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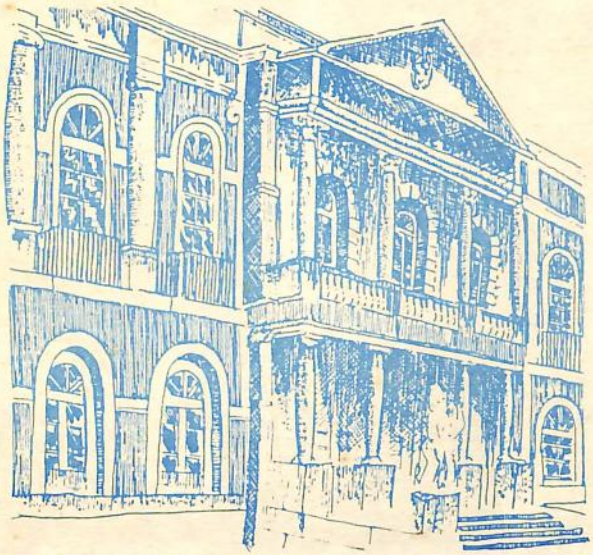

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HOW DOES LATIN AMERICA FIT INTO HIGH TECHNOLOGY ?

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Fevereiro/1989

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The question of how does Latin American countries fit into high technology has come to absorb an increasing share of the attention of development economists in recent years. A source of controversy particulary important for industrial policy formulation is the different perceptions of the opportunities and difficulties faced by developing countries in difusing information technology to the production sector and in entering into the electronic industry itself.

Authors stemming from the "dependency school" (see Cardoso and Faletto, 1979, for example) were the first to alert us to the gloomy perspectives for autonomous industrial development in the region, because of its dependency on the import of technology and penetration by foreign multinationals. Recent work on the impact of information technology in developing countries has brought the question of competitiveness more to the front. Rada (1985) argued that the existing technological gap between developed and developing countries will increase due to the absence of a local microelectronics-based capital goods industry. This argument suggests that existing Third World industrial firms would face increasing difficulties in modernizing their plants and keeping up in quality and product change. Developing countries usually lack the required hard currency to import automated equipment. But even if they did not face a debt crises, imported equipment would not produce the same positive impact on productivity as in industrialized countries due to poor local technical support, smaller scale of operations and different relative costs of labour and other inputs.

A less pessimistic view is shared by Carlota Perez and Luc Soete (1988). They argue that in a changing "techno-economic paradigm" from an electro-mechanical, to microelectronic technical base, there are also favourable conditions for lagging countries for catching up since there is time for learning while everybody else is doing so. In addition, "given a reasonable level of productive capacity and locational advantages and a sufficient endowment of qualified human resources in the new technologies, a temporary window of opportunity is open, with low thresholds of entry where it matters most. New products have relatively low entry requirements in managerial ability and

capital as compared to mature products that have exhausted their technological dynamism."

Our starting point is the fact that there are both opportunities and constraints for technological development in Latin America. There is a need to analyse specific conditions, industries and products, rather than to generalize.

Entering in the sophisticated electronics industry is of course, a major shift in the traditional development pattern pursued by the region. Many Latin American countries' economies grew in the post war period thanks to their large natural resources and cheap labour, which led to increasing exports of oil, food, and minerals and to a widespread import substitution industrialization, largely based on foreign loans, investment and technology. From 1963 to 1985 the share of Latin America in the world industrial output grew from 4.4% to 5.3%(1). Although the resulting industrial pattern for the majority of countries was a collection of unarticulated assembly plants for consumer goods, highly dependent on imported technology, inputs and government protection (see Perez, 1988) some larger countries have succeded in becoming exporters of energy and labour intensive manufactured products such as steel, petrochemicals, pulp and paper, processed food and even automobiles and aircrafts. In 1987, for example, the two largest Latin American countries - Mexico and Brazil produced a trade surplus of US$ 8.4 and US$ 11.2 billion respectively. Unfortunately, it is not clear yet if this large surplus is only a result of domestic market recession and the need to serve the huge external debt (estimated in US$ 450 million for Latin America as a whole) or a more structural and sustained shift in international competitiveness.

