NATIONAL SYSTEMS OF INNOVATION & DEVELOPMENT: LATIN AMERICA in the 1990s

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A Co-evolution

- Ideas about (National) innovation Systems
- (New) Industrial and Technology Policies

Important Empirical Research

- From TRACES (1968) e HINDSIGHT (1969)
- To SAPPHO (1972) e YIS (1984)

AdHoc Group of OECD's DST (Chesnais, Nelson, Freeman, Pavitt).

- *Technical Change and Economic Policy* (OECD, 1980)
  - First document that challenged the traditional macroeconomic interpretation of the 1970's crisis,
  - Emphasizes the role of technical change as a potential solution to the crisis
- *. . .* electronics is the major research-based sector which has maintained, and even increased its innovative vitality. The principal feature has been innovation in the manufacture and design of electronic components. The years from 1975/1976 on have seen what has come to be known as a "microelectronic revolution". *. . .* such radical innovations are bound to have pervasive effects in many sectors where improved methods of calculation, communication, control and the storage and manipulation of information are necessary or possible. The diffusion of electronics throughout other manufacturing and service industries will result in an economy in which one technology influences innovation almost everywhere(OECD, 1980, p. 48).

The new concept of the innovation process

- Based on interactive effects between variables in the oppositon to the impact any variable might on the explanation of innovation and diffusion processes
- Involving feedbacks between (i) research; (ii) stock of S&T knowledge; (iii) potential market; (iv) various phases etapas of the productgive process; (Kline and Rosenberg, 1986; OECD, 1992).
- Emphasis on uncertainty and unpredictability of the innovation process (Rosenberg, 1976, 1982)
- Dynamic impact of clusters of innovations instead of isolated innovations (Freeman and Perez, 1988).

- Firm reconceptualized as a learning organization embedded in a wider institutional context (Lundvall, 1988).
- Focus on knowledge, learning and interactivity among actors leading to innovation systems (Lundvall, 1992, 1995; Freeman, 1988)
  - "**national or local environments** where organisational and institutional developments have produced conditions conducive to the growth of interactive mechanisms on which innovation and the diffusion of technology are based" (OECD, 1992a p. 238).
- **Innovation process:'path dependent', local specific and institutionally conformed**

- Analysis leads to the Sundquist Report (OECD, 1988)
  - need of an integrated approach
  - technical change “social process, not an event, and should be viewed not in static, but in dynamic terms” (OECD, 1988, p. 11).
- TEP (the Technology–Economy Programme) 1989 to 1992.
- *Oslo Manual*, (based on Kline-Rosenberg model)
- *Technology and the Economy*: *The Key Relationships* (OECD, 1992)
  - started with Kline-Rosenberg
  - Introduced other concepts—networking, strategic partnerships, spillovers, importance of tacital knowledge.
  - Concept of National Innovation System. “When the outcome of this programme was summed up in Montreal in 1991, the concept, National systems of Innovation, was given a prominent place in the conclusions” (Lundvall, 1992)

- OECD, 1971. Science, Growth and Society (Brooks Report). OECD, Paris.
- OECD, 1980. Technical Change and Economic Policy. OECD, Paris.
- OECD, 1988. New Technologies in the 1990s: A Socio-economic Strategy (Sundquist Report). OECD, Paris.
- OECD, 1992a. Proposed Guidelines for Collecting and Interpreting Innovation Data (Oslo Manual). OECD, Paris.
- OECD, 1992b. Technology and the Economy: The Key Relationships. OECD, Paris.

National (Innovation systems)

- ✓ – founded on the idea that innovation processes processos are characterized by **interactive learning**; interactivity paves the way for a systemic vision of innovation.

