# Ideological "guerrillas" and the quest for technological autonomy: Brazil's domestic computer industry

Emanuel Adler

Why and how was Brazil—which has suffered from many "classic dependency syndromes"[1]—successful in implementing a computer policy that explicitly aimed to reduce technological dependency on outside sources? Why and how did it establish a domestic computer industry that excluded international computer giants such as IBM from Brazil's lucrative micro- and minicomputer markets? To answer these questions, I shall analyze the economic, technological, and political factors that were partially responsible for overcoming some obstacles associated with technological dependency.

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1. For example, a relatively poor educational system, scientific and technological underdevelopment, lack of managerial experience and capital, and a strong dependence on the products of multinational corporations (MNCs). The dependency literature has become too large to be summarized in one footnote. A good article analyzing different approaches and their respective definitions is Gabriel Palma, "Dependency: A Formal Theory of Underdevelopment or a Methodology for the Analysis of Concrete Situations of Underdevelopment?" *World Development* (August 1978). See also James Caporaso, ed., special issue on dependence and dependency in the global system, *International Organization* 32 (Winter 1978). For an analysis of some of the consequences of technological dependency see Charles Cooper, ed., *Science, Technology, and Development: The Political Economy of Technical Advance in Underdeveloped Countries* (London: Frank, 1973); for a study of Latin America's dependency see Richard Bath and Dilmus D. James, eds., *Technological Progress in Latin America: The Prospects for Overcoming Dependency* (Boulder: Westview, 1979); and for an analysis of Brazil's technological dependency on MNCs, see Peter Evans, *Dependent Development: The Alliance of Multinational, State and Local Capital in Brazil* (Princeton: Princeton University Press, 1979).

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For example, an "economic miracle" in Brazil produced the capital necessary for industrial and technological development, and a balance-of-payments crisis forced its leaders to impose import controls and step up import substitution. Furthermore, since 1964 Brazil had experienced some measure of political stability, allowing for policy continuity. Most significant was the revolution that occurred in the technology of microelectronics, which decreased the costs and increased the simplicity of computer production.

At the same time, I shall show that a causal analysis based only on structural opportunities and/or constraints is insufficient because it does not account for the interaction of process-oriented and material factors: structural constraints and opportunities are not the only factors that matter, and motivated behavior is not merely behavior in the "national interest."

In the case of Brazilian computers, technological dependency could not be overcome until the dependency had been perceived and identified, and solutions examined and selected. This process required the mobilization of ideological and institutional resources that, while they do not by themselves provide sufficient conditions for human behavior, do stimulate change by increasing the available solutions. The literature on bargaining theory claims that dependence on foreign sources of capital and technology,[2] even in high-technology sectors, can be partially overcome with time. The developing country, learning from experience, eventually gains access to sources of bargaining power earlier controlled by multinational corporations (MNCs), thereby shifting the balance in its favor.[3] I shall argue that, though accurate, the bargaining explanation is incomplete because it ignores the cognitive, mainly ideological, factors that inform capabilities and attributes.

Any learning or bargaining process is necessarily cognitive in that it involves beliefs, perceptions, and motives. These cognitive factors should not be taken for granted. Institutions that act to acquire the know-how necessary to force the balance of power to shift in their favor do not act as machines programmed to overcome MNC control of capital and technology but as purposive and sometimes even voluntaristic groups. Believing dependency to be the key development problem their countries face, such groups view autonomy from the MNCs as the most natural solution. The absence of such ideologically motivated groups might prevent a country from taking

2. See for example, Raymond Vernon, *Storm over the Multinationals: The Real Issues* (Cambridge: Harvard University Press, 1977); Theodore Moran, *Multinational Corporations and the Politics of Dependence: Copper in Chile* (Princeton: Princeton University Press, 1977); and C. Fred Bergsten, Thomas Horst, and Theodore Moran, *American Multinationals and American Interests* (Washington, D.C.: Brookings Institution, 1978).

3. For a study showing how the balance of power can shift in favor of developing countries even in high-technology sectors see Joseph M. Grieco, "Between Dependency and Autonomy: India's Experience with the International Computer Industry," *International Organization* 36 (Summer 1982). For a more extensive analysis see *Grieco, Between Dependency and Autonomy: India's Experience with the International Computer Industry* (Berkeley: University of California Press, 1984).

action to reduce dependency. A successful bargain was made possible in the Brazilian case partly because an ideology based on a "theory" of dependency was turned into a strategy for achieving change, that is, for overcoming dependency.

In this study I will identify a "pragmatic antidependency" school of thought, prevalent among the Brazilians responsible for Brazil's computer policy, which views dependency as a problem and which also believes that such dependency can be reduced through learning, control of foreign technology and investment, development of a domestic capacity for innovation, and direct state intervention aimed at linking domestic industry with the scientific and technological infrastructure.

This pragmatic antidependency approach refutes classic Marxist structural dependency theory, which, accepting only global and structural solutions to what are diagnosed as global and structural problems, concludes that developing countries are unable or unwilling to reduce their dependence on MNCs. The antidependency approach is attuned to bargaining theory in that it claims bargaining can take place beyond marginal issues, that dependency can be reduced sooner rather than later, and that developing countries are therefore not condemned to eternal dependency. Both pragmatic antidependency and bargaining theories reject structural determinism. Pragmatic antidependency is influenced by an eclectic Latin American ideology that I call *egalitarian nationalism,* a mixture of nationalist beliefs (which reject internationalism in both their pure liberal and Marxist versions) and Marxist humanitarian and egalitarian values, which derives from a strong indigenous statist tradition.[4]

## The cognitive factor

Ideologies, as specific sets of ideas, can be powerful because they tell actors (including institutions and groups within institutions) what their goals should be, the importance of these goals compared to other goals, how to pursue these goals, and who their friends and enemies are. Ideologies can be important for understanding politico-economic behavior because they "have origins that cannot be reduced to material developments . . . [and that] can have substantial and independent effects," as well as the "obvious potential to develop into potent political forces. This happens when a set of political doctrines is adopted by a group of people, assumes a critical position in their belief systems, and then becomes a guiding force behind their actions."[5]

4. For the importance of eclectic ideologies in Latin America see Charles W. Anderson, *Politics and Economic Change in Latin America* (Princeton, N.J.: Van Nostrand, 1967), p. 41.

5. John S. Odell, *U.S. International Monetary Policy: Markets, Power, and Ideas as Sources of Change* (Princeton: Princeton University Press, 1982), pp. 362–63; and Lorand B. Szalay and Rita Mae Kelly, "Political Ideology and Subjective Culture: Conceptualization and Empirical Assessment," *American Political Science Review* (September 1982), p. 585.

I shall refer to political ideologies as doctrines or strategies that embody a consensus on causes and effects, antecedent conditions and preferred outcomes which motivate individuals and groups to effect political, economic, and social change. Two major implications follow from this definition. First, because individuals and groups attach the label "real" only to those situations that are both perceived and interpreted,[6] strategies for achieving change vary according to how a situation is understood, evaluated, decoded. Whereas structural factors may generate the potential for events to happen in a certain way, human intervention (read: interpretation of reality) may cause the events to happen quite differently.

> All but the most extreme policy situations seem highly complex and uncertain; policy makers typically disagree among themselves as to diagnosis and prescription, or later analysts uncover evidence and reasoning that support more than one plausible interpretation of the national interest. Conflicting schools of thought cutting across interest groups, political parties, and bureaucracies are often evident. Policies sometimes seem to vary to a greater extent with the rotation of these schools of thought through the offices of government than with other variables. The cognitive analyst may argue that for a given case, a change in reigning ideas would have made a greater difference for a policy content than conceivable changes in other factors. Situational factors may explain the rejection of an old policy, the timing of a policy change, or the degree of policy coherence, but contain no explanation for the choice of a new policy from among the alternatives.[7]

Second, the consensus embodied in political ideologies can be achieved only in the light of mutual understanding among people within groups and institutions. Therefore, a cognitive explanation is by no means an alternative to an institutional explanation. The actors I characterize in this study as sharing a strategy for achieving change succeeded within and through institutions. Institutions are "carriers" for ideologies that may compete with other ideologies both inside and outside the institutions. This study suggests that institutions integrate certain constellations of collective understanding and that these constellations may remain intact even if the institutions later cease to depend directly on them. By helping to set up goals and direct attention to political processes and resources, these constellations may become a precondition for institutional and policy change.

Inherent in the cognitive factor, however, are certain epistemological dangers; for example, the claim that ideas matter may be taken for granted, or the cognitive perspective may be so overstated that it becomes a truism.[8]

6. Burkart Holzner and John H. Marx, *Knowledge Application: The Knowledge System in Society* (Boston: Allyn & Bacon, 1979), p. 82.
7. Odell, *U.S. International Monetary Policy*, p. 62.
8. Ibid.

Nevertheless, these dangers should not discourage the search for an understanding of how cognitive and structural factors interact. The Brazilian computer case illustrates this interaction and proves that the point is not self-evident.

