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BRAZIL MEETS THE GLOBAL CHALLENGE: IT POLICY IN A POST-LIBERALIZATION ENVIRONMENT

Short title: Impacts of Liberalization on Brazil's IT Policies

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Abstract

Since the early 1990s, Brazilian IT policy has changed substantially from greenhouse protectionism in selected segments of the market to a more liberal regime. This paper analyses the impact of liberalization on IT equipment production, diffusion, employment and foreign trade. There were both benefits and setbacks, depending on the aspect analyzed. Users benefited from greater access to imported equipment, which could eventually contribute to productivity growth in the overall economy. On the negative side, there was a loss of local linkages with internal sources of components, technology and employment. The paper concludes that the future of the Brazilian IT industry does not seem to be in commodity hardware production. Rather, it lies in design- and engineering-intensive applications. Such “production close to use” can spur domestic use as well as create business opportunities for domestically owned companies in markets not dominated by foreign multinationals.

Keywords

IT industry, IT diffusion, industrial and technology policy, developing countries, Internet, Brazil, Mercosur.

I. INTRODUCTION

There has been a lot of discussion about factors behind success and failure in the global computer industry. Some economists argue that industrial success is a function of liberal economic systems and open markets leading to optimum resource allocation. There is, however, plenty of evidence showing that no country has become an important player in this industry without some level of government support (e.g. Evans, 1995; Dedrick and Kraemer, 1998; Amsden, 1989).[2] Among developing countries, Brazil and India were pioneers in implementing government policies to promote the entrance of national enterprises into selected segments of the computer industry in the late 1970s (see Evans, 1995). Brazilian informatics policy was based on the creation of a "greenhouse" to nurture locally-owned companies, protecting them from direct imports and competition with world industry leaders in a relatively large and fast- growing internal market. Protection was restricted to the low end of the computer market.[3] In return, greenhouse firms were committed to indigenous technology development and could not source

[2] Even the US government, which opposes industrial policies in world forums, has implemented policies to promote the development of advanced technologies at home through national security agencies. Recently, policies towards the diffusion of high-tech industries has become more explicit through President Clinton's National Information Infrastructure projects.

[3] The market for minicomputers and peripheral equipment was reserved to local firms in a time when mainframes still dominated the market. Microcomputers were later included.

from external technology suppliers when local design and manufacturing capabilities were available. By the end of the 1980s, Brazil had a set of diversified IT corporations with significant presence in the local market.

When restrictions to foreign ownership and imports were abolished in the early 1990s, most domestic computer firms could not survive independently. Foreign competition in the domestic market forced local firms into specialized niches or towards the service end of the IT business. Consequently, the content of locally manufactured components and the use of indigenous technology in hardware and software declined sharply. A new informatics policy introduced in 1991 (Law 8.248/91) aimed at keeping some local manufacturing and supporting R&D activities. Protection was replaced by incentives and tax rebates.

After almost ten years of more liberal policies, there have been increasing concerns among policy makers, academics and industry analysts about the impacts of liberalization on IT use and production. While the former "market reserve policy" has been widely studied, the impacts of more recent policy have not yet been fully analyzed.[4] This paper is a further contribution to the evaluation of this policy from the point of view of IT diffusion, the development local industry, technological capabilities and foreign trade.[5] It argues that despite the fact that Brazil did not become an international player in global IT markets, continued state involvement has produced substantial fruits. It has revealed local capabilities in areas that require highly skilled professionals rather than unskilled labor, as the conventional international product

[4] Cassiolato and Baptista (1996), Mazzeo (1999) and Campos (1998) are a few of the exceptions.

[5] Recent empirical data on industry and technology development (e.g. MCT/SEPIN, 1998) helps to illuminate the results of a decade of liberalization of the local market, and of the introduction of a new set of incentives as substitutes for greenhouse protection.

cycle in the international division of labor would suggest. Greenhouse policy in the past led the Brazilian IT sector to invest "significantly in the accumulation of technological capabilities and develop important backward linkages" (Cassiolato and Baptista, 1996). The user-supplier relations established by local firms in areas like banking automation still engender important R&D efforts, contributing to the diffusion of IT in line with local needs. Also, the previous existence of both industrial capacity and a skilled workforce have become a driving force in attracting new foreign direct investment in IT production in Brazil to serve the Latin American market.

Recent policy as well as industrial and trade developments in the Brazilian IT industry, particularly their conflicting outcomes, provide a fresh perspective on this ongoing debate. A review of industrial policy and its endurance in light of broader liberal economic policies allows us to further assess its mediating impact on the industry structure and companies' strategies. By analyzing the effect of liberalization on the rate of computer diffusion, one can assess its contribution to the development of an information society.

II. POLITICAL AND ECONOMIC ENVIRONMENT

Brazilian politics have been in a period of relative stability since the early 1990s. The ongoing democratization, begun already in the late 1970s, was further consolidated by economic stability brought about by the end of inflation with the 1994 Real Plan. Even before then, the Brazilian state had begun reducing its economic role. Economic liberalization policies had already started in the Collor government, and continued to be pursued in the following governments. Privatization of state enterprises at both federal and state levels gained impetus from 1996 and has been completed in most sectors. The cumulative share of foreign capital in the privatization

process grew steadily over the period 1996–1998, when it reached 42% in all industries.[6] Over the last decade Brazil has joined major multilateral trade agreements, such as the World Trade Organization (WTO), and spearheaded the development of the Mercosur Free Trade area (Brazil, Argentina, Uruguay and Paraguay).

