The underestimated role of universities for the Brazilian NSI

GIST Symposium on Brazil's Innovation System: Challenges and Prospects

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Eduardo Albuquerque
(Cedeplar-UFMG)

Summary

- Introduction: trajectories of growth and development

1. Celso Furtado and the historical roots of underdevelopment
2. Brazil NSI in the world context
3. Successful cases of interaction
4. Brazil and a Global Innovation System
5. Opportunities and challenges

Introduction: trajectories of growth and development

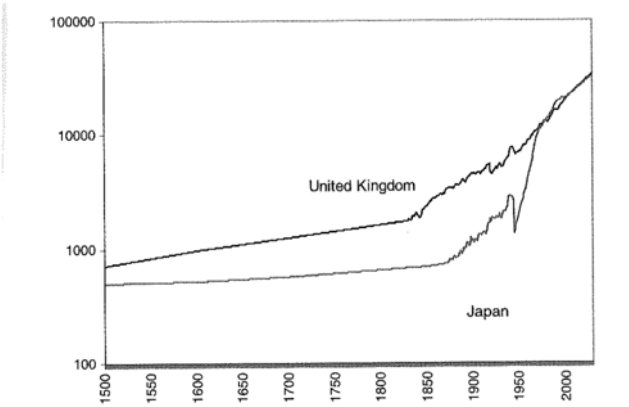
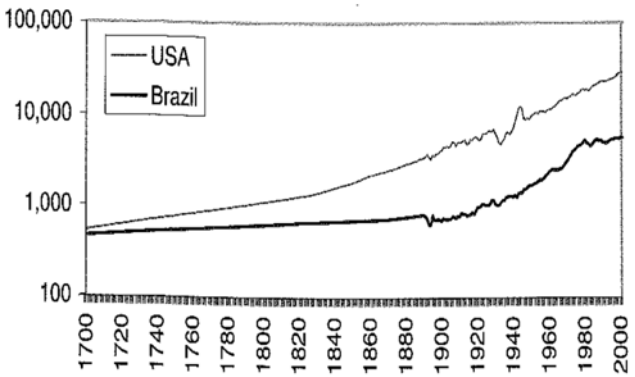


Figure 3.3. Comparative levels of Japan/UK GDP per capita, 1500–2030 (1990 international dollars)



Brazil after 2000:

y=GDPperCapitaBRAZIL/GDPperCapitaUSA (PWT. 7)

1950	15.35
1955	15.95
1960	19.01
1965	19.40
1970	21.97
1975	29.25
1980	32.46
1985	25.63
1990	22.78
1995	23.09
2000	19.82
2005	19.63
2009	23.07

What means y=23?

- Japan in 1870:
  - y = 23 (vis-à-vis UK)
- Germany in 1860:
  - y = 58 (em relação ao UK)
- China (vis-à-vis USA)
  - 1955: 1,73
  - 1980: 2,44
  - 2009: 17,79
- Brazil (vis-à-vis USA)
  - 1900: 17
  - 1927: 16

1. Celso Furtado and the historical roots of underdevelopment (1)

In the same book, Furtado (1987, p. 33) links the 'modernization–marginalization' polarisation with 'inadequacy of technology'.[2] This articulation is complex. The historical starting point is the formation of a social-economic elite, in general in the exporting activities related to agricultural goods demanded by countries at the centre. This wealthy social-economic elite (never greater than 10% of the population) adopts consumption patterns similar to those countries where the first technological revolutions were taking place. This elite has enough resources to import goods from developed countries to consolidate its consumption patterns. Hence, an internal market for these goods is created.

Once there is a market for the wealthy minority, opportunities for limited industrialisation arise. Then, in the first stages of industrialisation, the process of import substitution internalises the production of those goods that replicate the consumption patterns of developed economies. However, import substitution requires protection for internal production of consumer goods and subsidies for the import of capital goods. Here we see a very important feature of the whole process: the incentives for import of capital goods at least temporarily block the development of an internal capital goods industry. And both the evolutionists and the structuralists would stress that this temporary block has lasting effects for internal technological development.