For the most part, Brazil's political, economic, and, to some degree, military elites regarded with skepticism the idea that Brazil could develop a computer industry without the participation of MNCs, especially IBM. A group of ideologically motivated actors who enjoyed the support of scientific and technological institutions and funds established in the late 1960s to develop Brazil's technological potential attempted to convince the elites otherwise. These actors included scientists, technologists, and technocrats, who, for the sake of their ideas and ideology, elected to act as political and ideological "guerrillas" within public institutions. By placing their ideas about technological autonomy on high-level agendas, by keeping their ideas there, and by proving the economic viability of their ideas, they finally induced political leaders to give them a chance.

This group of what I term *pragmatic antidependency guerrillas* used their scientific, technological, and managerial knowledge, as well as their access to political power, to mobilize not only the *know-how* and *know-what* but also the *know-where-to* regarding computers. They were benevolent conspirators, who maintained belief in the possibility of a domestic computer industry even when the technological means to fulfill their vision were still minimal. And they continued to fight for their idea in the face of opposition from the politico-economic leaders.

The guerrillas' actions point up the importance of the cognitive approach in our understanding of state intervention in industrialization processes in the Third World. For, although a "long history of economic dependence" can have "a deleterious impact on domestic private enterprise, in terms both of its ability to accumulate capital and of its development of technology. . . . Essentially, a choice has to be made between direct state or parastatal intermediation and reliance on foreign entrepreneurship." The ideological choice that Third World countries must make should not be taken for granted: whether to let MNCs run the show in the course of industrialization processes, or whether to allow the "nationalist logic of external benefits and long-range returns" to lead toward state intervention.[9]

Research on the Third World ought to include studies on what enables one particular ideology and its institutional carriers to overcome alternative ideologies and their carriers. The Brazilian computer case would make an ideal subject for such a study, for it shows how the ideologically oriented pragmatic antidependency guerrillas induced and even co-opted the eco-

9. John R. Freeman and Raymond D. Duvall, "International Economic Relations and the Entrepreneurial State," *Economic Development and Cultural Change* (January 1984), pp. 375–76; and ibid., p. 376.

nomic and political elites (who favored partnership with MNCs) to accept a market reserve that enabled the industry to develop. Any such study, however, must place cognitive and institutional factors in the context of the political, economic, and technological capabilities that influence elite behavior.

## Brazil's computer market and the growth of its domestic computer industry

In the early 1970s the Brazilian computer market was already the twelfth largest in the world. While the world market was growing at a rate of about 20 percent a year, the Brazilian data-processing market was growing at a rate of 30 to 40 percent, second only to Japan. Growth rates were still high in the mid-1970s, between 20 and 30 percent. By 1975, when the national computer policy went into effect, Brazil had become the tenth largest data-processing market; by 1976 the market was worth about $1.4 billion, or 1 percent of the Gross Domestic Product (GDP).[10]

By 1982 the value of installed computers in Brazil had reached $2.8 billion.[11] In dollar terms the computer industry grew 64 percent between 1979 and 1980, 26 percent between 1980 and 1981, and 51 percent between 1981 and 1982 (the latter after adjusting for 100% inflation). Growth for 1979–80 reflects the entrance of new domestic enterprises into the market; the 1981–82 figure represents a real growth in sales. The market is expected to reach $5 billion by 1985.[12]

The growth in the number of installed computers between 1970 and 1982 is set forth in Table 1, which is broken down into the six categories adopted by the Brazilian Special Secretariat of Informatics (SEI).[13]

Between 1970 and the appearance of the first Brazilian computers in the marketplace in 1978, the number of computers in the country grew almost fourteenfold. Even discounting microcomputers, the number of computers increased 270 percent between 1973 and 1978, and 673 percent between 1973

10. Wando Pereira Borges, president of Digibrás, *Hearings before the Parliament (Câmara dos Deputados)* (Mimeo, Brazil, D.F., 31 August 1977); Grieco, *Between Dependency and Autonomy*, p. 158; Paulo Bastos Tigre, "Indústria de Computadores e Dependência Tecnológica no Brasil" (Master's thesis, University of Rio de Janeiro, 1978), p. 75; CAPRE, *Boletim Técnico* 1 (January–March 1979), pp. 38–39; and G. B. Levine, "Brazil 1976—Another Japan?" *Datamation* 21 (December 1975).

11. SEI, *Boletim Informativo* 3 (June–September 1983), p. 10.

12. *Data News*, 3 May 1983, p. 9; and *Brazil Trade and Industry*, May 1982, p. 11.

13. The SEI (which has been in charge of computer policy since 1979) classifies computers according to their mean value: class 1, $20,000; class 2, $90,000; class 3, $180,000; class 4, $670,000; class 5, $1,900,000; and class 6, $3,000,000 (SEI, *Boletim Informativo* 8 [July–September 1982], p. 5). Roughly, the six classes stand for microcomputers, minicomputers, small, medium-sized, large, and very large computers. The microcomputer category includes electronic accounting machines and desktop models.

**TABLE 1.** *Number of installed computers in Brazil, 1970–82, by size*

| *Class* | *1970* | *1971* | *1972* | *1973* | *1974* | *1975* | *1976* | *1977* | *1978* | *1979* | *1980* | *1981* | *1982* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Micro | [a] | [a] | [a] | 586 | 1,514 | 2,143 | 3,131 | 3,846 | 4,290 | 4,791 | 4,722 | 8,756 | 17,702 |
| (%) | [a] | [a] | [a] | (38) | (54) | (56) | (60) | (64) | (62) | (60) | (53) | (61) | (73) |
| Mini | [a] | [a] | [a] | 19 | 81 | 173 | 265 | 356 | 656 | 1,015 | 1,675 | 2,719 | 3,571 |
| (%) | [a] | [a] | [a] | (1) | (3) | (4) | (5) | (6) | (10) | (13) | (19) | (19) | (14) |
| Small | 378 | 403 | 454 | 639 | 775 | 1,057 | 1,309 | 1,296 | 1,378 | 1,494 | 1,688 | 1,858 | 1,950 |
| (%) | (75) | (70) | (68) | (40) | (27) | (27) | (25) | (21) | (20) | (18) | (19) | (13) | (8) |
| Medium | 122 | 163 | 184 | 250 | 288 | 327 | 338 | 353 | 370 | 377 | 388 | 408 | 400 |
| (%) | (24) | (28) | (28) | (16) | (11) | (9) | (7) | (6) | (5) | (5) | (5) | (3) | (2) |
| Large | 2 | 2 | 10 | 45 | 72 | 82 | 99 | 122 | 166 | 226 | 248 | 374 | 544 |
| (%) | (0) | (0) | (1) | (3) | (3) | (2) | (2) | (2) | (2) | (3) | (3) | (3) | (2) |
| Very large | 4 | 10 | 19 | 33 | 42 | 61 | 72 | 87 | 93 | 97 | 123 | 134 | 172 |
| (%) | (1) | (2) | (3) | (2) | (2) | (2) | (1) | (1) | (1) | (1) | (1) | (1) | (1) |
| Total excluding microcomputers | 506 | 578 | 667 | 986 | 1,258 | 1,700 | 2,083 | 2,214 | 2,663 | 3,209 | 4,122 | 5,493 | 6,637 |
| Total | 506 | 578 | 667 | 1,572 | 2,772 | 3,843 | 5,214 | 6,060 | 6,953 | 8,000 | 8,844 | 14,249 | 24,339 |

a. Available information is unreliable.

*Source.* SEI, *Boletim Informativo* 1 (August–October 1981), p. 9; 2 (July–September 1982), p. 4; and 3 (June–September 1983), p. 6.

and 1982. The number of installed computers grew 71 percent in 1981–82 alone.

The data indicate a very dramatic change in the market between 1970, when small and medium-sized computers accounted for 99 percent of all computers, and 1978, when micro- and minicomputers made up 71 percent of the total. By 1982 this latter figure had jumped to 87 percent. Large computers also grew at a high rate: 346 percent between 1977 and 1982, with 51 percent between 1980 and 1981 alone.[14] Because by 1982 mini- and microcomputers were doing what small and medium-sized computers had done in the past, and since the power and speed of large and very large computers were unmatched, the market for medium-sized computers was compressed while the extremes grew significantly.

Before Brazil formulated a computer policy the country's computer requirements were met by MNCs such as IBM, Burroughs, Hewlett-Packard, Honeywell Bull, Data General, Digital, and Olivetti. Brazil's computer imports increased from $13.3 million in 1969 to $99.8 million in 1974 and to $111.9 million in 1975.[15] IBM, Burroughs, and Hewlett-Packard manufactured computers in Brazil to meet domestic as well as global requirements. By 1980 IBM do Brasil, the largest computer company in Brazil, held 53.8 percent of the total value of installed computers and was IBM's fastest-growing subsidiary, generating about 50 percent of the company's Latin American business with the medium-sized and large computers, tapedrives, terminals, printers, and data-entry equipment produced in its Sumaré plant.[16] Burroughs, the second largest company with approximately 15 percent of the total value of installed computers in 1980, manufactured medium-sized, large, and very large computers.[17]

Once Brazil decided to enter the domestic computer market, the industry developed rapidly. Only two years after that decision, domestic companies were producing hardware and software, peripheral devices, terminals, modems, and special ("intelligent") terminals. The dollar value of installed domestic computers grew from 2 percent of the total value of installed computers in Brazil in 1978, to 19 percent by 1982, by which time 67 percent of installed computers had been produced by domestic companies. Figure 1 shows the growth of domestic installed computers between 1980 and 1982, by number and value.

