and productive sectors; develops technical and logistics support activities for public and private institutions and provides services related to its area of operation (CGEE, 2008).

Brazil's progress in promoting innovation has been discussed a great deal in seminars. Evando Mirra, at the April 2008 event observed that the "Brazilian economy is

in a position to create new cycles of long-term economic growth". He highlighted that in comparison with other emerging economies, Brazil has a strong scientific base that operates "along every phase of the innovation process," not just in few select industries. Moreover, the Brazilian economy has a base of sound and promising fundamentals: with a significant trade surplus and a large stock of international reserves; relatively low (although rising), stable and predictable levels of inflation; expanding capital and credit markets; reduction in unemployment rates and increase in formal-sector jobs and real wage increases that have reduced inequality; and a buoyant private sector with sufficient resources to invest.

In June 2007, Mendes had already identified some of Brazil's competitive advantages: a strong local scientific base, sizeable industrial capacity, large domestic market, biodiversity, well-developed Telecom infrastructure, a substantial presence of multinational corporations, and significant purchasing power. Additionally, Brazil has comparative advantages in certain sectors such as pharmaceutical, software/ IT and capital goods, as well as in specific areas of research including biotechnology, nanotechnology and renewable energies. At the same seminar, Goldemberg defended the focus of Brazilian research on development and greater production and yield from renewable energies, such as Brazilian ethanol.

However, at the April 2008 event, Arbix adverted that while Brazil's innovation performance is fast improving—leading in deep-water oil exploration technology and in the production and use of renewable fuels—it is far from entering the ranks of top international innovators. According to Arbix, this is because "the weakness of state power, the inefficiencies of public institutions, and a complex bureaucracy that obstructs concrete actions are problematic issues that make the task of coordinating initiatives for building an innovation-based economy more difficult". The challenges for governance of the national system for Brazilian innovation continue. It is necessary to have a better coordination of policies and not only create new policies. Arbix underscores that the challenge of innovation in Brazil is not due to a lack of resources or entrepreneurial capacity, but rather in making all of the disparate government, university and business efforts combine to produce tangible products, services and processes. However, he continues, the fragmented nature of its national innovation system makes it difficult for the government to coordinate actions among the various, disparate agencies and organizations tasked with implementing the country's innovation policies.

Arbix further underscores that a possible solution is to articulate policies and institutional arrangements responsible for coordination. The proposal is the creation of hubs, networks and arrangements for innovation that connect groups of firms. The aim of this proposal is to "develop productive arrangements or services of excellence". The design of these arrangements should be flexible, extending to local, regional, sector-based or project based schemes; government institutions would be responsible for supporting the articulation and provision of competitive financing, with the creation of supporting juridical entities; and local authorities (city councils, secretaries,

regional entities) should be actively involved in the process. Moreover, the country should chose ten thematic areas (i.e. development of composites for the aeronautics industry, biotechnology for ethanol, nanotechnology for the petrochemical sector) on which to focus and concentrate resources. By formulating these "meso projects" with strong state coordination that utilize institutional knowledge of activities, needs and operational capacities of the players in these chosen areas, Brazil can more effectively stimulate innovation within companies.

Arbix also cited four instruments available in the Brazilian government that may be most effective in spurring innovation. First, build and promote a National Fund, whose purpose would be to sponsor innovation and establish a system of support for private enterprises, especially in the "pre-project" phase. Second, utilize this system of pre-project support to help nascent firms perform self-assessments and identify weaknesses and opportunities. Third, use the National Fund to stimulate investment in new products and enterprises through the creation of venture capital funds. Fourth, design a plan to apply the government's purchasing power to generate innovation.

On the issue of government coordination, Brito Cruz (April, 2008) added that the absence of coherent and legitimate coordination among the diverse actors is responsible for lowering Brazil's innovative capacity. Furthermore, he highlights that more emphasis should be directed to the fact that Brazil needs to increase its overall level of investment, which has been at around 1 percent of GDP since 2002. The aim should be to achieve the level of OECD countries, 2.2 percent of GDP.

Comparing Brazil to the 7 countries analyzed in the MOBIT project in relation to Brazil's approach to research, development and innovation, Arbix made three distinct observations. First, Brazil does not always benchmark its performance with the highest available international standards. Second, while there is a drive to boost university-business cooperation, these efforts are met with resistance and, in general, hampered by inadequate institutions. Third, funding mechanisms for research in Brazil are growing at an impressive pace, with competitive financing for firms and universities becoming the norm, yet insufficient resources and attention are dedicated to attracting foreign researchers and students. Measuring the progression of Brazil's innovation system against the new innovative strategies adopted by the United States, Canada, Ireland, France, United Kingdom, Finland and Japan, it is evident that Brazil must embrace a more offensive approach towards innovation—making it the organizing principle around which all public and private sector efforts converge.

However, it is worth underscoring a differential Brazil has in relation to other developing countries, like China and India, which have been enjoying rather high rates of economic growth and innovation projects. That is the fact that Brazil is at a differentiated level compared to those economies in terms of installed industrial structure, including the intense participation of multinational companies present in the country for more than 100 years now. Brazil already has a diversified and consolidated industrial structure that certainly needs modernization and more vigor; however, it will not

generate such a strong impact on economic growth as seen in China and India. These two countries are going through an initial stage of development that permits growth rates of nearly 10% per year. That does not mean Brazil cannot achieve higher growth rates than it has in recent years, but they will most probably not equal those seen in China and India. What is important is for industrial and innovation policies to be maintained over the long term and to apply them together with policies to stabilize the economy, without allowing the latter to hamper the former.