1. Celso Furtado and the historical roots of underdevelopment (2)

The result of this combination of protection for the consumer goods industry and subsidies for imports of capital goods is a specific developmental path, which combines productivity gains with the growth of unemployment. This specific path explains the origin of a growing structural employment surplus. This process leads both to modernisation and marginalisation: industrialisation begins, but instead of solving the employment problem, it brings the seeds of new sources of unemployment. Therefore, modernisation and marginalisation are the combined products of this specific developmental path.

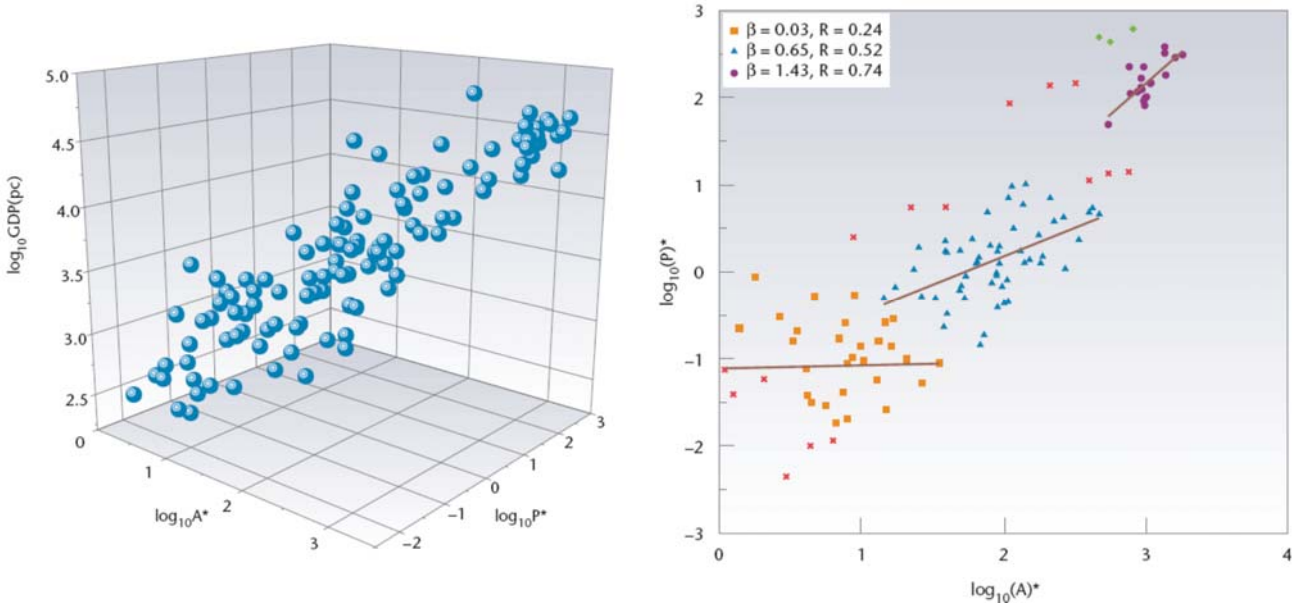
Later, internal production of some capital goods for these consumer goods industries may take place, pushing the economy to the stage of a 'high level underdeveloped economy'. But even this limited capital goods industry is not able to mitigate the growing structural employment surplus phenomenon.