The 1994 Real Plan, Brazil's stabilization plan, was based on an economic strategy which linked the local currency (Real) to the dollar at a relatively fixed rate. This provided a basis for stopping the inflationary spiral. Trade liberalization followed, contributing to an increase in the internal supply of goods by reducing the demand pressure on prices. As shown in Table 1, inflation rates fell from more than 2,000% a year in 1993 and 1994, to only 6% a year in 1997. However, residual inflation in the initial years (1994 and 1995) of the Real Plan, due to the increase in prices of non-tradable goods and services, was not fully compensated by the exchange rate, resulting in an overvaluation of the Brazilian currency. Increasing demand for imports turned a historically positive trade balance into a negative one. Following a historical cycle, the deficit in the balance of payments, which stood at 4.5% of the GNP in 1998, became a major problem again. In order to attract foreign resources to close the gap, interest rates are among the highest in the world. The future of the Brazilian economy is not yet clear, despite the promising results of a January 1999 devaluation.

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One of the main impacts of overall liberalization on the Brazilian economy in recent years has been a growth in foreign direct investment, from a mere US$2.8 billion in 1992 to

[6] Sociedade Brasileira de Estudos de Empresas Transacionais e da Globalização (SOBEET), cited in Arbex (1998).

US$22 billion in 1998 (for a total of $46 billion in 1996–1998). Between 1999 and 2002, total investment in telecommunication and electricity services is expected to reach US$80 billion.

III. INDUSTRIAL AND TECHNOLOGY POLICY

Since the early 1990s, the country's industrial policy has been shifting towards a more liberal regime. Local industry progressively lost its greenhouse protection and became exposed to international competition. The strategic response by firms facing competition from imports in the local market led to a downgrading of Brazilian specialization in the international division of labor (Cassiolato and Baptista, 1996). This trend had a major impact on the more advanced sector of electronic equipment. From 1980 to 1994 its weight in the overall industrial sector decreased from 10% to 8%.

The current Brazilian policy for the IT industry epitomizes this shift from protectionism to liberalism. The IT policies prevailing in the 1980s were oriented towards local production and general development of technological capabilities. The outcome of a decade of protectionism was a locally owned industry manufacturing a wide range of hardware and also designing software, both for the local market. At this time minicomputers were largely used and the manufacturing scale did not yet constitute an important competitive edge as it does today for PCs. By the end of the 1980s local production of IT equipment (including telecommunications) had reached US$7 billion, with a high degree of local content both in technology and components. The liberalization of the IT market for imports and foreign investments in the 1990s altered the industry structure. International IT leaders gradually took over most existing firms and turned away from local design and manufacturing to imports. The surviving locally-owned firms were those oriented toward niche markets, client-specific software, and telecommunication

equipment, where the client-supplier relationship was strong enough to withstand foreign competition (La Rovere, Tigre and Fagundes, 1996).

The 1991 policy (Law 8.248/91) was aimed at establishing alternative mechanisms to preserve some local equipment manufacturing and R&D activities in the IT sector. The policy consisted of four types of incentives. First, fiscal benefits available until 1999 consisted of a waiver on the IPI (industrialized goods tax) resulting in a reduction of 15% in the final cost of production. Second, a discount of 50% on income tax of R&D expenditures was available to firms in all industrial sectors. Recent measures, however, restricted this incentive to up to 4% of total income tax. Third, in order to provide support for new capital investment, a discount of 1% of the income tax payable by companies investing in IT firms was available until 1997. Fourth, government procurement policy favors the acquisition of IT goods developed and produced in Brazil, as long as they have similar prices to imported equipment. By 1997, 248 firms had benefited from these measures. Part of the firms' R&D expenses were channeled to government-sponsored R&D programs.

In 1999, the IPI rebate was further extended by Congress until the year 2013, with a scheduled reduction of fiscal incentives. The waiver on the IPI will be progressively reduced, from 100% in 1999 to 57% in 2013. In order for firms to take advantage of the fiscal benefits, the legislation required the following complementary actions by firms:

- Firms must invest at least 5% of a company's revenues from IT products (excluding software and professional services) in R&D activities, of which 2% must be through joint projects with universities, research institutes or in government sanctioned programs in IT.
- Manufacturing firms are to comply with the "Basic Productive Process," which is a set of production steps defined for each class of product. This production phase is considered to be

the borderline between imports and local manufacturing. In PCs, for example, most firms assemble the motherboard in Brazil as a minimum standard of value added in order to qualify for fiscal benefits.

- Firms are required to comply with quality standards by obtaining ISO 9000 certification.

The extension of existing fiscal incentives was in part justified by the persistence of a large gray market for IT products. Tax exemptions in IT-related programs amounted to R$600 million in 1997, but smuggled products pay no taxes. There is in fact a trade-off between fiscal incentives and balance of payments. Higher taxes may act as a stimulus to the smuggling of computers, as well as prevent locally produced computer prices from falling.