Hughes (November, 2007) explained that globalization has changed the structure of the international economy, bringing about opportunities for emerging economies not only to be niche producers of technology-based goods but also generators of knowledge. As the process of research and development "has gone global," both India and China's strong base of skilled technicians, engineers and scientists make the countries attractive locations for foreign direct investment (FDI) and regional R&D centers for global companies. This changing dynamic has led both countries to develop ambitious innovation strategies, he observed, especially related to education and labor force qualification. Nevertheless, Brito Cruz (April, 2008) highlighted a little-known statistic about Brazil: "Per year, Brazil graduates more than four times the number of PhDs in the area of computer science than does India, yet internationally, India is the only emerging market recognized for its excellence in computer science". Salermo (April, 2008) argued that this happens because Brazil has no iconic company. "We do not have a company that has mastered a key technology," he elaborated. Moreover, Brazil does not successfully publicize its efforts and accomplishments.

Another great advantage for China and India is the consistency and coordination of their policies directed towards industrial development. This differs from Brazil, which for more than 10 years limited itself to horizontal policies of privatization and free trade, without the appropriate support for domestic companies. The Brazilian government has reassumed its interest in industrial development, but according to the seminar speakers, effective coordination of support policies and programs is still lacking.

It is thus clear that Brazil has now taken a new and quite coherent path in terms of innovation. More than a government policy, this tendency is made steadfast by several federal and state government entities, as well as state-owned companies and universities. Some results have already begun to emerge, although falling far short of original goals and expectations. As diagnosed in the debates and exhibits, part of the problem refers to the private sector, particularly the still timid engagement and investment in research and innovation, with some important exceptions. Based on this premise, the next section presents business strategies that are being implemented in Brazil in face of increasing global competition and in response to governmental policies to stimulate and promote innovation in companies.

BUSINESS STRATEGIES

National and international business sector representatives participated in the seminars with presentations on their companies' innovative strategies and their opinions of governmental policies, the obstacles and recent changes for developing innovation in Brazil. Innovation was generally underscored as the companies' main goal and the search for partnerships was the most used means for achieving them. Universities and research institutes were identified as important partners. Most see advances in the Brazilian policy to support the business sector; however, they warn of the existence of historical factors that continue to hamper the country's industrial development, as well as of the need to adjust some regulatory aspects.

Companies are constantly searching for innovation or new combinations of existing technologies that allow them to create and develop new products and services that offer larger market shares and greater profitability. According to the Oslo Manual (OECD, 1997), the main sources of company knowledge include: in-house and external research and development activities, acquisition of incorporated (in machines and equipment) and non-incorporated (licenses, patents, etc.) external knowledge, training, introduction of technological innovation in the market (commercialization) and industrial projects and technical preparations (assays and tests to implement the innovation in the market). Besides these more formal and easier to measure sources, companies can also obtain new knowledge through interaction with other players in the innovation system: consumers, suppliers and competitors.

The innovative search is characterized by a long-term process that requires the construction of internal capacities for learning and creating new knowledge. According to Cohen and Levinthal (1989), R&D activities play two extremely important roles in company competitiveness. The first and most direct is the creation of new knowledge for generating innovation. The second is to expand the company's capacity to absorb external knowledge. The authors affirm that the more in-house R&D, the greater the company's ability to identify, assimilate and explore existing knowledge in its environment. The possibility to absorb external knowledge and thus increase the company's innovative capacity is another great stimulus for investments in R&D activities. Development of the company's absorption capacity permits creating partnerships with other players in the environment that benefit the generation of innovation

in the company, since new knowledge can be entered in the process in a consistent and continuous manner.

Such R&D activities will have different functions according to the new product's industrial cycle. During the introduction stage, R&D activities initially have the role of developing a new product to be launched in the market and to achieve a competitive position. In the following stage, growth, R&D helps to grow the new business and improve the competitive position through product improvements. During the product maturity stage, R&D activities will maintain the competitive level. And in the phase of decline, a decision is made as to abandon or renew that line of research.

In Brazil, basic innovation activities for establishing the companies' competitive capacity generally receive little importance in business strategies. Brazilian Technological Innovation Research (Pintec) data, applied by the Brazilian Institute of Geography and Statistics (IBGE), reveal the main characteristics of innovative activities in Brazil. The Research is in its third edition (IBGE, 2007a) and it analyzed the nature of innovative activities at 93,301 companies with more than 10 employees, most from the industrial sector (91,055), although service sector companies were included for the first time: telecommunications (393), informatics (3,811) and R&D (42) between 2003 and 2005.

One-third, or 34.4%, of the companies interviewed developed some sort of product or process innovation during the years analyzed in the study. However, a significant majority of these innovation were for the company and not for the domestic market. The large percentage of process innovation and the characterization of machine and equipment purchases as the main innovative activity carried out by the companies in Brazil justify this scenario. Altogether, 20% of the companies implemented product innovation, 40% process innovation and another 40% product and process innovation. However, the product as well as the process innovation are in the most part innovation for the company, with a small portion of innovation for the domestic market and an even smaller portion of innovation for the global market. In every case, the largest portion of innovation deals with improvements in already existing products or processes. The companies are identified as a most responsible for developing product innovation, whereas other companies or institutes are more often responsible for process innovation. This is to be expected since many of the process innovation stem from innovation at suppliers.

According to the Maastricht Economic Research Institute on Innovation and Technology and the Joint Research Centre of the European Commission's global ranking for innovation presented by Triebnigg (November, 2007), Brazil is in 42nd out of 49 countries, with a global summary innovation index of 0.22. The index analyzes innovation drivers, knowledge creation, diffusion, applications and intellectual property.

One of the main reasons for Brazil's low innovation score is the reduced volume of resources set aside for innovative activities, especially internal and external R&D.

Brazilian companies invest about 0.77% of their net sales revenues (NSR) on internal R&D, 0.34% on industrial projects and other technical preparations, 0.23% on introducing innovation in the market and only 0.09% on external R&D. The only activity that receives more than 1% of company NSR is the purchase of machines and equipment (1.31%), which although being an innovative activity since it changes the company's competitiveness, the knowledge and innovation generated are at the company supplying the machine or equipment. However, despite the low volume of expenses on innovative activities, data from the third edition of Pintec are quite positive since they demonstrate that the resource volume practically doubled in all activities, without a proportional increase in the number of companies that carries them out.