1. Celso Furtado and the historical roots of underdevelopment (3)

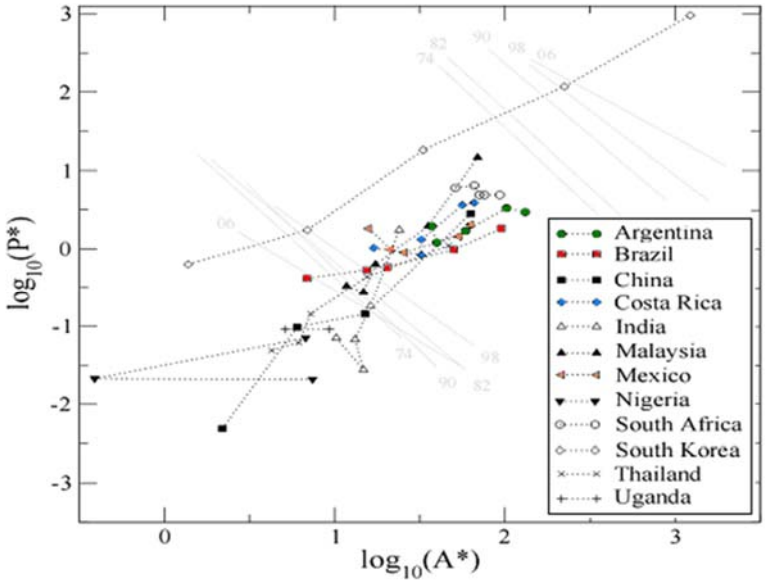
So far, this summary is based purely on Furtado's writings. A dialogue with evolutionists may bring about a dynamic framework. This process that underlies the growing structural employment surplus phenomenon is repeated again and again, pushed by the technological revolutions that characterise capitalist economies (Freeman and Louçã, 2001). Technological progress at the centre keeps introducing new products, leading the elite to update its consumption patterns. Then there are new imports of goods followed by new import substitution. This new industrialisation demands the necessary import of capital goods. In summary, dynamically there is a process that undergoes permanent renewal by the dynamics triggered by technological revolutions at the centre and consolidated domestically by the specific developmental path outlined by Furtado.

The end result is the reproduction of the modernisation–marginalisation polarisation over time. On the one hand, with regard to modernisation, local industries are 'pushed' by

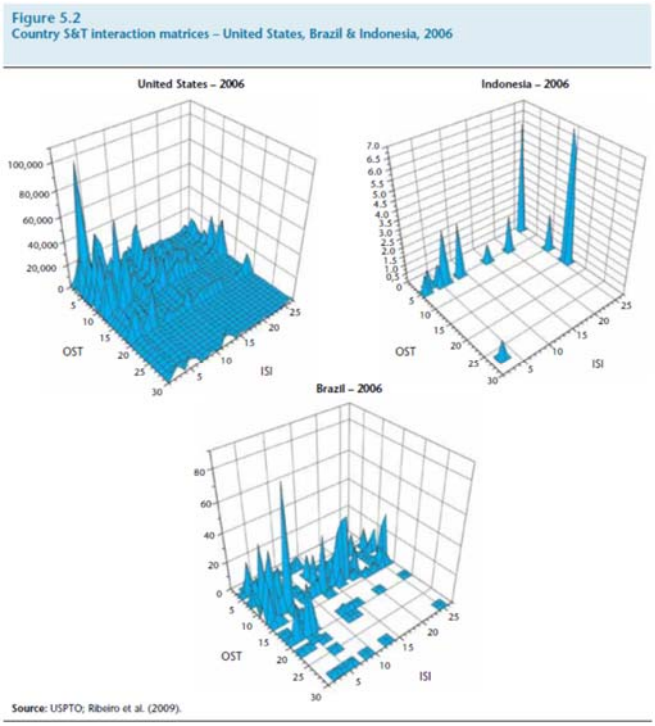
2. Brazil NSI in the world context (1)



2. Brazil NSI in the world context (2)



2. Brazil NSI in the world context (3)



3. Successful cases of interaction (1)

TABLE 4 – BRAZIL – Importance of public research (universities and research institutes) by science and engineering fields