Other programs based on "positive" policy mechanisms include the National Research Network (RNP in Portuguese) and Softex 2000. RNP aimed at developing Internet links among science and technology institutions, and has also boosted commercial use of the Internet by providing infrastructure and technical capabilities. In 1997, RNP invested $20 million in local IT service providers, schools, and infrastructure such as high-speed backbones, and in linking universities and business centers. The project is now shifting to academic and social use through Internet II, since private backbones are now available to support electronic commerce.

The program for software exports (Softex 2000) was introduced in 1993 with ambitious aims: to capture 1% of the world software market, corresponding to US$2 billion in exports through the year 2000, in addition to local firms capturing a 50% share of the national market. The program includes the formation of regional centers to stimulate cooperation among small software firms, the installation of marketing offices overseas (USA, Germany, Argentina, China) in order to support Brazilian firms' export efforts, and provision of incentives for training IT professionals within firms. The program is now managed by a non-governmental organization.

The Softex 2000 results and prospects are controversial. Yet discounting its over-ambitious aims, the program is certainly contributing to greater exposure for local firms to the demands of international markets, providing a kind of "quality test" for products developed in Brazil.

Other government-sponsored R&D programs in IT are oriented towards building infrastructure and promoting joint projects between universities and private firms. The main results, according to the oversight agency CNPq, were the creation of a new cooperative research culture, the standardization of hardware and software platforms, and the provision of incentives for graduate programs in computer science, which expanded from 13 in 1990 to 20 in 1995.

As a member of Mercosur, Brazil is negotiating a common policy for international trade and industrial development for the IT sector with Argentina, Paraguay and Uruguay. So far an agreement has been reached that the countries' tariffs on imports from outside the Mercosur zone will converge to 16% in 2006. As Brazil is now the only country in the region with substantial IT production, its users do not benefit from the zero tariff now practiced on trade with its Mercosur partners. Brazil is unlikely to join the International Technology Agreement (ITA) proposed by the USA to eliminate all barriers on the IT products trade.

IV. IMPACTS OF LIBERALIZATION

The relationships between policy liberalization, industry development and IT diffusion are conflicting. There are both benefits and setbacks, depending on the aspect analyzed. The analysis of impacts of liberalization is divided into three segments. First the impacts on industry structure are presented. Despite widespread denationalization, industry structure changes are per se

classified as neither positive nor negative. Second, more positive aspects such as computer diffusion and user accessibility are discussed. Finally we present major setbacks related to employment, balance of trade and R&D activities.

Changes in Industrial Structure

The Brazilian computer industry structure has changed substantially in the liberalization decade, but the top three producers remain the same. Mainframe manufacturers like IBM and Unisys have lost market share to PC manufacturers. As shown in Table 2, IBM is still the leader followed by Brazilian-owned Itautec, Unisys, and Hewlett-Packard. With the end of the market reserve policy, most Brazilian-owned computer hardware firms disappeared, moved into other markets such as services and distribution, or were bought out by foreign firms entering the Brazilian market. Those that survived were either part of industrial and financial conglomerates (like Itautec and SID) or entered into joint ventures with foreign firms in order to gain access to new technologies.

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Microcomputers

In 1997 the Brazilian microcomputer market was over 1.2 million systems (worth US$2.5 billion), or 37% of total Latin American market. Local brands accounted for two thirds of the total, of which the gray market (which includes both smuggled products and products assembled by small firms from smuggled components) is responsible for over half. The market is extremely fragmented with very low levels of concentration, due mostly to the gray market, as shown in Table 3.

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Compaq, Itautec and IBM lead the Brazilian PC market. These firms are well established in the country and have their own manufacturing plants, R&D activities and service operations. The largest Brazilian-owned PC maker, Itautec, is part of a large industrial and banking conglomerate (Itausa) which also controls Philco (consumer electronics) and has its own semiconductor operations. Most other competitors have complete knock-down assembly or buy from OEMs. The PC market also faces stiff competition from the so-called gray market that has kept large foreign firms on their toes.

Competition in the Brazilian PC market is likely to become even stiffer with the entrance of new global heavyweights. Dell, for example, began producing computers in Brazil in the second half of 1999, using its direct sales, build-to-order business model. The gray market is now beginning to collapse, as customers recognize the importance of quality and after-sales services. Also, the introduction of cheaper system families to reach the lower-income residential market, and the increasing participation of low-cost distribution channels (such as supermarkets), are contributing to reduce the weight of the gray market.

The Brazilian market in the notebook sub-segment is still quite small, with just 100,000 units sold and revenues of $150 million (top five vendors) in 1997. However, gray market domination here is also much higher, about 65%, thanks to the ease of smuggling notebooks. Since local production began only in 1997, lower prices may push back the gray market in forthcoming years.

Market growth was accompanied by lower PC prices, which fell by half between 1992 and 1996. Vertical government markets—education, communications, etc.—are also becoming a significant niche as the acceleration of state reform promotes modernization. Households, offices, and small and medium enterprises are the most important segments for future market

growth. Estimates are that the computer use index of Brazilian SMEs will jump from 20% today to about 80% within four years.

