UNIVERSIDADE FEDERAL DE MINAS GERAIS
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CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL

TEXTO PARA DISCUSSÃO Nº 156

LESS-DEVELOPED COUNTRIES AND INNOVATION IN HEALTH: NOTES AND DATA ABOUT THE BRAZILIAN CASE

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CEDEPLAR/FACE/UFMG
BELO HORIZONTE
2001

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ABSTRACT

This communication discusses the specificity of health innovation in a less-developed country, investigating the Brazilian case.

To evaluate the specificity of the Brazilian system, this communication presents data about employment, expenditures, industrial firms in health-related industrial sectors, scientific resources, and diffusion of medical equipment.

This communication concludes summarising the main characteristics of the Health Innovation System in Brazil.

RÉSUMÉ

Cette communication discute la spécificité de l'innovation dans le domaine de la santé aux pays moins developpés à travers de une investigation du cas brésilien.

Pour montrer la spécificité du système brésilien, cette communication presente des informations sur l'emploi, les dépenses, les firmes industrielles du secteur industriel de la santé, les ressources scientifiques et la diffusion du équipement médical.

En conclusion la communication fait un résumé des principales caractéristiques du système d'innovation de la santé au Brésil.

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I- INTRODUCTION

This communication discusses the specificity of health innovation in a less-developed country, investigating the Brazilian case.

According to the World Bank (1999) income ranking, Brazil is classified as a country with upper middle income (8^{th} GNP and 72^{nd} GNP per capita). According to the World Health Organisation (2000), Brazil is classified as the 125^{th} country in terms of overall health system performance.

This communication presents an initial investigation about the Brazilian health innovation system. This sectoral system of innovation is an intersection between the welfare system and the innovation system (Albuquerque & Cassiolato, 2000). In the Brazilian case there is an overlapping of an uneven and incomplete welfare system (WHO, 2000) and an immature system of innovation (Albuquerque, 1999).

The objective of this communication is to evaluate the Brazilian health innovation system using data and statistical information recently collected.

II- THE SPECIFICITY OF THE HEALTH INNOVATION SYSTEM IN DEVELOPED COUNTRIES

The theoretical possibility of division of a National System of Innovation (NSI) into its constitutive sectors (Breschi & Malerba, 1997) introduces the investigation about the Health Innovation System.

Rosenberg, Gelijns & Dawkins (1995) and Hicks & Katz (1996) are studies that introduced this line of research, and provided the main points of this section.

The Health Innovation System, in countries like United States (with a mature system of innovation), has distinctive features vis-à-vis others sectoral subsystems of innovation.

A survey of the literature points seven key distinctive characteristics of a Health Innovation System.

First, there is the close intertwining of science and technology in medical technology. Nelson (1995, p. 220) evaluates that “the advent of modern biotechnology certainly has exacerbated the intertwining problem, but the intertwining has been there for a long time”. Klevorick et alli (1995) indicate that the health-related industrial sectors are highly “science-based”.

Second, the interdisciplinary nature of the research that supports medical innovation. Gelijns & Rosenberg (1995, p. 4) put forward that “the successful development of a particular technology frequently requires close co-operation among a growing number of individuals with diverse but relevant professional backgrounds. In the case of pharmaceutics and biology, for example, the development of a drug may require co-operation among organic chemists, molecular biologists, immunologists, material scientists, toxicologists, chemical engineers, clinicians and so on. In the case of medical devices, the interdisciplinary nature of innovation appears even more obvious”.

Third, the strong involvement of the public sector in financing research in the health sector (Bond & Glynn, 1995).

Fourth, the relevance of interactions between health sector’s firms and institutions, specially for medical device innovation. Gelijns & Rosenberg (1995, p. 5) show the role of the “crossing of institutional boundaries”, concluding that “medical innovation depends heavily on interactions between universities, particularly academic medical centres, and industrial firms”.

Fifth, the strong user-producer links for innovation and improvements in the health sector. Hospitals and physicians play key roles in these user-producer interactions (for example, Spetz, 1995).

Sixth, there are several patterns of technological progress within the health sector. These patterns differentiate sectors strongly dependent upon university research (biotechnology) from sectors dependent upon interactions among different industries and health professionals (medical device).

Finally, the health sector may be seen as an intersection between the innovation system and the welfare system. Hospitals, for example, might be simultaneously part of the welfare system and part of the innovation system (Hicks & Katz, 1996). This distinctive feature is very important, as it indicates how innovations and improvements in the health sector may have significant impacts upon the people’s welfare.

Figure I summarises the Health Innovation System’s institutions and the interactions among them.

This summary about the Health Innovation System in developed countries presents a benchmark for the investigation of the health sector in less-developed countries.

III- INSTITUTIONS AND DATA ABOUT THE BRAZILIAN HEALTH SYSTEM OF INNOVATION

The main features of the Brazilian Health Innovation System reflect the immaturity of the Brazilian NSI. On the one hand, the weaknesses of the Brazilian NSI might impair the evolution of the Health Innovation System. But, on the other hand, probably, there might be room for sectoral industrial and public policies taking advantage of "windows of opportunity".