Furthermore, the number of companies that carry out internal R&D activities grew continuously and they are employing a larger portion of employees on these activities. In the 2003 survey, most of the companies surveyed still conducted their internal R&D activities on an occasional basis. In the 2005 survey, nearly 60% of the companies conducted internal R&D activities on a routine basis. This is an extremely positive factor according to Cohen and Levinthal. Besides that, although the absolute value is still small, the number of employees dedicated to R&D grew from 0.7% in 2003 to 1.3% in 2005. There was also an increase in the number of employees with graduate studies' degrees and an increase in the number of those exclusively dedicated to these activities.

Tuccori (November, 2007) explained how important R&D activities where for the improvement of Natura. She affirmed that the number of new products launched by her company is directly tied to the amount of R&D it performs. In 2002, Natura launched 91 new products; in 2006, that number climbed to 225. During this same period, the company's R&D investments rose from US$16.5 million to US$49.25 million. Tuccori noted that Natura's focus on innovation relies on human capital and an integrated, comprehensive strategy.

It is important to notice what Mendes stressed at the seminar in June 2007. He believes the most important point was the recognition that business is the crucial player in the innovation process. This means that all public policies are oriented towards advancing companies' ability to "produce and generate goods and processes with higher added value; increase technical skills and human capital; and to foster competitiveness and productivity by boosting entrepreneurship and improving management skills." While universities, not-for-profit organizations and government laboratories certainly contribute to the innovation process, Arbix emphasized that the business sector is truly the one capable of turning knowledge and ideas into products, services, strategies and new business models. This statement reinforces the importance of R&D activities highlighted above. Brito Cruz (November, 2007) complements the discussion by stating that the number of researchers at companies still needs to increase considerably, since today there are only about 23%. He says the lack of innovation in Brazil's private sector is not so much a product of insufficient information; rather, it is more likely

linked to the dearth of scientists working in private enterprises. In Brazil, different from several other countries like the USA, England, Korea and Italy, the vast majority of R&D activities is conducted in the academic sector and not the business sector (Lima, 2008).

However, despite the greater number of companies conducting internal R&D activities, these activities are still not the main sources of innovation at companies in Brazil. In relation to the external sources of knowledge, clients and suppliers are considered the most important sources for most companies. The other external sources, such as universities and research centers, competitors and professional training centers were classified as having little if any importance for a very significant portion of innovative companies. The same pattern holds true in the choice of the main partners for cooperative activities. Clients and suppliers are also identified as being of utmost importance to innovative companies. However, cooperation with clients is balanced in terms of conducting R&D and assays for testing products as well as other collaborative activities. Collaboration with suppliers occurs with greater frequency for carrying out other cooperative activities, despite their importance in conducting R&D and assays for product testing.

Different from survey data, company presentations at seminars on the challenges of innovation in Brazil revealed that national as well as multinational companies see great importance in partnerships with universities and research institutes. Assano, of IBM (November, 2007), says innovation occurs in the intersections between science, business and society. Innovation is driven by collaboration. Companies need universities to innovate and sustain long-term growth. Companies try to facilitate the exchange of knowledge between academic research centers and industry with the objective of improving products, processes and services. Tuccori, of Natura (July, 2008), underscores that the company's innovation generation model changed with the change in demand. Today, it follows the open innovation approach, for which the company collaborates with other firms and universities in the design and development of R&D.

The differences between survey data and company reports can be explained by a characterization of the Brazilian industrial sector—the large number of small, little innovative companies and the small number of large, innovative companies. Nearly 66% of the companies in the survey have up to 29 employees, and 30% of them are innovative. However, 1.72% of these companies have more than 500 employees, and 80% are innovative. Thus, the answers from the small companies end up having greater weight due to the number of these companies, and the answers from the large companies, similar to those that participated in the seminars, have a greater weight. However, this does not disqualify the analysis by Pintec or the company presentations. Quite the contrary, it justifies the complementariness of information.

A study conducted by the National Confederation of Industries (CNI, 2005) reinforces these data since it shows that the large companies are exporters and innovative, but they appear in the industrial structure in much lower numbers than the rest (1.7%).

Companies with on average 30 employees represent 78% of the sample and they are characterized by low productivity and non-differentiation of their products. The study concludes that the Brazilian industrial structure is based on using existing capacity with low propensity to develop new products, processes, brands and international distribution system.

The reduced innovation of small Brazilian companies must be viewed with care. The consolidation of these companies is extremely important to the economy since they are significant generators of jobs. Support for the development of these companies, conditions for them to grow and generate innovation, must also be the object of governmental policies. Olívio Ávila (November, 2007) argues that current legislation favorable for innovation must be adjusted so as to permit its use by a larger number of innovative companies, especially small and mid-sized ones.

Some factors affect small and large companies in a similar manner, such as the obstacles to innovation generation. According to PINTEC data, the shortage of financing was one of the three main obstacles to innovation generation identified by companies. The other two were the high costs of innovation and excessive economic risks. These factors were also identified by those companies that participated in the seminars as being important hindrances to innovation. The vast majority of companies self-finance their R&D activities (89%) as well as the other activities they carry out (81%). Of the 11% of expenses on R&D activities financed by third parties, the largest portion is financed by the public sector. Between 2003 and 2005, 6,169 companies of a total of 32,796 companies that implement innovation received government support according to the data provided by the companies for the study. It is worth pointing out, as seen above, that this is a period of expansion of programs that support innovation, but the results are still moderate. As is characteristic of innovative activities in Brazilian companies, the vast majority of the support went to buying machines and equipment (3,833 companies). The second program, which most served companies, was the financing of research activities in partnership with universities and research institutions (450 companies), directly related to Sectoral Funds. The fiscal incentives provided by the Law of Informatics to companies in this sector appear as the third most used support program by companies, reaching 431 of them. Fiscal incentives for research and development[8] only appear in fourth, serving 249 companies. Besides these specific programs, 2,129 companies also benefited from other Brazilian government financing programs.