Banking Automation

A market segment that led the growth of the Brazilian IT market throughout the market reserve policy era and beyond is banking automation. The size of the country, high inflation rates and the pattern of competition in the banking market encouraged Brazilian banks to adopt IT very early and to support the development of individual firms (Botelho, 1998). Not surprisingly it was from that segment that three Brazilian-owned IT manufacturing firms emerged—Procomp, SID and Itautec—which have survived the onslaught of foreign competition launched by the end of the market reserve and trade liberalization. The banks in 1998 spent US$2.06 billion in hardware, software and services, continuing an upward trend. Home banking and Internet banking together served 2.1 million personal clients and 338 thousand firms, representing 6% of the 42 million bank accounts in the country.

Peripheral Equipment and Components

A recent sign of the industry's rationalization has been the arrival of large parts, components and software distributors. The Brazilian IT distribution business was worth US$2.16 billion a year in 1999.

Yet another indicator of the global coming of age of the Brazilian IT industry is the rapid growth and internationalization of the board and component production segment. Global giants have acquired local firms or entered into partnership with local firms. Third-party contract manufacturing will increase in the near future following the international trend.

As Brazil’s end market grows, local peripheral production has attracted major companies. For example, in 1997 monitor production was close to US$600 million. In 1999, national firms

produced 900,000 monitors, led by Samsung with 400,000 units. National and foreign firms divided the 1997 market as shown in Table 4.

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In 1990, the national (foreign and domestic firms) production of components (for all electronics segments, including domestic appliances) had revenues of US$1.6 billion. By 1998, its revenues had fallen to a low US$1.3 billion.[7] The range of components produced by the industry also diminished significantly in the period.

Software

There are over 10,000 software firms, employing about 200,000 people, with total revenues of US$1.27 billion. Brazil is the largest packaged software market in Latin America and accounts for 36% of the Latin American software market. According to MCT/SEPIN (1998), the share of software in the overall IT industry has been progressing in the last few years, going from 16% in 1991 to 21% in 1997. The industry exported about US$40 million in 1998 and is expected to reach US$60 million in 1999.

Small firms dominate, but again a few foreign giants have come to take the leadership in a highly fragmented market. Datasul of Santa Catarina is the largest national software firm with expected revenues in 1998 of US$70 million.

Impacts on IT Diffusion

In 1997, according to MCT/SEPIN (1998), the total Brazilian IT market was worth US$15 billion (see Table 5). From 1991, when market liberalization began, to 1997, industry revenues grew 16.1% per year, whereas imports of assembled products expanded by 21.6% per year. In

[7] ABINEE in Mattos (1999).

the meantime exports remained flat. During this period the import increase was due mainly to the import of final products, which accounted for 54% of total imports in 1995. In the IT hardware segment, one observed an increase in the local production of systems and importation of peripherals.

******INSERT TABLE 5 HERE******

The boom in IT spending is a result of the Real Plan, since under stable macroeconomic conditions companies could better calculate the costs and benefits of such investments, and could enable credit for consumers. EDP equipment accounts for about US$7.5 billion of the Brazilian IT market. This makes the country a major emerging market among developing countries. Still, some market segments remain very underdeveloped, such as industrial automation.

As shown in Table 6 below, the IT market in Brazil has grown faster than the GDP in the course of the 1990s (1991–1997). Although the IT market's share of the GDP has fluctuated over the period, it has increased over the last few years. IT diffusion is positive because it can contribute to economic development. Economists like Gordon (1999) argue that the IT industry accounts for nearly all of the productivity growth in the economy. According to the US Department of Commerce, the IT industry accounts for one third of the GNP growth in the USA.

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In 1998 Brazil had 6.8 million PCs, almost equivalent to China and India together (see Table 7). Brazil has 8.4 PCs per US$ billion of GNP, a relatively higher diffusion rate than in the average developing country and even Japan. This is an indication that computer diffusion is high compared to the level of development. In per capita terms, however, computer diffusion is only one-fifth of the average in developed countries. But it is similar to Argentina, which has as higher per capita income. The future of computer diffusion in Brazil will depend on increases in

the income levels of the poorest segments of the population, and/or on government programs to equip schools, clinics and other social institutions.

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Prices

Import liberalization had a positive impact on market growth, since it contributed to a drop in prices for computers. Price reductions are observed worldwide due to technological innovation and increased competition, and must be analyzed in relative terms, taking the USA as a benchmark. Prices actually began to drop even before the end of market reserve, due to competition and lower taxes. Tigre (1992) shows that between 1985 and 1989, the price differentials between Brazil and the United States decreased for all IT products. In 1989, before the liberalization policies were initiated, prices of microcomputers in Brazil were only 15% higher than in England and France. Now PC prices in Brazil are similar to these European countries but are higher at retail than in the USA, since taxes and high margins in the channel add to the gap.

Software availability

New regulations protecting software copyrights were introduced in early 1998, responding to long-standing US government demands (Bastos, 1992). This reinforced guarantees to foreign suppliers, which are now serving Brazilian markets better. Leading international software firms now have local subsidiaries and often cooperate with local firms. Joint developments are being undertaken to translate software into Portuguese, to develop local applications, and to provide better user support services. Many foreign IT firms (especially in hardware, but in increasing numbers in software) are investing in R&D locally in order to take advantage of fiscal incentives and the availability of a qualified workforce.