This communication suggests that the Brazilian Health Innovation System is less articulated than the system displayed at Figure I. There are four reasons for this.

First, the institutions of the Brazilian Health Innovation System are not as developed or strong as in developed countries.

Second, it lacks firms in health-related industrial sectors, or the established firms in these sectors are not dynamic and innovative.

Third, the interactions among firms, institutions and physicians are not as developed as in mature NSIs.

Fourth, as an intermediate system of innovation, there are potentialities to be exploited.

This sections is divided into five subsections, investigating each of the constitutive dimensions of the Brazilian Health Innovation System, using available statistical data.

III.1- HEALTH SECTOR: GENERAL DATA, PROFESSIONALS AND EXPENDITURES

According to the World Bank (1993), Brazilian expenditures with health are 4,2% of GDP. Table I shows data for developed countries (United States tops the list with 13,3% of GDP) and Brazil. The public sector involvement with health expenditures (33,3%) is similar to the average of countries with high "index of human development" (PNUD, 1996).

The size of the Brazilian health sector (measured by formal employees), according to Girardi (1998) is shown in Table II. Girardi defines the "health macro-sector" aggregating employees from all health-related activities: industrial sectors of pharmaceutics and medical devices, the commercialisation of these products (wholesale and retail trade), health insurance, sanitation, services of medical and health care, health professionals in education and R&D, and health professionals in other activities. Table

II shows that the health sector has 2,457,969 formal employees (10.31% of formal jobs in the Brazilian economy). The health services alone have 1,779,178 formal employees (7.47% of formal jobs).

These professionals are unevenly distributed. For example, the state of São Paulo has 3.5 physicians per 1,000 inhabitants, while the state of Amazonas has only 1.3 physicians per 1,000 inhabitants (IBGE, 2000a). This inequality of resources and access can be found also at local level: certainly, the richest strata have more access to high quality services than the poorest strata.

Table III indicates the role public and private sectors in the provision of medical care. The public sector, through the *Sistema Único de Saúde* (SUS) provides universal coverage. It is important to stress that SUS provides both simple services for the poor and high-quality and complex medical procedures for poor and rich citizens. Table IV shows how the public sector (state and universities) delivers 60% of ambulatory services (expenditures as a proxy) and 39% of hospital services.

Finally, Table V shows the epidemiological profile of Latin American and Caribbean countries vis-à-vis developed and Sub-Saharian countries (World Bank, 1993).[1] The Brazilian epidemiological profile is similar to the Latin American and Caribbean countries, possibly with a greater share of non-communicable diseases and a smaller share of communicable diseases than Latin American and Caribbean countries. Brazil has a distinctive feature in this regard, as it mixes characteristics shared with more developed countries (the importance of non-communicable diseases) and characteristics shared with less-developed countries (the persistence of communicable diseases).

This uneven epidemiological profile presents specific demands for the health innovation system.

III.2- INDUSTRIAL FIRMS OF THE HEALTH SECTOR AND THEIR INNOVATIVE ACTIVITIES

III.2.a- GENERAL DATA: EMPLOYMENT, REVENUES

Table VI shows data for pharmaceutical products and medical and dentistry devices.

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[1] The data for Brazil is not available.

The pharmaceutical sector (three-digit classification) has 715 firms (out of 107,764 manufacturing firms – 0.7%), produces 2.6% of the industrial product, and employs 1.6% of the industrial employment (IBGE, 2000b). This sector is less concentrated than the Brazilian high-tech industry average: the concentration ratio (CR) for the four leading firms (CR4) is 21.0%, and the CR12 is 41.7%, while the figure for the Brazilian high-tech industry is CR4 = 62.6%. The mark-up (ratio between net revenues and direct costs) is 2.5 (one of the highest in the Brazilian manufacturing, which has the average value of 1.7). The leading firms are shown in Table VII. It is important to highlight the role of foreign-owned firms in this list.

The medical and dentistry devices industry has 497 firms (0.5%), with 0.2% of industrial product, 0.2% of manufacturing net revenue and 0.4% of employment. The CR4 is 31.2%, and the CR12 is 47.3%. The mark-up is also high: 2.3. The leading firms are at Table VIII.

III.2.b- R&D EXPENDITURES

There are no reliable figures for R&D private expenditures in the Brazilian industry (this year the IBGE is programming a special inquiry about industrial R&D). Estimates from the Ministry of Science and Technology indicates that the private sector has 20 to 30% of the country's R&D. The literature reports little commitment of the private sector with innovative efforts (Matesco, 1994).

The literature reports the leading role of the pharmaceutical sector in R&D investments in developed countries (Scherer & Ross, 1990). However, in Brazil, according to an Industrial Census (IBGE, 1985), the pharmaceutical sector invested in R&D less than the national (low) average: 0.43% and 0.53%, respectively, of net revenues. More recent data from ANPEI (Andreassi, 1997) show that the pharmaceutical firms invest less than the national average in R&D.