Grynszpan (June, 2007) identifies the deficiency of the Brazilian capitals market as one of the weaknesses of the Brazilian system in generating innovation. For him, the transformation of intangible goods (knowledge) into tangible goods (innovative products) needs a solid foundation of venture capitalists or private equity markets that support and fund the companies' innovation development. Agreeing with Grynszpan's analysis, Marandola noted that insufficient capital markets hinder the biopharmaceutical industry's ability to innovate since biopharmaceutical companies rely on avail-

able cash flows to finance R&D investments. As a remedy to such "system failures," Marandola suggested expanding the reach of current tax incentives and recalibrating the tax system to encourage greater R&D investment. According to Mendonça (November, 2007), the country's current economic environment is not conducive for large-scale innovation. Mendonça cited the high tax-rate and fees levied on businesses, poor labor relations, limited availability of financing, and the complexity of fiscal incentives provided by the government and various other impediments to innovation. For firms to survive in this "harsh climate," he recommended they adopt a "long-term, strategic vision of innovation". This requires rigorous market analysis; managing partnerships with other firms, universities and government research centers; and adopting a business practice which benchmarks and compares a company's performance to that of its respective competitors.

Besides the obstacles identified by Pintec, other factors were highlighted during the seminars: legal instability, weak institutional framework, bureaucracy and the population's low level of education. As Reinach argued in the November 2007 meeting, the problem with innovation in Brazil is not these inherent risks and costs associated with the process of product development, but rather the added costs that result from the country's weak institutional framework and inadequate legal enforcement. He lamented that institutionally, Brazil has yet to develop a coherent consensus on how innovation will be treated. While the government has made efforts to decrease some of the risks associated with capital investments by offering a series of incentives—such as financial credit through the Ministry for Science and Technology's public financing company, FINEP and the BNDES—its inconsistent bureaucratic actions often disadvantage the very actors it seeks to support. For example, companies that develop revolutionary products in industries with no substitutes are often punished by regulatory agencies "for being monopolistic." Reinach concluded that these inconsistencies and contradictions serve to damage investor confidence in the government's commitment to promote innovation and discourages future investments.

Leite (July, 2008) also identified the bureaucracy of government financial agencies as a great disadvantage to public financing. She argued that the time between the presentation of the project and the money release is very long. Moreover, the money released as the project is ongoing, only with short-time targets met, that is, there is no long term view. However, she also pointed out some advantages, such as low interest rates for innovation development usually with grace period and long tenors, as well as the credibility it brings to the project and the company.

In the study conducted by McLaughlin-Rotman Centre for Global Health with 16 Brazilian companies in the biotechnology/pharmaceutical area and presented at the July 2008 meeting, the barriers and challenges for the development of these companies in Brazil were identified. Despite the study's sectoral specificity, its results provide good examples of these issues in Brazil. In terms of infrastructure, there is a shortage of installations for certifying pre-clinical studies under international standards of good

practices, the import process is morose and involves high taxes and there is insufficient institutional transparency. In relation to cultural issues, the weak university-business interaction must be underscored and universities are seen as only training teachers, not researchers, for the companies. Furthermore, employee costs are very high due to strict labor laws and the public sector's incentive system. Governmental instability and a lack of coordination of policies and laws were identified as obstacles to companies in Brazil. Last but not least, the deficiency and moroseness of the intellectual property system and the financial system, with high interest rates and low levels of private equity were highlighted.

In terms of education, Brazil has a rather contradictory scenario. On one hand, its graduate studies system is one of the best in Latin America, with high rates of Masters and PhD degrees, about 30,000 Masters and 10,000 PhDs per year, especially in the human and social sciences and life sciences. It also has a large number of research universities, 92 public and 86 private universities. The public schools are generally the best quality, more directed towards research and offer a greater variety of courses. Besides the universities, the country also has 2092 other institutions of higher learning, such as university centers and integrated colleges9. The Brazilian graduate studies system generates significant academic production, representing nearly 2% of papers published internationally, 15th in the world (INEP, 2006; CAPES, 2006; Nicolsky, 2008; OECD, 2006).

On the other hand, basic education is extremely poor. About 10% of the population is illiterate[10] and the population studies on average 6.8 years, which is not sufficient to conclude elementary school. The governmental policies have focused on expanding the number of enrollments in elementary and high school, however without the appropriate attention to quality. Access is also a problem in higher learning courses where its reach is restricted. The enrollment rate of youths aged 18-24 is around 10%, which indicates an elite system that concentrates at higher income levels and in the country's wealthiest regions (south and southeast). For example, half of Brazil's higher learning institutions are located in the southeast. According to Brito Cruz's presentation in November 2007, in São Paulo alone, there are three State universities, 19 technology schools, 40% of PhD formation, 55% of Brazilian science and it receives 13% of State budget for higher education and R&D funding. The federal government's educational policies at this level are also trying to expand the number of enrollments in programs that facilitate private university financing and public university expansion programs (IBGE, 2007b; OECD, 2006).

Besides expanding the public university system to serve a larger portion of the population, the government has also stimulated an expansion in activities carried out by the universities, mainly geared towards economic development. Thus, besides its role as a generator of qualified human resources and developer of scientific research, the university has become an important source of knowledge for the business sector (as shown above in this section) and an enterprising institution - creator of companies.

However, the latter role has been performed by universities for more than 20 years through the creation of spin-off companies throughout the country through incubators and technological parks. According to Risola (November, 2007), business incubator centers serve as an ideal vehicle for entrepreneurs. They bring together leading experts and provide them with the necessary resources, technical knowledge and training that allow them to better manage financial resources and the development of new companies and products in an "environment that promotes cross-pollination of ideas."

