

**THE RESEARCH PROJECT  
“COMPARATIVE STUDY OF THE NATIONAL INNOVATION SYSTEMS OF  
BRAZIL, RUSSIA, INDIA, CHINA AND SOUTH AFRICA (BRICS)”**

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**RESEARCH PROBLEM AND JUSTIFICATION**

**1. Research background and main focus**

A significant part of the growth potential of the world economy for the coming decades resides mostly in some large less developed countries. Brazil, Russia, India, China and South Africa (BRICS) have such potential. More than just that, BRICS are thought as having the capacity to “change the world” by the threats and opportunities they represent from the economic, social and political points of views.

International agencies and some analysts suggest that investors should pay careful attention to the opportunities presented by these countries. In this case, the emphasis has been restricted to the identification of investment possibilities in the BRICS production structures and to the perspectives presented by their consumer markets.

In the study hereby proposed the interest in analyzing BRICS goes much beyond. These countries present significant development opportunities, as well as several common characteristics and challenges. Identifying and analyzing them may help to uncover the possible paths for fulfilling their socio-political-economic development potential.

The central focus of the study is the national innovation system (NIS) of the five BRICS. The notion of innovation system has in its centre the production, S&T and education sub-systems; but includes also the financial subsystem, the investment patterns, the legal and political frameworks as well as other spheres connected to the national and international, contexts where knowledge are generated, used and diffused. In this effort it is necessary to develop conceptual and methodological frameworks capable of depicting their different private, public and governmental dimensions and that allow the comparison of the NIS of the five countries, pointing out convergences, divergences and synergies.

Particular attention will be given to policy implications. Better knowledge about the experience of the BRICS´ NIS will allow the identification and the analysis of competing areas, as well as common bottlenecks and complementarities, which are of paramount importance for the implementation of actual and potential joint actions. In order to do so,



the study aims at including, not only students and researchers specialized on production and innovation development, but also policy-makers in national and international debates.

## 2. Why a comparative research project on BRICS' NIS is important

The concept of national innovation systems - NIS - was introduced by Christopher Freeman<sup>1</sup> and Bengt-Ake Lundvall<sup>2</sup>. This concept emphasizes the interactive character of production and innovation, the importance of (and complementarities between) incremental and radical, technical and organizational innovations, as well as their different and simultaneous sources. Firms are seen as organization embedded within specific socio-economic-political environments that reflect particular historical and cultural trajectories.

Since the beginning of the nineties this concept has been used as an analytical tool and as a framework for policy analysis in both developed and underdeveloped countries. As a result, (i) research and policy activities explicitly focusing on systems of innovation can be found in most countries and a rapidly growing number of studies of specific national systems of innovation has been produced; (ii) most countries, BRICS included, have been discussing and implementing public and private policies that focus on innovation, learning and capacity building.<sup>3</sup>

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<sup>1</sup> Freeman, C. (1982). Technological infrastructure and international competitiveness, draft paper submitted to the OECD *ad hoc* group on science, technology and competitiveness, Paris: OCDE; Freeman, C. (1987). *Technology policy and economic performance - lessons from Japan*. London: Frances Pinter.

<sup>2</sup> Lundvall, B.-Å. (1985). *Product innovation and user-producer interaction*. Aalborg: Aalborg University Press. Lundvall, B.-Å. (1988). Innovation as an interactive process: From user-producer interaction to the National Innovation Systems. In G. Dosi, C. Freeman, R. R. Nelson, G. Silverberg, and L. Soete, (Eds.), *Technical change and economic theory*, London, Pinter Publishers.

<sup>3</sup> Arocena, R. and Sutz, J. (2003). Knowledge, innovation and learning: systems and policies in the North and in the South. In J. E. Cassiolato, H. M. M. Lastres and M. L. Maciel (Eds), *Systems of innovation and development*. Edward Elgar: Cheltenham, UK. Chairatana, P. and Tan Sinh, B. (2003) Strategising ASEAN agro-innovation system: the case of Thailand and Vietnam. 1st. Globelics Conference, Rio de Janeiro, Brazil. Johnson, B. and Lundvall, B.-Å. (2003) Promoting Innovation Systems as a Response to the Globalising Learning Economy. In: Cassiolato, J. E., Lastres, H. M. M. and Maciel, M. L. (Eds.), *Systems of innovation and development*. Cheltenham: Edward Elgar. Joseph, K. J. and Intarakumnerd, P. (2004) GPTs and innovation systems in developing countries: a comparative analysis of ICT experiences in India and Thailand. 2<sup>nd</sup> Globelics Conference, Beijing, China. Muchie, M.; Gammeltoft, P. and Lundvall, B.-Å. (2003) *Putting Africa first: the making of African innovation systems*. Aalborg: Aalborg University Press. Mytelka, L. K (2000) Local systems of innovation in a globalized world economy. *Industry and Innovation*, 7(1), 15-32. Oyelaran-oyeyinka, B. Determinants of inter-organizational collaboration in Africa's system of innovation, 2<sup>nd</sup> Globelics Conference, Beijing, China, October 16-20, 2004. Reinert, E. and Reinert, S. (2003). Innovation systems of the past: modern nations - states in a historical perspective, 1st Globelics Conference, Rio de Janeiro. Reza Razavi and Maleky, A. (2004). Applying national innovation systems approach in the context of industrializing countries: methodological unity and terminological diversity in literature. 2<sup>nd</sup> Globelics Conference, Beijing, China Segura, B. O. (1999). Sustainable systems of innovation: the forest sector in Central America, SUDESCA Research Papers No 24, Department of Business Studies, Aalborg University, Aalborg. See also [www.globelics.com](http://www.globelics.com).

Underlying the system of innovation approach is a:<sup>4</sup>

- § resurgence of the interest in historical and national development trajectories and in the role of technical change;
- § recognition that incremental and radical, technical and organizational innovations are simultaneous and complementary;
- § emphasis on innovation and learning, which are characterized as interactive processes with multiple directions and sources (internal and external to firms and national boundaries);
- § re-conceptualization of firms as organizations embedded within socio-economic-political environments, reflecting specific historical and cultural trajectories;
- § emphasis on the need of taking into account the productive, financial, social, institutional and political spheres in their micro, meso and macro contexts.