By 1983 Brazil had about one hundred domestic computer companies,

14. SEI, *Boletim Informativo* 3 (June–September 1983), p. 7.

15. *Dados e Idéias* 5 (April–May 1977), p. 30.

16. Robert A. Bennett, "IBM in Latin America," in Jon P. Gunneman, ed., *The Nation-State and Transnational Corporations in Conflict: With Special Reference to Latin America* (New York: Praeger, 1975), Appendix B, p. 225.

17. United Nations Center on Transnational Corporations (UNCTC), *Transborder Data Flows and Brazil* (New York: United Nations, 1983), p. 80; *Brazil Trade and Industry*, May 1982, p. 12; and information provided to me by IBM do Brasil.

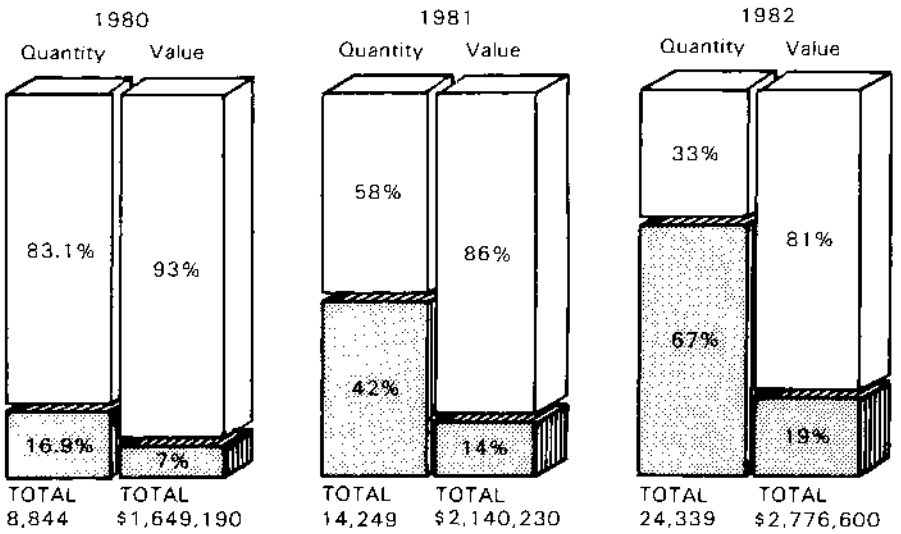


**FIGURE 1.** *Number and value (in thousands) of installed domestic (shaded sections) and foreign computers, 1980–82*

*Source.* SEI, *Boletim Informativo* 3 (June–September 1983), p. 10.

which employed 18,000 individuals; gross sales amounted to $687 million or 46 percent of total gross sales.[18] Most had been founded after 1976 under the guidance of the national computer policy. In 1982 they accounted for 67, 91, 13, and 1 percent of the value of installed micro-, mini-, small, and medium-sized computers, respectively.[19] The largest company, Cobra SA (a state-owned company) ranked third in sales, with about 36.2 percent of the total value of installed minicomputers by June 1982. At that time the other large national companies important in this segment of the market were Labo, with 18.4 percent; SID, 7.6 percent; Edisa, 23.3 percent; and Sisco, 5.0 percent. Cobra, Dismac, Edisa, and Prológica held approximately 72 percent of the value of installed microcomputers.[20]

Domestic computer companies invest a relatively high share of their sales in research and development. In 1980 domestic firms producing computers with indigenous technology spent an average of 14.4 percent of their sales on R&D, while national firms working under foreign licenses spent an average of 7.9 percent. The total Brazilian domestic computer industry's R&D average was 8.7 percent, which is more than the 6.1 percent spent by the American computer industry during the same year.[21]

18. *Data News*, 15 May 1984, p. 4.
19. SEI, *Boletim Informativo* 3 (June–September 1983), p. 11.
20. Ibid., pp. 13, 18.
21. Paulo Bastos Tigre, *Technology and Competition in the Brazilian Computer Industry* (New York: St. Martin's, 1983), p. 94.

The reduction of domestic industry imports—they fell from $81 million in 1981 (26.6 percent of the total computer imports) to $49 million in 1983 (21.4 percent of total computer imports)[22]—is one indicator of the success achieved by the pragmatic antidependency policy and its emphasis on R&D. Shares in sales of products based on local technology (technology not obtained under licensing agreements or for which such agreements have recently expired and only minor improvements made since) have risen dramatically between 1979 and 1981, while those of imports have declined during the same period (see Table 2). Domestic systems rose from 28 percent in 1979 to 60 percent in 1981, and imports fell from 29 to 7 percent. Although all terminals are now manufactured entirely domestically, peripheral devices still depend on foreign technology. Totaling the five categories shown in Table 2, we find domestic technology increased from 31 percent in 1979 to 53 percent in 1981, while imports decreased by a factor of almost four. During the same period the MNC import content of total sales rose from 28 to 40 percent.[23]

Finally, it should be pointed out that some domestic computer companies have now reached a level of technological sophistication and economic efficiency which allows them to produce for export. Cobra, Microdigital, Prológica, and Elebra have been the domestic export leaders (Elebra has even exported components to the United States).

## Economic growth, technology, and the international computer industry

From 1968 to 1973—the period of Brazil's economic miracle—Brazil's GDP grew at an average yearly rate of 10.1 percent. Industrial production grew even faster, so that by 1975 the Brazilian manufactured value added was about 25 percent of the Brazilian GDP, representing almost 20 percent of the value added of all the developing countries combined. Even more remarkable was Brazil's real growth in capital goods manufacturing output, which averaged 20.8 percent a year between 1968 and 1973.[24] This growth rate produced the capital necessary for Brazil's industrial and technological development and kindled expectations that Brazil had at last found the road to self-sustained growth.

Buttressing the economic progress was the relative stability and continuity of Brazil's political regime, which began with the coup in 1964 that

22. *Data News*, 6 November 1984, p. 6.

23. UNCTC, *Transborder Data Flows and Brazil*, p. 98.

24. Pedro S. Malan and Regis Bonelli, "The Brazilian Economy in the Seventies: Old and New Developments," *World Development* 5 (January–February 1977), pp. 36 and 38, and United Nations Industrial Development Organization (UNIDO), *Industrial Priorities in Developing Countries* (New York: United Nations, 1979), pp. 2–3.

TABLE 2. *Dollar share of sales for equipment manufactured with local technology and of imports*

| | 1979 | | 1980 | | 1981 | |
|---|---|---|---|---|---|---|
| | *Technology* | *Imports* | *Technology* | *Imports* | *Technology* | *Imports* |
| Systems | 28% | 29% | 41% | 18% | 60% | 7% |
| Peripheral devices | — | 111 | 4 | 48 | 6 | 36 |
| Terminals | 100 | 8 | 100 | 8 | 100 | 3 |
| Modems | 10 | 21 | 37 | 22 | 50 | 13 |
| Special terminals | 100 | 6 | 100 | 22 | 100 | 14 |
| Total | 31 | 29 | 39 | 20 | 53 | 8 |

*Notes.* Figures for sales include exports. Imports for a given year appear as percentages of sales during that year. Since corporations may import to increase inventories, percentages may be higher than 100.
*Source.* UNCTC, *Transborder Data Flows and Brazil* (New York: United Nations, 1983), pp. 223–25.

overthrew João Goulart and continued until the 1984 elections. Economic leadership during this period was also remarkably stable: minister of planning, João Paulo dos Reis Velloso, a key figure in the development of Brazil's computer industry, held this position (later changed to secretary of planning) from 1969 to 1979.

Emboldened by its economic growth, Brazil became involved in large infrastructure and industrial projects: during this period Brazil built Itaipú, the biggest hydroelectric plant in the world, implemented a policy to run cars with alcohol, and established a huge nuclear energy program.[25] The evolution of computer technology and of the international computer industry came at an opportune time for Brazil. Searching for new ways to develop domestic technology, Brazil took advantage of the rise of mini- and microcomputers and of the progress in semiconductor technology.