UNICAMP is a perfect example in this sense. It is Brazil's largest patent holder and has an innovation agency, INOVA, which manages the university's technology licensing for diverse private sectors, the main one being the pharmaceutical, which has 22% of the licenses. It also helps in partnerships between university research groups and private sector companies and carries out other activities such as the search for financing, company incubation and public sector actions (Feldhaus, July, 2008). Another example, coordinated by the aforementioned Risola, is USP's CIETEC, which aims at promoting the development of national science and technology; transforming knowledge into innovative and competitive products and services; expanding the survival rate and competitiveness of small and micro companies; and positioning the country as a creator and export center of innovative technologies. The center was created 10 years ago and has been achieving positive results, such as the exchange of technical, cultural, administrative and managerial know-how; development of common projects; access to new markets; promotion and commercialization of technological innovation; and achieving objectives that are beyond the individual reach of each company. In 2006, the incubator finished the year with 115 incubated and 55 graduated companies, as well as 3 patents and 12 trademarks and 5 patents and 27 trademarks protocoled (Risola, November, 2007).

Arbix (April, 2008) argued that universities have been actively encouraged to adapt to the changing dynamics of the global economy and the shifting forms and functions of the innovation process. To the academic community, this is not seen as a sign of their declining significance or irrelevance; instead, it is viewed as "an evolution of their part in this process". The principal focus among policymakers, researchers and business people is to promote increased cooperation with firms and enhance the "socio-economic relevance of academic research agendas".

However, despite the advances of the Innovation Law, which increases the university's flexibility and intellectual property rights and creates the Technological Innovation Nuclei (TIN) to facilitate interaction with the business sector, university-business interaction is still incipient and faces many difficulties in its development. Arbix (April, 2008) explained that to support greater university-business partnerships, competitive funding systems are being developed for both universities and companies. Besides that, the desire and willpower on both parts to make the relationship happen to exchange knowledge and new learning is the driving force behind its success.

The intellectual property issue is on the factors that hampers university-business interaction in Brazil. The use of trademarks was the main method for protecting innovation used by companies in Brazil between 2003 and 2005, followed by industrial secrets and patents. The chosen form of protection certainly varied according to the sector, type of product or process to be protected. However, there has been a significant increase in the number of patents in force at companies that implemented innovation between the second and third edition of the study, from 5% to 11.3%, respectively (IBGE, 2005, 2007a). For example, between 1996 and 2006 Embrapa (Castelo Branco, July, 2008) obtained 190 patent applications, 191 trademarks, 297 plant varieties, 30 software programs and 1400 license agreements. Nevertheless, Brazil still has a very low number of patents, especially of residents. The country is ranked 28th in the world in terms of patents, with only 121 obtained in 2006 at the United States Patent and Trademark Office (USPTO). Triebnigg (November, 2007) argued that patent protection and an effective and well-equipped trademark agency are important factors that foment innovation in the pharmaceutical sector. He also underscored the importance of INPI's modernization.

Other important players in this scenario are the multinational companies that were established in Brazil in the 1950s in a strictly productive manner, taking advantage of the fiscal incentives and cheap labor. However, development of products related to the local market's specific demands began to create greater importance in some of these subsidiaries for product research and development in Brazil. A great example of this was the Fiat Palio family of cars developed by Fiat Brazil in an unprecedented partnership between Brazilian and Italian researchers. The Brazilian subsidiary had a certain degree of autonomy in the creation of the global development platform for this line of products and in a totally autonomous manner; it was responsible for remodeling the new version of the product sold after 2000. The Palio line was a big success in Brazil, making Fiat the sales leader, passing VW for the first time in the country, and it only failed to achieve the desired results in Argentina and Turkey due to the economic crises the two countries were hit by when the car was launched (Ciravegna, 2004).

Another example is Novartis, which invested R$ 24 million in 2006 in clinical studies for a total of 49 studies and more than 3500 patients. Besides that, the company has a research project in partnership with the Federal University of São Paulo (UNIFESP) for didactic, scientific and technological exchange. According to Triebnigg (November, 2007), company president, Novartis is committed to assessing opportunities and contributing towards innovation in Brazil. Besides its investments in R&D, the company also recently invested about R$ 223 million in expanding its production capacity to serve the domestic and foreign markets. Along these same lines, Assano (November, 2007), IBM executive, underscores the importance of multinationals in the context of creating technological capacity in developing countries and he shows numbers that indicate that in 2004, nearly US$ 5 billion were invested in Brazil, China, Korea and Taiwan and that there is a concentration of approximately 60% of direct foreign

investment (FDI) in emerging economies (China, Brazil, Mexico, Singapore). The main sectors to receive these investments are IT, Hardware, Automotive, Pharmaceutical and Biotechnology. According to Olívio Ávila (November, 2007) the creation of conditions to attract R&D investment on the part of global companies is an important challenge to increase Brazilian technological capacity. Triebnigg (November, 2007) observed there are several factors that global companies take into consideration when investing in R&D, especially intellectual property, regulatory environment, public policies that stimulate innovation and the health system, in the case of pharmaceutical companies.

Although it competes in attracting multinational companies with India and China, Brazil has some advantages in relation to the two countries such as the consolidation of the Brazilian industrial base and the long tradition of multinational companies established in the country. If used properly, these advantages can generate virtuous effects for Brazilian development, including inserting Brazilian innovation in the global market. These factors provide security and confidence for the company in search of a new site to set up its subsidiary. It is highly positive to the country for these new multinationals to come, especially those with a vision like IBM (November, 2007) where nowadays innovation is no longer confined to R&D laboratories, but it is necessary to interact with other players in the system for it to occur. Besides the constant search by the company to expand and facilitate the exchange of knowledge with these players, it also seeks to identify the current research trends, the new technologies and the emerging problems for academic research. This type of vision brings even more positive results to the country, permitting greater development of its scientific and technological capacity.