- The origin of the concept
  - – Freeman 1983 and 1987
    - Unpublished OECD-paper 1983
    - Book on Japan 1987

Main implications of the vision of innovation as an interactive process

- ✓ Knowledge and technology are the result of interactive processes not transferable.
- ✓ Information is possible to transfer
- ✓ INNOVATION IS FIRM SPECIFIC

Similarities between the system of innovation approach and the ECLAC school

- Economic Development
  - characterized by structural change in the economy ignated by technological discontinuities
  - non-linear, unique process depending upon historical, political, economic and cultural specificities
- Technical change (or innovation) as the main determinant of economic development
- Industrialization (Presbich, Furtado) X New IT paradigm (Freeman, Peres)
- The resolution of the conflict between the emergence of the new paradigm and the old institutional structure require a diferentiated role for the State

Learning capabilities and economic development

- How are individuals, communities, firms and organizations geared to learning and innovation?
- What kind of learning culture is there?
- Is there an adequate institutional and infrastructural underpinning of learning?
- How are broadly based learning capabilities formed and developed?
  - **How market structure affect learning and capacity building? (THE MESO DIMENSION)**
  - **How implicit policies affect learning and capacity building? (THE MACRO DIMENSION)**

Latin America is a heterogeneous mix of subregional economies

- Small Central American and Caribbean nations are highly dependent on exports of agricultural products and traditional manufactures like apparel
- The Andean countries (Venezuela, Peru, Ecuador, Bolivia, and Colombia) are almost exclusively primary-product exporters, with the exception of Colombia where manufactured exports make up one-third of the total.
- Southern Cone countries (Argentina, Chile, and Uruguay) also emphasise primary products, although they have more developed manufacturing sectors than the Andean nations.
- By contrast, in the region's two largest economies – Brazil and Mexico – manufactured exports account for more than one-half and three quarters, respectively, of total exports.

TEP (the Technology–Economy Programme) 1989 to 1992

- Starting point: innovation as an interactive process
- NSI - “organizing” concept
- Emphasis on networking

Latin America is a heterogeneous mix of subregional economies

- Furthermore, the dominance of Brazil and Mexico in the region's exports increases in proportion to the technological complexity of goods: the two countries account for 60% of traditional exports, 77% of basic intermediate inputs, and 85% of Latin America's exports of advanced industrial products.

- The acute financial crisis in Asia has contributed to the dramatic improvement in Latin America and the Caribbean's position as a destination for foreign direct investment (FDI) in the 1990s, with the increase in FDI to the region doubling from US$ 33 billion to $65 billion between 1995 and 1997.

- However, one-half of total FDI in 1997 went to just two countries, Brazil (30%) and Mexico (19%), reinforcing the existing disparities in the region.

NSI in LA nowadays

- how structural reforms are influencing technological behaviour throughout the Latin American production structure.
- how trade liberalisation and market de-regulation efforts are affecting the way in which firms import, generate, adapt, diffuse and use new technologies
- how the new patterns of behaviour compare with those prevailing during the import-substitution period.

NSI: the co-evolution of micro, meso and macroeconomic forces

- 1 - At micro level: learning strategy of each individual firm and its success along such front.
- ✓ How much does it spend in R&D and engineering activities ?
- ✓ How much does it get out of such expenditure in terms of new products and production processes or in terms of improvements of those that it already had?
- ✓ How much attention does it provide to human capital training interacting with universities, technical schools and the like?

Technological behaviour is determined by the co-evolution of micro, meso and macroeconomic forces

- 2 - At the meso level: the **competitive and technological regime** in which each particular industry operates.

- 3 - At the macro level: organisations, regulatory systems, institutions and public policies applied in the field of science and technology. The role of IMPLICIT policies
  - ✓ How much does a country spend in R&D activities?
  - ✓ What is the relative public/private involvement in knowledge generation and diffusion efforts? etc.
  - ✓ What is the role of the financial sector?

PRODUCTION ORGANIZATION AND TECHNOLOGICAL BEHAVIOR DURING THE IMPORT SUBSTITUTION PERIOD.

- Expenditure in R&D activities, measured as a percentage of GDP, has always been low in Latin America, especially if we compare with OECD countries and with the emerging economies of South-East Asia.
- As a rule, R&D expenditure has never been much more than half a percentage point of GDP, even in the region's larger economies

Knowledge generation efforts in the public sector of the economy.