Semiconductor technology received a boost when the transistor invented by Bell Laboratories in 1947 was integrated, along with other necessary components, into a single silicon base, or "chip." This integration reduced manufacturing costs, increased efficiency, and enlarged information storage

25. Success eluded Brazil's attempt to master the nuclear fuel cycle and set up a large number of nuclear plants, despite the agreement signed with West Germany to effect the largest technology transfer in history and despite spending billions of dollars. For an analysis of the Brazilian–West German deal see Norman Gall, "Atoms for Brazil, Dangers for All," *Foreign Policy* 23 (Summer 1976). For a description of the Brazilian nuclear power industry and its problems see Margarete K. Luddeman, "Nuclear Power in Latin America: An Overview of Its Present Status," *Journal of Interamerican Studies and World Affairs* 25 (August 1983).

capacities.[26] The price per bit of storage fell from about 1.000 cent per bit in 1970 to 0.050 cent per bit in 1979,[27] and it is expected to fall to 0.001 cent per bit by 1989.[28]

The revolution in semiconductor technology was responsible for the development of minicomputers, which appeared for the first time in 1965 when Digital Equipment Corporation introduced its PDP-8 model. The minicomputer industry has since become fiercely competitive. At the beginning of the 1970s, approximately forty new companies were created to manufacture minicomputers.[29] Since then minicomputers "have experienced price declines of at least five while at the same time their main memory capacities have increased by factors of two to four times, and processing speeds have increased by perhaps a factor of 1,000. . . . [B]y the middle of the 1970s technological innovations were leading minisystems to be so powerful as to challenge the lower range of the mainframe computer market." By 1980, before the appearance of 32-bit superminicomputers or "superminis," the minicomputer market was estimated at $15 billion—roughly one-fourth of the world computer market.[30]

Probably the most important technological jump in semiconductor technology to date occurred in 1971, when Intel introduced a chip known as the microprocessor, which can be programmed to carry out information-processing and control functions[31]—in essence, a computer-on-a-chip. After several generations, processing power of the chip has increased tremendously, while cost per function has decreased.[32] The microprocessors were built into microcomputers almost as powerful as minicomputers, at a fraction of their cost, and are increasingly finding their way into homes as "personal computers."

When Brazilian technocrats first discussed developing a domestic computer industry in 1971, these advances in computer technology did not escape them. However, their ideas of the state of the art at that time were based on computer technology of the late 1960s; they were not aware of the advantages they would later receive from advances in the technology of

26. Atul Wad, "Microelectronics: Implications and Strategies for the Third World," *Third World Quarterly* 4 (October 1982), p. 629.

27. Michael Borrus, James Millstein, and John Zysman, with the assistance of Aeton Arbisser and Daniel O'Neill, *International Competition in Advanced Industrial Sectors: Trade and Development in the Semiconductor Industry*, Joint Economic Committee, 97th Cong., 2d sess., 18 February 1982, p. 34.

28. Dimitri Ypsilanti, "The Semiconductor Industry," *OECD Observer* 132 (January 1985), p. 14.

29. *Business Week*, 2 August 1982, p. 55.

30. Grieco, *Between Dependency and Autonomy*, p. 58; *World Business Weekly*, 21 April 1980, p. 35.

31. Wad, "Microelectronics," p. 679.

32. For example, a 32-bit microprocessor with the power of a mainframe computer can execute one million or more instructions per second; analysts predict it will cost no more than twenty dollars by the end of the 1980s. *Business Week*, 30 July 1984, p. 56.

microprocessors and microcomputers. By 1977, when the crucial political decisions were made, those responsible for domestic computer policy were fully aware of the importance of these developments. Timing was not irrelevant. That MNCs, in particular IBM, had not yet begun manufacturing mini- and microcomputers in Brazil when the national endeavor was first considered constituted an opportunity. For had the MNCs already established a niche in Brazil with these systems, the cost and difficulty of pushing them out of the market might have proved too high.

The new technological developments generated a very dynamic world semiconductor market characterized by the entry of companies from several nations and capable of supplying millions of computers-on-a-chip every year. The worldwide worth of semiconductors increased from about $400 million in 1959 to $5.4 billion in 1974, and to approximately $20 billion in 1983. The growth of this market spawned many additional firms in the United States as well as in Japan and Europe, which began to compete for the production market for integrated circuits. For example, Japan sold 70 percent of all the 64k chips in 1982 and is now aggressively involved in the production and sale of 256k chips;[33] and today six out of the ten largest manufacturers of chips are Japanese. By 1982, Japan, Western Europe, and the United States controlled 30, 17, and 50 percent, respectively, of the production of integrated circuits.[34]

These technological and market changes have partially transformed the highly concentrated and oligopolized international computer industry. In the 1970s this industry grew at a rate of between 10 and 15 percent annually; correspondingly the number of computers in use worldwide has doubled every few years.[35] One giant, IBM, has always overshadowed all other computer companies. In 1970, IBM controlled 60 percent of the computer market (valued at $11.7 billion). By the end of the decade this lead had narrowed to a still impressive 40 percent of the $53.5 billion market.[36] IBM's gross sales were worth $46 billion in 1984.[37]

Today U.S. companies hold 80 percent of the computer market. Seven of the industry's top ten companies are American: IBM, Burroughs, Texas Instruments, Motorola, Digital, NCR, and Control Data. But Japan, which has been making large inroads, holds close to 10 percent, or about $9 billion, of that market. In 1983 Japan's computer equipment exports amounted to $3.9 billion, with Nippon, Fujitsu, and Hitachi listing among the ten largest computer companies worldwide.[38] Smaller Japanese companies are supply-

33. *Business Week*, 23 May 1983, p. 53.
34. Borrus et al., *International Competition in Advanced Industrial Sectors*, p. 123, and Ypsilanti, "The Semiconductor Industry," p. 15.
35. *World Business Weekly*, 20 April 1981, p. 30.
36. *Time*, 11 July 1983, p. 45, and *Business Week*, 8 June 1981, p. 84.
37. *New York Times*, 20 January 1985, p. D-5.
38. *Business Week*, 16 July 1984, p. 61, and *Data News*, 6 November 1984, p. 14.

ing computer hardware to U.S. firms and, together with Taiwanese and Korean companies, selling components and personal computers on world markets. In all, 500 computer hardware manufacturers, 5,000 software companies, and about 430 producers of communication equipment currently sell $268 billion worth of products. With the present compound annual growth of 20 percent, data-processing revenues are expected to reach $1 trillion by 1990.[39]

## Development of a Brazilian computer industry

Encouraged by the changes that were taking place in the international computer industry, and anxious to promote industrialization and domestic technological development, as early as 1971 Brazil's technocrats decided to invest the capital made available by the economic miracle in a domestic computer industry. The availability of inexpensive chips, along with the possibility of obtaining technology under license helped Brazil shift its technological dependence from the older computer hardware market dominated by market giants to the dynamic semiconductor market dominated by foreign components, and software know-how available from small new companies. The domestic computer industry development was thus an ideological, institutional, and political outgrowth of the general science and technology policy that Brazil implemented at the end of the 1960s.

A group of economists working for the National Bank for Economic and Social Development (BNDES), headed by José Pelúcio, identified the source of Brazil's underdevelopment as technological dependency. Their diagnosis assumed that economic development was linked not only to growth rates but also to an increased capacity for understanding and perceiving the impact of forces of modernization. This diagnosis found partial support from the military; the diagnosis received strong support from planning institutions, which were staffed largely by economists trained by the Economic Commission for Latin America, and from the scientific and technological community, many of whom had been involved in setting up the National Research Council (CNPq) and the nuclear independence policy at the beginning of the 1950s. Adherents of the dependency diagnosis believed Brazil would achieve autonomy not by rejecting foreign technology but by attaining the ability to make technological decisions.

The dependency diagnosis may be considered pragmatic because it did not accept the structuralist view that the world capitalist system necessarily leads to stagnation and to eternal dependence. Instead, it attempted to identify Brazil's weaknesses in order to effect reforms. To achieve the objective of technological autonomy, Brazil developed an indigenous technological

39. *Business Week*, 16 July 1984, pp. 62, 49.

capacity guided by a national strategy of selective interdependence, possibilities of importing technology, local comparative advantage, and possibilities of exporting the resultant technology.[40]

The strong relationship that developed between Pelúcio, the guiding force behind the science and technology policy during the 1970s, and Velloso, was crucial to the implementation of such a policy. Velloso was a powerful advocate for technological antidependency ideas and their realization. A strong supporter of a market economy and interdependence, he nonetheless believed that the key to an economically sound future lay in developing a domestic technological potential including strategic sectors such as computers.

The government established the Studies and Projects Financing Agency (FINEP) in order to support national technological development and to link the domestic technological infrastructure to national industry; Pelúcio headed FINEP for most of the 1970s. The National Science and Technology Development Fund, which operated under the jurisdiction of FINEP, became the main financial instrument for scientific and technological development. The National Research Council, currently the National Council of Science and Technology, became the central organism for planning, coordinating, and implementing scientific and technological policy. The Industrial Technology Secretariat was charged with promoting and developing domestic technology. Further, technological funds were made available within the framework of research institutes and banks; technology foundations and companies were attached to research institutes to work in priority areas; the university system was reformed and a graduate studies plan issued; and fellowships and grants for scientific and technological training increased significantly.