This stimulus for the national and international private sectors must be carried out in a coordinated and continuous manner by the government. Pacheco (November, 2007) highlighted that the globalized nature of today's international economy makes the crafting of innovation policies extremely complex. Gone are the days when governments can simply "engineer" policies that target specific types of innovation. Technological and scientific advances, which are critical components of sustainable economic growth, are now primarily driven by market demand. Merril (November, 2007) argues that the government's focus on its own and on academia's actions occurs because it is easier to manage these institutions and deal with them when implementing policies.

Mendonça (November, 2007) noted that Brazil has taken steps to spur innovation by adopting "subvention, equalization measures and better fiscal policies". Yet, "the number of companies that operate in this 'innovation niche' are still the ones that would do so regardless of these policies". However, the presentations made at the seminars and summarized in this paper show that an ever increasing number of companies in Brazil are changing their opinions about the importance of innovation and expanding the direction of their strategies toward increasing innovation. Pintec's own

data also confirm these changes. The data show that innovative as well as non-innovative companies, out of a total of 34,403 companies, have plans for strategic and organizational changes. The main ones involve the organizational structure, significant changes in concepts and marketing strategies, product esthetics and design and also the implementation of production management techniques. Thus, the chance for resumption in economic growth and industrial development in Brazil based on the search for innovation is proving to be a very possible future for the country.

An important factor for this resumption is the expansion of the domestic company export capacity. By acting in the global market, companies become more capable and competitive. Brazil's export agenda is still largely composed of primary products and commodities (40.4%) and products of average technological intensity (20.7%). The proportion of high technology products is 12.8% (MCT, 2007). For that reason, according to Olívio Ávila (November, 2007), the increase in domestic company export capacity in relation to conditions, promotion and legislation is fundamental. More specifically, it is important to create conditions to increase the international market share of Brazilian companies that produce mid to high added value goods; foment the globalization of Brazilian companies with national capital, because there are few of these with global operations; and legislation that stimulates and rewards company export efforts.

On a sectoral basis, it is possible to identify areas of greatest capacity for exporting. Brazil has a big advantage in the agriculture sector, exporting primary products and commodities, as mentioned above, but it also has advantages in a few high technology sectors. However, the capacity of sectors more intense in technology and with significant levels of exportation is more related to actions by one or another company, such as the deep-water oil exploration and production by Petrobras or the manufacturing of planes by Embraer.

In short, the Brazilian business sector is comprised of companies with little innovation that invest little in activities to generate innovation. In general, they are incremental innovations and for the company. There are few innovations for products and for the domestic and international markets. There is still little interaction with the academic sector and export capacity is low. The companies are mainly geared towards domestic market demands, including in regulatory terms. Stratifying the data by company size and sector, it is possible to observe some more significant scenarios for the generation of innovation in Brazil. Large companies are more innovative, especially in certain sectors. However, the new economic scenario in Brazil and the innovation policies seem to be leading to a new vision by companies in Brazil, which are increasingly seeking to expand new knowledge and the search for innovation.

CONCLUSION

The information summarized in this paper show the change Brazil has been going through in recent years in the development of science, technology and innovation. This change began in the early 2000s and it has been getting stronger every year. As shown in the two sections that comprise this article, the changes in standard have been taking place in governmental policies as well as business strategies. It is slow and long-term change where perceived advances in the short term are still small, especially when compared to other developed and developing countries. However, it is important to value the change underway. It seems to be on the right path for the country's economic and industrial development. Another noticeable change can be seen in the expansion of the concept of innovation. It is not restricted to applied research activities, but rather also involves steps related to the development of new products, technologies, processes, business models, logistics and organizational structures, among others. However, this does not mean that the changes that have occurred thus far are sufficient.

The Brazilian government has historically played a very important role in R&D investments. However, this pattern has been changing recently, with equilibrium in government and business sector expenses, at about 50% each. The OECD standard is for more private sector investments, 69% of OECD's total R&D and about 1.5% of GDP. Among the BRICS, Brazil is among the lowest in private sector expense intensity[11] at 0.49%, with India at 0.14%, both in 2006. In China, these expenses have been expanded, and in 2006, they approached European Union levels (1.11%) and 1.01% of GDP. Like Brazil, in most OECD countries large companies are the most responsible for investments in R&D. This greater importance of private sector expenses is mainly due to government tendencies to replace direct with indirect financing through fiscal incentives for R&D development. This tendency is also seen in Brazil, where between 2001 and 2006 there was the greatest reduction (0.09%) in public financing of private R&D. This was reinforced by the enactment of the Law of Good in 2007, which should stimulate new private investments in the country.

However, public-private partnerships for developing innovation are also quite frequent and positive for the country's development. The main Brazilian example is Embrapa, which established a public-private partnerships a few years back in the ag-

riculture sector and has been promoting the sector's technological and productive development in an exemplary manner. Another recent example includes the partnerships between public pharmaceutical laboratories and private, national pharmochemical firms for the national production of anti-retroviral medication to supply the national program to care for AIDS patients. Partnerships of this sort show the importance of joint action by system players to promote innovation and development in the country.

The report also observes the importance of developing countries in the new scenario of R&D internationalization, mainly motivated by access to technology by other countries. Between 2000 and 2005, developing countries broadened their participation in global R&D activities to 18.4%, with special importance for China. On the other hand, developed countries maintained or reduced their investments. Japan kept its participation at 14%, while the USA and European Union recorded a 2% and 3% drop, respectively, falling to 35% and 24%. Brazil needs to take advantage of this tendency and expand its capacity to attract new international investments, besides stimulating national investments. In economies like the United Kingdom and Italy, multinational branches represent 39% and 26%, respectively, of R&D expenses financed by the private sector. Besides that, cooperation is identified in the report as one of the main motivations of companies for globalizing R&D activities. For European companies, suppliers (17%), clients (14%) and universities (9%) are the main partners for innovative companies.