Among the main advantages of this approach, we point that it deals with the complexity of different cases; and that it targets groups of different agents (firms of different sizes and performing various types of activities, as well as other organizations dealing with education, training, R&D, promotion, financing, etc.) and connected activities that usually characterize any production and innovation structure. Therefore, it surpasses the restrictions of traditional focus on sectors, individual organizations and space (municipalities and micro-regions) both as analytical and intervention units. By establishing a bridge between the territory and economic activities, it covers economic, social and political contexts, as well as the cognitive environments where the main processes of learning, capacity building and innovation takes place and where tacit knowledge flows.

From the point of view of less developed countries (LDCs), the usefulness of the IS perspective resides in the fact that it

- offers a broader understanding about the possibilities of acquiring and using knowledge and technologies;
- understands innovation as a cumulative, context specific and socially determined process and emphasizes the importance of innovation as a source of dynamic competitiveness, instead of the stress on the so-called traditional comparative advantages or spurious competitiveness (based on low labor costs, the exploitation of natural resources without a long-term perspective and the manipulation of the exchange rates);
- links micro, meso and macro dimensions of competitiveness and does not ignore the role of 'implicit' policies as important constraints to technological and industrial development in these countries have included: macro-economic instabilities, hyper-inflation, high external debt and high interest rates;
- helps to avoid the trap of dissociating economic, environmental and social development

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<sup>4</sup> For details see Cassiolato, J. E., Lastres, H. M. M. and Maciel, M. (2003) *Systems of Innovation and Development*. Cheltenham: Elgar

- does not dismiss the possibility of using innovation policies to reduce regional and social inequalities.

One of the basic goals of Globelics is to advance the use of the IS perspective on a world basis. A BRICS comparison is an essential part of this endeavor since it brings important methodological and empirical challenges (see item on methodology below). At the same time, as all these countries are fostering innovation policies, a comparative analysis such as the one hereby proposed can have a significant policy impact: it is envisaged an engagement of government officers in the project. Within Globelics, the BRICS project complements other important activity in this direction the Globelics Academy Ph.D. School ([www.globelicsacademy.net](http://www.globelicsacademy.net))

It is worth noticing that the statistical information used in this research proposal, as well as those utilized in most analysis about BRICS are those produced by international agencies, namely UN, Unido and Unctad. We are aware that there are imperfections, inadequacies and lack of content that make the characterization of BRICS and their comparability more difficult. Here this information is used to show how BRICS are shown to the world by international organizations that produce such information. One objective is to identify main imperfections and what is missing. It should be stressed that addressing these inadequacies constitute an important objective of the proposed study.

### **3. Preliminary characteristics of BRICS' Innovation Systems**

The objective of this item is to present the weight and dimension of the national innovation systems of BRICS, and the possibilities for their mobilization. It is noted, however, that it is here that available data both nationally and internationally are more scarce and incomplete, failing in giving even a sketchy picture of their national innovation systems. Hence the relevance and urgency to advance characterizing the five NIS and in generating indicators capable of better represent their different private, public and governmental dimensions. In the approach used in this project<sup>5</sup> innovation systems include:

- the production (from raw materials to the commercialization of goods and services) and innovation subsystem;
- the policies, representation & financing subsystem;
- the role of demand (including income distribution, structure of consumption, social organization, social demand - basic infra-structure, health, education.

The characterization of these, their actors and activities, will be object of specific studies and depends on detailed research about their constitution, evolution and the role of strategies and policies in the five countries. The scarce information available internationally refers mostly to indicators related to the production and the S&T subsystems. Such information will be presented below

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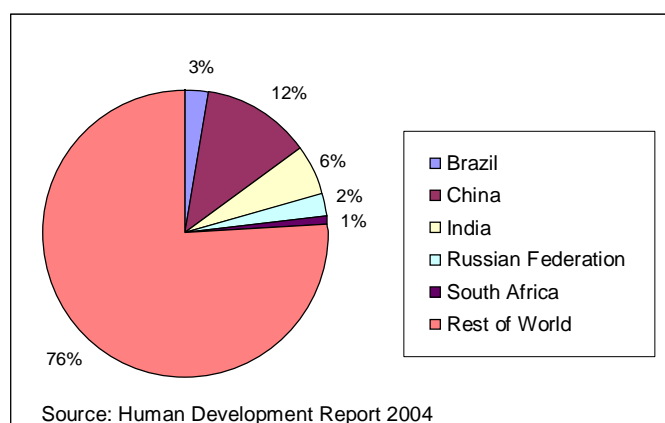
<sup>5</sup> See Figure 3 and Box 2 in the methodology item.

**a. The production structure and performance**

As Figure 1 shows, in 2002, the combined GDP of BRICS (in PPP) already represented 24% of the world GDP; China and India were responsible, respectively, for 12% and 6%. More than that, these countries present other characteristics that make them a focus of observation and analysis. BRICS have gone through an intense process of transformation in the turn of the millennium. They are pursuing different development strategies reflecting diverse forms and degrees of integration into the world economy.

The economic performance of BRICS has widely varied in the last decades. China has maintained the fastest growing economy worldwide. Brazil has had an irregular and mediocre performance, well below its potential. India has grown significantly and more regularly. Russia, after the 1990s crisis, has recovered and South Africa has had a small improvement in its economic performance, also well below its potential. These different performances were accompanied by significant changes in the productive structure of the five countries. In all of them the services sector increased its relative importance.