Internet Diffusion

The Internet is a US$2–3 billion business in Brazil, including access, site hosting, hardware, software, telecommunications, and personnel. Over 2 million people are connected, and the number of Internet service providers and information providers grew rapidly since the commercial use of the Internet was authorized in September 1996 (see Table 8). At the top, there has been some rationalization among the major providers, often connected to media groups. The largest service provider, Universo Online, is itself the product of a fusion between services established by two such groups (the newspaper-based media group Folha de São Paulo and the publishing giant Editora Abril).

The Internet market has been undergoing considerable rationalization, as large foreign competitors enter the market. Expansion and quality improvement in the telecommunications network will contribute to the diffusion of the Internet. New technologies for access, such as the introduction of cable modems in the latter part of 1999, will also stimulate diffusion.

The number of Internet hosts experienced a geometric growth, from 800 in 1995 to 77,148 in 1997. This corresponds to the sum of six other larger Latin American countries, placing Brazil in the 19th position worldwide. Similarly, the number of registered domains jumped from 24,173 in September 1997 (according to the Internet Steering Committee) to 67,407 in December 1998 (according to the Fundação de Amparo à Pesquisa do Estado de São Paulo [FAPESP], Brazil's domain registration clearinghouse). In 1997, Internet advertisement

represented US$12–15 million, jumping to US$25 million in 1998. Estimates are that in 1999, the volume will be on the order of US$40–100 million.[8]

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Although liberalization can claim to help Internet diffusion in Brazil by facilitating the global information flow, we must also recognize the positive role played by former policies. A major factor behind Brazil's rapid Internet diffusion is the technological capabilities accumulated during the market reserve policy, when tens of thousands of engineers were involved in R&D activities. Although Internet technology was not yet available in the 1980s, more general IT capabilities accumulated in Brazil were key to the absorption of new technological capabilities. Many engineers formerly involved in R&D activities are now involved in Internet-related businesses. Also, the technological capabilities acquired in telecommunications research centers like CPqD were key to the diffusion of the Internet in Brazil. The former policy had created technical capabilities in hardware and software design and manufacturing, which now support new ventures. It can be noted that the Internet is progressively becoming a domestic communication tool rather than just a way to communicate internationally. In 1995, over 95% of the Internet flow in Brazil was international (Brazilian users connecting to overseas web addresses), while in 1997 more than 40% of the traffic became domestic as more local sites became available.

[8] In 1999 it was estimated that 3.2 million people in Brazil were using the Internet. At that time there were 8.5 million PCs in use in Brazil, of which about a million were connected to the Internet. In 2001, analysts estimate that there will be 7 million Internet users in Brazil.

Economic and Social Impacts

Employment

As Table 9 shows, in 1998 the IT industry employed 100,100 people, an absolute loss compared to the 129,615 jobs provided by the industry a decade before. In relative terms, employment fell by two thirds, from 22 employees per million dollars of sales in 1988 to only 7 in 1998. There are at least two explanations for such a job loss. First, productivity has increased sharply from the times of market reserve, as a result of the decline in vertical integration and the use of new technology. However, this is a worldwide industry trend and should not be attributed only to import liberalization. Second, locally owned firms which were displaced from industry tended to employ more, in relative terms, than subsidiaries of foreign firms, since some activities like R&D are undertaken mainly at home. American computer firms employ 7 people per million dollars of sales in the USA, but only two employees per million dollars in their overseas subsidiaries.

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In a large number of cases, however, the highly qualified Brazilian IT workforce did not become idle. Displaced professionals often established their own businesses in market-oriented areas such as sales, technical services, software, and system integration. These firms are usually small, often run by self-employed engineers working informally for small firms and individual clients whose activities are not captured by the available statistics. Another part of the highly qualified workforce is moving overseas to work in fast-growing American firms. Skilled R&D engineers are recruited in Brazil to work in local branches of US corporations, and are then transferred overseas. Direct recruitment also occurs, as demonstrated by recent ads in the local press recruiting software Ph.D.s to work in the USA. For Brazil this highly qualified workforce

migration is a double-edged sword: on the one hand it represents a brain drain of scarce human resources; on the other, professionals working in advanced R&D centers may acquire experience for the future development of the Brazilian computer industry. As the Taiwan case shows, building personal and institutional connections and acquiring business experience in leading IT industry clusters like the Silicon Valley and Route 128 may provide a learning opportunity for professionals who end up returning to their home countries (Dedrick and Kraemer, 1998).

Balance of Trade

A major problem has been the growing deficit in the sector's balance of trade. From 1992 to 1997, the trade deficit in the IT and electronics industries grew sevenfold, from less than US$1 billion to about US$6.5 billion, as shown in Table 10. In 1998, when the overall electronics industry deficit fell slightly to US$5 billion, the computer trade deficit alone reached US$1.3 billion, moving against the overall industry trend, aided by growing imports and flat export growth. The incentive policy requirement that local manufacturing firms comply with the basic production process does not guarantee the use of locally manufactured components, which are often not produced in the country anyway. Firms can comply with policy requirements by simply assembling imported components in CKD mode.

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This deficit has been the result of lowering tariffs on computer products and eliminating non-tariff barriers. Duties on components dropped from 35% to 19%, but tariffs on inputs not produced in Brazil range from zero to 5%. Production costs are estimated to be around 30% higher than production in Asia and elsewhere. The higher cost is a result of employee benefits (which run as high as 100% of wages), various import duties and sales taxes, and an inefficient customs service, which can take 20 days to clear a shipment of components.

