FROM INDUSTRY PROTECTION TO INDUSTRY PROMOTION: IT POLICY IN BRAZIL

CENTER FOR RESEARCH ON INFORMATION TECHNOLOGY AND ORGANIZATIONS
University of California, Irvine
3200 Berkeley Place
Irvine, California 92697-4650

OCTOBER 1999

AUTHORS:
Antonio José Junqueira Botelho
Pontifica Universidade Catolica do Rio de Janeiro (PUC-Rio)
email: abotelho@alum.mit.edu

Jason Dedrick and Kenneth L. Kraemer
Center for Research on Information Technology and Organizations
University of California, Irvine
email: jdedrick@uci.edu, kkraemer@uci.edu

Paulo Bastos Tigre
Universidade Federal do Rio de Janeiro (UFRJ)
email: ptigre@ie.ufrj.br

Authors listed alphabetically. This research has been supported by grants from the Sloan Foundation, the Computation and Social Systems Program in the Computer, Intelligent Systems and Engineering (CISE) Division and the International Program of the Social and Behavioral Sciences (SBE) Division of the U.S. National Science Foundation.

We would like to thank Simone Amaral for her helpful assistance in collecting data and in preparing tables and charts. We also would like to thank officials at ABINEE, MCT/SEPIN, FINEP and CNP as well IT industry company managers for their time and insights

Table of Contents

List of Figures

List of Tables

ABSTRACT

There has been a great deal of discussion about the factors behind success and failure in the global computer industry. Some 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. Thus, a more useful question to ask is what are the environmental variations - actors, opportunities, infrastructure and other resources available - iterating with industrial policies that facilitate industrial development in different national contexts. The interaction between IT policy, industrial structure and the global environment is critical. At the national level, this requires substantial coordination, organizational change and institutional partnerships. No country has been successful in developing such an industry in isolation, given the need for technology, sharing, trade and investment.

Among developing countries, Brazil pioneered in implementing government policies to promote the entrance of national enterprises into selected segments of the computer industry. This included 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. As a result, by the end of the 1980s Brazil had a set of diversified IT corporations with significant presence in the local market. By the early 1990s the protectionist policy began to be dismantled, in a context of increasing globalization and economic liberalization. Facing external competition, most firms disappeared, were sold out to foreign technology partners or other firms, or shifted into specialized niches or less competitive segments than hardware production. The content of locally-manufactured components and technology in IT production declined sharply.

Although liberalization has had negative consequences for Brazil's domestic computer industry, especially for hardware and components production, it has led to lower prices for computers and telecommunications services. This has stimulated dramatic growth in computer use and the spread of the Internet, which have produced benefits for computer users through increased productivity. Also, it has stimulated new jobs in software and information services, helping to compensate for the loss of jobs in the hardware sector.

From Industry Protection to Industry Promotion: IT Policy in Brazil

I. INTRODUCTION

The computer industry is very dynamic and technology-intensive, with production concentrated in a relatively small number of firms and countries. The PC era opened up a window of opportunity for countries with a highly qualified workforce and/or a large internal market. However, hardware production remains concentrated in the USA, Japan and a few Asian countries, particularly Taiwan and Singapore (Dedrick and Kraemer, 1998).

There has been a great deal of discussion about the 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[1] (e.g. Evans, 1995; Dedrick and Kraemer, 1998; Amsden, 1989). Thus, a more useful question to ask is what are the environmental variations -- actors, opportunities, infrastructure and other resources available – interacting with industrial policies that facilitate industrial development in different national contexts (Dore and Berger, 1996). The interaction between IT policy, industrial structure, and the global environment is critical. No country has been successful in developing such an industry in isolation, given the need for technology sharing, trade and investment.

Among developing countries, Brazil pioneered in implementing government policies to promote the entrance of national enterprises into selected segments of the computer industry. The so-called market reserve policy created a "greenhouse" environment 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. As a result, by the end of the 1980s Brazil had a set of diversified IT corporations with significant presence in the local market. The output of local computer hardware producers grew from less than $200 million in 1979 to more than $4 billion in 1990 (Evans, 1992). However, by the early 1990s the protectionist policy began to be dismantled, in a context of increasing globalization and economic liberalization. Facing external competition, most firms disappeared, were sold out to foreign technology partners or other firms, or shifted into specialized niches or less competitive segments than hardware production. The content of locally-manufactured components and technology in production declined sharply.

Critics argue that Brazilian computer policy in the 1980s was a failure, since most local firms could not survive in an unprotected market. And unlike the Asian tigers, Brazil did not become an international player in global production markets. Supporters, however, point to the fact that Brazil's market reserve policy led the Brazilian IT sector to "invest significantly in the

[1] Even the U.S. 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 have become more explicit through President Clinton's National Information Infrastructure projects.

accumulation of technological capabilities" and that "important backward linkages were developed" (Cassiolato, 1997). These capabilities, together with the country's market size and growth rate,[2] have become the driving forces in attracting foreign direct investment by computer makers such as Compaq, Dell and Gateway to serve the Brazilian and South American markets. Moreover, 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.

Therefore the Brazilian case does not provide sufficient grounds for rejecting outright industrial policies for the IT sector. However, "greenhouse" strategies are no longer possible in a world dominated by international regulations, fast technological change and global production systems. Since the end of Brazil's market reserve in 1992, more liberal IT policies have been implemented, although there remain some advantages to local production.

The recent policy and industrial trade developments in the Brazilian IT industry are analyzed in this paper. The often conflicting results provide a fresh perspective on the ongoing debate over the impacts of liberalization and the role of industrial policy. By examining how the Brazilian IT industry reacted to institutional and technological changes set in motion by liberalization, we can illuminate the impact of environmental conditions on computer firms' strategy. In addition, 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 on companies' strategies. Finally, by analyzing the effect of liberalization on the pattern and rate of computer diffusion, it is possible to assess its contribution to the development of an information society in the country and indirectly to its impact on the local industry growth.

We conclude that while liberalization has had negative consequences for Brazil's domestic computer industry, especially for components production, it has led to lower prices for computers and telecommunications services. This has stimulated dramatic growth in computer use and the spread of the Internet, which have produced benefits for computer users through increased productivity. Also, it has stimulated new jobs in software and information services, helping to compensate for the loss of jobs in the hardware sector.

II. ENVIRONMENT

Political and Economic Environment

Brazil has long been considered a country with great economic potential due to its size, natural resources, and industrial base. Its golden period of industrial development was from 1965 to 1980, when the value-added growth in the manufacturing sector averaged 9.5% a year. Supported by protectionism, sectoral promotion and regulation, Brazil built a highly integrated and diversified industrial structure.

However, industrial growth was halted in the early 1980s when the country experienced a

[2] A recent survey indicates that Brazil's IT market reached $13.3 billion in 1998, 11.2% higher than in 1997. Hardware accounted for the lion's share with 51%, followed by professional services with $5 billion and software responsible for the remaining market. However, the hardware market had the lowest growth rate (4.6%), whereas professional services and software had growth rates of 27% and 11%, respectively. (*Computerworld*, 1999)

severe debt crisis. The 1980s are referred to in the economic literature as the "lost decade," characterized by high inflation and economic stagnation. The lack of external finance and investment pushed the country into further protectionism in order to keep a trade surplus. In the mid-1980s Brazilian exports reached 1.5% of total world exports while imports represented less than 1%. The situation has changed in the 1990s, as the government finally succeeded in bringing inflation under control and began to open up and deregulate many sectors of the economy (Table 1). But economic growth has been moderate in per capita terms. In 1997, Brazilian GNP per capita was still smaller than in the early 80s.

Table 1. Brazil's economic performance, 1991-1998

	1991	1992	1993	1994	1995	1996	1997	1998	(a) 1994-98	(a) 1981-90	(a) 1991-98
Real GDP growth	1.0	-0.5	4.9	5.9	4.2	2.8	3.2	0.2	3.3	1.5	2.7
GNP per capita growth	-1.5	-2.6	3	4.2	2.5	1.8	2.3	-	2.7	-0.7	1.3 (91-97)
Inflation rate	413	991	2103	2124	59.7	11.1	7.9	3.5	-	-	-

(a) average annual growth
Source: IMF, *World Economic Outlook, May 1999*.

Brazilian politics have been in a period of relative stability since the early 1990s. The ongoing democratization, begun in the late 1970s, was further consolidated by economic stability brought about by the end of inflation in the mid-1990s. Even before then, the Brazilian State had begun reducing its economic role. Economic liberalization policies started in the early 1990s and continued to be pursued throughout the decade.

The 1994 Real Plan, Brazil's stabilization plan, was based on an economic strategy which linked the local currency (real) to the dollar in 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. Increasing demand for imports turned a historically positive trade balance into a negative one. As shown in Table 1, inflation rates fell from more than 2,000% a year in 1993 and 1994, to only 7.9% 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. This resulted in an overvaluation of the Brazilian currency and to devaluation in 1999.