Data from ANPEI show that the medical device industry invests 5,5% of its sales in R&D.

III.2.c- EVALUATING THE INTERNALISATION OF TECHNOLOGICAL ACTIVITIES BY TRANSNATIONAL CORPORATIONS

Given the importance of foreign-owned firms in health-related industries, this subsection presents a tentative analysis of the contributions of transnational corporations for local innovative activities.

Biazzi & Albuquerque (2001) use patent statistics to calculate an index of "relative internalisation of technological activities" (RITA). The steps to calculate this index are as follows.

Using data provided by the INPI, a database is organized, with 57,640 resident patents and 54,480 non-resident patents applied between 1988 and 1996. This new database provides a comparison between non-resident patents applied by one transnational headquarters and the resident patents applied by its subsidiaries. The unity of analysis is the transnational corporation. A few steps are necessary for this comparison. First, information provided by the *Guia Interinvest 1998* enables the identification of the link between a transnational and its subsidiaries. Second, the database is searched to gather the non-resident patents applied by the headquarters and the resident patents applied by their subsidiaries. Third, the index RITA is calculated, dividing the subsidiaries' resident patents by the transnational's non-resident patents.

The intuition behind this index has two-side(s). On one hand, the index RITA captures both the relevance of the Brazilian market for the multinational and its technological capability. If a multinational firm considers the Brazilian market important and if this multinational has a huge technological capability (with a big patent portfolio), it is supposed that this corporation applies a great number of non-resident patents at the INPI. On the other hand, if the subsidiaries perform significant technological activities in the host country, it has a significant number of resident patents.

Therefore, this index compares two magnitudes and permits a comparative analysis: the resident patents of the subsidiaries indicate the technological effort made in the host country, and the non-resident patents indicate the potential contribution of the transnational to the host country. The RITA index, comparing the two magnitudes, hints whether or not the transnational is internalising all its potential technological capability. The relative dimension of this index must be stressed.

Investigating the technological activities of the 500 biggest global corporations (*Fortune 500*, 1998) and of the 100 most transnationalised corporations (UNCTAD, 1998), the RITA index for the firms operating in Brazil (respectively 152 and 69 global corporations with non-resident patents applied in the INPI) was 0.064 and 0.072 (Albuquerque, 2000b). These findings, at the firm level, are compatible with the overall figures for resident and non-resident patents (WIPO, 1999): the non-developed

economies show a greater disparity between these two data sets, contrasting with more even figures for the developed countries.

Table IX shows the values of RITA for 27 sectors (according to Fortune's 500 classification). The RITA index for the pharmaceutical sector (0.01215) is less than the national average for non-financial firms (0.064). These figures suggest that the actual contribution of transnational corporations of the pharmaceutical sector is less than their potential contribution (measured by their non-resident patents).

III.2.d- SCIENTIFIC RESOURCES

Brazil produced in 1994 0.74% of the world scientific papers (according to the *Institute for Scientific Information*) and 0.06% of the patents granted by the USPTO. This imbalance suggests that the productive sector is wasting opportunities created by the existing scientific infrastructure. This waste of opportunities is a common characteristic of other immature systems of innovation (Albuquerque, 1999).

Table X shows the distribution of researchers by scientific areas, according to the *Conselho Nacional de Pesquisa* (CNPq). These preliminary data refer to researchers mainly in universities and research institutes. Health Sciences rank first among the scientific areas, with 7,044 researchers out of 41,387. Adding the 5,565 researchers in Biological Sciences, the health-related disciplines have 30.47% of the Brazilian researchers.

Table XI shows the distribution of scientific papers produced by Brazilian scientists according to their scientific areas. This table indicates the relative specialisation of Brazilian science vis-à-vis the World's averages. In Clinical Medicine, the Brazilian share is less than the World share (respectively 22.9% and 30.7%, for 1995). In Biomedical research (18.0%) and in Biology (9.6%) the Brazilian shares are slightly bigger than the World share for these disciplines (respectively 16.4% and 8.0%, for 1995).

Table XII shows data, at a more desaggregated level, of scientific disciplines with more than 0.98% of the World papers. Agricultural sciences, Physics and Astrophysics top the list, but there are several disciplines health-related: Microbiology (1.16%), Molecular Biology (1.15%), Biology and Biochemistry (1.14%), Animal Science and Plants (1.11%), Immunology (1.01%), and Pharmacology (0.99%).

Table XIII shows data, at an even more desaggregated level, of scientific subdisciplines with more than 0.74% of the World papers. Six subdisciplines of Clinical Medicine and three of Biomedical Research reach this share.

These data suggest that the Brazilian scientific infrastructure has a relative specialisation in disciplines health-related. This relative specialisation could be useful for the maturing of the Brazilian Health Innovation System.

This scientific infrastructure has a double role to play.