Locally-owned Latin American enterprises account for 47% of the top 600 companies in the Third World listed in South Magazine. Of the regions' companies listed, about one-third (96 firms) are involved in manufacturing but only four are directly linked to the "hi-tech" sector (electronics and aerospace). Most firms rely on foreign technology and only a few large firms, from a limited range of sectors are actually involved in R&D activities (see Ferraz, 1988).

TABLE 1
LATIN AMERICAN TOP LOCALLY-OWNED MANUFACTURING FIRMS BY SECTOR OF ACTIVITIES

SECTOR	NUMBER OF FIRMS
Steel and Aluminium	21
Chemicals and Petrochemicals	19
Food, drinks, and tobacco	18
Engineering and Machinery	9
Textiles and Clothing	7
Glass, Ceramics and Wood	4
Electronics and Office Equipment	3
Automobiles and Auto Parts	3
Paper	3
Plastics and Toys	3
Cable and Wires	2
Domestic Appliances	2
Aerospace	1
Publishers	1
TOTAL	96

Source: South, July 1985, pp 65-76.

The new "techno-economical paradigm" is usually described to be information-intensive rather than energy and material intensive. This has two important implications for the future of the world's industry. First, it tends to reduce the use of traditional materials such as steel and other metals as the result of new designs and of the substitution of new materials for traditional ones. Second it changes production methods by the introduction of automated equipment thus reducing the competitive advantages of countries with cheap unskilled labour.

The largest Latin American manufacturing sector (steel) is considered to be competitive in World terms, since it has favourable access to rich ore and cheap energy sources and incorporates a relatively modern technology. However, the trend of new products incorporating microelectronics inputs or designed with computer aid is to save metals and energy. Automobiles, for example, use an average of less than 25 kilograms of steel today than did 10 years ago and the trend is to reduce a further 25 kg in the next 10 years. The development of satellite communications and optical fibres also contributes to reduce the demand for copper, aluminium and other metals (2). This, of course, may have important negative implications for Latin American countries

which based their exports on raw materials and intermediate goods. One possible consequence is a trend of declining terms of trade between traditional manufactured goods and high technology products. The Economic Commission for Latin America's economists, headed by Raul Prebish proved in the late 50's that the prices of raw material and foodstuff exported by Latin American countries were declining in relation to imported manufactured goods. This was due to a smaller price-elasticity of primary goods in relation to manufactures, since demand for commodities were growing more slowly than differenciated, technology intensive products. These findings influenced a range of import substitution industrialization policies in the continent in the following 20 years. However the new techno-economic paradigm renews the danger of declining terms of trade between, for example, steel, textiles and petrochemicals on the one hand and computers and technical information on the other (3).

Of course these trends cannot be taken too seriously, at least in the short run. Commodity markets are very much affected by conjunctural factors and, more important, there is still room for local market development in most Latin American countries. The old "techno-economical paradigm" has still to produce its "optimal" results in countries where abundant resources and low per capita consumption of basic goods and urban infra-structure are present. There are also opportunities for renewing mature industries by investing in new technologies. Steel manufactures, for example, can develop new alloys and materials such as titanium which is as resistant as steel but weight 30% less than aluminium. However, entering new markets or products requires a high level of endogenization of technological development, since new technology is not usually available for purchase at least in the early phases of the product cycle.

Willian Cline's (1987:31) vision of the role of the traditional "law of comparative advantages" of international trade for information industry development in Latin America is also relevant to the argument we shall be discussing. He argues that the dynamic technological nature of the informatics industry could make it a less promising candidate for successful infant industry development than more traditional sectors such as

steel and automobiles where technology is stable and where some countries in Latin America have already established internationally competitive production after decades of infant industry protection (4).