There is a great deal of concern among Brazilian government agencies like SEPIN and BNDES over the growing trade deficit in electronics. The government hopes to reduce the deficit by promoting exports and attracting suppliers of high-volume components such as motherboards, CRTs, disk drives, CD-ROMs and semiconductors. Firms such as Compaq, HP and IBM, which are market leaders in Latin America, concentrate some of their manufacturing operations in Brazil, especially for domestic demand and export to other Mercosur countries because products from Brazil can be exported to Argentina, Paraguay and Uruguay duty free.

Brazilian IT exports doubled between 1994 and 1997. However, this represents only 4% of total IT production, a percentage still lower than in 1986 when the ratio of external sales to total sales was 7.9% (Frischtak, 1992:166). Foreign-owned firms like IBM and Unisys, under a policy that required foreign firms to keep a balanced external trade, did most of the exporting during the market reserve policy. In the absence of such rules and with the decline of mainframe markets, computer exports from Brazil became unimportant in the early 1990s. Current exports are based on microcomputers ($311 million in 1997) and telecommunication equipment, mostly to Mercosur (42%), NAFTA (21%) and the Andean Group (16%) in 1997.

Compaq is now the leading exporter, with an estimated total of 230,000 PCs in 1998. As a major exporter, it has had significant cost benefits from its bonded warehouse. The warehouse allows it to import a component and store it without going through customs inspection or paying tariffs; the components are then re-exported as part of an assembled product.

Research and Development

During the 1980s, R&D investments were undertaken locally because technology transfer agreements were difficult to obtain. Government policy restricted the import of technology when local capabilities were available. Also, international market leaders were reluctant to release key

technology to a protected market to which they had little direct access.[9] Therefore, local firms usually developed their own products based on reverse-engineering or in-house design. Also, local R&D was oriented towards local idiosyncratic needs, as the case of financial automation shows.

Despite its more liberal principles, the new informatics policy (Law 8.248/91) aimed at sustaining local technological efforts through fiscal incentives, achieving some success in recent years. In 1997, the Brazilian IT industry invested 4.8% of total sales in R&D activities (see Table 11), a percentage comparable to Taiwanese (4.6%) and Korean (3.7%) computer industries (Dedrick and Kraemer, 1998:236). According to SEPIN, the top 30 firms account for 90% of total R&D activities. About two thirds of firms' R&D activities are done in-house, while the balance is done under cooperation agreements with universities or else goes to government priority R&D programs like RNP and Softex 2000.

It can be argued, however, that a substantial part of this R&D investment is simply customization or adaptation of imported designs to local needs. Almost half of total R&D expenses are in system and software development. System development is an activity oriented to serve individual users' needs and is usually based on standard hardware and software platforms. This kind of development does not require sophisticated technology. Cassiolato and Baptista (1996:71) argue that "R&D teams were dismantled and technology strategy of firms shifted

[9]AT&T for example refused to license UNIX to Brazilian firms, since it considered that local regulations on software proprietary rights were not safe enough. As a consequence, Cobra Computadores developed its own version of a UNIX-compatible operating system (see Evans 1995:137).

completely. Instead of internal development, these strategies started to be based on the setting up of several contractual arrangements with foreign suppliers of technology."

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VI. CONCLUSIONS

The results of almost a decade of IT policy characterized by market liberalization and fiscal incentives for local production and R&D activities are controversial. This paper has shown that there are both benefits and setbacks, depending on the aspect analyzed. Benefits for final users include a wider choice of products, at better prices. Firms now have better access to technology, as major international suppliers are present in the local market either directly or through local representatives. Computer diffusion has been promoted by the combination of a liberal import policy with an overvalued local currency, at least until the January 1999 devaluation.

The IT policy has produced some positive, although modest results. Special government-sponsored programs like RNP for Internet diffusion have been successful in boosting the infrastructure for hooking millions of users to the web. Software exports are being supported through Softex 2000, an experience that may reap important benefits in the future not as a hard-currency source but rather as quality benchmarking for locally produced software.

Also, R&D and local manufacturing incentives appear to have created a better environment for Brazil to become a regional IT production center. Already several major computer hardware firms have located regional production centers in the country. This has slowly begun to attract major component suppliers—the weak link in the local production chain—as well as major parts distributors and specialized contract manufacturers. The ongoing rationalization in production is increasing in scale and might spur the emergence of a local components industry. The extent to which Brazil will become a regional supply center for South

America would depend on policy coordination with other Mercosur countries. Argentina, Uruguay and Chile do not produce hardware anymore and are becoming a market for Brazil IT exports. In return they are increasing their software industry, and Brazil can represent an important preferential market for their software exports. A positive approach to integration is the rejection of the International Technology Agreement (ITA) by Latin American countries.[10] Joining ITA would represent giving up any attempt to develop a local electronics industry.

As for the setbacks, the IT policies in the 1990s have been unable to cope with important problems affecting IT production. This includes the deterioration of local linkages in production, resulting in a loss of the content of locally produced inputs and employment opportunities. Component suppliers who existed in the previous regime did not survive the winds of competition once the market was opened. In fact, component production, then and now, has not garnered much attention from IT policymakers. Another major setback is the spiraling increase in the balance of trade deficit.