First, it is key for the "absorptive capability" of the innovation system. Recent achievements like the sequencing of the *Xylella fastidiosa* gene indicates that the Brazilian scientific community in the Health sector is able to be up-to-date with the international community (Nature, 2000). This achievement is very important for future developments in Biotechnological fields, that might spill-over towards industrial firms.

Second, local capabilities are necessary for the research of diseases that are not top priority in the agenda of developed countries' firms and institutions: Chagas disease, leishmaniasis, etc.

It seems that the Brazilian scientific infrastructure in health-related disciplines can play this double role.

III.2.e- DIFFUSION OF MEDICAL INNOVATION THROUGHOUT THE HEALTH SECTOR

According to Pan-American Health Organisation (PAHO, 1998) Brazil represents 1.7% of the World consumption of medical and hospital equipment (US$ 2.0 billion).

PAHO (1998) estimates that resident firms supply 60% of this equipment. The role of imports is important, specially for more complex and high-tech equipment. A case-study of one philanthropic hospital (Santa Casa of Belo Horizonte) shows the relevance of imports from companies like Hewlett Packard (monitoring systems, pressure transducers, echocardiographs), Dräger (anaesthetic equipment), Siemens (X-rays) etc (Albuquerque & Cassiolato, 2000).

The diffusion of high-tech innovations generated abroad seems to be fast. According to the IBGE (2000a), in 1999 Brazil had 1,555 computed tomography (CT) scanners, and 289 magnetic resonance imaging (MRI) devices. The pattern of distribution of these resources are uneven: São Paulo has 1.47 CT scanners per 100,000 inhabitants, while Amazonas has 0.3 CT scanners per 100,000 inhabitants.

III.3- INITIAL EVALUATION OF THE DATA PRESENTED

Taking as reference Figure I, the data presented in this section suggest that Brazil has all components of a Health Innovation System. However, these components are not completely developed (few firms in health-related sectors, medical care institutions with limitations, health expenditures are less than the developed countries' average etc). This incomplete development of the main components of a Health Innovation System determines an additional problem with the interactions and technological flows throughout the system. Furthermore, weak interactions impair the dynamics of positive feedbacks among the institutions of the system.

But, it should be kept in mind, there are "islands of efficiency and welfare" within the Brazilian Health Innovation System. This is a problem (social inequalities and their consequences) but could be a promise, as the more advanced components/regions would pull the less advanced ones.

IV- CONCLUSION: THE MAIN CHARACTERISTICS OF THE HEALTH INNOVATION SYSTEM IN BRAZIL

This communication presents initial results from an ongoing research. The data gathered indicates few distinctive and special characteristics of the present state of development of the Brazilian Health Innovation System:

a) less resources (public and private) devoted to health R&D vis-à-vis the developed countries;
b) lack of dynamic and innovative local firms in the industries related to the health systems;
c) strong presence of transnational corporations in the medical device and pharmaceutical industries, and a weak commitment of their subsidiaries with local R&D;
d) the important role of imports of medical equipment;
e) a passive and unorganised absorption of new technologies from abroad, resulting in a waste of resources from the health system;
f) an important initial accumulation of scientific resources in the health-related disciplines, that could be useful to improve the absorptive capability of the Brazilian system;

g) the scientific infrastructure available could be better used by the productive sector, as a source of public knowledge that supports innovation;
h) weakness in the interactions among the scientific infrastructure, the firms and the health system;
i) weakness of the regulatory institutions;
j) the resources accumulated by the scientific infrastructure might be important for taking advantage of "windows of opportunity" in the sector and for the institutional building leading to an active and organised process of technological transfer from abroad.

These points are a starting point. They summarise few major differences between the dynamics of innovation in health in developed countries, as described by the literature (Rosenberg et alli, 1995; Weisbrod, 1991; Hicks & Katz, 1996), and in less-developed countries, taking the Brazilian case as an example.

Given the huge welfare impacts of improvements in the health innovation system, its formation and development should be a top priority for policy makers.

V- REFERENCES

ALBUQUERQUE, E. (1999) National systems of innovation and non-OECD countries: notes about a tentative typology. *Revista de Economia Política*, v. 19, n. 4, pp. 35-52.

ALBUQUERQUE, E.; CASSIOLATO, J. E. (2000) *As especificidades do sistema de inovação do setor saúde*: uma resenha da literatura como introdução a uma discussão sobre o caso brasileiro. São Paulo: FeSBE (Estudos FeSBE I).

ANDREASSI, T. (1997) *Expenditures in technological innovation*: a study in Brazilian companies. Brighton: SPRU (mimeo).

BIAZZI, E.; ALBUQUERQUE, E. (2001) *Transnational corporations and patenting activities*: data description and statistical tests about the relative internalisation of technological activities. DRUID Academy Winter Conference, January 18-20, 2001, Copenhagen, Denmark (www.business.auc.dk/druid/conference/winter2001)

BOND, E.; GLYNN, S. (1995) Recent trends in support for biomedical research and development. In: ROSENBERG, N.; GELIJNS, A.; DAWKINS, H. *Sources of medical technology*: universities and industry (Medical innovation at the crossroads, v. 5). Washington: National Academy.