Industry	N	Agronomy	Computer science	Food science and technology	Biology	Industrial Design	Civil Engineering	Materials, Metal and Mining Engineering	Electrical Engineering	Mechanical Engineering	Chemical Engineering	Physics	Geosciences	Mathematics	Medicine	Veterinary	Chemestry
	Percentage of Respondents Indicating Research "Moderately" or "Very" Important																
01 Crop and animal production, hunting and related service activities	12	75.0	8.3	16.7	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	25.0	25.0
02 Forestry and logging	6	66.7	0.0	0.0	16.7	0.0	0.0	0.0	0.0	33.3	0.0	0.0	16.7	0.0	0.0	0.0	16.7
B Mining and quarrying	11	36.4	9.1	0.0	18.2	0.0	18.2	63.6	27.3	27.3	36.4	9.1	54.5	0.0	9.1	0.0	36.4
10+ 11 Food products na beverages	32	50.0	15.6	65.6	28.1	9.4	9.4	0.0	15.6	12.5	40.6	12.5	6.3	9.4	15.6	34.4	40.6
17 Paper and paper products	6	33.3	0.0	0.0	16.7	0.0	0.0	16.7	0.0	0.0	50.0	16.7	0.0	16.7	0.0	0.0	66.7
19 Coke and refined petroleum products	6	66.7	0.0	0.0	33.3	16.7	0.0	0.0	0.0	0.0	33.3	0.0	16.7	16.7	0.0	0.0	66.7
20 Chemicals and chemical products	24	29.2	12.5	12.5	16.7	8.3	0.0	29.2	4.2	16.7	37.5	0.0	4.2	4.2	12.5	8.3	66.7
21 Basic pharmaceutical products and pharmaceutical preparations	35	11.4	2.9	11.4	45.7	0.0	0.0	5.7	0.0	2.9	28.6	0.0	0.0	0.0	8.6	22.9	34.3
22 Rubber and plastic products	7	0.0	14.3	0.0	14.3	0.0	28.6	71.4	14.3	71.4	28.6	14.3	0.0	0.0	0.0	0.0	42.9
23 Other non-metallic mineral products	15	13.3	20.0	0.0	0.0	13.3	40.0	66.7	6.7	6.7	33.3	0.0	0.0	0.0	0.0	0.0	20.0
24 Basic metals	14	0.0	21.4	0.0	0.0	0.0	14.3	85.7	14.3	14.3	21.4	0.0	0.0	0.0	0.0	0.0	0.0
25 Fabricated metal products, except machinery and equipment	9	0.0	11.1	0.0	11.1	11.1	11.1	55.6	11.1	88.9	44.4	22.2	0.0	0.0	0.0	11.1	22.2
26 Computer, electronic and optical products	22	4.5	54.5	0.0	0.0	9.1	4.5	13.6	59.1	18.2	9.1	22.7	0.0	0.0	0.0	0.0	13.6
27 Electrical equipment	8	0.0	25.0	0.0	0.0	12.5	12.5	25.0	50.0	62.5	25.0	25.0	0.0	12.5	12.5	0.0	12.5
28 Machinery and equipment n.e.c	14	42.9	21.4	14.3	0.0	14.3	7.1	57.1	21.4	35.7	28.6	21.4	0.0	14.3	0.0	0.0	7.1
29 Motor vehicles, trailers and semi-trailers	8	12.5	0.0	0.0	0.0	25.0	0.0	50.0	12.5	62.5	25.0	12.5	0.0	0.0	0.0	0.0	0.0
32 Other manufacturing	7	0.0	28.6	14.3	28.6	0.0	0.0	42.9	0.0	42.9	14.3	14.3	0.0	0.0	14.3	0.0	0.0
35 Electricity, gas, steam and air conditioning supply	26	19.2	46.2	0.0	19.2	0.0	26.9	19.2	84.6	46.2	23.1	23.1	19.2	7.7	3.8	0.0	15.4
36 Water collection, treatment and supply	5	20.0	20.0	0.0	40.0	0.0	60.0	40.0	40.0	40.0	20.0	20.0	20.0	20.0	0.0	0.0	20.0
43+ 71 Specializes construction activities and architectural and engineering activities; technical testing and analysis	13	0.0	23.1	0.0	7.7	0.0	61.5	15.4	23.1	0.0	7.7	0.0	23.1	7.7	0.0	0.0	0.0
47 Retail trade, except of motor vehicles and motorcycles	5	0.0	20.0	0.0	0.0	20.0	0.0	20.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	20.0	20.0
61+62+63 Telecommunications, computer programming, consultancy and related services and information service activities	22	9.1	72.7	4.5	4.5	4.5	4.5	9.1	36.4	13.6	0.0	13.6	0.0	13.6	0.0	0.0	0.0
72 Scientific research and development	10	30.0	50.0	30.0	10.0	0.0	10.0	10.0	40.0	20.0	20.0	20.0	30.0	0.0	10.0	30.0	20.0
All (including sectors with less than 4 respondents)	325	22.2	24.0	11.7	16.3	5.8	12.6	25.8	22.8	22.8	23.4	10.5	7.4	4.9	4.9	8.9	24.3