However, as Perez (1988) notes, entering new sectors and technologies can provide better opportunities for investment return and economical development than merely reproducing mature sectors that have exhausted their technological dynamism. She observed that technical progress is not a cumulative uni-diretional process, "a sort of race along a fixed track, where catching-up is merely a question of relative speed. No doubts speed is a relevant aspect, but history is full of examples of how successful overtaking has mainly been based on running in a new direction".

Computers and other sophisticated electronics equipment are widely used in Latin America since the mid-1960's. The computer installed base in the region's two largest countries is perhaps larger than any other developing country. Table 2 shows that Brazil has a computer installed base (above the PC level) about five and a half times larger than Korea's which has one of the fastest growing economies among the NICs. The available information on Mexico does not discriminate between classes or type of equipment but a recent study (see Aladi, 1986:167) estimates that there are 7,900 firms using computers of all classes in the country. Even discounting a high proportion of microcomputers, this is likely to represent a larger use of computers in Mexico than in Korea.As far as the computer hardware sales is concerned, Brazilian market is still more than double the Korean, although growing in a slower pace (see Evans and Tigre, 1988b). Together, Mexico and Brazil account for 70% to 75% of the Latin American market. With Argentina added, the three comprise 85% of the market (5).

TABLE 2
COMPUTER MARKET (HARDWARE ONLY) AND INSTALLED BASE
IN SELECTED NEWLY INDUSTRIALIZED COUNTRIES

COUNTRY	MARKET SIZE (Us$ million)	INSTALLED BASE (1984, in units)
Brazil	1,300	9,205
Korea	600	1,646
Mexico	450	n.a.
Argentina	200	n.a.

Sources: Brazil and Korea, Evans and Tigre, 1988b; Mexico and Argentina: Miller, 1986:173, 176 (estimates).
Notes : Installed base does not include microcomputers. Market is estimated based on hardware sales only and does not include software, services and rentals.

The comparison between the large computer installed base in countries facing increasing economic difficulties like Brazil and Mexico and the relatively small installed base in booming Korea suggests that there is not necessarily a connection between the use of computers and economic growth. Table 3 helps to clarify further the question by examining the overall computer market in the two countries by type of user. While in Brazil and Mexico, government and finance accounts for more than 40% of total use, in Korea the private business sector has apparently a greater proportion of computer users. This difference may contribute to a greater impact of computers on industrial productivity in Korea.

TABLE 3
COMPUTER MARKET BY TYPE OF USER,
BRAZIL, MEXICO AND KOREA (1984)

TYPE OF USER	BRAZIL	MEXICO	KOREA
Government	12.5%	25.0%	10.0%
Finance & Insurance	28.0%	21.0%	19.3%
Commercial sector	18.3%	20.4%	
Manufacturing	32.5%	17.4%	61.9%
Utilities/Services	8.7%	4.3%	
Others *	-	11.9%	8.8%
TOTAL	100.0%	100.0%	100.0%

Sources: SEI, 1987:44; Miller, 1986:179; Evans and Tigre, 1988b.
Notes : Brazilian and Mexican data refers to 1984 market, while Korean data is for installed base in the same year.
* In Korea this correspond to Research and Education while in Mexico it was not identified.

Brazil, Mexico and to a lesser extent Argentina have already established a local electronics industry. Mexican estimated 1988 computer output is US$500 million (See Zermeno 1988) while Brazilian hardware production is at least four times larger. Both countries exported about US$200 million each in 1988. The three Latin American countries generally tend to share very similar problems in acquiring technology and dealing with multinational firms. One of the main question faced by policy-makers is whether and to what extent these countries should promote the development of indigenous technology. This usually requires direct government investment in R&D, incentives and protection against foreign technology. Alternatively these countries could rely mostly on foreign investment and technology.