BRESCHI, S.; MALERBA, F. (1997) Sectoral innovation systems: technological regimes, schumpeterian dynamics, and spatial boundaries. In: EDQUIST, C. (ed.). *Systems of Innovation*: technologies, institutions and organizations. London: Pinter, pp. 130-156.

GELIJNS, A.; ROSENBERG, N. (1995) The changing nature of medical technology development. In: ROSENBERG, N.; GELIJNS, A.; DAWKINS, H. *Sources of*

medical technology: universities and industry (Medical innovation at the crossroads, v. 5). Washington: National Academy.

GIRARDI, S. (1999) Aspectos do(s) Mercado(s) deTrabalho em Saúde no Brasil-Estrutura, Dinâmica, Conexões: NESCON-UFMG: Belo Horizonte

HICKS, D.; KATZ, J. (1996) Hospitals: the hidden research system. *Science and Public Policy*, v. 23, n. 5, pp. 297-304, Oct.

IBGE (2000a) *Estatísticas da Saúde*: Assistência Médico-sanitária. Rio de Janeiro: IBGE.

IBGE (2000b) *Pesquisa Industrial Anual* Rio de Janeiro: IBGE.

KLEVORICK, A.; LEVIN, R.; NELSON, R.; WINTER, S (1995). On the sources and significance of inter-industry differences in technological opportunities. *Research Policy*, v. 24, p. 185-205.

MURRAY, C. J. (ed.); LOPEZ, A. (1996) *The global burden of disease* : a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected. Harvard: Harvard School of Public Health.

NATIONAL SCIENCE FOUNDATION (1998). *Science and Engineering Indicators 1998*. Washington: National Science Foundation. (http://www.nsf.gov)

NATURE (2000) n. 1792, 13/07/2000, www.nature.com.

NELSON, R. (1995) The intertwining of public and proprietary in medical technology. In: ROSENBERG, N.; GELIJNS, A.; DAWKINS, H. *Sources of medical technology*: universities and industry (Medical innovation at the crossroads, v. 5). Washington: National Academy.

PAN-AMERICAN HEALTH ORGANIZATION (1998) *Health in the Americas*. (http://www.paho.org)

PNUD (1996) *Relatório do desenvolvimento humano*. Lisboa: Tricontinental.

ROSENBERG, N.; GELIJNS, A.; DAWKINS, H. (1995) *Sources of medical technology*: universities and industry (Medical innovation at the crossroads, v. 5). Washington: National Academy.

WEISBROD, B. (1991) The health care quadrilemma: an essay on technological change, insurance, quality of care, and cost containment. *Journal of Economic Literature*, v. 29, n. 2, pp. 523-552.

WORLD BANK (1993) *World Development Report 1993*: Investing in Health. Oxford: Oxford University.