The share of the national budget earmarked for science and technology, which had been .84 percent in 1970, rose to 3.64 percent in 1982, R&D expenditures as a percentage of Gross National Product almost tripled between 1971 and 1979, from .24 to .65 percent, and the percentage of scientists and engineers engaged in R&D increased from .8 to 2.1 for every 10,000 people between 1974 and 1978.[41] Brazil also issued the strong Industrial Property Code and related acts aimed at opening "technological packages" so that indigenous technologies would be used when possible.

Pelúcio, the BNDES, and the other autonomy-oriented science and technology institutions and planners also provided the means to train computer

40. See Francisco R. Sagasti, "A Framework for the Formulation and Implementation of Technology Policies: A Case Study of ITINTEC in Peru," in Earl Ingerson and Wayne G. Bragg, eds., *Science, Government, and Industry for Development*, the Texas Forum (Austin: University of Texas Institute of Latin American Studies, 1975), pp. 207–10.

41. Seriado Estatístico, *Revista Brasileira de Tecnologia* 13 (April–May 1982), p. 61; United Nations Educational, Scientific, and Cultural Organization. *Statistical Yearbook 1975* (Paris: UNESCO, 1975), p. 527, and ibid., *1978–79*, p. 845.

science professionals. The improvements in the scientific and technological infrastructure in the sector produced a critical mass of experts sufficient for "the government to adopt an aggressive policy of technological independence in the sector."[42]

FINEP supported development of hardware, software, and process-control uses in addition to financing several university projects and establishing computers at Brazilian universities. The CNPq provided fellowships and research support to institutions, assisted a microelectronics project, and organized a task force to coordinate the policy of future data-processing technology.

By the mid-1970s, when the computer policy began to take shape, those graduates sent abroad to study were beginning to return, strengthening their institutions and universities. Although prior to 1972 professional training depended heavily on MNCs and their "free courses," by 1977 forty undergraduate and graduate university courses were being offered.[43] Universities in São Paulo, Minas Gerais, and Rio Grande do Sul offered graduate programs in computer science. By 1982 Brazil had 19 universities, 450 research scientists organized into 74 groups, and 12 government research centers working on computer technology. Total human resources available in the data-processing equipment industry were 14,646 in 1981, 31.5 percent of whom were university graduates.[44]

## Cobra: the early days

Early in 1971, when the Brazilian navy decided to equip its vessels with English Ferranti computers, it also initiated a project to plan, develop, and manufacture a domestic computer prototype suitable for naval operations, preferably one that could interface with Ferranti.[45] The navy's Communication and Electronics Directorate contacted Pelúcio at the BNDES Science and Technology Fund. The Guaranys Project grew out of this relationship (naval officer José Luis Guaranys became more involved in this project than anyone else) as did a special working group (GTE/FUNTEC 111) established to formulate goals for the project. The Guaranys Project had two primary objectives: establish a three-sided *(tripé)* partnership of Brazilian state and private enterprises with MNCs[46]—with the foreign partner agreeing to trans-

42. National Council of Science and Technology (CNPq), *Avaliação e Perspectivas*, vol. 3, 1978, p. 47.

43. Ricardo A. C. Saur, *Hearings before the Parliament (Câmara dos Deputados)* (Mimeo, Brazil, D.F., 1977), p. 17.

44. CNPq, *Avaliação e Perspectivas*, p. 47; UNCTC, *Transborder Data Flows and Brazil*, p. 91, 97.

45. Ferranti built a general purpose and real-time 16-bit computer designed for use in data communications networks, real-time information systems, and process control. Steve Yolen, "Computer Production Prospects in Brazil Brighten," *Electronics News*, 7 June 1976, p. 32.

46. Evans developed the *tripé* thesis in *Dependent Development*.

fer its technology to the company; and promote and finance the development of a domestic minicomputer prototype.

The selection in April 1973 of the private Brazilian company, E. E. Eletrônica, and the creation of a holding company called Brazilian Digital Electronics initiated the first course of action. One year later Brazilian Digital Electronics became Digibrás, in effect an industrial promotion agency set up to study the market, provide consulting services and support for national firms, identify R&D needs, and organize the necessary supporting companies.

Digibrás was originally supposed to create two computer companies, one in association with Ferranti mainly to meet military requirements, and the other in association with either Japanese Fujitsu or West German Nixdorf to produce computers for the civilian markets. The first company, founded in 1974, was Cobra, a joint venture between the state, E. E. Eletrônica, and Ferranti (which held only about 3% of the capital shares and acceded to Cobra's demand to transfer its technology). The venture resulted in the first Brazilian-assembled minicomputers, the 700 Series.

When the attempt to create a second company failed, Cobra began a search for the foreign technology that would allow Brazil to produce a minicomputer for commerce and industry by itself. Although Data General seemed the most likely candidate to transfer minicomputer technology to Cobra, the American company was not willing to accept Brazil's condition that patents, blueprints, and general know-how be transferred to Cobra at the end of the licensing period. A small American company, Sycor, Inc., did, however, accede to Cobra's terms, and in 1976 Cobra and Sycor signed agreements to effect technology transfer, provide technical assistance and training, and purchase certain products. Sycor was exempted from import controls and thus gained almost exclusive access to a fast growing market, while Cobra obtained the necessary technology to develop what became its 400 Series.[47]

Cobra relied on foreign technology while the development of the domestically designed minicomputer and peripheral devices were still in the making but remained committed to absorbing this technology. The use of foreign technology was relatively successful because "it substantially reduced the time required to begin local production of minicomputers and helped to avoid mistakes both in product and process designs that would probably have occurred had Cobra relied initially on local technological sources only."[48] The 400 Series became Cobra's main product until its domestically designed minicomputer, the G-10, came of age.

The hardware for Brazil's first domestic computer was developed at the

47. See Jack Baranson, *North-South Technology Transfer: Financing and Institutional Building* (Mt. Airy, Md.: Lomand, 1981), pp. 38–42.

48. Paulo Bastos Tigre, "Brasil: A Future in Homemade Hardware," *South*, February 1982, p. 99.

University of São Paulo, while the software was worked on at the Pontifical Catholic University of Rio de Janeiro. First planned as a solely scientific computer, the G-10 was then transferred to Cobra, which broadened its scope. Cobra received another boost when the Federal Data-Processing Service, the largest Brazilian data-processing enterprise, and the University of Rio de Janeiro transferred terminals they had developed to Cobra. With these additions the G-10 minicomputer became Cobra's 500, a computer designed in Brazil and using almost entirely locally developed components.

Cobra's financial situation in 1976 did not match its relative success in R&D and technology transfer. Lacking purchase requests from the private market, Cobra initially sold only to government institutions and the armed forces. Assistance for the failing enterprise came from two quarters. IBM's help was inadvertent: its plan to introduce its minicomputer System 32, which would have killed Brazil's domestic minicomputer industry even before it was born, mobilized Cobra's allies. More positive help came from a consortium of eleven banks, including such giants as Bradesco and Itaú. Foreseeing the need for electronic automation in banking, these banks decided to purchase 39 percent of Cobra's shares.[49]

The government's determination to keep Cobra alive was based on the belief that only a state-owned company could lead the effort to absorb foreign technology, develop local technology, and satisfy Brazil's growing need for domestic computers. Cobra had thus become a means to achieve a national goal that was more significant than market efficiency and even import substitution. By setting up Cobra, Brazil was following in the footsteps of India, which had established a "national champion," the Electronics Corporation of India Limited,[50] in order to develop its domestic computer industry. But equally influential to Brazil's ultimate success in reducing dependency in the computer field was CAPRE.

## CAPRE and the guerrillas' autonomy model

The government created the Commission for the Coordination of Electronic Processing Activities (CAPRE) on 5 April 1972 to manage development of a domestic computer. CAPRE undertook to gather available information about the computer market and the human resources, as well as to provide incentives for scientific and technological development in this sector. CAPRE also endeavored to prevent unnecessary imports and to prevent government agencies from using data-processing equipment inefficiently.

CAPRE's subordination to the Planning Ministry, under Velloso, was crucial for its ultimate success. The ministry's transformation into a secre-

49. Silvia Helena, "Os Banqueiros e ar COBRA," *Dados e Idéias* 5 (April–May 1977), p. 35.
50. Grieco, "Between Dependency and Autonomy," p. 625.

tariat with direct links to the president and assumption of responsibility for Brazil's scientific and technological network became a source of political power for CAPRE and a shelter for the guerrillas involved.

The pragmatic antidependency ideology unified the Planning Secretariat, the scientific and technological institutions, the universities and their scientists, and CAPRE. While Pelúcio set up the groundwork and Velloso provided cautious support, Ricardo Saur, CAPRE's executive secretary, engaged in direct action to turn this ideology into industrial reality.

CAPRE became more than the institution entrusted by presidential decree to develop a specific technology: it became the home for an ideologically assertive group—a "guerrilla headquarters" of sorts—that set itself up to sell ideas, raise consciousness, and use political power to achieve its goals. While CAPRE took its first formal actions—creating national programs for data-processing centers and computer training, identifying the strengths and liabilities of the scientific and technological infrastructure[51]—the pragmatic antidependency guerrillas began their intellectual and political "attacks." Although most of the guerrillas came from CAPRE, some worked in institutions such as the Federal Data-Processing Service and Cobra. The core, known among each other as the Group, included Saur, Ivan de Costa Marques, Mário Ripper, Arthur Pereira Nunes, and Claudio Zamitti Mammana. They began by formulating in their own minds a doctrine that became known as the National Model.