**Figure 1: Share of BRICS' GDP on World GDP in PPP - 2002**



**Table 1: BRICS – Average rates of Growth of real GDP (%), 1980 - 2004**

	1980-89	1990-00	2001-04
Brazil	3.1	2.9	1.8
China	10.6	10.4	8.8
India	5.7	6	6.1
Russia	-	-4.7	6.1
South Africa	1.4	2.1	3.2

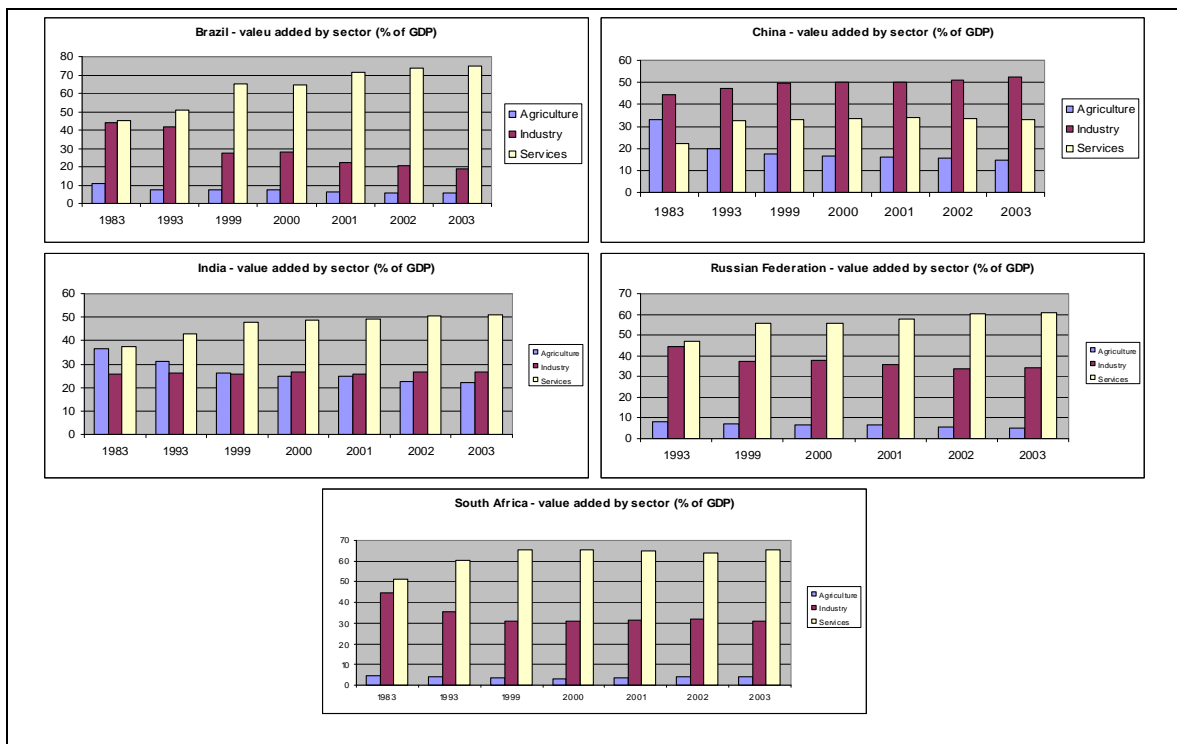
Source: UNCTAD Handbook of Statistics, 2005

Brazil has gone through a structural transformation since the late 1980s, with a significant reduction of the share of manufacturing industry in total GDP and a high growth of services (respectively, 19% and 75% in 2003). It is worth emphasizing that agricultural goods that have had an important role in the trade superavit were responsible for only 5.7% of GDP in 2003, a significant fall from 11% in 1983.

Although the share of the agricultural sector in India's GDP is declining, it still represented 22% in 2003 (comparing with 36.6% in 1983) and constitutes an important determinant of the overall economic growth. In the last two decades, the contribution of manufacturing industry to India's GDP has been constant, around PIB 26%. The services sector in India is the one that is growing fastest, particularly those linked to ICT: the share of services in GDP has grown from 37.6% in 1983 to 51.2% in 2003.

In Russia, the share of agriculture fell from 8.3% in 1983 to 5.1% in 2003. The participation of the manufacturing sector in the GDP declined from 44.6% in 1983 to 34.2% in 2003 (and remains highly based in heavy industries - oil; energy and metallurgy – and machinery). The share of services in total GDP grew from 36% in 1990 to 60.6% in 2003.

**Figure 2: BRICS – Value added by sector (% do GDP)**



Source: World Development Indicators database

The services sector also has a more important role in the South African economy. The share of this sector in GDP was 51.1% in 1983 and 65.2% in 2003. The development of the financial sector and the growth of tourism have contributed for this growth. The share of manufacturing decreased from 44.5% in 1983 to 31% in 2003. The metal and engineering sectors dominate the manufacturing sector and mining remains important from the point of view of foreign trade and employment. Although agriculture is responsible for a small share of South Africa's GDP, it still represents an important source of employment.

The composition of China's GDP has an unusual and growing share of the manufacturing sector: it was around 42% in 1983 and reached more than 50% in 2003. However, most of the labor force remains in rural areas. The relative share of the agricultural sector, that reached 33% in 1983, is constantly falling, to 14.6% of GDP in 2003. The share of services grew from 22% in 1983 to more than 30% in 1993, remaining at this level ever since.

All countries raised their export and import levels, both in volume terms and as a participation in GDP in the last two decades. In 2002, in China, Russia and South Africa, foreign trade reached a percentage higher than 50% of GDP, and in Brazil and India, approximately 30% of GDP.

Tables 2 and 3 show exports and imports of BRICS, both in current US\$ and as a percentage of world exports and imports during 2000-2004. After a phase of stagnation between 2000 and 2002, world exports grew significantly from US\$ 6,481 billion in 2002 to US\$ 9,123 billion in 2004. Imports also followed the same trend. The participation of BRICS has varied significantly.