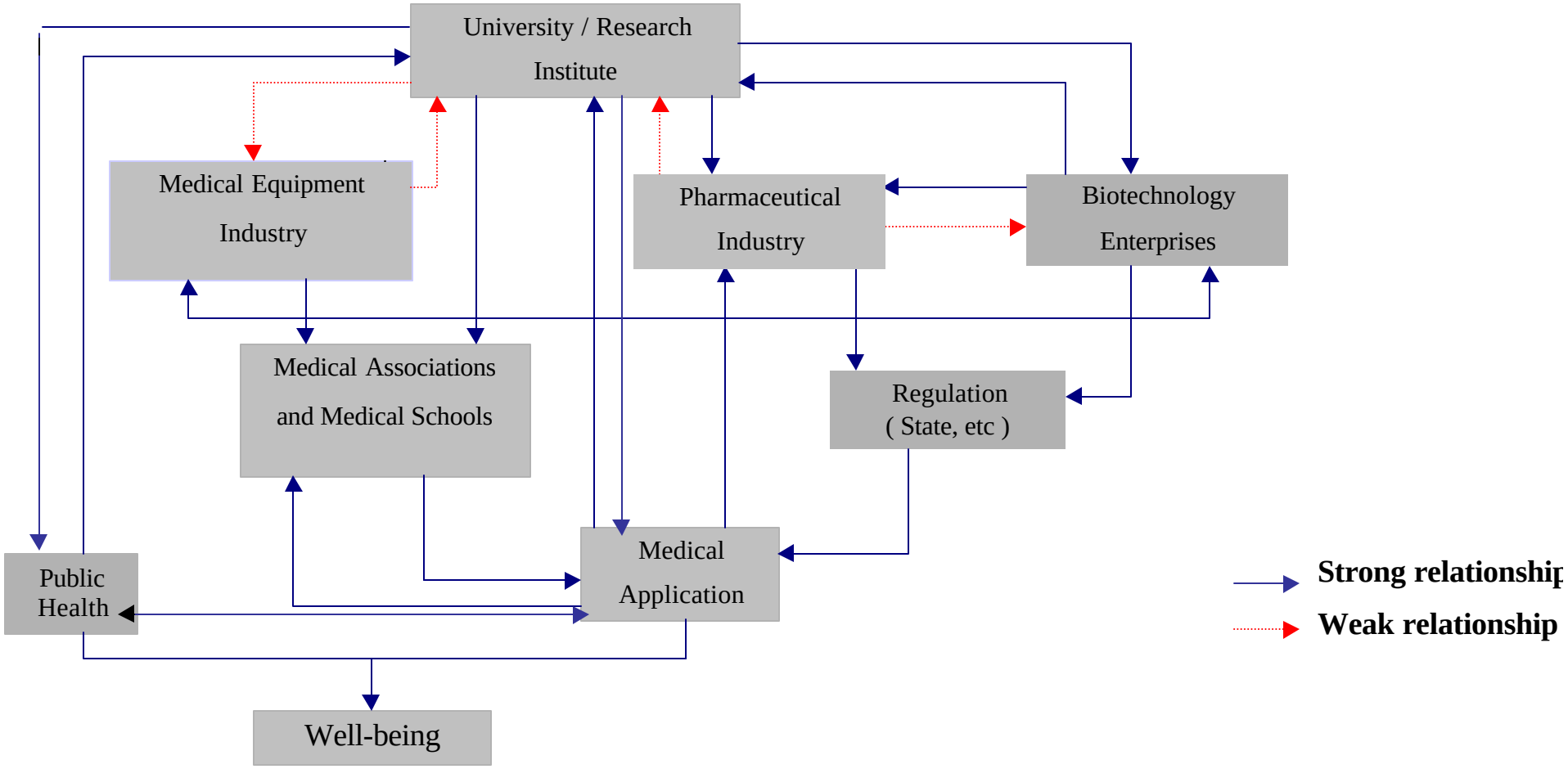
WORLD BANK (2000) *World Development Report 1999-2000*: Entering the 21st Century. Oxford: Oxford University.

WORLD HEALTH ORGANIZATION (2000) *The World Health Report:* Health systems: improving performance. Geneva: WHO (http://www.who.org).

FIGURE I

FLUX TECHNOLOGIQUE ET SCIENTIFIQUE DU SYSTÈME D'INNOVATION DU SECTEUR DE LA SANTÉ:

LE CAS DES PAYS DEVELOPPÉS



SOURCE: élaboration de l'auteur, Cordeiro (1980) e Gelijns & Rosenberg (1995)

TABLE I

EXPENDITURE ON HEALTH,
RELATIVE PARTICIPATION OF PRIVATE AND PUBLIC SECTOR

PAYMENTS	TOTAL EXPENDITURE (% of GNP)	PRIVATE EXPENDITURE (% of total expenditure)	PUBLIC EXPENDITURE (% of GNP)
United States	13,3	56,1	5,84
Canada	9,9	27,8	7,15
Sweden	8,8	22,0	6,87
United Kingdom	6,6	16,7	5,49
Germany	9,1	12,3	7,98
France	9,1	26,1	6,72
Netherlands	8,7	26,9	6,35
Averange for countries with high l'IDH	6,0	34,4	3,94
Brazil	4,2 (*)	33,3 (*)	2,80

SOURCE: PNUD (1996), (*) World Bank (1993)

TABLE II

MACRO-SECTEUR DE LA SANTÉ AU BRÉSIL (31/12/97)

NUMÉRO D'ÉTABLISSEMENTS ET EMPLOIS

DANS DES SECTEURS D'ACTIVITÉS SÉLECTIONNÉS EN LE

	Number of establishments	Number of employs	%
Health services		1.779.178	7,47
Privates		979.319	4,11
Publics	Not available	799.859	3,36
Health macro-sector	142.709	2.457.969	10,31
Education	32.968		3,57
Service sector	629.973	91.956	31,18
Public Administration	12.955	5.452.215	22,88
Total	1.844.388	23.830.312	100,00

* This macro-sector is composed of industrial activities that produce medicaments, pharmaco-quemicals, medical and surgical equipments and instruments; activities of negotiating this products; health social securty, activities of public sanitation, health professional on educational activities, R&D and health professionals on others activities.