The Model had two key features: only national companies would participate in Brazil's computer industry; and each piece of foreign technology could be purchased only once. The Group infused the scientific and technological community and the political system with optimism, insisting that "the thing could be done." As teachers at universities and as technocrats at government agencies, they emphasized Brazil's few but significant technological successes in order to generate a positive feedback effect. Computers, industry, politics, and academia became interwoven upon the creation of the Seminars of Computation at the University, which became another forum for airing the guerrillas' ideas: market protection, national enterprises, and technological autonomy.[52] *Dados e Idéias*, a monthly data-processing magazine issued by the Federal Data-Processing Service, also provided pressure for instituting economic controls on the computer market. Beside publishing technical material, *Dados e Idéias* became a forum for commentary and criticism on the government's computer policy and on the dangers of technological dependency.

It is interesting to note that a similar phenomenon seems to have occurred in India. Grieco hinted at the existence of guerrillas and guerrilla "attacks"

51. Saur, *Hearings*, p. 16.

52. See, for example, Seminario sobre Computação na Universidade, *Recomendações*, Florianópolis, 29 September 1977.

when he discussed the political actions of the Atomic Energy Commission (referred to as a "network"): "This gave the atomic energy policy 'network' a strong incentive to break its stalemate with Defence and, building upon national dissatisfaction over the country's progress in electronics, this network waged a campaign in 1969 and 1970 that led to a victory over Defence for control of national electronics policy. New policy units were created—the Electronics Commission and the Department of Electronics—which were supposed to be neutral but which were, in fact, heavily staffed by key members of the atomic energy network."[53] As is widely known, India's Atomic Energy Commission has been one of the country's ideological leaders in the push for technological independence.

In December 1975 CAPRE acquired new power through Resolution 104, which held that all imports of computer parts, accessories, and components required CAPRE's prior authorization. CAPRE raised import duties, required deposits without interest for the value of imports, and set import quotas. In addition it established an import limit: $110 million in 1976, $100 million in 1977, and $130 million in 1978.[54] Its formal power grew when it was charged with imposing further import control measures and with studying the state of the art and proposing a national informatics policy. CAPRE thereby became the "guardian of the gate," freeing the guerrillas to act as they chose.

Brazil's deteriorating balance-of-payments situation after 1974 played into the need for import control which gave CAPRE increasing authority over the computer market. But CAPRE's concerns were " . . . much broader than the simple objective of controlling imports so as to rectify the country's balance-of-payments problems. The Government was convinced that informatics was strategically important to the nation and that, therefore, Brazil needed a policy which would enable it to acquire the technical capability necessary to reduce its dependence."[55] From the guerrillas' perspective, the balance-of-payments crisis was a blessing.

CAPRE's power stemmed from its ability to set guidelines and policies without much high-level interference. Despite CAPRE's position, however, Velloso and other high-level policy makers did not envision a totally domestic computer industry. The government still wanted to exploit the MNCs'

53. Grieco, "Between Dependency and Autonomy," even identified the main "guerrilleros" when he wrote: "In 1971, the individual selected to head both the Commission and the Department was M. G. K. Menon, who was until then director of the Tata Institute for Fundamental Research, which is under the Atomic Energy Commission. His key deputy in the Department was A. Parthasarathi, who had been a principal officer in the AEC. An important analyst for the AEC, N. Seshagiri, was chosen to head the Electronics Commission's intelligence-gathering and analysis unit" (p. 627).

54. *Dados e Idéias* 1 (April–May 1980), p. 8. For example, in 1976 CAPRE examined 2,000 requests and granted only $115 million of the $250 million requested.

55. UNCTC, *Transborder Data Flows and Brazil*, p. 63.

technology, although "the multinationals here," according to Saur, "including the biggest, IBM, declared their lack of interest in this effort."[56]

CAPRE made two decisions in July 1976 which created the basis for reserving the mini- and microcomputer markets for Brazilian enterprises and reflected the government's pragmatic approach vis-à-vis the MNCs. Decision 01 divided the market and the industry into two sections. While it recommended that "the national informatics policy for the medium and large computer market be based on investment rationalization and optimization of installed resources" (i.e., on the market, namely foreign industry), it also recommended that when feasible mini- and microcomputers and peripheral devices be reserved for the domestic industry.[57] Decision 02 gave CAPRE the power to control the purchase of software and data-processing services by government agencies and enterprises.

Decision 01 continued the policy initiated in the early 1970s but also represented a response to IBM's announcement, made in a blitz advertising campaign that attracted almost four hundred potential buyers,[58] that its minicomputer System 32 would be assembled in Brazil from parts brought in under its import quota.

These two policy decisions reflected CAPRE's efforts to protect a weak national industry without giving the MNCs the impression that Brazil was enforcing a protectionist policy. Because high-level government officials continued to hope that IBM and other MNCs would enter into joint ventures with domestic companies, they would not agree to reserving the entire mini- and microcomputer market for domestic companies.

CAPRE's strategy was determined by its council; however, the decision to have two "containment lines"—allowing only Brazilian companies to produce domestic computers and accepting joint ventures with the MNCs was strictly a guerrilla strategy.

The Economic Development Council's Decision 05 of 12 January 1977 aided the CAPRE guerrillas by establishing the following criteria for fiscal incentives in the data-processing industry: extent of nationalization; export potential; extent of technology transfer; analysis of enterprises already in the market; and domestic capital majority. CAPRE used these criteria to select "winners" from among the domestic and foreign companies invited under Decision 01 of June 1977 to present proposals for the production of minicomputers in Brazil.[59] Among the sixteen companies that submitted proposals were seven MNCs, but only joint ventures.

As the time for a decision approached, Velloso was under heavy fire from

56. Saur, *Hearings*, p. 4.

57. CAPRE, *Boletim Informativo* 4 (July–September 1976), p. 53.

58. Marília Rosa Millan and João Lizardo Hermes de Araújo, "Na Palavra dos Técnicos, um Ponto de Vista Nacional," *Cadernos de Tecnologia e Ciência*, 1 (December 1978–January 1979), p. 36.

59. CAPRE, *Boletim Informativo* 4 (July–September 1976), p. 53.

two camps. Ministers and high-level government officials outside the Planning Secretariat and the science and technology institutional network, and industrial elites, mainly from São Paulo, pointing out Cobra's ailing condition, remained unconvinced that Brazil could successfully challenge IBM. Further, IBM and other MNCs were pressuring the highest echelons of Brazil's political power structure to prevent a decision that would leave them outside the market. The media put CAPRE's case on the front pages, playing up the tough MNC line regarding joint ventures and IBM's attempt to use System 32 to undermine Cobra. The subject of MNCs, which had traditionally aroused nationalist feelings, generated outrage once the facts became public knowledge. The government found it increasingly difficult to do anything that indicated it was bending under pressure from the MNCs. That the powerful banking consortia which had invested money in Cobra were pressing for the domestic alternative and that key military actors at the armed forces high command favored domestic companies and market closure also worked in CAPRE's favor.

The critical decision was made in mid-April 1977, at an informal meeting of the CAPRE council and the ministers directly and indirectly involved in the data-processing sector. Although the ministers tended to prefer joint ventures because they feared that the movement toward a national computer industry was based on enthusiasm alone, they nevertheless decided that any interested company could present a bid and that final decisions would be based on the conditions specified by the Economic Development Council.

The ministers told CAPRE informally that nationals should be preferred only if their bids were as good as those of MNCs; if not, CAPRE should accept IBM's proposal. However, because according to one of the Economic Development Council's criteria for investment in computers, MNCs had to be willing to engage in joint ventures, it would have been almost impossible for CAPRE to choose IBM. Thus, the CAPRE council decision of June 1977 calling for bids from domestic and foreign firms to produce minicomputers was in fact a cover-up: a decision had already been reached.

CAPRE's blow to the MNCs came at the end of 1977. It chose four companies, rather than the anticipated three: Cobra and three private domestic consortia that had just been or were still in the process of being created and that were developing minicomputers under foreign licenses: SID, Labo, and Edisa. CAPRE later approved a fifth company, Sisco, which developed minicomputers with its own technology.[60] Under the terms agreed to by the companies involved, technology transfer had to be completed by 1982, and payment for this technology was not to exceed 3 percent of net sales. Local firms could purchase foreign technology only once and had to develop further models locally.

60. Silvia Helena, "Minis: A Decisão Final," *Dados e Idéias* 2 (October–November 1977), pp. 34–35.

This choice represented a strategic victory for CAPRE and Saur, as it allowed the market reserve policy to be implemented. In addition it permitted government policy makers to say: "We played according to the rules, we asked for bids from everyone, and we let the best bid win."