SOURCE: RoKS project survey, Brazil. Authors' elaboration.

3. Successful cases of interaction (2)

For each economic or social success case in Brazil, there is a public research institute and/or a university in a supporting role. This relationship that lies behind most Brazilian products with comparative advantages in the international market was built during a long historical process of learning and accumulation of scientific knowledge and technological competencies. This process involved significant linkages between productive effort, government's policy and funding, and research and education institutions. The most notorious examples are: in health sciences, the production of serums and vaccines by Oswaldo Cruz Institute and Butantan Institute; in agrarian sciences, production and exports of soybean and other grains, cotton, cellulose and meats by firms and planters interacting with Campinas Institute of Agronomy (IAC), Federal University of Viçosa (UFV), Embrapa (Brazilian Agricultural Research Corporation), and several regional education and research institutes; in mining, materials engineering and metallurgy, production of ores and development of steels and special metal alloys by mining and steel corporations in collaboration with Federal University of Minas Gerais (UFMG); in aeronautical engineering, aircraft production by Embraer (Brazilian Aeronautics Corporation) supported by a specialized research institute — the Aeronautics Technical Center (CTA) and a specialized higher education institution — the Aeronautics Technology Institute (ITA); in geosciences, oil and gas production by Petrobras (Brazilian Oil Corporation), specially the drilling technologies for deep waters developed in interaction with Federal University of Rio de Janeiro (UFRJ), State University of Campinas (Unicamp) and many other education and research institutions all over the country.