Source: Rais-Caged, Girardi (1998, p. 8)

TABLE III

BRAZILIAN HEALTH SYSTEM: NUMBER OF INDIVIDUAL THAT UTILIZED THE HEALTH SERVICES ACCORDING TO THE TYPE OF SYSTEM AND PROVIDER. (1998)

SYSTEM	PROVIDER	NUMBER OF INDIVIDUALS (millions)	PARTICIPATION (%)
Public	SUS	115,0	73,7
Private	Personal assurance	9,0	5,8
	Cooperatives	10,0	6,4
	Group medicine	17,3	11,1
	Health social security	4,7	3,0
TOTAL		156,0	100,0

SOURCE: Gazeta Mercantil (18/05/1998)

TABLE IV

AMBULATORIAL AND HOSPITAL EXPENDITURES OF SUS ACCORDING TO THE NATURE OF PROVIDER (1996)

Nature	Ambulatorial expenditures (%)	Hospital expenditures (%)
Public	50	15
Universital	10	24
Private philanthropic	17	25
Private lucrative	23	36
Total	100	100

SOURCE: Oliveira Jr. (1998, p.73)

TABLE V

DISTRIBUTION OF LOST AVAI BY CAUSE AND DEMOGRAPHIC REGION (1990)

CAUSE	LATIN AMERICA AND CARIBE	SUB-SAHARIAN AFRICA	DEVELPED ECONOMIES	WORLD
Population (millions)	444	510	798	5267
Communicable diseases	42,2	71,3	9,7	45,8
Tuberculosis	2,5	4,7	0,2	3,4
Sexual diseases et HIV	6,6	8,8	3,4	3,8
Diarrhoea	5,7	10,4	0,3	7,3
Child infections with possible immunisation	1,6	9,6	0,1	5,0
Malaria	0,4	10,8	-	2,6
Worm diseases	2,5	1,8	-	1,8
Respiratory infections	6,2	10,8	2,6	9,0
Maternal causes	1,7	2,7	0,6	2,2
Perinatal causes	9,1	7,1	2,2	7,3
Others	5,8	4,6	0,5	3,5
Non-communicable diseases	42,8	19,4	78,4	42,2
Cancer	5,2	1,5	19,1	5,8
Nutricional deficiencies	4,6	2,8	1,7	3,9
Neuro-psychiatric diseases	8,0	3,3	15,0	6,8
Brain stroke	2,6	1,5	5,3	3,2
Cardiac ischmia	2,7	0,4	10,0	3,1
Pulmonary obstruction	0,7	0,2	1,7	1,3
Others	19,1	9,7	25,6	18,0
Traumas	15,0	9,3	11,9	11,9
Cars accidents	5,7	1,3	3,5	2,3
Intentional	4,3	4,2	4,0	3,7
others	5,0	3,9	4,3	5,9
Total	100,0	100,0	100,0	100,0
Millions of AVAI	103	293	94	1362
Equivalent in child mortality (millions)	3,2	9,0	2,9	42,0
AVAI per thousands of inhabitants	233	575	117	259

Note: -, less than 0,05%

SOURCE: World Bank, 1993

TABLE VI

Relation between health-related industries (pharmaceutical and medical devices) and the Brazilian industry (1997)

Group of activity	Number of enterprises		Gross value of the industrial production (in thousands of reais)		Liquid sales revenue (in thousands of reais)		Employees	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Pharmaceutical products	715	0,007	9711009	0,026	10183945	0,026	79444	0,016
Production of medical, hospital, odontologic, laboratory and orthopedic equipment and instruments	497	0,005	715305	0,002	811875	0,002	17761	0,004
Total of industry	106.764		376.390.361		397.561.091		5.007.653	

Source: IBGE annual industrial report –1997

TABLE VII

The 10 major entreprises of pharmaceutical industry in Brazil in 1998.

	Entreprises	Amount of deal (in thousands of reais)
1	Novartis	951.766
2	Schering	598.928
3	Roche	501.788
4	Bristol Myers Squibb	479.098
5	Aché	415.273
6	Wyeth Whitehall	310.654
7	Boehringer Ingelheim	294.591
8	Glaxo Welcome	269.906
9	Tortuga	166.232
10	Merck	164.489

Source: Balança Anual da gazeta Mercantil 1999

TABLE VIII

The 9 major entreprises of the medical and hospital equipment sector in Brazil, year 1998

Entreprises		Amount of deal (in thousands of reais)
1	Dabi Atlante	41.338
2	Biolab Mérieux	30.295
3	Kavo	29.225
4	Micronal	20.390
5	Brauner	18.551
6	Braile Biosintética	9.817
7	Celm	5.482
8	Vigodent	4.191
9	Lutz Fernando	2.149

Source: Balança Anual da gazeta Mercantil 1999

TABLE IX

Number of Firms, Total and Mean of Patents, and Mean and St. Dev of RITA per Industrial Sector (1988 - 1996)