**Table 2: BRICS – Foreign trade (in million of US\$ current) and share of GDP (%)**

Countries	Exports + Imports				(Exports + Imports)/GDP			
	1970	1980	1990	2002	1970	1980	1990	2002
Brazil	8,719	25,412	61,212	133,196	13.0%	10.3%	14.0%	28.9%
China	4,833	38,919	114,710	696,909	5.3%	12.9%	29.9%	55.0%
Índia	4,792	28,839	51,144	156,581	7.9%	15.7%	15.8%	30.8%
Rússia	-	-	349,249	206,358	-	-	36.1%	59.7%
South Africa	8,352	50,411	48,600	67,230	45.7%	61.2%	43.4%	63.2%

Source: United Nations Statistics Division



**Table 3: BRICS – Merchandise trade  
value (billion of current US\$) and share in world total (%) – 2000-2004**

<b>Exports</b>	<b>2000</b>		<b>2002</b>		<b>2004</b>	
	value	%	value	%	value	%
World	6,446.61	100%	6,481.17	100%	9,123.52	100%
Brazil	55.09	0.85%	60.36	0.93%	96.47	1.06%
China	249.20	3.87%	325.59	5.02%	593.37	6.50%
India	42.38	0.66%	49.25	0.76%	72.53	0.79%
Russia	105.57	1.64%	107.11	1.65%	183.19	2.01%
South Africa	29.98	0.47%	29.72	0.46%	45.93	0.50%
<b>Imports</b>	<b>2000</b>		<b>2002</b>		<b>2004</b>	
	value	%	value	%	value	%
World	6,705.87	100%	6,718.23	100%	9,458.27	100%
Brazil	58.63	0.87%	49.60	0.74%	65.90	0.70%
China	225.09	3.36%	295.17	4.39%	561.42	5.94%
India	51.52	0.77%	56.52	0.84%	95.16	1.01%
Russia	44.66	0.67%	60.22	0.90%	94.83	1.00%
South Africa	29.70	0.44%	29.27	0.44%	55.20	0.58%

Source: UNCTAD

The most notable fact is the well-known growth of participation of China in the international trade: its exports grew from 3.9% in 2000 of world exports to 6.5% in 2004 (a 67.9% growth) and imports, from 3.4% to 5.9% of world imports in the same period (growth of 76.8%). As it may be observed from the table 3, Chinese imports almost doubled in two years (from US\$ 295 billion in 2002 to US\$ 561 billion in 2004). It is worth emphasizing the strong role of primary goods in these imports, what benefits countries specialized in these goods.

India, Russia and South Africa experienced a mild growth both for exports and imports. Brazilian imports decreased their relative share of world imports in the period (from 0.87% to 0.70%), even if the absolute value increased from US\$ 59 billion to US\$ 66 billion.

#### **b. Science and technology development**

Table 4 presents available data on BRICS R&D expenditure as a percentage of GDP in the 1996-2001 period. In a general view, it is possible to perceive that the share of Brazil, Russia and China is considerably below the world average, representing less than half of the percentage spent worldwide. However, one should note that R&D expenditure is just a part of innovation expenditures. Here, again, available international information does not allow a better comparison. At the BRICS project an attempt will be done to find indicators

that could better describe the innovative potential of these countries including inputs to innovation other than R&D expenditure and the role of local, traditional knowledge.

**Table 4: R&D expenditure / GDP (%)**

	1996	2001	Var 1996-2001
Brazil	0.77	1.05	36
China	0.60	1.09	82.4
India	0.78	0.90	-
Russia	0.90	1.16	29.0
South Africa	na	0.76	-
World	2.06	2.46	19.5

Source: NEIT-IE-Unicamp, from World Development Indicators do IRDB

Table 5 presents information about enrollment in higher education as a percentage of total population in graduate age for 1990 and 2000. Once again, China shows an impressive growth in the number of enrollments that went from 3% in 1990 to 12.7% in 2000, representing an increase of 326.6%. In the case of India, similar figures show a growth of 74.6% during the same period. In both countries, the growth in the university enrollment/population in graduation age was higher than the world average (49.9%). In Brazil, the growth (44%) was slightly below the world average even though the percentage of university enrollment over population in graduation age keeps being higher (16.2% in 2000) than both China (12.7% in 2000) and India (10.6% in 2000). In the case of Russia, although the increase was relatively smaller than the world average (20,5% between 1990 and 2000) the percentage of university enrolment over population in graduation age was already significant in 1990 (52,1%) and reached 62.8% in 2000. South Africa experienced the smaller growth (10.4% between 1990 and 2000).

**Table 5: Enrollments in higher education as % of population in university age**

	1990	2000	Var 1990-2000
Brazil	11.2	16.2	44.0
China	3.0	12.7	326.6
India	6.1	10.6	74.6
Russia	52.1	62.8	20.5
South Africa	13.2	14.6	10.4
World	16.0	23.9	49.9

The summary of the basic characteristics of the national innovation systems of BRICS shortly discussed above include:

- **Russia:** strong position in higher education, with a powerful scientific system, particularly dedicated to space and defense activities; R&D expenditures growing.

- **India:** high quality scientific system expanding; weak industrial R&D; human resources of high quality and productive capabilities particularly in IT (software) and pharmaceuticals.
- **South Africa:** increasing effort in high quality education; R&D and innovative activities weak; limited scientific capabilities; productive capabilities in mining.
- **China:** considerable effort in mobilizing the national education and innovation systems; accumulation of productive, innovative and R&D activities; capabilities growing at high ratios, with emphasis in hi-tech sectors.
- **Brazil:** scientific system increasingly qualified; R&D and innovation activities very unequal with successes in airspace, energy, metallurgy and agro-business; weakening and disarticulation of several important innovation systems (eg. telecom) in the 1990s.

## PROJECT OBJECTIVES

The main objectives of the project submitted to IDRC are to:

- stimulate interactions and the exchange of experiences between researchers and policy-makers interested in innovation in BRICS aiming at creating capabilities and finding joint workable solutions;
- characterize the structure of BRICS' national innovation systems, their recent evolution and perspectives;
- compare the five countries innovation systems, identifying differences and similarities, common bottlenecks and complementarities;
- develop and use concepts and information capable of representing the Innovation Systems of BRICS;
- discuss policy implications and put forward policy recommendations, extracting lessons that can be useful not only for these countries but also for other developing countries.

The specific objectives of the project are to:

1. increase the interaction of innovation researchers and government officers of BRICS through meetings and other forms of articulation (seminars, web page, etc).
2. increase the knowledge about the NISs of BRICS through
  - the development of adequate concepts and methodologies;

- the analysis of selected BRICS innovation systems –sectoral and - and horizontal themes that affect innovation in these countries;
- 3. increase the capability both of researchers – in special graduate students - and government officers of BRICS through research on innovation systems, discussions, innovation panels and other forms of articulation;
- 4. diffuse the knowledge generated through the publication of a book, setting up a web page and participation in meetings and panels.