The point being made here is that selective entering into new technology through local Research and Development may constitute an appropriate strategy for Latin American countries with enough of an established industrial and human resources base to benefit from the opportunities created by the microelectronics revolution. This requires government policies aiming at inducing local firms to innovate, rather than relying passively on licensing.

The Brazilian experience on alternative sources for electronics technology acquisition provides evidences that in-house product design is of fundamental importance for competitiveness both in local and export markets. The case of minicomputer manufacturers COBRA and EDISA is a good illustration. COBRA achieved commercial success with locally-developed minicomputers, but failed to break into the supermini market under license of Data General. EDISA had a difficult start by marketing FUJITSU-designed minicomputers, but the company recovered sharply after designing in-house a 32 bit supermicro (6). In the telecommunication industry the government-owned R&D centre CPqD provided opportunities for private locally owned firms to enter the market of sophisticated products such as small digital switching systems, multiples and fibre optics.

Opportunities for independent design strategies are present mainly in niche markets where technology from abroad is

not available or accessible and where returns are high. In Brazil one of the most successful area for local design is automation for both the industrial and service sectors (banking and retailing). In these markets, the supplier has to be close to the clients and learn their needs for specialized, custom-made equipment. Brazilian manufacturers are already exporting locally-designed service automation systems to Europe and other Latin-American countries. The recent development of non-proprietary standards both in hardware and software also provides opportunities for local design. By adopting "de facto" international standard such as the Intel 80386 or Motorola 68000 microprocessors, MSDOS and UNIX like operational systems and the Open System Interconnection (OSI) communication protocol established by the International Standards Organization (ISO), small manufacturers worldwide can license or copy solutions or specifications developed elsewhere thus reducing the costs of in-house R&D.

Industrial automation design capabilities stem mainly from large capacity building investments in areas like ethanol refining, petrochemical and steel-making plants. These investments were completed in the 1980's and provided a demand for locally-developed, custom-made programable controls and supervision systems. Some other areas of industrial automation such as numerical controls for locally designed machine-tools also provided opportunities for local technology development. While capital goods produced under license of foreign firms usually require foreign designed, compatible NCs, locally designed machine tools require less sophisticated numerical controls than those based on foreign technology. Local firms successfully descaled German designed equipment by reducing the number of axis in FMS thus reducing costs and matching local needs.

The contrast between the technological development achieved by the Brazilian professional electronics industry, where there is government intervention to promote innovation, and the local consumer electronics industry where foreign investment and technology are freely accessible (see Evans and Tigre, 1988a) is quite illustrative. In the vast majority of cases, firms

operating in the Manaus Free Zone pursue a dependent technological strategy and usually do not attempt to initiate or even to imitate technical changes in its products, except as a result of parents or licensors request. Although dominating the large Brazilian consumer electronics market, estimated in US$3.1 billion in 1986, the foreign firms operating in Manaus exported only US$2.6 million in the previous year (7), thus showing that two decades of "free market policies" did not provide a base for international competitiveness. The contrasting strategies pursued by computer and consumer electronics firms clearly show that when the free flow of technology is permitted, either by direct foreign investment or by passive reliance on continuous licensing, the local capability to create know-how may not develop at all. The Argentinian case described by Nochteff (1984) is quite similar to this. Chicago inspired free-market policies adopted by the militar regime destroyed in the mid 1970's the existing electronics industry by opening the market to imports.

Local technology development does not imply the notion of autarchy and isolation. On the contrary, foreign investment and technology licensing and cooperation have an important role to play in Latin American high tech industry. Flamm (1988) showed that economies of scale in the use of research tended to be a driving force in the economics of the electronics industry, since the cost of developing a new product is usually independent of the volume in which that product is finally manufactured. In several segments of the electronics market such as mainframe computers, microprocessor design and manufacturing, and large telephone switching systems, international leaders have their own proprietary standards and the technological capabilities and R&D investment required for developing new products are a major barrier for new entry in the industry. Also, in design intensive, specialized market segments such as robots, CAD/CAM, Winchester disk drives and other sophisticated peripherals, local developments in Brazil failed to provide an alternative to licensed technology, since the narrowness of the local market does not provide opportunities to pay-off R&D costs.