Privatization of state enterprises at both federal and state levels gained impetus beginning in 1996 and in some sectors, such as telecommunications, has been completed. Over the last decade Brazil has joined major multilateral trade agreements such as the World Trade Organization (WTO), and has spearheaded the development of the Mercosul Free Trade area (Brazil, Argentina, Uruguay and Paraguay).

Foreign direct investment has grown fast in recent years, from a mere US$2.8 billion in 1992 to US$22 billion in 1998 (for a total of US$46 billion in 1996-1998). FDI now represents about 12% of total investment. The privatization of public enterprises and the reorganization of local private sectors opened up new opportunities for foreign investors. The cumulative share of

foreign capital in the privatization process grew steadily from 1996-1998, when it reached 42%.[3]

The future of the Brazilian economy is not yet clear, despite the promising results of the January 1999 devaluation. The major problem is the deficit in the balance of payments, which stood at 4.5% of the GNP in 1998. In order to attract foreign resources to close the gap, interest rates are over 30%, among the highest in the world.

Information Technology Infrastructure

IT infrastructure encompasses local capabilities to design, manufacture and use IT; the quality and availability of telecommunication infrastructure and services; installed computer base; provision of advanced services; and R&D capabilities. This section discusses the availability of qualified workforce and telecommunication service. Other related aspects will be analyzed in the IT diffusion and computer industry sections.

Human resources

Brazil has 355 scientists and engineers working in scientific and technological development per million inhabitants, a figure comparable to other South American countries. In absolute terms, however, due to its large population, the number of professionals working in the IT sector with undergraduate and graduate degrees is larger than any other Latin America country. Table 2 shows that there were more than a half million software professionals working in Brazilian firms, both users and producers, more than a fourth of the number of professionals in U.S.

Table 2. Human resource indicators for Brazil and other countries

Country	Mexico	Brazil	Korea	Taiwan	Singapore	Malaysia	United States
Population (millions)[a]	91.1	159	44.9	21	3.3	20.1	267.1
Adult Literacy (%)[a]	90	83	98		91	84	99
Mean years of education[b]	4.7	3.9	8.8		3.9		12.3
Secondary enrolment ratio (%)[a]	58	45	101		n.a.	57	91
R&D scientists and technicians per 1,000 people[a]	0.3	0.2	2.9		2.6	0.2	4
Number of software professionals[c]	321,482	549,840	340,168	140,070	11,336	53,389	2,006,309

a. UNDP, 1998; b. UNDP, 1993; c. Jones, 1993, *Software Productivity and Quality Today: The Worldwide Perspective*. Data updated in 1995 in correspondence to authors.

In 1997, Brazil had 700 Ph.D.s in the field of information technology, a substantial growth from 200 in 1980 (MCT/SEPIN,1998, p. 10). The nature of demands on IT capabilities has varied since the time of the market reserve policy. In the more open market of the 1990s, the demand for technical capabilities has shifted from hardware design and manufacturing engineers to software and data processing. Employment opportunities are now increasing in developing and updating business applications rather than in R&D, and the growth of the software sector demands a highly qualified workforce. About 40% of computer industry

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

employees have a graduate or post-graduate degree, while in software, the percentage of university-trained personnel jumps to 68% (Tigre, 1995, p. 194).

In 1995 the IT industry employed 102,000 people, of which 40,000 had a university education. Of those, 10% were in R&D activities. However, total employment in the industry fell by 3% from 1991, and by 11% for university level employees. Nearly half of the industry's employees are in computer hardware firms and the other half in software and information services. While employment in manufacturing is diminishing, the demand for people trained in software development, system maintenance, data communication management and other user-support activities is growing at a steady pace. Part of this growth is not captured by the available data shown in Table 3, which is based on a survey conducted by SEPIN with mainly large firms. However, most firms in these sectors are very small, often run by self-employed engineers, working informally for small firms and individual clients. Their activities are not captured by the available statistics.

The employment trend from hardware to software and services has had an important impact on the demand for skilled people. This may be assessed through an analysis of the distribution of employees by activity performed. Hardware firms employ more than 50% of total personnel in production and technical assistance, while software firms employ relatively more in R&D and marketing. The majority of people employed in service activities perform "production" activities, a class ranging from simple activities such as data entry, data processing, and printing to more complex functions in data communications and system development.

Table 3. Distribution of employees by activity performed, 1995 (%)

Main activity	Sales & Marketing	Management	Production	Technical Assistance	R&D	Others
Hardware	14.7	14.8	31.9	18.2	8.0	12.4
Software	17.6	19.7	12.8	19.9	23.8	6.1
Services	5.3	17.0	37.6	8.7	14.8	16.5
Total	10.4	16.1	33.7	13.8	12.0	14.1

Source: MCT/SEPIN (1998).

Telecommunications

Until 1998, Brazilian telecommunication services were provided by Telebrás, a state-owned holding company controlling telecommunications operators in each Brazilian state. A privatization plan was implemented starting in the mid-1990s, which included opening up the telecommunication market for competition and dividing Telebrás into three regional operators and several cellular phone firms. These firms were sold in public auctions to consortiums led mainly by European telephone operators including Telefónica de España, Italia Telecom, Portugal Telecom and American MCI. Further efforts are being made to attract at least one more company to compete in each region and market segment.

Before privatizing the Brazilian telecommunication system, Telebrás had made efforts to upgrade the technology, introduce new services, and increase the supply of new telephone lines. Also, tariffs were allowed to rise and cross-subsidies were reduced, resulting in increased profitability for the telephone operators. This encouraged investment in the privatization (Botelho and McKnight, 1997; Botelho et al., 1998). Table 4 below shows that investment

increased substantially in the mid-1990s as compared to 1990, resulting in almost one million new conventional lines a year and large-scale introduction of cellular phones. From 1990 to 1996, digitalization jumped from 13.9% to 55%, boosting productivity and reducing costs. These improvements made the local telephone system very attractive to private investors. Telecommunications providers are now regulated by ANATEL, and have agreed to comply with ambitious investment and quality goals.

Table 4. Brazil - Telebrás performance, 1990, 1996

	1990	1996
Conventional telephone main lines	9,300,000	14,900,000
Cellular subscribers	10,000	2,800,000
Public-use telephones	227,000	433,000
Digitalization of local lines	13.9%	55%
Employees	93,000	89,000
Localities served	13,900	20,900

Source: Mansell and Wehn, 1998. Telebrás annual reports (various years).

There are 17 million fixed telephone terminals and 5 million cellular phones in Brazil (mid-1998) and the telecommunications market was expected to post a 10% growth in 1998. Despite such improvements, telephone density in Brazil (about 12 telephones per hundred inhabitants in 1997) is still very low when compared to developed countries (51/100 inhabitants). It is similar to Eastern European countries (17/100) and other South American (9/100) and West Asian (11.5/100) countries. Table 5 compares Brazil's telecommunications infrastructure and costs to a set of comparison countries. Mansell and Wehn (1998, p. 29) identified Brazil as having an average relationship between main lines per 100 inhabitants and GDP. That is, Brazil has a telecommunications diffusion pattern that would expected for its level of development.

Table 5. Telecommunications indicators, Brazil and other countries

	Main lines per 1000 inhabitants[a]	Cellular mobile subscribers per 1000 inhabitants[b]	Cost of 3-min. local call (US$)[a]	Cost of 3-min. call to the U.S. (US$)[a]
Mexico	95	7	.08	3.01
Brazil	*96*	*8*	*.04*	*4.68*
Malaysia	183	43	.04	5.99
Thailand	70	18	.12	7.39
Korea	430	37	.04	4.88
Taiwan	430	36	.04	
Singapore	513	98	.01	4.02
Hong Kong	547	129	n.a.	2.64
United States	640	128	.09	

Sources: a. World Bank, *World Development Report, 1998.*
b. ITU, 1997. *World Telecommunication Development Report 1996/1997.*

III. INDUSTRIAL AND TECHNOLOGY POLICY

Until the late 1980s Brazilian industrial policies were based mainly on import protection. Originally this policy was designed to promote import substitution. But in the 1980s, as the developmental ideology faded, it became instead a response to a foreign currency shortage. By

the 1990s Brazil was following much of the developing world toward liberalization and privatization of the economy, although its approach was more gradual than that of other countries.

Computer Policy in the 1980s: Market Reserve

Computer industry policy in the 1970s and 1980s followed an infant industry strategy of protecting domestic producers in certain industry segments in order to give them a chance to develop and become competitive. This policy, dubbed the market reserve, initially focused on minicomputers, and then expanded to include microcomputers. Foreign competitors were kept out of those segments of the Brazilian market, except in some cases of joint ventures with local companies. This policy gave local firms the space to grow and develop capabilities, but it also isolated them from the dynamism of the global PC industry that was exploding in the 1980s. Additionally, it raised the ire of the U.S. government, which saw it as simple protectionism that was keeping U.S. companies out of a large potential market.