- A vast array of public-sector enterprises and R&D laboratories and technological institutes were created in Latin America during the Second World War and throughout the 1950s.
- State:
  - production of many goods and services, such as energy, transportation, telecommunications, urban sanitation services, etc.,
  - development of many heavy industries, (iron and steel, petrochemicals or aluminum).
- Public firms undertook responsibility for producing complex goods and services thus requiring a significant amount of technological capabilities and expertise.
- Geo-political issues (domestic technological capabilities both in the nuclear field as well as in aeronautics).
- Public sector (R&D institutes and laboratories),

- In order to fulfil their commitment many State-owned public utilities found it necessary to create their own engineering and R&D departments in order to study the specificity of local demand and better to understand the nature of the locally-available natural resources.

- These engineering departments fulfilled a vital role in designing and maintaining the new production facilities brought on stream by public sector firms such as YPF, Pemex, Petrobras, etc. in the petroleum field, Usiminas (Brazil), Somisa (Argentina), Lázaro Cárdenas (Mexico) in the Iron and Steel industry, etc.
- Pari pasu with the above a large number of public financial agencies (BANADE, BNDE, NAFINSA, CORFO, etc.) emerged. These agencies took responsibility for the funding of large-scale investment projects.

- We also get a similar picture of success when we look at the performance of State-run agricultural institutes such as INTA in Argentina, EMBRAPA in Brazil, INIA in Chile, etc.

- These agencies made great progress in the design and testing of agricultural equipment, in delivering agricultural extension services, etc.

Technology-generation efforts in the private sector of the economy.

- Domestic subsidiaries of transnational corporations
- Locally-owned companies
  - Small and medium-sized enterprises
  - Large domestic conglomerates

Domestic subsidiaries of transnational corporations

- A large number of foreign companies arrived in the region in the second half of the 1950's and throughout the 1960's, bringing with them new product, process and organizational technologies that were often unknown in the domestic production environment.
- Local engineering capabilities and the functioning of the National Innovation System changed quite significantly as a consequence of their arrival.
- These firms did not come to Latin America with the idea of developing a local technological infrastructure, but many of them found that they needed to do so in order to operate in a highly idiosyncratic production and institutional environment.

- Given the firm-specific nature of much industrial technology, many of these enterprises had to ‘adapt’ to the local circumstances production routines and organizational know how that was originally created in their headquarters to be utilized in a very different context.

- As a result of that many of these firms found it necessary to create "localized" engineering departments and supplier development programs that were geared to the needs, operational scale and organizational patterns of local production.

- Such technological efforts were ‘minor’ or ‘incremental’ although in more than a few occasions they demanded experimental work, the use of pilot plants, and involved a significant amount of new knowledge generation within the firm.

Locally-owned companies

- **Small and medium-sized enterprises, most of which were family-owned firms.**
- A large number of locally-owned SMEs developed in Latin America during the 1940's and 1950's induced by high tariff protection and subsidized government financing.
- Many of these firms were family-owned companies that engaged themselves in the production of textiles and garments, footwear, machine tools, furniture, farm machinery, etc.
- Even though many of these firms often started out as repair shops using second-hand machinery and very little under the form of production organization know how, it is to be noted that many of them grew quite rapidly during the 1950's and 1960's.

- Many of them managed to put together their own technical and engineering departments, designing new products and developing new production processes, training their own workers and technicians and making rapid progress along a highly idiosyncratic long-term learning path.

- Technological learning process in this type of firms was more haphazard and less systematic.

- Focused primarily upon copying foreign product designs to which local consumers had become accustomed in the past, without worrying too much about issues of costs or quality.

Large domestic conglomerates

- Raw material processing industries and produce highly standardized ‘commodities’ as pulp and paper, iron and steel, vegetable oil, cooper, petrochemicals etc.
- These are mostly ‘machine-paced’ industries in which technical progress tends to be ‘embodied’ in new equipment and originates in the capital goods industries catering for their needs.
- In spite of the above many raw material processing firms tend to carry out a significant amount of ‘in house’ engineering efforts with the purpose of ‘adapting’ to the local raw materials and production environment the ‘generic’ machinery and equipment they purchase from equipment suppliers.

- It is on account of this that many of these firms found it necessary to set up formal engineering departments quite early in the game in order to supply themselves with incremental units of technical know how with which to improve production processes and further understand the highly idiosyncratic nature of the local raw materials they were dealing with.