4. Brazil and a Global Innovation System (1)

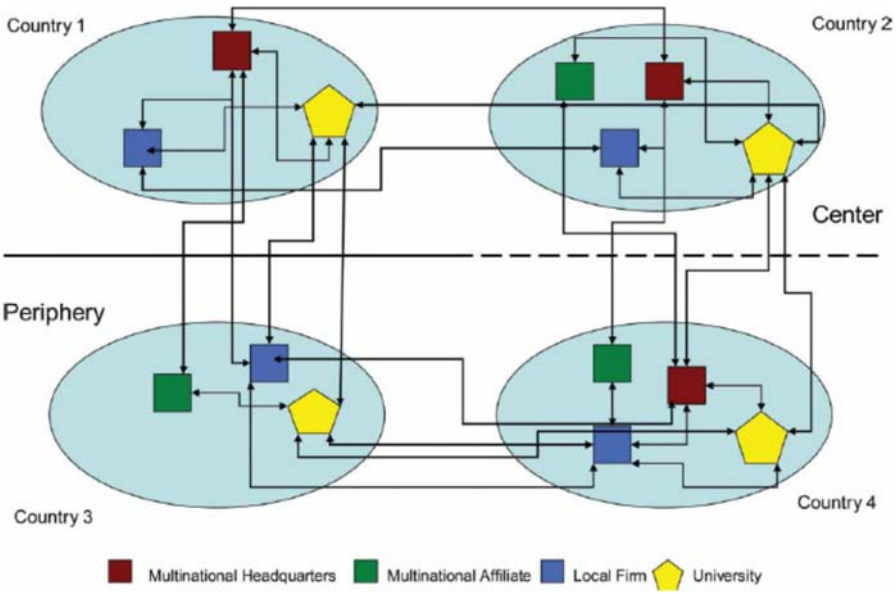
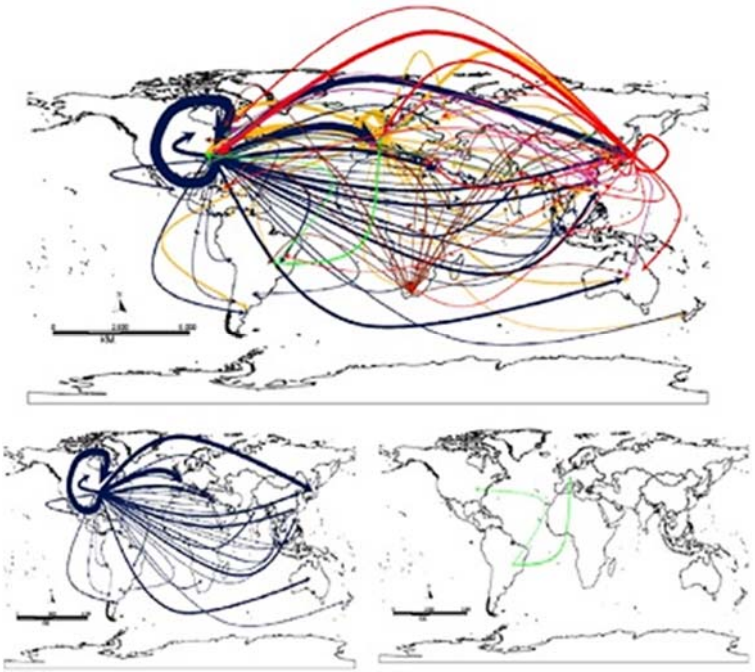


Figure 1. Global interactions between firms and universities – a tentative framework.
Source: Authors' elaboration, following a review of the literature (see Section 3).

4. Brazil and a Global Innovation System (2)



5. Opportunities and challenges (1)

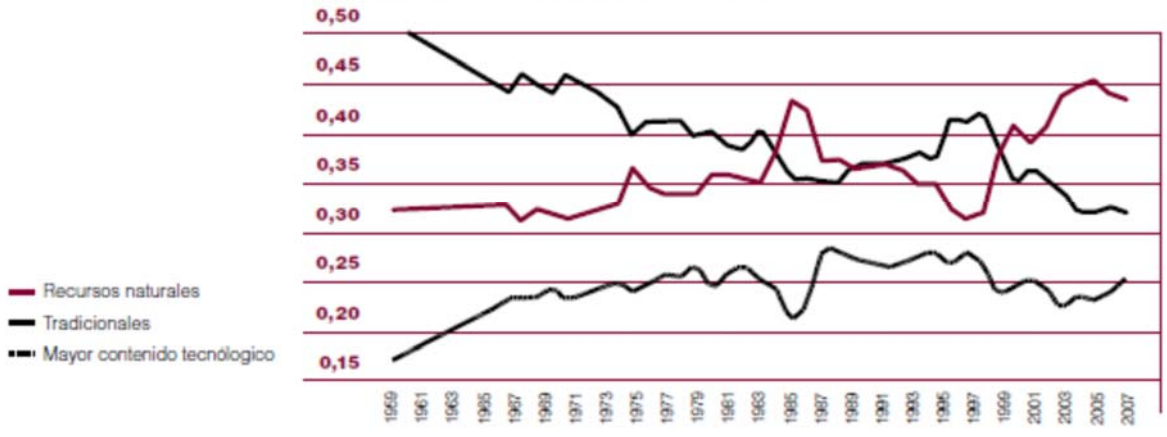
Table 5.6
Applications filed with INPI by residents and non-residents for invention patents (PIs) and utility models (MUs) by OST technology subdomain – Brazil, 2000-2005