Following a decade of economic stagnation, Brazil's industrial policy shifted in the early 1990s to a more liberal regime. The shift was driven in part by the fear of being left out of global markets, and in part by the neoliberal ideology that was sweeping developing countries around the world. In the computer industry, another concern was the high levels of smuggling and gray market activities that had developed to get around the trade barriers of the market reserve policy. Further pressure for change was brought to bear by the U.S. government, which threatened Brazil with Super 301 trade sanctions for its market reserve policy.

Policy in the 1990s: Liberalization with Industry Promotion

Under the new policy environment, local industry progressively lost its "greenhouse" protection and became exposed to international competition. In response, firms adopted a defensive strategy centered on major adjustments to reduce costs and improve competitiveness of locally manufactured products. This included a redefinition of the production chain, from sophisticated towards standardized products with a lower embodied technological level. The current Brazilian policy for the IT industry epitomizes this shift from protectionism to liberalism. The market reserve policies of the 1980s were oriented towards local production, promotion of locally-owned firms, and general development of technological capabilities. In particular, the minicomputer and PC markets were reserved for domestic companies or joint ventures that included domestic capital. However, in the 1990s, policies shifted to an open market with incentives for local production, exports and R&D.

Fiscal incentives

A 1991 policy (Law 8248/91) was aimed at establishing alternative mechanisms to preserve local equipment manufacturing and R&D activities in the IT sector. The approach taken was to offer exemptions to various taxes if companies would commit to certain levels of local production, local content, and R&D. There were no barriers to imports or foreign investment; however, computer makers that simply imported products for sale had to forego the benefits provided under the law.

The policy consisted of four types of incentives. First, fiscal benefits 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 on 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 favored the acquisition of IT goods developed and produced in Brazil, as long as they had similar prices to imported equipment. In order to take advantage of the fiscal benefits, the legislation required firms to do the following:

- Firms must invest at least 5% of a company's revenues from IT products (excluding software and professional services) on 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" (PPB in Portuguese) which is a production step 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.

By 1997, 248 firms had benefited from these measures. Part of the firms' R&D expenses were channeled to the government-sponsored R&D programs.

Promotion of IT use

The National Research Network (RNP in Portuguese) is probably the most successful government-sponsored technology program in IT. It has been a major driving force behind Internet diffusion in Brazil. It is managed by a committee of academics and representatives of the IT-user business community. In 1997, the program invested $20 million in local IT service providers, schools, and infrastructure, such as high-speed backbones, and linking universities and business centers. RNP aimed at developing Internet links at science and technology institutions, but it has also boosted commercial use of the Internet by providing infrastructure and technical capabilities. The project is now shifting to academic and social use, since private backbones are now available to support electronic commerce.

Software industry promotion

The program for software exports (Softex 2000) was introduced in 1993 with ambitious aims: capture 1% of the world software market, corresponding to US$2 billion in exports through the year 2000 in addition to having local firms capture a 50% share of the national market. The program estimated that 50,000 new skilled jobs could be created. 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 incentives for training IT professionals inside firms.

The Softex 2000 results and prospects are controversial. On the one hand, one can question the feasibility of a software development strategy based on exports, given the high levels of

concentration in the global software market and growing barriers to entry in the form of R&D and marketing investments. On the other hand, discounting its overambitious 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 programs in IT are oriented towards building infrastructure and promoting joint projects between universities and private firms. In 1996 US$3 million were invested in laboratories and US$10 million in 21 cooperative projects, involving 43 firms and 60 R&D centers. 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 sciences, which expanded from 13 in 1990 to 20 in 1995.

Trade policy

As a member of Mercosul, Brazil is negotiating with Argentina, Paraguay and Uruguay to develop a common policy for international trade and industrial development for the IT sector. An agreement has so far been reached that the countries' tariffs on imports from outside the Mercosul zone will converge to 16% in 2006 (Table 6). 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 Mercosul partners. Brazil is unlikely to join the International Technology Agreement (ITA) proposed by the USA to eliminate all barriers on IT products.

Table 6. Brazil's IT tariffs under Mercosul

Products	Import tax rate (%)	
	1998	2006
Microcomputers	32	16
Medium-size computers	30	12
Inkjet printers	32	16
Laser printers	30	12
Monitors	32	16
Telephone exchange	32	16
Cellular phones	22	16
Programmable controls	31	14
Assembled boards	27	12
Integrated circuits	15	6

Source: MCT/SEPIN (1998).

Policy renewal in 1999

The provisions of the 1991 post-market reserve policies originally extended until 1999. In 1999, however, the government decided to extend them for another 10 years, partly because there was little enthusiasm for trying to revise the policy, and partly because Brazil was not willing to adopt a pure laissez-faire approach like those of Mexico or Chile.

IV. BRAZIL'S COMPUTER SECTOR

The outcome of a decade of protectionism in the 1980s was a combination of locally-owned and some foreign companies manufacturing a wide range of hardware, and also designing software for the local market. By the end of the 1980s local production of IT equipment reached US$4.6 billion, with a high degree of local content both in technology and components. The liberalization of the IT market for imports and foreign investment in the 1990s altered the industry structure. Multinational IT companies gradually took over most local firms and turned away from local design and manufacturing to imports. The surviving locally-owned firms were oriented toward niche markets such as banking automation, client-specific software, and telecommunication equipment, where the client-supplier relationship was strong enough to withstand foreign competition (La Rovere et al., 1996).

Computer Production

Computer hardware production in Brazil initially slumped after liberalization in 1991, as imports replaced domestically-produced hardware. However, production grew rapidly from 1992 through 1996 as foreign and domestic producers expanded to serve the growing local market. Production leveled off again in 1997-1998 as the local economy suffered a downturn (Figure 1).

Brazil should see an increase in PC production in 1999 thanks to investments in production facilities by two major vendors, Dell and Gateway. Dell will begin producing computers in the second half of 1999 in a $75 million plant in Rio Grande del Sul.[4] Dell plans to produce 250,000 units per year by the year 2000. Gateway also is entering the market in 1999 through its 23% investment in local PC maker Vitech (with an option to buy up to 100% eventually).[5]

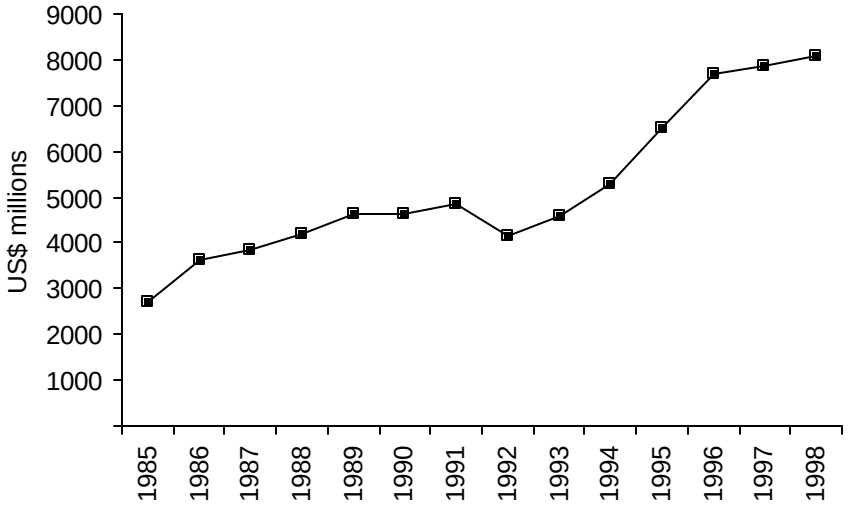
Most computer production in Brazil is done in Campinas, a city near São Paulo, which is the home to the production facilities of Compaq, IBM and Vitech, as well as other electronics companies such as Lucent, Philips and Motorola. Campinas offers a good infrastructure, proximity to the largest market in Brazil, a good supplier base, and has good universities that supply people and conduct R&D in conjunction with leading companies. Smaller production clusters are found in the Manaus free-trade zone in the Amazon region, Rio de Janeiro, and Rio Grande do Sul.

---

[4] Darlington, Shasta (1999, October 1). Brazil: Interview—Dell wired for explosive Brazil growth. *Reuters English News Service*.

[5] Fritsch, Peter (1999, September 23). Gateway invests in Brazil computer seller. *The Asian Wall Street Journal*.

Figure 1. Computer hardware production in Brazil, 1985-1998



Source: Reed Electronics Research, *Yearbook of World Electronics Data.*

Table 7, which compares market and production of EDP products in selected developing countries and NICs shows that Brazil is a large producer, mainly because it has a large market to serve. Asian newly industrialized countries such as Singapore, Taiwan and Malaysia, in contrast, are world production centers and exporters of EDP equipment.