Brazil has yet to realize its potential as a regional export-oriented production center. The removal of the barrier of the overvalued currency in January 1999 may help to turn this export potential into reality. However, as long as much of this export potential remains centered strictly on the Mercosur market, it will be limited by a low ceiling and menaced by trade wars, as the recent trade tiffs between the two main commercial partners demonstrate. In addition, it remains to be seen whether this export-led production growth will attract sufficient parts and component producers to stave off a mushrooming trade deficit.

The future of the Brazilian IT industry does not seem to be in commodity hardware production. In Latin America, Mexico is in a much better position than Brazil to develop a large-

[10]Costa Rica, which received massive investments from Intel, and Panama are exceptions.

scale exporting industry. After looking at local firms' success in financial automation, Botelho (1988), Frischtak (1989), Cassiolato (1992), and Evans (1995) shared the opinion that Brazil's real comparative advantage lay in design- and engineering-intensive applications rather than in manufacturing per se. The evidence collected in this study gives support to this conclusion. For example, in the country's 1998 presidential elections, a locally designed electronic voting system accounted for 35% of total votes, thus preventing fraud. In 1999, close to two million income tax filings were done through the Internet. In both cases, original local innovations were the key to success. Given the size of the domestic market, there are good opportunities to produce software and services aimed at local users, especially if domestic use is encouraged. Such "production close to use" can spur domestic use as well as create business opportunities for domestically owned companies in markets not dominated by foreign multinationals. In addition, this strategy avoids increased technological competition on the hardware side of the computer industry (Bresnahan and Greenstein, 1999).

Finally, in a decade characterized by deep structural changes, computer industry evolution cannot be analyzed in isolation from broader economic and industrial policies. Economic reforms have changed the country's industrial specialization pattern in the global market. Brazil has reduced its role in the production of advanced manufacturing products like capital goods, while increasing exports of semi-manufactured commodities (Laplane and Sarti, 1997). The longer this trade strategy continues the greater will be industry's structural weakness. The future of the local computer industry will therefore depend on its interaction with government policies concerning not only sector-specific incentives, but also broader policies. These include macroeconomic policies (mainly exchange rates), infrastructure development (both telecommunications and higher education), regional and international agreements in trade

and services, and government procurement policy to promote local innovation in applications with high social and economic returns.

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*** *TABLES* ***

Table 1: Brazil's Recent Economic Performance

	1991	1992	1993	1994	1995	1996	1997	1998[a]	1994/97[b]	1981/90[b]	1991/97[b]
GNP growth	0.1	-1.1	4.4	5.7	3.9	3.1	3.7	1.5	4.1	1.3	2.8
GNP per capita growth	-1.5	-2.6	3	4.2	2.5	1.8	2.3	0.1	2.7	-0.7	1.3
Inflation rate (%/y)	-	991	2111	2166	59.7	15.5	6.0	2.5	-	-	-

[a]Estimates.

[b]Average annual growth.

Source: MPO/IBGE (1998) and International Monetary Fund (1998).

Table 2: Structure of the Brazilian Computer Industry in 1986 and 1997

Firm	Market-Share 1986	Market-Share 1997	Difference
IBM	34.4%	20.0%	- 14.4%
Itautec	5.2%	6.3%	+ 1.1%
Unisys	9.9%	6.2%	- 3.7%
Cobra	4.6%	less than 1%	
HP	N/A	5.3%	
Market size ($ million)	2.126	6.384	

Source: 1986: *Anuário Informática Hoje* 1987/88. 1997: Confidential industry sources.

Table 3: PC Market Share in Brazil, 1997

Company	Units	Market Share (in %)	PC Revenues (in US$ millions)	Market Share (in %)
Compaq (USA)	132,609	10.4	293.1	11.4
Itautec (Brazil)	87,135	6.8	203.9	7.9
IBM Brasil (USA)	73,231	5.6	183.6	7.2
UIS (Brazil)	63,238	4.9	108.6	4.2
Tropcom (Brazil)	59,867	4.7	136.6	5.3
Byte On (Brazil)	43,542	3.4	71.2	2.8
Hewlett-Packard (USA)	39,453	3.1	86.7	3.4
Microtec (Brazil)	36,980	2.9	74.4	2.9
Fivestar (Brazil)	36,764	2.9	74.7	2.9
Acer (Taiwan)	31,638	2.5	78.9	3.1
Others	675,478	52.8	1,254.9	48.9
Total	1,279,935	100.0	2,566.6	100.0

Source: International Data Corporation cited in Crespo (1998).

Table 4: Brazil Monitor Production Ranking – 1997

Company	**Segment Sales** (US$ million)	**Market Share** (%)
Samsung (S. Korea)	98.9	17.8
TCE (Brazil)	78.0	14.0
Philips (Netherlands)	56.7	10.2
LG Electronics (S. Korea)	38.7	6.0
Videocompo (Brazil)	24.7	4.6
Sony (Japan)	15.3	2.8
Metron (Brazil)	14.5	2.6
Waytec (Brazil)	7.8	1.4
PCI (Brazil)	8.7	1.6
Others	210.9	37.0
Total	555.3	100.0

Source: JP Consultores Associados in Mattos and França (1998).