Industrial Sector	Classification	Number of Firms	Patents		RITA	
			Total	Mean	Mean	St. Dev.
41	Tobacco	2	106	53,0	0,73585	0,80050
28	Metals	8	564	70,5	0,38277	0,97805
10	Electronics, Electrical Equipment	21	3099	147,6	0,14668	0,35162
30	Motor Vehicles and Parts	18	2132	118,4	0,14304	0,19651
15	Food	7	1360	194,3	0,10649	0,12877
11	Electronics, Semiconductors	3	181	60,3	0,08569	0,05563
6	Chemicals	33	7708	233,6	0,06179	0,17853
1	Aerospace	2	437	218,5	0,05168	0,06833
5	Buildings Materials, Glass	3	230	76,7	0,04883	0,01324
42	Trading	2	254	127,0	0,04413	0,01867
35	Rubber and Plastic Products	8	1149	143,6	0,04168	0,10487
17	Forest and Paper Products	6	406	67,7	0,03885	0,09516
38	Soaps, Cosmetics	7	1651	235,9	0,03389	0,05665
31	Petroleum Refining	10	1370	137,0	0,02859	0,05217
13	Engineering, Construction	1	46	46,0	0,02174	-
21	Industrial and Farm Equipment	17	1653	97,2	0,01985	0,04658
32	Pharmaceuticals	14	2809	200,6	0,01215	0,01488
27	Metal Products	5	464	92,8	0,00974	0,01357
40	Telecommunications	3	168	56,0	0,00794	0,01375
8	Computers, Office Equipment	3	1057	352,3	0,00733	0,00727
36	Scientific, Photo, Control Equip.	3	905	301,7	0,00610	0,01056
99	unidentified	6	433	72,2	0,00402	0,00984
14	Entertainment	3	321	107,0	0,00000	0,00000
34	Railroads	1	46	46,0	0,00000	-
37	Securities	1	58	58,0	0,00000	-
4	Beverages	1	127	127,0	0,00000	-
29	Mining, Crude-Oil Production	1	43	43,0	0,00000	-

Source: INPI, Fortune(1998), Guia Intervest 1998, author's elaboration

TABLE X

RESEARCH LINES AND NUMBER OF RESEARCHERS

ACCORDING TO SCIENTIFIC AREAS (1995-1997)

Scientific areas	Research lines	Researchers
Agricultural sciences	3.322	5.460
Applied social sciences	1.410	2.878
Health sciences	*4.481*	*7.044*
Engineering and computer sciences	4.564	6.627
Human sciences	2.670	5.629
Exacts and Earth sciences	4.342	6.287
Languages, and Arts	906	1.897
Biological sciences	3.788	5.565
TOTAL	**25.483**	**41.387**

SOURCE: CNPq (Directoire des groupes de recherche: http://www.cnpq.br)

TABLE XI

DISTRIBUTION OF SCIENTIFIC PAPERS PRODUCED BY AREAS :

YEARS (1981-95)

Areas	Produced Papers (%)									
	1981		1985		1989		1992		1995	
	World	Brazil	World	Brazil	World	Brazil	World	Brazil	World	Brazil
Clinical Medicine	31.5	21.2	32.2	20.3	32.2	18.5	31.5	25.2	30.7	22.9
Biomedical research	***15.0***	***18.5***	***16.6***	***22.7***	***17.0***	***24.8***	***16.8***	***17.9***	***16.4***	***18.0***
Biology	***10.6***	***14.3***	***9.0***	***10.2***	***8.5***	***8.5***	***8.1***	***8.9***	***8.0***	***9.6***
Chemistry	14.8	12.5	14.2	10.6	13.9	9.5	14.0	9.8	14.0	12.1
Physics	12.3	19.4	13.9	23.3	15.2	24.5	15.7	24.1	16.9	25.4
Earth and spacial sciences	4.6	5.9	4.6	4.8	4.6	6.2	4.9	6.4	5.3	5.1
Engineering and technology	8.3	5.0	7.2	4.6	6.3	4.4	7.0	4.9	7.0	4.5
Mathematics	2.8	3.2	2.4	3.5	2.3	3.6	2.0	2.8	1.8	2.5

SOURCE: NSF (1998)

TABLE XII

THE MAJOR SCIENTIFIC DISCIPLINES IN BRAZIL WITH PARTICIPATION HIGHER THAN 1% OF WORLD TOTAL (1996)

Disciplines	% Papers produced in Brazil / % Papers from the rest of the World
Agricultural sciences	2,04
Astrophysics	1,82
Physics	1,44
Microbiology	***1,16***
Mathemathics	1,15
Molecular biology	*1,15*
Biology and biochemistry	***1,14***
Animal science and Plants	1,11
Ecology	1,09
Immunology	1,01
Pharmacology	0,99

SOURCE: ISI, élaboration de l'auteur.

TABLE XIII

CLINICAL MEDICINE AND BIOMEDICAL RESEARCH: DISCIPLINES WITH A PARTICIPATION HIGHER THAN 0,62% OF THE WORLD PRODUCTION (%)

(1992-1996)

Clinical Medicine	**Years**	**Participation (%)**
General medical research	92-96	2,5
Environment and public health	92-96	1,16
Oral and medical surgery	92-96	1,06
Clinical immunology and contagious diseases	92-96	0,86
Pharmacology and toxicology	92-96	0,86
Immunology	92-96	0,78
Biomedical research		
Molecular biology and genetics	92-96	1,44
Applied biotechnology and microbiology	92-96	1,36
Microbiology	92-96	1,06
Physiology	92-96	0,67

SOURCE: ISI, élaboration de l'auteur.