Table 7. Hardware production/markets, 1998

Country	Production	Market
Singapore	25,083	7,847
Taiwan	23,501	1,474
Malaysia	7,150	1,486
China	14,196	7,591
Korea	8,033	5,777
Brazil	8,090	9,728
Mexico	4,856	2,851
Thailand	6,554	1,780

Figures in US$ millions
Source: Reed Electronics Research, *Yearbook of World Electronics Data.*

Peripheral equipment and components

One impact of the ascendance of foreign producers in the Brazilian IT industry is the rapid growth of contract manufacturing in the country. Following their global practices, Compaq and Epson already have outsourced all their production of integrated circuit boards used in Brazil, while Hewlett-Packard does the same for its printers. Large contract manufacturers such as Solectron (printed circuit boards and printers), SCI (printers) and Flextronics (computers and cell phones) have entered the Brazilian market alongside local firms like ABC-Bull (computers), TCE (monitors) and PCI Computadores (computers).

As the final market grows, local peripheral production has also grown and attracted major companies. For example, in 1997 monitor production was close to US$600 million, even

though smuggling is still estimated to account for 45% of the market. 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 8.

Table 8. Brazil monitor production ranked by company, 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, cited in Mattos and França (1998).

On the other hand, production in Brazil of electronic components has actually fallen from US$1.6 billion in 1991 to US$1.3 billion in 1998.[6] The range of components produced by the industry also diminished significantly in the period. The reason for this decline is the opening of the market, and the inability of local producers to match the costs achieved by high-volume global producers of semiconductors and other components.

Software

There are over 10,000 software firms in Brazil, employing about 200,000 people with total revenues of US$1.27 billion.[7] Brazil is the largest packaged software market in Latin America and accounts for 36% of the Latin American software market, although the overall Hispanic GNP is four times that of Brazil. Estimates of the size of the software industry vary widely depending on the source. One estimate puts the Brazilian software market (packaged and custom software) in 1997 at R$3.2-3.5 billion, with local production (both domestic and foreign firms) accounting for about 60%. U.S. Department of Commerce estimates put the local market at US$1.1 billion, with local production of $294 million and exports of US$45 million.[8] According to the Brazilian software association Softex, exports of Brazilian-designed software were US$50 million in 1998, compared with US$25 million in 1997, and US$15 million in 1996.[9]

[6] ABINEE, cited in Mattos (1999).
[7] This data includes small firms which are not captured in the data above showing IT industry employment at 102,000.
[8] U.S. Department of Commerce, International Trade Administration. (1998). *World - Computer/IT Software/Services Fy99* (IMI981113 Best Market Reports). Washington, DC: U.S. Department of Commerce, International Trade Administration.
[9] SABI (1999, January 21). Brazil: Rio leads software exports. *Jornal do Brasil*.

According to MCT/SEPIN, the share of software in the overall IT industry has been progressing in the last few years, going from 15.7% in 1991 to 21.3% in 1997. The industry grew, on the average, 35% a year between 1993 and 1995, and its growth in recent years and in the near future should continue to be in excess of the overall IT industry in Brazil—an average of 25% a year.

The industry is concentrated in Rio de Janeiro and São Paulo, but also has important emerging centers in Santa Catarina and Rio Grande do Sul. In Santa Catarina there are 600 software and related enterprises with total revenues of US$250 million and employing 7,000 people. Small firms dominate in number, but a few foreign giants have come to take the leadership in a very fragmented market. For example, in network systems, the American Novell do Brasil holds 80% of the market. Here again, smaller firms, which had some market presence, have been forced to seek niche markets, become distributors of foreign programs, or develop custom applications for popular foreign programs.

As the Brazil IT market has grown, a number of foreign software and information services firms have set up local subsidiaries for localization and various services. These include Microsoft, which made a US$30 million investment, SAP, Novell, Progress Software, Andersen Consulting and EDS.[10] In 1999, Motorola announced plans to set up a software development center to develop embedded software for cellular phones.[11]

Datasul of Santa Catarina is the largest national software firm, with expected revenues in 1998 of US$70 million. It sells integrated management packages for manufacturing firms (similar to SAP) and it expects to generate 30% of its revenues in 2000 from exports, against 10% in 1998.

Distribution

An important sign of the industry's growth and internationalization is the arrival of large distributors of parts, components and software. The Brazilian IT distribution business is worth US$2.16 billion a year. Ingram Micro, the world's largest IT distributor, acquired a local distributor and other heavyweights of the segment (CHS, SED) acquired local firms or set up their own networks (Tech Data).

Trade in IT Products

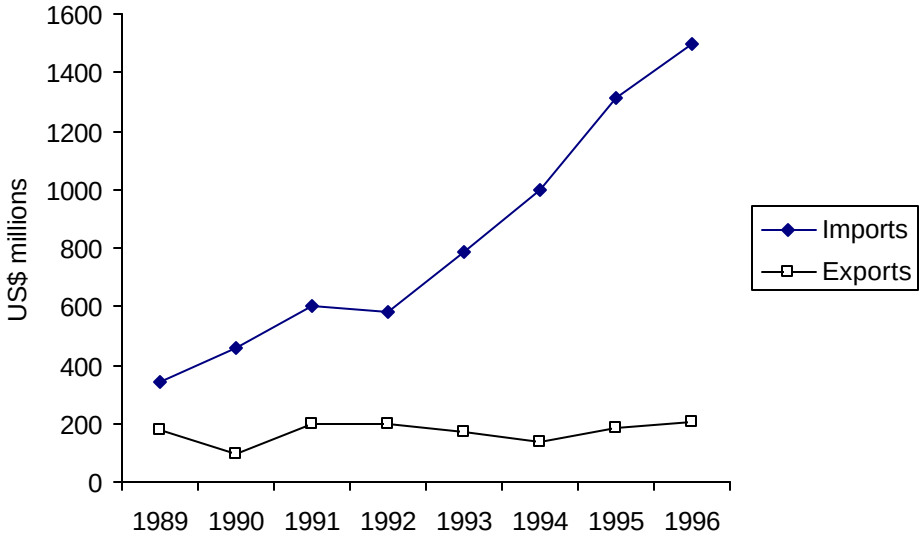
Since 1991 the trade balance on IT products has deteriorated rapidly, as shown in Figure 2. This has been the result of lowering tariffs on computer products and eliminating non-tariff barriers. Duties on components dropped from 35% to 19%, but tariffs on inputs that are not produced by anyone in Brazil 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 process, which can take 20 days to clear a shipment of components.

---

[10] Industry sources.

[11] Brazil: Motorola to create software development center (1999, October 1). *Gazeta Mercantil*.

Figure 2. Brazil's trade in computer hardware, 1989-1996



Source: Reed Electronics Research, *Yearbook of World Electronics Data*.

From 1991 to 1996, hardware imports increased by 250% while exports were almost flat. In the hardware segment, local production of systems increased, but imports of components and peripherals grew rapidly. There is a great deal of concern among Brazilian government agencies over the growing trade deficit in electronics, which reached US$6.4 billion in 1997 (Table 9). 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. The national development bank BNDES plans to spend US$2 billion over four years to promote the electronics industry through low-interest loans.

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 Mercosul countries since any production in Brazil can be exported to Argentina, Paraguay and Uruguay duty free.

Table 9. Information technologies balance of trade, 1992-98 (US$ million)

Items	1992	1993	1994	1995	1996	1997	1998*
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**

Source: Banco Central do Brasil-DEPEC/SECEX. Homepage.
*Through June.

There has been a recent upsurge in total IT exports (hardware, software, services) from US$271 million in 1995 to US$566 million in 1997. However this represents only 4% of total IT production, a percentage which is still lower than in 1986 when the ratio of external sales to total sales was 7.9% (Frischtak, 1992, p. 166). The recent recovery of exports is based on microcomputers and telecommunication equipment, mostly to Mercosul (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. The firm is the market leader in Latin America and has one of its five international assembly plants in the state of São Paulo. According to interviews with the company, Brazil's assembly center has a definite edge over its corporate competitors in Houston, Singapore, China and Scotland as a site for serving South America, since it pays no duties in its exports to Mercosul countries and has much lower air freight costs. As a major exporter, Compaq 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 exported as part of an assembled product.

Second-tier Brazilian computer firms are also pursuing the Latin American market. Top-ranked local firm United Information Systems (UIS), based in the Manaus Free Trade Zone, plans to invest US$40 million to expand its operations in Chile, Venezuela, Colombia and Argentina. In 1997 UIS acquired the Seaton Group and floated its shares in the New York Stock Exchange. Peripheral equipment producers are also beginning to utilize their installed capacity to export. LG Electronics, which has two plants in Brazil, stated its plans to export 20% of its monitor and TV production of US$200 million in 1998.