Velloso played his cards very diplomatically, assuring the MNCs that the joint-venture condition was not mandatory and that CAPRE would judge the proposals by additional criteria. The MNCs, taking Velloso's words as a genuine indication that the door was open to them, felt that although Brazil would prefer to have local equity—even control—it was prepared to waive this condition if other factors proved more compelling.[61] However, while Velloso was telling the MNCs that everything was fine, CAPRE was telling IBM's vice-president the opposite. Although some domestic companies among the bidders had yet to begin operation, CAPRE decided to favor them anyway as a result of its strong determination to exclude MNCs from the minicomputer market and the green light signaled by the ministers' decision.

After winning the minicomputer battle, CAPRE began to eye the medium-sized computer market. Fearing that the MNCs might scale down medium-sized computers and use them to compete with Brazilian minicomputers, and/or that the domestic industry once in operation might not be able to compete in this market, CAPRE in December 1978 issued new criteria for the manufacture of central processing units and peripheral devices beyond the minicomputer range. These criteria included assurances that such projects would not interfere with mini- and microcomputers, and that there would be local decision making, the possibility of technology transfer, a growing nationalization index, and export potential.[62] CAPRE thereby prohibited IBM and Burroughs from manufacturing medium-sized computers in Brazil.

## SEI: the evolution of the model and its struggle to survive

CAPRE's responsibilities increased as new domestic computer companies appeared on the scene. The military, which, except for the navy, had not shown any particular interest in the process, was impressed by the successful challenge to IBM. By the end of 1978, they realized that the data-processing sector was too strategically important to leave in the hands of a Planning Secretariat that, after the 1979 elections, might be led by "internationalists" (as actually happened when first Mário Henrique Simonsen and then Antônio Delfim Netto became planning secretary) who might retreat from the antidependency policy and again fall prey to the MNCs.

Heading the military's interests was the National Intelligence Service

61. *Business Latin America*, 19 October 1977, p. 331.
62. *Conjuntura Econômica*, February 1979, p. 95.

(SNI), from whose ranks came João Batista Figueiredo, elected president of Brazil in March 1979. In January 1979 the SNI initiated an inquiry commission, headed by Ambassador Paulo Cotrim, whose findings criticized CAPRE. According to the commission, CAPRE lacked a policy aimed at reducing dependency on foreign sources of software and microelectronics. With the Figueiredo government poised to take office, and the SNI's mistrust of CAPRE's "leftist" technocrats, CAPRE began to lose its power base, and the architects of the autonomy policy were edged out.

When the Cotrim commission was turned into a presidential committee, it decided to abolish CAPRE and to place data-processing policy under the jurisdiction of the National Security Council (CSN). Following the commission's guidelines, the committee recommended increasing incentives for domestic technological development and establishing a policy to nationalize development of semiconductors. The Special Secretariat of Informatics (SEI) replaced CAPRE in December 1979, and the cooperation between government technocrats and the scientific community which had characterized the mid-1970s eroded. SEI was attached to the CSN and reported directly to the president.

SEI's main tasks were to advise the CSN on informatics and to formulate a national informatics plan and policy. It was also charged with stimulating and assisting the development of technology, components, equipment, programs, and services, and with protecting the technical and commercial viability of domestic companies producing systems and components.[63] In addition, SEI was to try and coordinate real-time control systems, microelectronics, and national software policies.

SEI marked a new stage in the politics associated with Brazil's domestic computer industry and policy. Economic elites and consumer associations opposed the protectionist policy on efficiency grounds and, encouraged by the prevailing atmosphere of *abertura*, or political openness, also objected to CSN's control over policy matters. Furthermore, some members of the new cabinet strongly opposed CAPRE's Model and explicitly desired to enter into joint ventures with MNCs.

Also opposed to the changes were the guerrillas, the scientific and technical communities, and a majority of the computer associations created after CAPRE began to implement its policy—essentially the Model's watchdogs. Institutions such as the Brazilian Association of Computer and Peripheral Equipment Industries, the Association of Data-Processing Professionals, the Association of Data-Processing Service Enterprises, and the Brazilian Computation Society feared that SEI would, in time, ally themselves to the MNCs, approve joint ventures, and eventually erode the Model.

Thus, SEI had to begin by rowing against not one but two streams. It had succeeded, and even prospered, by operating under the CSN's shield. But it

63. UNCTC, *Transborder Data Flows and Brazil*, p. 69.

had also strengthened its position by promising opponents of the Model that the market reserve would soon be watered down or even eliminated and promising watchdogs of the Model that the reserve would be not only maintained but strengthened.

SEI's first actions evidenced determination to keep the market reserve, to control the data-processing sector, and to deal with the MNCs firmly yet pragmatically. Its first Normative Act (March 1980) set guidelines for data-processing imports, stipulating that preference be given to "the national alternative" and that software be developed domestically. Later that year, SEI ordered that all data-processing equipment be registered, that both domestic and foreign federal government purchases receive prior permission, and that the government favor domestic data-processing services.[64] It also stated that approval for new projects aimed at manufacturing data-processing equipment and parts, and the import of components would depend on the extent to which they used locally developed technology and were directed by Brazilians.

The first major test for the new policy came in August 1980, when SEI gave IBM permission to manufacture limited quantities of its medium-sized Model 4331 computers in Brazil. At that time the market for medium-sized computers was growing by 10 percent a year, and SEI preferred locally made equipment over imports.[65] Domestic producers, scientists, and guerrillas feared that this decision would prevent the domestic development of medium-sized and large computers, and would suffocate local industry. A permanent commission was therefore set up to oversee and protect the national computer industry's actions. The commission also decided to regard SEI's permission to IBM as inconclusive.[66]

SEI was slightly restructured in 1981: the Advisory Council consisting of private- and public-sector representatives was created, SEI's scope was broadened, and incentives were established for Brazilian firms only. The Advisory Council represented a major gain for supporters of the market reserve because it provided them with an additional forum in which to advance their ideology. For example, when SEI's secretary general Octavio Gennari Netto announced that the market reserve for computers would be

64. SEI, "Ato Normativo" (Mimeo, March 1980); ibid., June 1980.

65. But SEI made certain that Model 4331 remained a medium-sized computer by stipulating that its minimum memory power had to be 2 million bytes, that the nationalization index would be set at the 85% level established by the Industrial Development Council, and that for each two units sold in Brazil, three had to be exported. *Business Latin America*, 22 October 1980, p. 344.

66. Coordination of Entities for the Defense of an Informatics National Industry, "Análise da Decisão da SEI de 6 de Agôsto de 1980" (mimeo, 14 August 1980). According to SEI's secretary general Octavio Gennari Netto, the decision to allow IBM to manufacture its Model 4331 did not undermine the Model because at the time Brazil did not have the potential to manufacture a computer that size. He stated that the permit was not the result of pressure by IBM but of an understanding at SEI that the market would gain (customers were unattended at that size level) and the Model would not lose.

maintained for only another three years,[67] supporters of the Model protested so strongly that the idea was never mentioned again; the SEI eventually passed Normative Act 016 of July 1981, which made permission to manufacture reserved products increasingly difficult to obtain. SEI grew even stronger in 1982 when it took over some of Digibrás' functions. (This takeover led subsequently to Digibrás' demise in 1983.)

More recently SEI has announced that it must approve all R&D performed in the informatics sector and that the federal government can contract informatics services from foreign firms only when no national company is qualified to render that service. SEI has also broadened the market reserve to include digital machinery used in measurements and in biomedical work, and has created a section to register all domestic and foreign software programs marketed in Brazil. Although the registry is not obligatory, SEI will not approve any unregistered imports or manufacturing projects.

Aiming to correct a major bottleneck that had prevented Brazil from producing genuine domestic systems and to promote development of domestic 16-bit software, Normative Act 027 of November 1983 states that SEI will approve only those microcomputer manufacturing projects whose software is developed locally. In 1984 the Special Software Commission was set up to establish the juridical basis for a Software Law.

SEI leaders have also confronted the problem of developing their own chips; currently Brazil purchases these from abroad or from foreign companies located in Brazil. In the 1970s the Ministries of Industry and Commerce and of Communications tried to get a foothold in the semiconductor industry; FINEP and the CNPq helped by training appropriate personnel and promoting relevant R&D. But these efforts did not bear fruit, and a semiconductor company set up by the state was shut down in 1980 because of financial difficulties.

When SEI began dictating Brazilian microelectronics policy in 1981, it established a component import control policy and began to coordinate the R&D activities of various institutions. In order to carry out these activities, SEI created a microelectronics research institute. The Informatics Technological Center (CTI) opened in May 1984 in Campinas, near São Paulo, and two private domestic firms, Itaú and Doças de Santos, were chosen to locate near CTI and open plants to manufacture microelectronics products.