## METHODOLOGY

Conceptually, the project is structured within the National Systems of Innovation and the Development frameworks. Characterizing and comparing the BRICS´ NSIs is a challenging enterprise. The first methodological challenge is to develop a common structure capable of capturing their specific characteristics and, at the same time, is appropriate for comparison. These are countries with huge dimensions and resources, large populations, wide income disparities (and hence wide disparities in capabilities), regional imbalances, with parts of their systems developed and s others relatively underdeveloped (see Annex 1 for details). In addition, most of them have experienced huge transitions in their political, economic and social structures.<sup>6</sup>

Guided by development theories, in the project we will attempt to build up the understanding of the national systems of innovation of BRICS by refining and applying the broad analytical structure. Figure 3 below presents the narrow and broad characterization of National Innovation Systems.

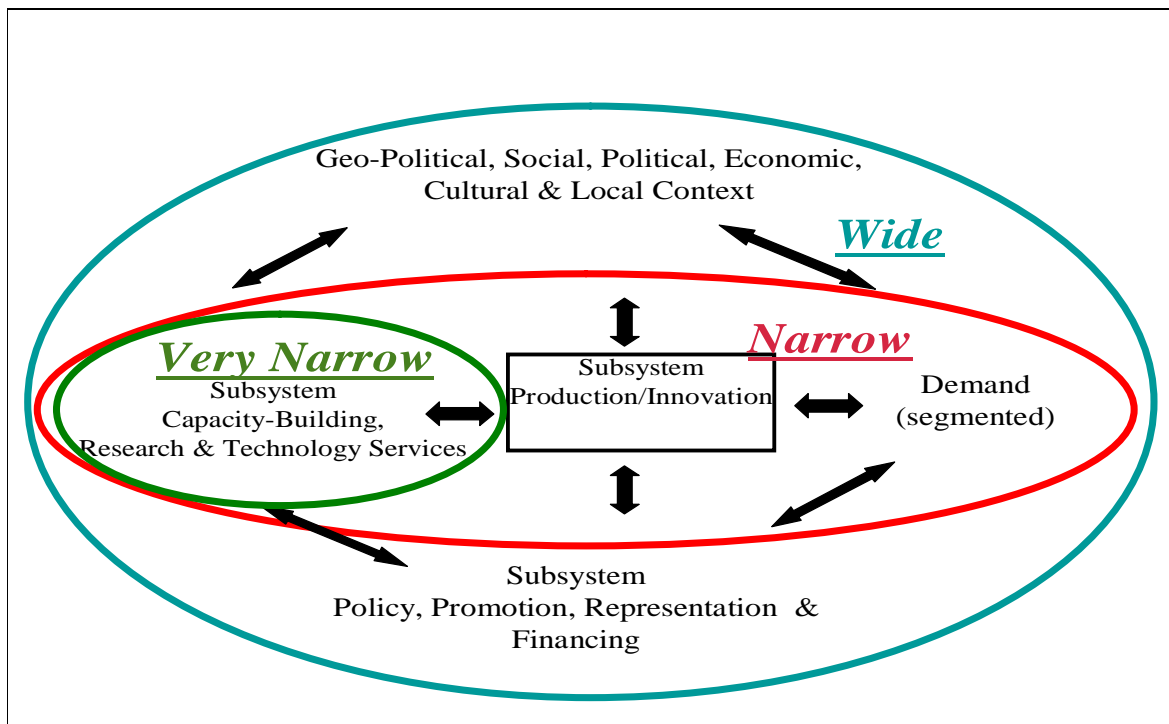
Some authors tend to focus on the innovation system in the narrow sense. In this vision, the NIS concept is a follow up to earlier analyses of national science systems and national technology policies.<sup>7</sup> To authors that follow this approach, the key issue is to map indicators of national specialization and performance regarding innovation, research and development - R&D - efforts and science and technology - S&T - organizations. The policy issues raised are typically related almost exclusively to explicit S&T policy focusing on

<sup>6</sup> See among others: Abrol, D. (2004). Dynamics of innovation systems amidst neo-liberal globalization: lessons from Índia. 2nd Globelics Conference, Beijing, China. Baskaran, A. and Muchie, M. (2003) Indian national system of innovation and globalization: some lessons for African national system of innovation. 1st. Globelics Conference, Rio de Janeiro, Brazil. Gu, S. Transformation and recombination learning in the NIS of China, paper presented at the 1<sup>st</sup>. Globelics Conference, Rio de Janeiro, Brazil, November, 3-6, 2003. López, A. and Lugones, G. (1999). Los sistemas locales em el cenário de la globalización. In J. E Cassiolato and H. M. M Lastres (Eds), *Globalização e inovação localizada: experiências de sistemas locais no Mercosul*. Brasília: MCT/IBICT. Katz, J. (2001). Structural reform and technological behaviour: the sources and nature of technological change in Latin America in the 1990s, *Research Policy*, 30, (1), 1-19.

<sup>7</sup> Nelson, R. (1993) *National Innovation Systems A Comparative Analysis* New York & Oxford: Oxford University Press; Mowery, D. & Oxley, J. (1995). Inward technology transfer and competitiveness: the role of national systems of innovation. *Cambridge Journal of Economics*, 19 (1), 67-93.

R&D. The analysis may include markets for knowledge – intellectual property rights and the venture capital aspects of financial markets, but hardly the broader set of institutions affecting the innovation system (such as macro-economic implicit policies for innovation and the financial system) and shaping competence building in the economy (such as education, training, industrial relations and labor market dynamics).<sup>8</sup>

**Figure 3: The broad, narrow and very narrow versions of a national system of innovation**



Although it brings important information regarding the national innovation system, the narrow version provides only an incomplete account of its structure and evolution. The broad approach is inclusive, incorporating the narrow dimension and going beyond it.<sup>9</sup> It takes into account the role of firms, education and research organizations, government (as a whole and not only in terms of science and technology policies), financing organizations, and other actors and elements that influence the acquisition, use and diffusion of innovations.