R&D Investments and Incentives

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.[12] So local firms usually developed their own products based on reverse-engineering or in-house design. After liberalization, the new informatics policy (Law 8248/91) aimed at keeping local technological efforts alive through fiscal incentives, has been achieving some success in recent years. In 1997, the Brazilian IT industry invested 4.8% of total sales in R&D activities (Table 10), a percentage comparable to Taiwanese (4.6%) and Korean (3.7%) computer industries (Dedrick and Kraemer, 1998, p. 236).

[12] 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, p. 137).

Table 10. R&D expenditure in 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*	642	4.8

Source: Based on MCT/SEPIN (1998).
*Preliminary data.

R&D related to IT in Brazil encompasses a wide range of activities, but more on the development side than on real research. Almost half of total R&D expenses are in system and software development (see Table 11), activities that are oriented to serve individual users' needs and that are usually based on standard hardware and software platforms. This kind of development does not require sophisticated technology. 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 goes to government priority R&D Programs like RNP and Softex 2000.

An important question is whether IT firms' R&D investments are already part of their long-run strategies in Brazil, or are a mere response to tax cut opportunities. Recent research conducted by Fundação Dom Cabral[13] in 1997 provides some clues about the importance of existing incentives for IT industry R&D activities. Between 1994 and 1996, 67% of firms had increased their R&D expenditure by 50% or more as a direct response to fiscal incentives. Firms also reported important shifts in R&D strategies after the incentives became available. This includes improvement in mid- and long-run R&D planning, a sharp increase in cooperation with university and R&D centers, new development activities, and consolidation of R&D teams. In the absence of such incentives, 95% of interviewed firms would consider reducing their local R&D activities.

Table 11. Private sector spending for R&D by activities, 1994-96

Type of activity	Investment R$ million	%
System integration	274	26.7
Software	213	20.9
Hardware	157	15.3
Training	84	8.2
Quality integrated system	80	7.8
Priority programs	48	4.7
R&D laboratories	46	4.5
Research	36	3.5
S&T service	27	2.6
Technology transfer	26	2.5
Process development	16	1.6
Others	15	1.5
Components development	3	0.3

R$1 = roughly US$1 during this period
Source: MCT/SEPIN (1998).

[13] See MCT/SEPIN, 1998.

IT Market

In 1998, the total market for IT in Brazil was estimated at US$17.7 billion, up from US$14.7 billion in 1997. The market has grown rapidly, led by software and services, since liberalization in 1991 (Table 12).

Table 12. The Brazilian IT market, 1991-1997 (In R$ billion*)

Segment	1991	1992	1993	1994	1995	1996	1997	1998	Growth 97/91 (%)
Hardware	4.1	4.5	4.5	4.9	5.9	6.9	7.5		82.9
Technical services	1.9	2.2	2.4	3.1	3.5	3.9	4.3		126.6
Software (packaged and custom)	1.1	1.2	1.5	1.8	1.9	2.8	3.2		190.9
Total	**7.1**	**7.9**	**8.4**	**9.8**	**11.3**	**13.6**	**15.0**	**18**	**111.2**

*R$1 = roughly US$1 during this period
Source: MCT/SEPIN (1998).

Market structure

The Brazilian computer market has changed substantially in the last decade, but the top three vendors remain the same. IBM has lost market share, but is still the leader in the IT market with US$1.7 billion of sales in 1997 (about 20% of total market) due to its longtime relationship with large Brazilian users (Table 13). Brazilian-owned Itautec became second (6.3%), followed by Unisys (6.2%), and Hewlett-Packard (5.3%).

Following 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. For example, Parks Informática, one the top three modem manufacturers, has four international strategic alliances (TxPort, Develcon, Paradyne and Nuera Communications) in order to expand its product line. Leading PC manufacturers like Scopus left manufacturing to become system integrators in novel areas such as Internet banking and electronic commerce.

Table 13. Top computer firms in Brazil 1986, 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 (US$ million)	2,126	6,384	

Source: 1986, *Anuário Informática Hoje 1987/88*; 1997, confidential industry sources.

PC market

In 1997 the Brazilian PC market was over 1.2 million systems worth US$2.5 billion, or 37% of the Latin American market. Local brands account 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 14.[14]

Table 14. Brazil PC industry rank, 1997

Company	Units	Market Share (in %)	PC Revenues (in US$ millions)	Market Share (in %)
Compaq (US)	132,609	10.4	293.1	11.4
Itautec (Brazil)	87,135	6.8	203.9	7.9
IBM Brasil (US)	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 (US)	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).

The Brazilian PC market is led by Compaq, Itautec and IBM. These firms are well established in the country and have their own manufacturing plants, R&D activities and service operations. Most other competitors only do complete knockdown assembly or buy from outside OEMs. The PC market also faces stiff competition from the gray market that has kept large foreign firms on their toes. This competition forced IBM out of the residential PC market in favor of the corporate market. Local competitors offer low-cost products (e.g. PCs at US$1,000) through innovative distribution channels such as supermarkets (UIS) and franchise networks (Tropcom's Net Box).

Competition in the Brazilian PC market is likely to intensify with the entrance of the new global heavyweights Dell and Gateway, with their efficient direct sales strategies. The market leader since 1996, Compaq, which just entered the Brazilian market in 1994, plans to stick to its strategy of selling through indirect channels. So does the national company Itautec, which dominates the residential high-end market. 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.

[14] JP Consultores Associados provides for the same year a different ranking of the top 5 desktop vendors: Compaq (US$386 million); IBM Brasil ($317 million); Itautec ($284 million); Tropcom ($125 million) and UIS ($94 million). Cited in *IDG Now Market Snapshot* (1998).

The largest Brazilian-owned PC maker, Itautec, is part of a large industrial and banking conglomerate (Itausa) which also controls Philco (consumer electronics) and semiconductor operations. Its EDP business (US$500 million in 1997) represents 45% of total revenues in electronics, while its semiconductor business accounts for 10% of revenues. The group underwent a major re-structuring at year-end by shedding a peripheral business in copier maintenance, adopting a new organizational hierarchy, reorganizing its production and administrative units, and licensing personnel. Itautec recently launched its first US$1,000 computer family (Transglobe) and launched an innovative and inexpensive home installation service to gain market share in this competitive market segment. Itautec also plans to use the new system to expand its banking and commercial automation businesses into SMEs.

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. But its growth of 45% is much higher than the overall hardware segment and is likely to continue in the years ahead, albeit at a lower level of 35%. However, the gray market domination here is also much higher—about 65%, thanks to the ease of smuggling notebooks into the country. Since local production began in 1997, lower prices may push back the gray market in forthcoming years. The market leaders are Compaq (24% of the market in 1997, according to JP Consultores Associados), IBM Brasil (16%), Toshiba (10%), Texas Instruments (6%) and Hitachi (6%).

Market growth was accompanied by lower PC prices, which fell by half between 1992 and 1996. Vertical government markets—such as education and communications—are also becoming a significant niche as the acceleration of state reform promotes modernization. For example, in 1998 the Ministry of Education purchased 68,000 PCs under the National Program for Informatics in Education, which aims to have a computer in each public school with over 150 students. Brazil's state postal and telegraphic service company (ECT) recently purchased close to 6,000 PC systems to automate its branches.

Households, offices and small and medium enterprises are the most important segment for future market growth. Estimates are that within four years the percentage of Brazilian SMEs using computers will jump from 20% in 1998 to about 80%.

Banking automation

Banking automation is a market segment which led the growth of the Brazilian IT market throughout the market reserve policy era and beyond. 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 banking automation providers (Botelho, 1998). Not surprisingly it was from that segment that three hardy 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.

Unlike Itautec and SID, Procomp is independent of any Brazilian financial or industrial group and has had double-digit growth every year since its founding less than 15 years ago. In 1998, its revenue grew 23% to US$320 million. It plans to reach US$420 million in 1999. Part of its success lies in its business focus on banking automation (BA). Its in-depth knowledge of the banking market permitted it to introduce continuously cheaper solutions than the competition,

making it the market leader in the BA segment. It has automated 70% of the 18,000 banking branches in operation to control 60% of this market. It faced the challenges of liberalization by entering strategic alliances with global leaders in complementary technology (Stratus, Verifone and Interbold), with help from a capital injection from the investment bank Merrill Lynch, which acquired a 15% share in Procomp. For Procomp the venture was perceived as a strategic opportunity to learn more about the investment banking business, a BA market segment poised for growth in Brazil in the coming decade. Procomp has also made significant inroads in other growing automation markets such as government and commerce.

The banks in 1998 spent US$2.06 billion in hardware, software and services, continuing an upward trend up from US$1.8 billion in 1997 and US$1.5 billion in 1996. In 1998, 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.

IT Diffusion

In 1998 Brazil had 6.8 million PCs, equal to 8.4 PCs per US$ billion of GNP—about average for a developing country (Table 15). In terms of PCs/100 inhabitants, however, Brazil's 4.2 is much higher than the average in developing countries, although well below that of newly industrialized countries (NICs) such as Korea or Taiwan.