OST technology subdomain		No.	Share of total (%)		
			Total	Non-residents	Residents
Total		118,705	100.0	66.1	33.9
Strong advantage of non-residents	10. Organic fine chemicals	14,157	100.0	97.7	2.3
	16. Pharmaceuticals, cosmetics	3,730	100.0	93.7	6.3
	11. Macromolecular chemistry	1,882	100.0	92.6	7.4
	15. Biotechnology	4,644	100.0	91.1	8.9
	12. Basic materials chemistry	5,190	100.0	87.4	12.6
	3. Telecommunications	218	100.0	87.0	13.0
	5. Semiconductors	3,175	100.0	84.6	15.4
	4. Information technology	1,984	100.0	84.5	15.5
	13. Surface treatment	2,773	100.0	84.2	15.8
	14. Materials, metallurgy	814	100.0	79.8	20.2
	6. Surface treatment	4,465	100.0	78.1	21.9
	18. Technical procedures	4,446	100.0	75.9	24.1
	20. Materials processing	2,895	100.0	75.4	24.5
	17. Agricultural & food products	2,092	100.0	74.7	25.3
	No OST subdomain technology	2,616	100.0	74.4	25.6
	23. Machine-tools	2,957	100.0	68.0	32.0
	24. Engines, pumps, turbines	6,336	100.0	66.9	33.1
	8. Medical engineering	4,135	100.0	65.7	34.4
	26. Mechanical components	2,290	100.0	63.8	36.2
	9. Nuclear techniques	14,157	100.0	62.3	37.7
	2. Audiovisual technology	3,730	100.0	61.7	38.3
	1. Electrical components	1,882	100.0	59.4	40.6
	28. Space technology, weapons	4,644	100.0	56.0	44.0
	7. Analysis, measurement, control	5,190	100.0	53.9	46.1
	27. Transport	218	100.0	53.0	47.0
	21. Environment, pollution	3,175	100.0	51.8	48.2
Advantage of residents	19. Handling, printing	1,984	100.0	47.4	52.6
	25. Thermal procedures	2,773	100.0	42.9	57.1
	30. Civil engineering, building	814	100.0	36.8	63.2
	22. Agricultural & food processing apparatus	4,465	100.0	31.7	68.3
	29. Consumer goods & equipment	4,446	100.0	25.8	74.2

Source: INPI.

5. Opportunities and challenges (2)

Gráfico 13. Participación relativa en el valor de transformación industrial de tres grupos de actividades económicas (1957-2007)



Fuente: IBGE

5. Opportunities and challenges (3)

- Systemic turbulence (Arrighi, 1994), “tectonic shifts in the world economy” (NIC, 2012) and opportunities for catch up
- The present level of NSI formation as a good starting point for Brazil’s catch up.
- Industrial and technology policies: entry in new sectors – emerging technologies
  - Which sectors?
    - Biotecnology
    - Nanotecnology
    - New energy sources (solar energy)
  - How?
    - Diversification of large firms
    - New firms
    - How far must the government go? New state-owned firms?
  - Search for an active insertion in the new international division of labor
- How to organize those orientations?
  - New sectors and an institutional mismatching
  - Is the government ready for an ambitious industrial and technology policy?
  - How to articulate these policies with a national development project?
- Combination between the formation of a innovation system and a welfare system
- How to build a catch up friendly financial system?
- The challenge of a democratic elaboration of these policies and priorities – the need for a more sophisticated political debate
- Will the combination between NSI, WS and democracy be the “institutional innovation” of Brazil’s catch up?