However, successful acquisition of foreign technology is a bargaining process which requires, among other factors, local

technical capabilities, firms committed to the learning process and adequate government policies. Freeman (1974) noted that simply to assimilate any sophisticated technology today, and operate it efficiently, requires some independent capacity for R&D, even if this is mainly adaptative R&D. Local firms must develop capabilities to understand state-of-the-art technology and establish overseas links for mutual cooperation rather than just obtain manufacturing licenses for usually outdated products. Rapid technological change has pushed electronic firms worldwide to release key technological information during the product development phase in a strategy designed to anticipate future integration with suppliers and downstream industry. Participating in the so-called "forward engineering" network (in contrast with reverse engineering) is essential to induce technology updating (See Ripper, 1988).

As far as direct foreign investment is concerned, state policy initiatives are essential to induce MNs to export and to reinforce links with local firms. In Mexico, IBM substantialy improved the conditions to manufature microcomputers locally after the government rejection of its first proposal in 1985. In the new proposal IBM agreed to export 92% of its production; to establish a semiconductor development center and to limit its level of domestic sales of microcomputer to 30% of the Mexican market (see Cline, 1987:84). In Brazil, restrictions on foreign investment also gave bargaining power to computer authorities to require MNs to export a large proportion of their output, in return for access to the local mainframe market. It also induced IBM to search for cooperation with local manufacturers, including pure licensing agreements and joint product development (8). The Mexican and Brazilian experience in dealing with computer MNs suggests that, at least with respect to exports and technology transfer, intelligent and aggressive state policies can extract some benefits from MNs for the local industry which may not be obtained in its absence.

The development of a high-tech industry in Latin America should include a flexible range of policies aimed at combining different technology sources, according to local market segment

size, technological capabilities and technical and economical barriers of entry. Despite low level of overall R&D expenditure (the largest countries in the region spend less than 1% of their GNP in science and technology), and market size, Latin American countries face opportunities to develop new competitive advantages in manufacturing. This requires a higher commitment to training, selective R&D, and favourable integration in overseas business and technology cooperation networks.

NOTES

1) Naciones Unidas, Division Conjunta CEPAL/ONUDI de Industria e Tecnologia. "Industrializacion y Desarrollo Tecnologico". Informe n.4, pp.20.

2) The Hanna Mining Co. forecast that lead and nickel prices will remain stagnant till the end of the century and that the average consumption of iron ore in the US during the 1990's will be only 74 million tons, against 109 million in 1979. (See Business Week, "The Death of Mining", cover story, 1984).

3) Freeman (1987) has pointed to the increasing importance of technology for trade performance. Referring to recent empirical and theoretical work, he concluded that price is of decisive importance only for homogeneous primary commodities and bulk chemicals traded in intrnationally competitive markets or subjected to relatively simple processing or refining. But in most capital goods markets and for many consumer goods, factors such as quality variety related to design, technical service, reputation, and marketing play a more important role.

4) In 1988, export of automobiles in Brazil reached US$ 3 billions, and this is now the single most important Brazilian export product.

5) Quoted from Miller, 1986:176, referring to a personal interview with Josef Warman Grig.

6) Sales of COBRA 500 minicomputer line totaled about 3,500 units in 5 years, against less than 50 units of Data General's 4000/8000 line produced under license. EDISA sold about 500 units of the 68010 Motorola based microcomputer in the first year (1986) only.

7) See Baptista, 1987.

8) In October 1988, IBM licensed SID to manufacture a Communication Control Unit. This was the first pure licensing agreement made by IBM in Brazil. In the same year, IBM started to market a Tape Drive unit jointly developed with Brazilian manufacturer Conpart.

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