Table 15. PCs as percent of GNP and per capita, 1998

Country	PCs (millions)	PCs/US$ billion of GNP	PCs/100 inhabitants
USA	129.0	12.3	36.9
Japan	32.8	5.6	26.1
Italy	10.5	6.7	14.7
Average Developed	*42.4*	*7.4*	*22.3*
Brazil	**6.8**	**8.4**	**4.2**
China	8.3	5.3	0.4
India	2.4	6.6	0.2
Mexico	4.6	12.6	3.7
Argentina	1.6	4.8	4.5
Colombia	1.3	14.6	3.5
Average Developing	*3.4*	*8.7*	*2.75*
Korea	6.5	14.0	12.7
Taiwan	2.6	8.3	11.8
Average NICs	*3.56*	*8.7*	*10.9*

Sources: Campos, Rui (1998). *Informática no Brasil: Fatos e números* (vol. III). MCT/SEPIN (1998). For China, Japan, Italy, U.S., Mexico and Korea see *Computer Industry Almanac*.

Internet Diffusion

The Internet is a US$2-3 billion business in Brazil, including access, site hosting, hardware, software, telecommunications and personnel. 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. In early 1998, a survey in the industrially prosperous southern state of Santa Catarina indicated that 90% of the 300 largest industrial firms had a home page in the Internet.

By mid-1999, according to Network Wizards, the number of Internet hosts in Brazil was 310,138, nearly doubling from 163,890 a year earlier. The number of users is estimated at between 2.2 million and 3.2 million, depending on the source and time of survey, a number which at least quadrupled from 1996 (Table 16).

Table 16. 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
Providers	-	-	321
Access points	-	-	865
Average prices (US$)	-	-	27.55
Market (US$)	-	-	400 million

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

There are over 300 commercial Internet service providers, a large number for the size of the market. Some have established joint ventures with foreign firms (e.g. U.S. leader Netcom). At the top, there has been some rationalization among the major providers, often connected to media groups. The largest 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). Universo Online also has the largest site with Portuguese content. A barrier to growth is the lack of more Portuguese-language content. Early surveys (at December 1996) showed that 62% of Internet users spoke English. However, there has been a rapid growth in Portuguese-language content since then, driven by the growth in Brazilian Internet users and attracting more people online.

The Internet market will undergo considerable consolidation in the next few years, as large foreign competitors enter the market. Already the US giant AOL has set up a joint venture with the Venezuelan Cisneros group to launch an Internet provision service in Brazil (as well as in Mexico and Argentina). And other international players are entering the market: the Argentine group ImpSat purchased the top-ranked provider Mandic (June 1998), and another—the large American firm Via Internet Works—purchased the corporate service provider Dialdata Internet Systems (January 1999).

Microsoft, Yahoo and AT&T are also preparing to enter the Internet in Brazil, joining the pioneer StarMedia. In August 1999, Microsoft announced that it would invest US$126 million in Brazil 's cable television operator Globo Cabo, with plans to provide Brazilian households with advanced broadband and Internet services.[15]

A major factor behind Brazil's rapid Internet diffusion is the technological capabilities accumulated during the market reserve policy when tens of thousands engineers were involved in R&D activities. Many of them now run Internet providers, design applications, and give support to the diffusion of on-line information systems. Also, the technological capabilities acquired in telecommunications research centers like CPqD were key to the diffusion of the Internet in Brazil.

[15] Microsoft to invest US$126 million in Globo Cabo – Brazil. (1999, August 24). *Business News Americas.*

The Internet is progressively becoming a domestic communication tool rather than only a way to communicate internationally. In 1995 over 95% of 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. By 1998 Brazil ranked among the 20 largest users of the Internet, with more than one million subscribers. This is more than half of all users in Latin America, in absolute terms.

Factors Affecting IT Diffusion

The diffusion of IT can contribute to economic growth by increasing productivity and competitiveness of local firms. It can also contribute to social welfare and to the efficiency of the public sector. IT diffusion cannot be attributed to IT policies alone, however. There are also important institutional constraints and macroeconomic factors that affect credit availability and general business climate. Furthermore, continuous technological development in the international IT industry has contributed to price reduction and better products. Finally, IT diffusion depends on a number of variables associated with general economic and social development. These include: education; characteristics of regions, sectors and firms; income distribution; availability of hardware and software; and various barriers to diffusion.

Educational level

Universal education plays an important role in IT diffusion. The use of computers requires literacy and generic skills for continuous learning. The design, implementation and maintenance of networks involves a number of technical skills for installation, user training and maintenance. In addition, although most software is available in Portuguese, fluency in English is necessary to access much of the Internet and databases, and to exploit the technical literature. In 1996, the illiteracy rate in Brazil was 15% but less than one-third of the population had seven or more years of school (MPO/IBGE, 1998, p. 129). The rapid growth of sites in Portuguese and the fact that the number of Portuguese-only Internet users is growing, seems to indicate that this barrier is becoming less important (Junior, 1998).

Regions, sectors and size of firms

In Brazil the pattern of IT diffusion has varied according to the size of firms, business segment, and region. Brazilian banks, leading firms, advanced industrial sectors, and key government agencies (like tax authorities) have been heavy IT users since the early 1960s and 1970s, while small businesses and social services agencies are marginal users. Regionally, there is heavy use in the wealthier, more industrialized Southeastern region, which includes São Paulo and Rio de Janeiro, while poorer rural areas have low levels of use. Unlike developed countries where IT diffusion is a relatively "natural" process, in Brazil the informatization of schools, health services, rural villages and small firms requires external support. This is needed not only to buy equipment and software, but more importantly for training, infrastructure building and other basic investments.

Income distribution

A recent survey indicates that in Brazil there are 7.8 PCs per 100 households. In Brazil's highly skewed income distribution, families with monthly income above 30 times the minimum wage (giving them an income of over US$ 3,000 a month) account for only 10% of total Brazilian families but account for 60% of the total domestic computer base. Whereas in households with income above 30 times the minimum wage there is one computer for every two families, for those in the income range between 20 and 30 times the minimum wage the average index of PCs per 100 families drops to 17. Computers are very rare in families which income is less than 5 times the minimum wage (or about US$500 per month), which account for about 1/3 of total households. Table 17, based on a survey of 12 million households, provides a clue to the association between family income and domestic PC installed base.

Table 17. Domestic PC installed base by classes of family income

Income as multiple of minimum wages*	Number of families	Personal computers	PCs/100 families
Up to 2	1,228,090	0	0.0
More than 2, less than 3	1,020,255	2,261	0.2
More than 3, less than 5	1,821,733	4,093	0.2
More than 5, less than 6	817,139	5,215	0.6
More than 6, less than 8	1,274,646	19,009	1.5
More than 8, less than 10	897,768	17,303	1.9
More than 10, less than 15	1,529,351	72,022	4.7
More than 15, less than 20	862,184	84,181	9.8
More than 20, less than 30	853,863	144,996	17.0
More than 30	1,272,878	606,004	47.6
Not informed	966,162	17,336	1.8
Total	12,544,069	972,420	7.8

*Value of minimum monthly wage, US$100 (January 1999).
Source: MCT/SEPIN (1998) and MPO/IBGE (1996).

Availability of hardware and software

Given the size of the Brazilian market and the recurring problems in the balance of payments, manufacturing IT products domestically can ensure lower prices and promote diffusion. International financial market instability, exchange rate fluctuations, and limited access to foreign currency make import dependency unreliable.[16] Consequently, the availability of locally-manufactured equipment can favor the diffusion process in the long run. By importing components rather than finished products, it is estimated that Brazil could multiply by seven its capacity to deliver computers to local users (Tigre, 1995). The tricky trade policy problem is that component imports can also severely affect the balance of payments, as revealed by the current trade deficit.

There are other arguments in favor of having an availability of locally-manufactured IT products to promote IT diffusion. First, in most cases equipment designed and produced locally may be more adapted to local needs. This includes equipment specially designed to the idiosyncrasies of the local economy (banking automation is a good example); manuals and

[16] The most recent devaluation of the Real (January 1999) increased computer prices by 40% while prices of local products remained more or less stable.

keyboards in local language; and prices and configurations oriented to local markets. Also, when production is undertaken locally there is often better user support. After-sales service can benefit from the development of local technical capabilities, spare parts stocks, and specialized local literature.

Especially important to the support of local IT diffusion is the presence of local information services industries. Companies such as systems integrators, custom programmers, network integrators, and value-added resellers provide a vital link between producers and users, helping users to evaluate, install, integrate and maintain information systems. These services must be provided locally, and thus have the added benefit of creating jobs and opportunities for local entrepreneurs.