According to the report, Brazil's biggest challenge in this area is in improving the quality of human resources, especially due to the small number of researchers in industry and the low percentage of graduates in science and engineering as a result of section 2 in this paper. In China, for example, in 2006, 39.2% of the country's graduates were in science and engineering, about twice the OECD average, only trailing the USA. However, the country also has a low number of researchers per active worker and a small percentage of the population with higher education, characteristics of a developing and still strongly rural country.

It is also necessary to point out Brazil's discrepancy between published papers and patents. Brazilian publications grew 1.5% between 1995 and 2005, whereas patents had much lower numbers. However, despite the small number of Brazilian patents, especially when compared to countries like Korea, China, India and Taiwan, in relation to the number of triadic patents[12] per million inhabitants, Brazil is in a position similar to China and Russia. However, Brazilian patents, as already mentioned, mainly belong to non-resident inventors (60%). According to the report, this occurs because Brazil is one of OECD's non-member countries that receive the most foreign direct investment. But the low innovative nature of Brazilian companies also contributes to this scenario. China is very important in this sense in absolute terms. It is among the fifteen largest countries in number of triadic patents in 2005 and among the five that publish the most. However, in per capita terms, the production of triadic patents and scientific publications is still very low. China and India had very expressive growths in

the registration of high and medium technology patents between 1997 and 2004, 45% and 43%, respectively. The low percentage when these numbers are standardized by population for China (0.3%) and India (0.1%) is explained in part by the huge populations, but also by the R&D activities, which are more geared towards adaptations and the domestic market.

An important fact identified in the study that has been taking place due to the increase in R&D internationalization and international cooperation is the growth in joint patents between these countries. Co-invention patents grew 7.3% between 2002 and 2004. Smaller and less developed economies seek international collaboration as a means to overcome limitations associated with the size of their domestic markets and the lack of appropriate infrastructure for developing technology. Upon reaching higher levels of industrial development and greater domestic technological capacity, these partnerships are reduced, as seen in Turkey, Chile, India and China between 1992 and 1994 and 2002 and 2004, according to OECD researchers. In this area, Brazilian companies and government need to absorb the idea that even with a relatively large market, it is necessary to think of innovation on an international basis, whether as part of research and development chains or planned investments with an expectation for global scale returns.

An important issue in relation to the defense of intellectual property in Brazil and the promotion of innovation is the compatibility of policies. These two spheres are highly complementary and need to be pointed in the same direction. According to Sennes and Mendes (2008), Brazil has been contradictory in some measures taken in international forums in terms of its domestic objectives. For example, through both the Convention on Biological Diversity (CBD) and the World Trade Organization's (WTO) TRIPS Agreement, Brazil is pushing for an international regime that would create burdensome administrative obstacles to biogenetic product research. Brazil also defends the flexibility of developing countries to issue compulsory drug licenses. These positions create additional, burdensome procedures for patent applications and undermine international patent regimes—areas essential for innovation. But times are changing; Brazilians increasingly recognize the importance of an economy that encourages innovation. It helps bring in high-quality foreign investment, while boosting the global competitiveness of national companies. Progressive policies continue to be rolled out at home. The next step is respecting those rights for international companies.

It is worth remembering the issue mentioned in the first section of this paper, which is the need for coordinating Brazilian policies at the national and international levels. The promotion of economic and industrial development occurs through a combination of several levels and types of policies. The coordination and definition of a common objective for these policies is fundamental for achieving expected results. Brazil seems to be in the right direction for establishing governmental policies and business strategies to achieve improved levels of scientific, technological and innovative devel-

opment. The results are expected to be slow, but we cannot think nothing else needs to be done; quite the contrary. Brazilian strategies are on the right path, but much still needs to be done and mainly consolidated for the country to achieve higher levels of economic and industrial development.

The obstacles identified by Brazilian companies in generating innovation, such as high costs and risks, are Brazilian structural issues that need consistent and persistent policies to be solved. The promotion of cooperation between system players also needs to be maintained and expanded through a reduction in bureaucracy and the establishment of clear rules for defending intellectual property. Financing of innovative activities should promote interaction, but also reinforce the importance of these activities within the companies.

NOTES

1. The author wishes to thank Julia Paranhos for her collaboration in elaborating this study.

2. Institutions are understood as norms, habits and rules, deeply rooted in society and which play an important role in determining how people relate with each other and how they learn and use their knowledge (Johnson, 1992 *apud* Lundvall *et al.*, 2002).

3. R&D intensity is the ratio between gross domestic R&D expenses and the country's GDP.

4. According to Embrapa, a total of 190 patents were deposited between 1977 and 2006. Of that total, 72 were made between 1977 and 1995 and 118 between 1996 (the year an intellectual property policy was established in the entity) and 2006. The number shown here refers to patents actually granted, listed in the INPI database.

5. See Freeman (1995), Lundvall (1992), Nelson (1993).

6. Instituted in 2005, it aims at proposing national policies and specific measures to the President of the Republic to promote the country's industrial development (MDIC, 2008).

7. Instituted in 2007 to coordinate implementation of the Biotechnology Development Policy (ABDI, 2008).

8. Fiscal incentives for Research and Development and technological innovation (Law no. 8.661, Law no. 10.332 and Law no. 11.196).

9. The difference between these institutions and universities is that the latter generally have a multidisciplinary structure with a regular offer of at least 12 undergraduate programs in three subject areas, all recognized and with a formal evaluation from the Ministry of Education; graduate study programs with at least three Masters areas and one PhD; extension programs and at least 33% of the teachers exclusively dedicated to the university and 50% with a Master's or PhD.