<sup>8</sup> Lundvall, B.-Å. (2006). National innovation system: analytical policy device and policy learning tool. Mimeo. Department of Business Studies, Aalborg University, Aalborg, Denmark..

<sup>9</sup> Freeman, C. (1987). *Technology policy and economic performance - lessons from Japan*. London: Frances Pinter; Lundvall, B.-Å. (1992). Introduction. In Lundvall, B.-Å. (Ed.), *National systems of innovation: towards a theory of innovation and interactive learning*. London: Pinter.

A broader and systemic understanding of the innovation process is instrumental to avoid an overemphasis on R&D, encouraging policy-makers to take a far-reaching perspective on the opportunities for learning and innovation. Emphasis is put on interactions and on the role of historical processes - which account for differences in socio-economic capabilities and for different development trajectories and institutional evolution - creating systems of innovation with very specific local features and dynamics. Therefore, the stress on the importance of the national character of systems of innovation.

One main argument here is that to explain economic performance it is necessary to consider how new technological systems come forward and how existing national patterns of institutions and organizations evolve. This co-evolution is shaped by history and the social, political and cultural dimensions that are specific to each reality.<sup>10</sup>

The idea of this analytical structure is to develop three complementary types of studies: country reports on the national innovation system of BRICS, sectoral/thematic papers on specific topics of BRICs national innovation systems and, finally, comparative papers.

The first type of study aims at characterizing the national innovation system of the five countries. Departing from the broad concept of national innovation system, the project will develop a common framework capable of depicting their differences and that allow the comparison of the NIS of BRICS.

Broad frameworks providing the basis for analyzing national innovation systems usually contemplate:

- micro, meso, macro structures of analyses<sup>11</sup>
- spatial and sectoral dimensions<sup>12</sup>

<sup>10</sup> In this line, both Freeman and Lundvall point out the limitation of quantitative analysis based on abstract models and call for a method that they characterize as 'reasoned history' (Freeman, C. (1982). *Technological infrastructure and international competitiveness* Draft paper submitted to the OECD *ad hoc* group on science, technology and competitiveness, Paris: OCDE; Lundvall, B.-Å. (2006). *National innovation system: analytical policy device and policy learning tool*. Mimeo. Department of Business Studies, Aalborg University, Aalborg, Denmark).

<sup>11</sup> See among others: Freeman, C. (1987). Lastres, H. M. M. *Advanced materials and the Japanese system of innovation*. London: Macmillan, 1994.

<sup>12</sup> Lundvall, B.-Å. (1992). *National systems of innovation: towards a theory of innovation and interactive learning*. London: Pinter. Katz, J. (1996) *National innovation systems in Latin America*. Mimeo. ECLAC. Freeman, C. (2003) *Innovation Systems: city-state, national, continental and sub-national*. In: Cassiolato, J. E.; Lastres, H. M. M.; Maciel, M. L. (Eds.) *Systems of innovation and development*. Cheltenham: Edward Elgar. Dutrénit, G. Garrido, C., Valenti, G. *Sistema Nacional de Innovación tecnológica*. Universidad Autónoma Metropolitana, México, 2001. Malerba, F (2004). *Sectoral Systems of Innovation: concepts, issues and analyses of six major sectors in Europe*. Cambridge. Boscherini, F.; López, M.; YogueL, G. *Sistemas locales de innovación y el desarrollo de la capacidad inovativa de las firmas*. In: *Globalização e inovação localizada - experiências de sistemas locais no Mercosul*. Brasília: IEL/IBICT, 1999. Lastres, H. M. M., Cassiolato, J. E. *Innovation Systems and Local Productive Arrangements: new strategies to promote the generation, acquisition and diffusion of knowledge*. *Innovation: Management, Policy & Practice*. Volume 7/2 – April 2005.

In this project the proposed structure to analyze BRICS National Systems of Innovation from a broader perspective will describe and study their sub-systems: production and innovation; capacity-building, research and technological services; policies, representation and financing; demand. Box 1 presents, in detail, this proposed structure.

**Box 1: Proposed structure to analyze BRICS National Systems of Innovation**

Sub-System: Production and Innovation

- Structure of economic activities
- Sectoral distribution
- Spatial distribution
- Employment
- Size
- Informality
- Innovative effort

Sub-System: Capacity-building, Research and Technological Services

- Education (basic, technical & graduation)
- Pos-graduation
- R & D
- Training & Capacity-building
- S&T Information
- Metrology
- Consulting
- Intellectual Property

Sub-System: Policies, Representation and Financing

- Explicit policies (S&T&I, industrial, sectoral)
- Implicit policies (macroeconomic, investment, trade, etc.)
- Regulation (sectoral, foreign trade, intellectual property, environment, innovation)
- Promotion
- Financing
- Representation

Demand

- Income distribution
- Structure of consumption
- Social organization
- Social demand (basic infra-structure, health, education)

Five country reports on the National Innovation Systems will be produced during the first twelve months of the project. These country reports should use the same analytical framework and follow the same structure in order for a comparative analysis to be made.

The methodological approach is as follows:

- 1 - Country coordinators will jointly define the analytical framework for the country reports (months 1 to 3);
- 2 – Terms of reference for the country reports will be written (months 4 to 5);
- 3 – Country reports will be written (months 6-11).

The second type of study aims at giving a more detailed view of the national innovation system of BRICS through horizontal and vertical studies: papers on themes that affect the performance of the national innovation systems will be combined with papers that analyze sectoral innovation systems of BRICS.<sup>13</sup>

The sectoral papers will deal with some important specificities of BRICS, namely the heterogeneity of industry (both intra and inter sectors), the heterogeneity of the demand (in regional terms and in income levels) and the diverse policy requirements. These characteristics bring important considerations to traditional sectoral analysis of innovation systems. The line of reasoning is that to capture such specificities the spatial dimension should be included in any sectoral examination of innovation systems.<sup>14</sup> The sectoral/local papers will concentrate in the investigation of: ownership and coordination structure and regime; the role of investment and innovation strategies and financing; interaction with knowledge organizations and other agents in the capacity-building and education subsystem; impact of government policies; level of commitment with local labor forces, agents and with local development, etc.. The main purpose is to get an understanding of how and why firms innovate differently in different national contexts despite belonging to the same sector and operating in a similar national context. Whenever it is possible common indicators will be searched for and used. We have to recall that collection of statistics on sectoral S,T&I varies significantly between these countries and all the information used will be subjected to a critical assessment.