Barriers to diffusion

Piracy remains a major barrier to software industry growth. The Brazilian software industry association ABES estimates that piracy of software led to losses of US$880 million in 1998, with 61% of the programs used in Brazil being illegal.[17] There has been significant improvement nevertheless, as the index a decade earlier reached 98%. A Price Waterhouse study suggested that if by 2000 Brazil could bring piracy to 27%, the industry could generate 28,000 new jobs.

The hardware gray market constitutes another barrier to IT diffusion. In notebooks, during the first three months of 1998 alone, 5,000 smuggled units were apprehended by the government, about 10% of the market. While smuggled goods may have promoted diffusion when trade barriers were high, they now displace legitimate goods and discourage IT companies from targeting the Brazilian market more aggressively.

Payoffs from IT Diffusion

IT diffusion is likely to improve productivity and efficiency in many sectors of the Brazilian economy. It has already had a great impact on the level and quality of government services. In 1997, for example, close to half a million or 6.4 % of total income tax filings were done through the Internet. At the local level, the State of São Paulo is planning to interconnect all of its government structures, including its 6,000 state schools as well as its townships. This will allow a citizen, for example, to follow up via computer ongoing legal actions connected with the state, and to pay local taxes electronically. The goal is to reduce paperwork by 70%.

IT diffusion has also had positive impacts on Brazil's democratization. In the country's 1998 presidential elections, electronic voting accounted for 35% of total votes, thus preventing fraud.

[17] SABI (1999, May 14). Brazil: Microsoft intensifies anti-piracy actions. *Gazeta Mercantil*.

V. CONCLUSIONS

The results of almost a decade of Brazilian 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 from the liberalization process.

Benefits of Brazilian IT Policies in the 1990s

Final users now benefit from a wider choice of products at better prices. Firms have a better technology access, as major international suppliers are present in the local market. 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).

New regulations protecting software copyrights were introduced in early 1998, responding to long-standing U.S. government demands. 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 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.

However, part of this highly qualified workforce is moving overseas to work in fast-growing American firms. Skilled R&D engineers are increasingly recruited in Brazil to work in local branches of U.S. corporations, and are then transferred overseas. Direct recruitment also occurs, as demonstrated by recent advertisements in the local press recruiting software Ph.D.s to work in the U.S. 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 hand, professionals working in advanced R&D centers may acquire experience for the future development of the Brazilian computer industry. As the Taiwanese case shows, building connections and acquiring business experience in leading IT industry clusters like the Silicon Valley may provide a learning opportunity for professionals who later return to their home country.

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, a process that may reap important benefits in the future both as a hard-currency source and as quality benchmarking for locally-produced software. In addition, software firms have recently been qualified for export finance assistance from the government export program Proex, and the software sector was the first to receive financial grants from the newly-created government export agency Apex.[18] Significant benefits could be achieved from further promotion of the software industry, particularly by assisting small firms. Existing policy incentives, however, remain focused on hardware production and do not adequately contemplate software R&D investments.

[18] Apex will fund a US$500,000 program for the promotion of Brazilian software managed by Softex.

Today, Brazil appears poised to become a major production center. Brazil offers a relatively large market, manufacturing capabilities, installed base, and favorable access to other South American markets. International suppliers see Brazil as an important market and location to serve Mercosul and other Latin American countries. Already several major computer hardware firms (Compaq, Dell, IBM) have located regional production centers in the country. This has slowly begun to attract component suppliers—the weak link in the local production chain—as well as major parts distributors and specialized contract manufacturers. The ongoing rationalization of production is increasing scales and might spur the emergence of a local components industry.

Brazil also has a potential to become an international R&D center. The excellence in IT-related research, and the availability of a large university-trained workforce, can be capitalized upon by local and international firms. Finally, 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.

Problems of IT policy

The new IT policy has been unable to cope with important problems affecting IT production. These problems include the deterioration of local linkages in production, which results in a loss of locally-produced inputs. Component suppliers that 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 related problem has been the growing deficit in the sector's balance of trade. From 1992 to 1997, the deficit on the electronic industry balance of trade grew sevenfold, from less than US$1 billion to about US$6.5 billion. In 1998, when the overall electronic industry deficit fell slightly to US$ 5.7 billion, the IT trade deficit alone reached US$ 1.3 billion, aided by growing imports and flat export growth. The problem for Brazil in matters of trade is the failure to export, rather than the growth of imports. In addition, the growth in local PC production might reduce the deficit in computers, but increase the deficit in components. The basic production process (PPB) incentives do 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 motherboards and PCs using imported components entirely.

The devaluation of January 1999 appears to be finally turning Brazil's export potential into reality. For example, Hewlett-Packard doubled its export target for 1999 to US$ 70 million. However, as long as much of this export remains centered strictly on the Mercosul market, it will be limited by a low ceiling and menaced by potential trade disagreements within Mercosul. In addition, it remains to be seen whether this export-led production growth will attract sufficient producers of parts and components to avoid a mushrooming trade deficit.

The new IT policy also has not eliminated the large gray market for IT products, in spite of the reduction in prices for legal products. The gray market is estimated to be growing at a higher rate than the overall market, indicating that the real trade deficit is larger than the official figures suggest. There is indeed a pressing need for stricter government control on the smuggling of 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.

The 1999 decision to extend existing computer industry policies for another ten years may cause friction in international bodies and from foreign governments that frown on many forms of industry promotion. For instance, the World Trade Organization has lately been reacting to fiscal incentives based on tax exemptions. R&D incentives are more acceptable to the WTO since they are widely adopted by developed countries. They have proved essential to attracting some development activities to local subsidiaries of international computer firms. Also, they have been important for reinforcing links between industry and the national system of innovation. The government agency in charge of the current fiscal incentive program, the Ministry of Science and Technology's SEPIN, suggests the replacement of tax exemptions by R&D credits. One formula that has been put forth would give a proportional credit to firms that invest 5% of revenues in R&D.

Export incentives are another way to reduce the trade deficit and encourage local firms to produce internationally competitive products. This includes compensating existing differences in local interest rates as compared to international rates with export credits. Also, export policies such as Softex, if continued, can help local software firms to explore further opportunities in world markets. However, export incentives also are not seen kindly by trade partners and international trade regimes.

Towards a New IT Policy Approach

One of the most important areas of IT policy is the encouraging of private and public investments in infrastructure such as high-performance telecommunications, special facilities like teleports to attract IT-intensive firms, and special customs facilities for exports. Equally important is the increasing of technical education, and investing in programs to support IT diffusion in more backward sectors and regions. These investments in communications and human resources can help Brazil improve its national capabilities to support IT production and use.

Brazil must coordinate its IT strategy with the other Mercosul countries. Argentina, Uruguay and Paraguay have small hardware industries but are increasing their software production, and Brazil can represent an important preferential market for their software exports. The proposed internationalization of IT markets through the International Technology Agreement (ITA) has been rejected by Latin American countries on the grounds that it would represent giving up any attempt to develop a local electronics industry.[19] However, while Brazil may hesitate to further lower its trade barriers, it is unlikely to impose new barriers in the present international

[19] Costa Rica, which received massive investments from Intel, is the single exception.

environment. Instead, it will likely look for ways to promote its IT industry in the context of increasing liberalization.

In short, a new government policy for IT needs to focus on encouraging national industry—either with local or foreign capital—to develop greater integration with local suppliers, whose emergence and development should also be a policy focus. In addition, the national industry must be stimulated to gain greater technological capability so as to increase its exports of products with higher value-added. The long-term economic feasibility of the current expansion of the computer hardware industry hinges on the development of a strong network of suppliers of components.

Furthermore, IT policies need to encourage IT use as well as production, both to increase the benefits to the entire economy from IT use and to support local production close to use. Government procurement could be used to stimulate local innovation, and a more systematic attack on smuggling and software piracy would also be helpful. The diffusion of IT technology depends critically on the availability of software and related services.

There is certainly room for innovative industrial policy in promoting IT production and use in developing countries such as Brazil. However, these policies must take advantage of the market and work in conjunction with the aims of the private sector. Given those conditions, policies ought to be able to strengthen the strong spots generated by the market liberalization while seeking to mitigate some of the costs to local firms and workers. In the end, the political management of the IT trade linkages, inward and outward, will pose the greatest policy challenge. The greatest industrial challenge will be internalizing innovation technology and increasing value-added per employee. If both challenges are adequately met, then, Brazil may finally be in a position to compete with other countries—in the region and elsewhere—to become a global player in the production, development and use of information technology.

BIBLIOGRAPHY

ABINEE (Associação Brasileira da Indústria Elétrica e Eletrônica). (1996). *Recomendações da Abinee para o desenvolvimento competitivo da indústria de tecnologia da informação no Brasil*. São Paulo: ABINEE. Mimeo, 24 pp.

ABRANET (Associação Brasileira de Provedores Internet). (1999, January 14). *Gazeta Mercantil.*

Amsden, A. (1989). *Asia's next giant*. New York: Cambridge University Press.