Table 5: The Brazilian IT Market, 1991–1997 (in US$ billions)

Segment A	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**[a]	**Average Annual Growth 91–97 (%)**
Hardware	4.1	4.5	4.5	4.9	5.9	6.9	7.5	12.8
Technical services	1.9	2.2	2.4	3.1	3.5	3.9	4.3	17.7
Software (packaged and custom)	1.1	1.2	1.5	1.8	1.9	2.8	3.2	23.8
Total	**7.1**	**7.9**	**8.4**	**9.8**	**11.3**	**13.6**	**15.0**	**16.1**

[a]1997 estimate.

Source: MCT/SEPIN (1998).

Table 6: IT Diffusion and Economic Development in Brazil, 1991–1997[a]

	1991	1992	1993	1994	1995	1996	1997
GDP	441	438	456	482	502	516	531
Real GDP growth (%)	-	-0.5	4.9	5.9	4.2	2.8	3.0
IT market	7.1	8.0	8.4	9.8	11.3	13.6	15.0
IT market growth (%)	-17	13	5	17	15	20	10
IT as percentage of GDP (%)	1.6	1.8	1.8	2.0	2.2	2.6	2.8

[a]GDP and IT market in US$ billions.

Source: Authors' elaboration from MCT/SEPIN (1998) and International Monetary Fund data.

Table 7: PCs Per Capita and as Percentage of GNP (1998)

Country	PCs (millions)	PCs/US$ billion of GNP	PCs/100 inhabitants
USA	99.2	12,328	36.9
Japan	19.5	3,297	15.4
Italy	8.5	6,757	14.7
Average developed	42.4	7,460	22.3
Brazil	6.8	8,429	4.2
China	4.6	5,380	0.4
India	2.4	6,593	0.2
Mexico	3.7	12,657	3.7
Argentina	1.6	4,862	4.5
Colombia	1.3	14,602	3.5
Average developing	3.4	8,753	2.75
Korea	4.7	9,109	10.0
Taiwan	2.6	8,387	11.8
Average NICS	3.56	8,748	10.9

Source: Campos, Rui. *Informática no Brasil: Fatos e números* (vol. III, 1998).

Table 8: The World Wide Web in Brazil

	1996	1997	1998
Subscribers	0.3 million	0.8 million	1.6 million
Users	0.5 million	1.0 million	2.2 million
Service providers	-	-	321
Access points	-	-	865
Average prices (US$)	-	-	27.55
Market (US$)	-	-	400 million

Source: ABRANET (cited in *Gazeta Mercantil*, 14 January 1999), and França (1999).

"Average prices" refers to average bills for domestic subscribers

Table 9: Social and Economic Impacts of Liberalization

Indicator	**1988**	**1998**	**Difference**
1. Total employment	129,615	100,100	- 22,7%
2. Total sales (US$ million)	5,843	14,166[a]	+ 142%
3. Employment/$ million sales	22.18	7.07	- 68%
4. Exports (US$ million)	268	658	+ 146%
5. Imports	768	5,083	+ 561%
6. Trade deficit	500	4,425	+ 785%

[a]R$17 billion, converted to US dollars at average exchange rate of 1.2 reales to a dollar.

Sources: 1988 data: Secretaria Especial de Informática, *Panorama do Setor de Informática*, Series Estatísticas vol. 2 no. 1, August 1989. 1998 data: MCT/SEPIN, *Setor de tecnologias da informação. Resultados da Lei n. 8.248/91*, August 1998.

Table 10: Information Technologies and Electronics Balance of Trade (in US$ millions), 1992–98

Items	1992	1993	1994	1995	1996	1997	1998[a]
Imports	**1,772.1**	**2,521.7**	**3,518.4**	**5,395.6**	**6,487.8**	**7,617.7**	**3,207.9**
Data processing	561.1	779.4	983.8	1,278.5	1,436.1	1,493.4	705.8
Consumer electronics	231.2	407.5	621.6	1,027.1	1,039.2	1,054.4	322.1
Telecommunication	392.1	567.6	854.5	1,360.1	1,958.5	2,740.2	1,180.0
Components	567.0	767.2	1,058.5	1,729.9	2,054.0	2,329.7	1,000.0
Exports	**801.8**	**829.4**	**791.3**	**859.7**	**1,005.3**	**1,157.2**	**593.2**
Data processing	196.6	172.2	141.0	187.6	278.3	264.7	113.4
Consumer electronics	334.3	368.6	367.9	377.5	386.0	411.6	204.7
Telecommunication	134.8	147.8	124.1	130.4	154.4	289.4	172.6
Components	136.1	140.8	158.3	164.2	186.6	191.5	102.5
Deficit	**-970.3**	**-1,692.3**	**-2,727.1**	**-4,535.9**	**-5,482.5**	**-6,460.5**	**-2,614.7**

[a]Through June.

Source: Secretaria de Comércio Exterior (SECEX).

Table 11: R&D Expenditure in the Brazilian IT private sector

Year	R&D expenditure (R$ million)	R&D as % of sales
1991	275	3.6
1992	312	3.6
1993	299	3.1
1994	377	4.3
1995	443	4.5
1996	536	4.4
1997[a]	642	4.8

[a]Preliminary data.

Source: Based on MCT/SEPIN (1998).