The horizontal studies include topics that affect the national innovation systems of BRICS in general terms: different patterns of institutional organization, investment and financing of innovation and the impact of implicit and explicit policies. Emphasis should also be given to questions normally neglected such as those linked to patterns of social and regional

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<sup>13</sup> This part of the BRICS project has an important intersection with the PASTA project coordinated by Franco Malerba. The PASTA project is a comparative analysis of pharmaceuticals, agriculture, software, telecommunications and automobile innovation systems of developing countries. See Cassiolato, J., Britto, J., Guimarães, V. and Stallivieri, F. (2007), Sectoral system of innovation in the software industry: the Brazilian experience, paper presented in the PASTA Seminar, Bocconi University, Milan, May.

<sup>14</sup> This approach is being used by RedeSist in the analysis of more than 70 local innovation systems in Brazil. See Cassiolato, J. E., Lastres, H. M. M. and Maciel, M. L. (2003.), *Systems of innovation and development*. Cheltenham: Edward Elgar. Cassiolato, J. et al. (2007), for details.



inequality, the role of traditional knowledge and environment protection, the role of gender in the five NISs. Of particular relevance is the question of indicators of innovation. In fact one of the aims of the BRICS project is an attempt to find indicators that could better describe the innovative potential of these countries.

During previous meetings of the coordinating teams that have occurred in the last 12 months (see below) a preliminary list of sector/themes to be targeted by the project were proposed. Box 2 presents such a list from which five sectors/themes will be selected. For each of these five sectors/themes five papers will be commissioned, one for each BRICS. These papers should also provide the basis for a comparative analysis.

<b>Box 2 – Preliminary list of Themes/Sectors to be Studied by the BRICS Project Themes</b>	
1.	Innovation, finance and funding in the national system of innovation
2.	Transnational corporations and the national system of innovation
3.	Indicators of innovation
4.	The role of State and innovation policy
5.	The role of defence innovation in the national systems of innovation
6.	The role of SMEs in the national system of innovation
7.	Regional disparities in the national system of innovation
8.	Intellectual property rights and the national system of innovation
9.	Innovation, growth, inequality and sustainability in the BRICS
10.	University-industry relationships in the national system of innovation
11.	Human resources in the national system of innovation
12.	The evolution of BRICS collaboration in industry and innovation
13.	Gender in the national system of innovation
14.	National system of innovation in pharmaceuticals and health services
15.	National system of innovation in energy
16.	National system of innovation in agriculture and agro-industry
17.	National system of innovation in information and communications technologies
18.	National system of innovation in textile and apparel
19.	National system of innovation in creative (cultural) industries
20.	National system of innovation in biotechnology
21.	National system of innovation in the automobile industry
22.	National system of innovation in environmental services

The methodological approach to the vertical and horizontal studies is as follows:

- 1 – During the First Meeting of the Coordination Team the five sectors/themes will be chosen (months 4-5)
- 2 - Country coordinators will jointly define the analytical framework for the sectors/themes (S/T) papers (months 6 to 8);
- 3 – Terms of reference for the sectors/themes (S/T) papers will be written (months 7 to 9);
- 4 – Sectors/themes (S/T) papers will be written (months 10-14).

The third type of study refers to the comparative part of the project. Six papers comparing the National Innovation System (1 paper) and the sectors/themes (5 papers) will be produced. The methodological approach to the comparative part of the study is as follows:

- 1 - The five NSI reports and 25 terms of reference of the sectors/themes (S/T) will be presented and discussed on the International Seminar of the project (months 11-12).
- 2 - Country coordinators will jointly define the analytical framework for the comparative reports (months 13-14)
- 3 – Terms of reference for the comparative reports will be written (months 14 to 16);
- 4 – Comparative reports will be written (months 15-21).

The final part of the project will concentrate on writing the final report, organizing publication and diffusion of the findings. After all documents are finished a meeting of the coordinating committee will take place when innovation panels will be planned and the final report will be commissioned. The final report will contemplate an evaluation of the research effort and include a proposal for a subsequent phase of the project.

The diffusion and dissemination of results will occur mainly through innovation panels to be organized in all BRICS. Authors of the papers, policy makers and representatives of the civil society will participate in a one-day seminar where they jointly will discuss the policy proposals emanating from the studies.<sup>15</sup> Up to May 2007, there were three meetings of the coordinating team, aiming at gathering researchers and policy-makers interested in participating in this joint project, as well as identifying a common research agenda. The first Workshop took place in Aalborg in February 2006 ([www.globelics.org](http://www.globelics.org)). A second meeting took place during the Annual Globelics Conference of Trivandrum, Kerala, India in October 2006. As a follow-up, the Second Workshop of the BRICS Project took place in Rio de Janeiro, Brazil, from 25-27 April 2007. Among the participants of the workshop were researchers, government S,T&I officers from the five countries, a few invited scholars from the developed and developing world and guests from IDRC and the European Community ([www.redesist.ie.ufrj.br](http://www.redesist.ie.ufrj.br)).

It is envisaged that at least one book will be published with the results of the project. Edward Elgar has already been approached and is willing to publish material coming from

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<sup>15</sup> It is worth emphasizing that the Brazilian team has already a significant experience in establishing colloquiums of this kind. In the Second International Workshop of Rio de Janeiro there was an intense participation of policy-makers – including the Minister of Science and Technology, two Vice-ministers (Foreign Relations and Science and Technology), the President of the Brazilian Innovation Agency (Finep), the Technical Director of SEBRAE (the Brazilian Agency for Small and Medium Sized Firms), more than fifty policy-makers of different government organizations, senior officers of the Rio de Janeiro Industrial Association and representatives of labour movements. Also, RedeSist has been working for ten years in close contact with Brazilian government agencies (such as the Brazilian Innovation Agency, the National Development Bank and the Brazilian Agency for Small and Medium Sized Firms) and has organized yearly workshops with policy makers, entrepreneurs and representatives of the civil society to discuss policy proposals emanating from the studies it conducts.