Anuário Informática Hoje 1987/88.

Arbex, Mauro. (1998, December 13). Capital estrangeiro fica com 59.2% da privatização. *Gazeta Mercantil*.

Banco Central do Brasil-DEPEC/SECEX. Homepage: http://www.bcb.gov.br/

Baptista, M., and Cassiolato, J. (1996). The effects of the Brazilian liberalisation of the IT industry on technological capabilities of local firms. *Information Technology for Development*, *7*, 53-73.

Bastos, Maria-Ines. (1992, June). The interplay of domestic and foreign political constraints on the informatics policy of Brazil. Maastricht: The United Nations University, Institute for New Technologies (UNU/INTECH). Working paper no. 6.

Berger, Suzanne, and Dore, Ronald (Eds.). (1996). *National diversity and global capitalism*. Ithaca, NY: Cornell University Press.

Botelho, A. J. J. (1998). Meeting the liberalisation challenge: Technological learning in the Brazilian banking automation industry. *Science, Technology and Society*, *3*(1).

Botelho, A. J. J., and McKnight, L. (1997). Brazil: Is the world ready for when information highways cross the Amazon? In Kahin, B., and Wilson, E. (Eds.), *National and international initiatives for information infrastructure.* Cambridge, MA: The MIT Press.

Botelho, A. J. J., McKnight, L., Ferro, J. R., and Manfredini, C. A. (1998). Telecommunications in Brazil: Beyond monopoly. In Eli Noam (Ed.), *Telecommunications in Latin America*. New York: Oxford University Press.

Brazil: Motorola to create software development center. (1999, October 1). *Gazeta Mercantil.*

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

Cassiolato, José E. (1997). Learning to use telematics technologies in service firms: Lessons from the Brazilian experience. Rio de Janeiro: Economics Institute, Federal University of Rio de Janeiro. Working paper.

Computer Industry Almanac, Inc. (1999). Computer Industry Almanac says over 364 million PCs-in-use worldwide year-end 1998. http://www.c-i-a.com/199903pcuse.htm

Computerworld. (1999).

Crespo, Rose. (1998, June 23). Fabricantes nacionais disputam mercado de PC. *Gazeta Mercantil,* p. C-3.

Darlington, Shasta. (1999, October 1). Brazil: Interview—Dell wired for explosive Brazil growth. *Reuters English News Service*.

Dedrick, J., and Kraemer, K. L. (1998). *Asia's computer challenge: Threat or opportunity for the United States and the world?* New York: Oxford University Press.

Evans, Peter. (1992). Greenhouses and strategic nationalism: A comparative analysis of Brazil's informatics policy. In Evans, P., Frischtak, Claudio R., and Tigre, P. (Eds.), *High technology and third world industrialization: Brazilian computer policy in comparative perspective* (pp. 1-37). Berkeley, CA: International and Area Studies, University of California at Berkeley.

Evans, Peter. (1995). *Embedded autonomy: States and industrial transformation*. Princeton, NJ: Princeton University Press.

Evans, Peter, Frischtak, Claudio R., and Tigre, P. (1992). *Informática brasileira em transição: Política governamental e tendências internacionais nos anos 90*. Rio de Janeiro: Instituto de Economia Industrial, Universidade Federal do Rio de Janeiro.

França, A. L. (1999, January 18). Via Internet, dos EUA, é a nova dona da Dialdata. *Gazeta Mercantil*.

Frischtak, Claudio R. (1992). The international market and the competitive potential of national producers of equipment and systems. In Evans, P., Frischtak, Claudio R., and Tigre, P. (Eds.), *High technology and third world industrialization: Brazilian computer policy in comparative perspective* (pp. 165-196). Berkeley, CA: International and Area Studies, University of California at Berkeley.

Fritsch, Peter. (1999, September 23). Gateway invests in Brazil computer seller. *The Asian Wall Street Journal*.

Fritsch,W. (1992). Informatics policy in the new industrial strategy: A reform proposal. In Evans, P., Frischtak, Claudio R., and Tigre, P. (Eds.), *High technology and third world industrialization: Brazilian computer policy in comparative perspective* (pp. 144-164). Berkeley, CA: International and Area Studies, University of California at Berkeley.

FUNCEX (Fundação Centro de Estudos de Comércio Exterior). (1998, March). A experiência exportadora do setor de software brasileiro (relatório final). Estudo elaborado para a Secretaria executiva do MCT. Mimeo.

IDG Now Market Snapshot. (1998, May 7). *Desktop PCs and notebooks in Brazil*. São Paulo: International Data Group.

IMF (International Monetary Fund). (1999). *World Economic Outlook, May 1999*. Washington, DC: IMF.

ITU (International Telecommunications Union). (1997). *World Telecommunications Development Report, 96/97*. Geneva: ITU.

Jones, Capers. (1993). *Software productivity and quality today: The world perspective.* Carlsbad, CA: Information Systems Management Group.

Junior, G. (1998, April 3). E o cidadão digital brasileiro? *Gazeta Mercantil*.

Laplane, M., and Sarti, F. (1997). O investimento direto estrangeiro no Brasil nos anos 90: Determinantes e estratégias. Campinas: Núcleo de Economia Industrial e da Tecnologia, Instituto de Economia, Universidade Estadual de Campinas. Mimeo.

La Rovere, R., Tigre, P, and Fagundes, J. (1996). Information networks diffusion in Brazil: Global and local factors. In Palvia, P., Palvia, S., and Roche, E. (Eds), *Global information technology and systems management: Key issues and trends***.** Nashua, NH: Ivy League Publishing.

Mansell, R., and Wehn, U. (Eds.). (1998). *Knowledge societies: Information technology for sustainable development*. Oxford; New York: Published for and on behalf of the United Nations by Oxford University Press.

Mattos, A. (1999, January 20). Componentes de novo em campo. *Gazeta Mercantil*.

Mattos, A., and França, A. L. (1998, June 18). Tela grande chega aos computadores. *Gazeta Mercantil.*

MCT/SEPIN (Ministério da Ciência e Tecnologia, Secretaria de Política de Informática e Automação). (1997). *Panorama do setor de informática - 1997*. Brasília, DF: MCT/SEPIN.

MCT/SEPIN (Ministério da Ciência e Tecnologia, Secretaria de Política de Informática e Automação). (1998). *Setor de tecnologias da informação: Resultados da Lei n° 8.248/91*. Brasília, DF: MCT/SEPIN.

Microsoft to invest US$126 million in Globo Cabo – Brazil. (1999, August 24). *Business News Americas.*

MPO/IBGE (Ministério do Planejamento e Orçamento, Instituto Brasileiro de Geografia e Estatística). (1996). *Pesquisa de orçamentos familiares*. Rio de Janeiro: MPO/IBGE.

MPO/IBGE (Ministério do Planejamento e Orçamento, Instituto Brasileiro de Geografia e Estatística). (1998). *Brasil em números* (vol. 6). Rio de Janeiro: MPO/IBGE.

Reed Electronics Research. (1991-1998). *Yearbook of World Electronics Data.* Surrey, U.K.: Reed Electronics Research.

SABI (South American Business Information). (1999, January 21). Brazil: Rio leads software exports. *Jornal do Brasil.*

SABI (South American Business Information). (1999, May 14). Brazil: Microsoft intensifies anti-piracy actions. *Gazeta Mercantil.*

SCT/DEPIN (Secretaria da Ciência e Tecnologia, Departamento de Política de Informática e Automação). (1991). *Séries estatísticas: Panorama do setor de informática* (vol. 1). Brasília: SCT/DEPIN.

Telébras. (Various years). Annual reports.

Tigre, P. (1992). Current dilemmas and future options for informatics policy. In Evans, P., Frischtak, Claudio R., and Tigre, P. (Eds.), *High technology and third world industrialization: Brazilian computer policy in comparative perspective* (pp. 117-143). Berkeley, CA: International and Area Studies, University of California at Berkeley.

Tigre, P. (1995). Liberalização e capacitação tecnológica: O caso da informática pós-reserva de mercado no Brasil. In Schwartzman, S. (Coord.), *Ciência e tecnologia no Brasil: Política industrial, mercado de trabalho e instituições de apoio*. São Paulo: Fundação Getúlio Vargas Editora.

UNDP (United Nations Development Programme). (1993). *Human Development Report 1993*. New York; Oxford: Oxford University Press.

UNDP (United Nations Development Programme). (1998). *Human Development Report 1998*. New York; Oxford: Oxford University Press.

U.S. Department of Commerce, International Trade Administration. (1998). *World - Computer/IT Software/Services Fy99* (IMI981113 Best Market Reports). Washington, DC: U.S. Department of Commerce, International Trade Administration.

World Bank. (1999). *World Development Report 1998/99*. New York: Oxford University Press.