10. The indicator only includes people who are unable to at least write their names. Thus, if a person can write their name, and nothing more, they are not considered illiterate, which is completely different from someone who is educated.

11. Private sector expenses in R&D in relation to GDP.

12. Those that protect inventions simultaneously registered in patent offices in the United States, Europe and Japan.

REFERENCES

ABDI—Agência Brasileira de Desenvolvimento Industrial. *Institucional*. Available at: www.abdi.com.br. Accessed in: 17 Dec 2008.

BAHRUTH, E. *Política para o Complexo Industrial da Saúde*. II Enifarmed—2º Encontro Nacional de Inovação em Fármacos e Medicamentos. São Paulo, 12-13 nov. 2008.

CAPES—Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. *Estatísticas da pós-graduação 2006*. Available at: www.capes.gov.br. Accessed in: 29 Nov. 2007.

CARNEIRO, R. *Desenvolvimento em crise: a Economia brasileira no último quarto do século XX*. São Paulo: Editora Unesp/IE-UNICAMP, 2002. (Coleção Economia Contemporânea)

CIRAVEGNA, L. Decentralized automotive value chain globalization: a motor for functional upgrading? *DRUID Summer Conference*, Elsinore (DK), 14-16 June 2004.

CGEE—Centro de Gestão e Estudos Estratégicos. *Institucional*. Available at: www.cgee.org.br. Accessed in: 17 Dec 2008.

CNI—Confederação Nacional da Indústria. O triunfo da inovação. *Revista Indústria Brasileira*, p. 16-21, mar. 2005. Available at: www.cni.org.br. Accessed in: 28 Mar. 2008.

COHEN, W.; LEVINTHAL, D. Innovation and learning: the two faces of R&D. *The Economic Journal*, 99, p. 569-596, Sep. 1989.

EDIQUIST, C. Systems of innovation: perspectives and challenges. In: FARGERBERG, J., MOWERY, D., NELSON, R. (Ed.). *The Oxford handbook of innovation*. New York: Oxford Universtiy Press, 2005.

FERRAZ, J.C.; PAULA, G.M.; KUPFER, D. *Política industrial*. In: KUPFER, D; HASENCLEVER, L. (Org) Economia industrial: fundamentos teóricos e práticas no Brasil. Rio de Janeiro: Campus, 2000. p. 545-567.

FINEP—Financiadora de Estudos e Pesquisas. *Fundos Setoriais*. Available at: www.finep.gov.br. Accessed in: 06 Dec. 2008.

FREEMAN, C. The 'national system of innovation' in historical perspective. *Cambridge journal of economics*, 19, p.5-24, 1995.

IBGE—Instituto Brasileiro de Geografia e Estatística. *Pesquisa Industrial de Inovação Tecnológica 2003*. Rio de Janeiro: IBGE, 2005.

_____. *Pesquisa Industrial de Inovação Tecnológica 2005*. Rio de Janeiro: IBGE, 2007.

_____. *Pesquisa nacional por amostra de domicílio*. Rio de Janeiro: IBGE, 2007.

IEDI—Instituto de Estudos para o Desenvolvimento Industrial. Investimentos em Ciência, Tecnologia e Inovação na OCDE e nos BRICs. *Carta IEDI n. 344*, published in 23rd Dec. 2008. Available online: www.iedi.org.br. Access in: 23rd Dec. 2008.

IMD. *World Competitiveness Yearbook 2008*. Available at: www.imd.ch. Accessed in: 6th Nov. 2008.

INEP—Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira. Sinopse da Educação Superior—2006. Available at: http://www.inep.gov.br. Accessed in 27 Jul 2008.

KLINE, S., ROSENBERG, N. An Overview of Innovation. In: LANDAU, R., ROSENBERG, N. (Ed.), *The Positive Sum Strategy*. Harnessing technology for economic growth. Washington: National Academic Press, 1986.

LIMA, A. O papel do INPI na articulação do Sistema Nacional de Inovação. *Fórum Internacional de Inovação Tecnológica*. Vitória: Nov. 2008.

LUNDVALL, B-A. *National systems of innovation—towards a theory of innovation in a interactive learning*. Londres: Pinter Publishers, 1992.

_____.; BORRÁS, S. Science, technology and innovation policy. In: FARGERBERG, J., MOWERY, D., NELSON, R. (Ed.). *The Oxford handbook of innovation*. New York: Oxford Universtiy Press, 2005.

_____., JOHNSON, B., ANDERSEN, E., DALUM, B. National systems of production, innovation and competence building. *Research Policy*, v. 31, 2002, p. 213-231.

MCT—Ministério da Ciência e Tecnologia. *Fundos Setoriais de C&T—Dotação Orçamentária e Execução*. Available at: www.mct.gov.br. Accessed in: 06 Dec. 2008.

_____. *Ciência, tecnologia e inovação para o desenvolvimento nacional—Plano de Ação 2007-2010*. Brasília: MCT, 2007.

MDIC—Ministério do Desenvolvimento, Indústria e Comércio Exterior. Conselhos. Available at: www.mdic.gov.br. Accessed in: 23 Dec. 2008.

NELSON, R. (ed) *National Innovation Systems: a comparative analysis*. Oxford: Oxford University Press, 1993.

NICOLSKY, R. Tecnologia e aceleração do crescimento. Valor Econômico, 14 Set. 2007.

OECD—Organisation for Economic Co-operation and Development. *Oslo Manual*. Paris: OCDE/Eurostat 1997.

_____. Economic Surveys: Brazil. *OECD Publishing*, v. 2006/18, Nov. 2006.

SENNES, R. ; MENDES, R. Brazil's two-faced position. *Americas quartely*, v. 2, n. 3, summer 2008.

TAKAKI, A. ; Camargo, H. ; Mendes, R. ; sennes, r. Propriedade intelectual e inovação : uma análise de dez instituições brasileiras. *Parcerias Estratégicas*, Brasília, n. 26, Jun. 2008.