Globelics and the BRICS project. It is also the intention of the coordination team to approach scientific magazines for publication of the sectoral/thematic papers.<sup>16</sup>

It is worth pointing out that the Brazilian team, which coordinates this proposal, is being supported by FINEP – the Brazilian Innovation Agency of the Ministry of S&T and the Technology and Innovation Secretariat of the Ministry of Science and Technology. This support begun in 2006, will last for two more years and targets the elaboration of studies of different aspects of the Brazilian innovation system. This support will also be used for funding of the Russian component of the project that can not be supported by IDRC.

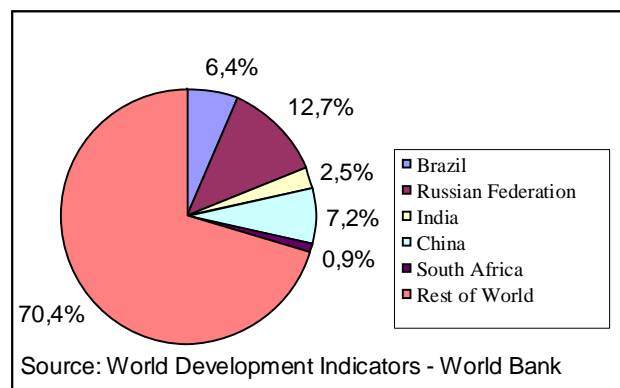
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<sup>16</sup> Among these scientific journals one can mention Research Policy, Journal of Evolutionary Economics, Industry and innovation, International Journal of Technology Management, among others international and national publications.

**Annex 1 BRICS’ territorial and population dimensions: richness of natural and cultural resources**

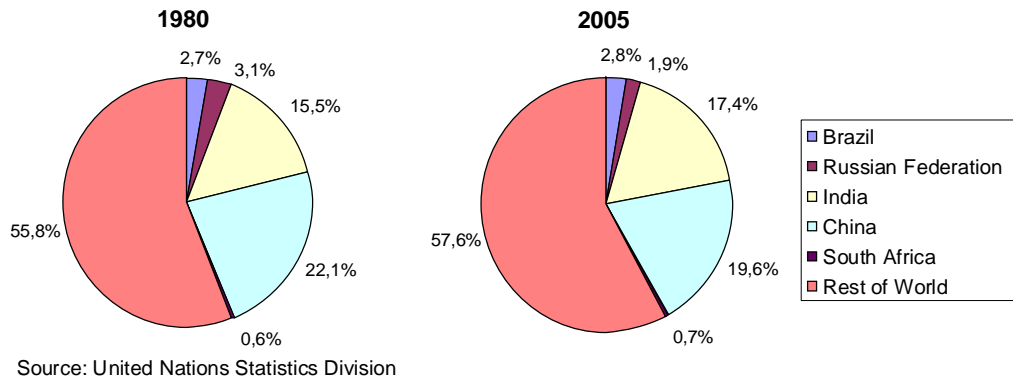
BRICS represent, approximately 30% of the world surface (Figure 4). The relevance of the vast territorial extension relates to the existence of mineral, hydro and energy resources, fertile land for agriculture and biodiversity. In fact, all five countries have developed activities in these areas with different degrees of intensity and success. The weight of agricultural, extraction and transformation activities geared towards mineral and energetic resources of BRICS can be observed in their role in the world commodity trade and in the evolution of their manufacturing activities in basic sectors. Perhaps even more important is that their rich biodiversity represents a crucial opportunity for the development of dynamic industries such as pharmaceuticals and biotechnology.

**Figure 4: Share of BRICS in the world surface - 2002**



The participation of BRICS population in the world population is still more strategic and significant than their territorial share. As it may be gathered from Figure 5, this participation was maintained around 43% of the world population between 1980 e 2005. China has her share reduced from 22,1% in 1980 to 19.6% in 2005. However, with the exception of Russia, the share of the other countries increased, both in absolute and relative terms. The most significant increase was of the Indian population, which represented 17.4% of the world population in 2005.

**Figure 5: Share of BRICS population the World’s population 1980-2005**



The large population represents both a threat and an opportunity. Challenges that are frequently associated to large populations are related to the supply of water, food and energy, as in the systems of health, housing, water treatment and education. Other problems are unemployment and high levels of inequality. These difficulties, common to BRICS that have a large share of their population excluded from accessing essential goods and services, require an urgent solution. Attempts to deal with them already being implemented in the five countries are very rich and could be evaluated in a comparative study. The result of such analysis may benefit all these countries and also other less developed countries. One could not ignore that the possibility of incorporating marginalized citizens, workers and consumers always represent an important perspective of socio-economic development for these countries.

Data gathered by UN show that Brazil and South Africa are among those countries with the worst income distribution and put India and Russia as those with the highest share of population below the poverty line among BRICS. Problems related to the perverse income distribution and to the low levels of access to qualified jobs and services such as education, health, housing, urban infra-structure, social security, etc., are reflected in the low index of human development.

Wide regional disparities of human and economic development are present in all five countries. A regional redistribution of income and access to basic goods and services is a significant challenge to these five countries. Hence the relevance of evaluating and comparing accumulated experiences, particularly those in which the incorporation of marginalized areas and regions is treated in a perspective of sustainable development, regarding social and environmental impacts. The opportunities that may result from this action are significant not only from a purely economic point o view, but more important from social, political and cultural concerns.

It is also worth pointing out that large territories and populations also incorporate a vast ethnical diversity. The strong and embedded cultural heritage represents an important intangible resource for these countries. This inheritance of traditional knowledge coupled with a variety of cultural manifestations has a significant influence in their present and future socio-economic development. This is a less known area, with scarce available information. However, pioneering studies confirm their potential for the BRICS Innovation Systems (IS). Again, the consequences of this effort for other LDCs are to be highlighted.