- Unlike large industrial commodity producers in developed countries (pulp and paper in Sweden and Finland, cooper in Canada or Australia, etc.), the large Latin American conglomerates engaged in raw material processing industries did not undertake significant efforts developing ‘in house’ engineering and R&D capabilities with the aim of increasing domestic value added moving into more complex products and ‘specialties’.

An overview on the functioning of the national innovation system during the ISI period.

- Close to 80% of the R&D efforts carried out during the ISI period were financed by the Public sector and were performed by public labs and engineering departments of firms producing energy, telecom, etc.
- National innovation systems of the ISI period also featured small ‘in house’ engineering departments of local subsidiaries of transnational corporations, of locally-owned conglomerates and of a large number of newly emerging family-owned SMEs
- These different groups of firms – public enterprises, subsidiaries of large MNCs, family-owned SMES, etc.) have to be imagined as moving along a highly idiosyncratic and firm-specific learning curve, as they matured through time.
- Each of them faced different needs and opportunities as far as technological and innovative behavior in concerned.

An overview on the functioning of the national innovation system during the ISI period.

- Their technological interaction was very low: ‘national innovation system’ developed as a fragmented and uncoordinated aggregate which lacked in purpose and sense of direction.
- State-owned enterprises established their R&D laboratories and engineering departments in order to design and operate a large number of new production facilities engaged in the production of public services such as energy or telecommunications, as well as a number of goods required by the defence sector of the economy.
- For such purpose these firms undertook responsibility for the development of human capital and for the design and construction of many new production facilities. .

An overview on the functioning of the national innovation system during the ISI period.

- As for the global economic environment in which these firms operated during the import substitution period we notice that high tariff protection, excess demand strongly militated against the development of a proactive technological ‘culture’ in the region.

- Latin American firms lived in the immediate post-war years in “seller’s markets” in which no strong competitive signals prevailed which would induce local companies into more dynamic patterns of technological behavior.

- Is the above picture changing, now that the region is moving toward trade liberalization and market de-regulations?

CHANGES IN THE NATIONAL INNOVATION SYSTEM AS A RESUT OF TRADE LIBERALIZATION AND MARKET DE-REGULATION EFFORTS.

- Recent structural reforms, on the one hand, and the rapid process of diffusion of computer-based production technologies, on the other, are significantly changing the technological behavior of individual economic agents, the structure and performance of markets, and the nature and functioning of the institutions and agencies that belong in the national innovation system of each of the countries in the region.

The 1990s - How structural change (liberalization, deregulation and privatization) affected systems of innovation in Latin America

- Liberalization has lowered the cost of imported capital goods and therefore encouraged their substitution for domestically-produced machinery and equipment.

- Change in the balance between public and private financing and performance of technological activities at local level. Although private agents are supposed to be playing a more important role in these activities empirical data seem to suggest that this is not the case

- Government policy has been promoting the partial privatisation of State-run technological institutes by forcing them to obtain an increasing share of current funding from the private sector.

The 1990s - How structural change (liberalization, deregulation and privatization) affected systems of innovation in Latin America

- R&D Institutes are changing the mix of activities they conduct reducing the number of research projects they undertake and increasing the share of consultancy and technical assistance activities, which provide them with resources they need.
- MNCs subsidiaries have discontinued local engineering activities that they undertake in order to adapt or improve product and process technologies provided by their parent companies.
- The increased use of imported components appears to be having a significant negative impact upon local firms as it destroys production chains in which a larger number of locally-owned SMEs had served as suppliers of foreign-owned companies.

The final result is that production is becoming less intensive in the use of local engineering and technical capabilities:

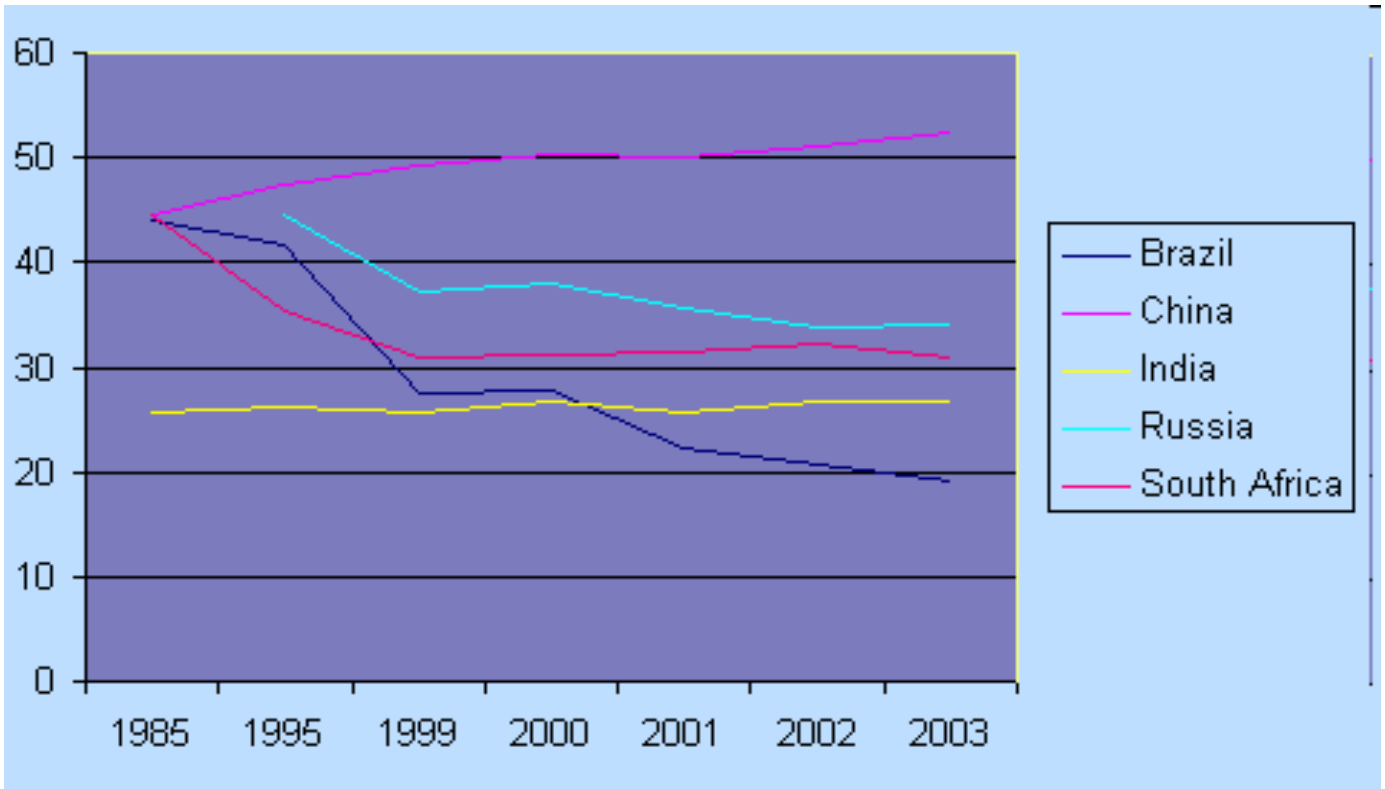
What are the impacts on NSI?

Strategies of MNCs in Latin America During the 1990s

Corporate Strategy Sector	Efficiency Seeking	Raw Materials Seeking	Market Seeking	Strategic Assets Seeking
Primary		Oil/gas: Venezuela, Colombia, Argentina Minerals: Chile, Argentina, Peru		
Manufacturing	Auto: Mexico Electronics: Mexico, Caribbean Wearing Apparel: Mexico, Caribbean		Auto: Mercosur Chemicals: Brazil Agroindustry: Argentina, Brazil, Mexico Cement: Colombia, Venezuela, Dominican Republic	Auto Parts: Brazil Telecom Equip: Brazil
Services			Financial: Brazil, Mexico, Chile, Argentina, Venezuela, Colombia, Peru Telecom: Brazil, Argentina, Chile, Peru Retail: Brazil, Argentina, Mexico, Chile Electricity: Colombia, Brazil, Argentina and Central America Gas Distribution: Argentina, Chile, Colombia Tourism: Mexico, Caribbean	

Source: Cassiolato and Lastres 2000 (adapted from CEPAL 2000)

Industry/GDP (1985-2003)



GFCF/GDP (1980-2002)

Unemployment (%)