The development abroad of the superminicomputer reopened the technological gap between the Brazilian data-processing industry and foreign competitors. This new development, which has fueled consumer and political opposition to domestic computer policy, has sent both SEI and domestic manufacturers back to the drawing board. In an effort to close the gap, SEI

67. Gennari confided that the statements attributed to him regarding the market reserve were the result of selective editing by the media in order to inflame the controversy between those for and against the market reserve. SEI may also have used these remarks to frighten the domestic industry into becoming more competitive.

decided to encourage the development of the superminicomputer in Brazil. Its call was answered by eight domestic companies: three committed themselves to develop the superminicomputer with local technology, another five requested permission to manufacture them with imported technology. These companies have committed themselves to effect technology transfer and a high nationalization index.

SEI had to choose among several alternatives: local production of superminicomputers with foreign technology; local production with local technology; joint ventures with MNCs. Some prominent senators, members of Congress, and industrialists, including Minister of Industry and Commerce João Camilo Penna,[68] called for joint ventures. SEI policy makers were in favor of acquiring foreign technology but rejected joint ventures. But supporters of the Model held out for total local control over the industry.

Initially SEI decided to opt for the second alternative, thus pleasing supporters of the Model, and to allow Cobra, SID, Labo, and Edisa to manufacture "supermicros"—16- or 32-bit microcomputers with increased memory capacity—with local technology. At the same time SEI was hoping that some of the companies involved would merge. When they had not done so by June 1984, SEI approved all five superminicomputer projects using foreign technology.

The Model's supporters responded swiftly. The Brazilian Association of Computer and Peripheral Equipment Industries, the Association of Data-Processing Professionals, and the Brazilian Computation Society, together with the Brazilian Society for the Progress of Science (counterpart to the American Association for the Advancement of Science), issued a communiqué stating that SEI's decision represented a retreat from the quest for technological autonomy in the computer area and calling upon SEI to reconsider.[69] Assuming that they would not be able to compete with foreign technology, the three local companies involved in developing the superminicomputer with indigenous technology put a halt to their projects and decided that they, too, would purchase technology abroad. Failure to develop a system for that market eventually forced Cobra to sign a technology transfer contract with Data General.

In retrospect, SEI took a tough yet pragmatic position: tough because it ruled out joint ventures, and pragmatic because it understood domestic industry's need for foreign technology to allow it to stay abreast of developments abroad. Although some foreign technology proved useful, the industry had adhered to the Model because only domestic companies were chosen to develop the superminicomputer, and the foreign technology will be eventually transferred.

Supporters of the Model fought additional battles during 1983 and 1984.

68. *Data News*, 26 July 1983, p. 2.
69. Ibid., 24 July 1984, p. 8.

More crucial in their eyes than the superminicomputer struggle was the battle to transform the Model (also known as the National Informatics Policy—PNI) into national law.

PNI supporters had to contend with bills calling for its extinction. The most threatening bill, proposed by Senator Roberto Campos of the then ruling Social Democratic party, would have abolished the market reserve, dismantled SEI and substituted a tariff system and joint ventures, and placed the informatics policy under the Ministry of Industry and Commerce. This proposal had the blessing of internationally oriented business circles, MNCs, and the U.S. government, which has always been openly critical of Brazil's computer market reserve and used Brazil's financial dependence to pressure its government into changing its policy.

On the other side of the political spectrum was an array of bills aimed at retaining the market reserve and import controls, and nurturing domestic computer companies. On 20 September 1984 the military government introduced a bill that would protect the Brazilian computer industry from foreign competition for eight years, provide fiscal incentives to stimulate local firms, and establish the National Council on Informatics and Automation (CONIN). The eighteen-member council would be attached to the presidency; on an equal footing with the CSN, it would control SEI's policies. This would mean that SEI would no longer belong to the CSN, and MNCs already producing computers in Brazil would be allowed to continue their operations—but foreign companies would be allowed to make new investments only if the resultant products were to be exported.[70]

The guerrillas, the computer associations that favored the market reserve, the scientific community, and others organized a propaganda campaign to ensure that Congress would pass a law favorable to the market reserve. The Brazilian Association of Computer and Peripheral Equipment Industries and the Brazilian Computation Society issued a document signed by 200 institutions which was entitled "The Defense of Brazilian Technology." This document, which accused the U.S. Commerce Department of interfering with Brazil's computer policy, called on Brazilian business circles to reject proposals to allow joint ventures with MNCs.[71] The campaign held public meetings at universities, published a new journal called *Brazil Informatics*, and sponsored an annual "National Informatics Day." The campaign succeeded: on 3 October 1984 Congress voted in favor of the government motion. Saur's reaction to the vote was that CONIN represented a refinement of the CAPRE informatics model, and, he added, "We have returned to what it was."[72]

70. *Transnational Data Report on Information Policies and Regulations* 7 (December 1984), pp. 431–32.
71. *Data News*, 18 October 1983, p. 6.
72. Ibid., 9 October 1984, p. 2.

## The empires strike back

Data General was one of the first foreign companies to fight the market reserve and associated policies. In June 1977, after its minicomputer deal with Cobra fell through, Data General tried to strengthen its position by applying pressure through the U.S. president's special representative for trade negotiations and Congress. But despite Data General's claim that other countries might follow Brazil's lead if Brazil's computer industry succeeded, the United States refused to involve itself in the negotiations. Data General thus ended up with no share of the Brazilian minicomputer market.[73]

Convinced that the Brazilian government would not exclude them from the minicomputer market, IBM do Brasil decided to play tough. The company initially held fast to its official policy of avoiding joint manufacturing ventures. Then they refused to comply with the technology transfer policy and complained about Brazil's new low import level. IBM's lobbying efforts emphasized the "obscurity" of Sycor's minicomputer technology and its lack of software. IBM also thought that the System 32 computers they had placed on the market in 1976 would generate demand for continued production. As a final argument, IBM pointed out that in view of its balance-of-payments difficulties, Brazil could not afford to pass up an IBM manufacturing venture that involved a strong export potential.

IBM do Brasil's president, José Bonifacio de Abreu Amorim, expressed his surprise at the government's policy: "We don't need to ask the government in advance for permission to build System 32. Does Ford ask the government for permission every time it wants to introduce a new model automobile? . . . The government, after all, wants us to export."[74] Amorim's attitude reflected IBM's failure to see that the Brazilians sought much more than exports or even jobs and control of the majority of shares; the government's ultimate aim was domestic technological development.

The pressure exerted by IBM in fact generated nationalist sentiments that supported CAPRE's objectives. Had IBM been more flexible and accepted some of the government's conditions, the Group's second containment line might have been able to accommodate it. But, despite Amorim's worry that the pressure might backfire, IBM World Trade argued that compliance with Brazilian regulations would eventually involve IBM in manufacturing joint ventures, a policy it specifically avoided. In light of IBM's investment in countries such as France, that policy was very important.

Other MNCs such as Burroughs and Hewlett-Packard watched the gathering storm. Though less influential than IBM, they put additional pressure on the Brazilian government. For example, Burroughs' marketing manager re-

73. Ibid., 17 August 1977, p. 1.
74. Steve Yolen, "Brazil Move May Impact IBM/32 Plans," *Electronics News*, 13 December 1976, pp. 30, 40.

marked that if Brazil protected the market, the MNCs would have to set up factories somewhere else, in "neighboring countries in Latin America."[75]

As time went by, and Brazil showed the MNCs that its domestic minicomputer industry was there to stay, foreign companies adapted to the new reality. Burroughs stated that it would continue to market products other than micro- and minicomputers in Brazil, and (along with other companies) also indicated that it was considering association with Brazilian enterprises. Although they were left out of the lucrative micro- and minicomputer markets, "IBM and Burroughs seem to have made the best of the situation, manufacturing large systems in Brazil since the mid 1970s. Both corporations have gained advantages from the informatics policy because the products produced locally by them benefit from the preference rules regarding imported goods and services."[76]

IBM, Burroughs, and Hewlett-Packard did get some of their projects approved through intensive lobbying, and IBM found ways to circumvent domestic manufacturing restrictions; in the end, however, they all had to accept the Brazilian computer industry's development and work with rather than against it. IBM has since signed an agreement with the Association of Data-Processing Service Enterprises involving nine joint software projects and has promised to provide technological help to the CTI.[77] Burroughs has also signed a technical and commercial agreement with the association to develop and market programs for Burroughs systems together with Brazilian software enterprises.

Today some MNCs are establishing sales agreements with their Brazilian counterparts; and their attitudes toward licensing have also changed. Whereas in the mid-1970s Cobra had difficulty finding a foreign company willing to transfer its technology, six years later "18 agreements had been signed involving 16 foreign and 14 local firms."[78]

There is a lesson here for MNCs in developing countries: successful MNCs will demonstrate sensitivity to the host country's prevailing set of beliefs, expectations, and objectives, and recognize that it is to their advantage to accommodate any differences. MNCs can yield or remain inflexible. IBM tried it both ways before learning the value of flexibility vis-à-vis a developing country that is determined to achieve its goals.

75. Maria de Conceição, "Uma Luta Desigual," *Dados e Idéias* 3 (December 1976–January 1977), p. 17.

76. UNCTC, *Transborder Data Flows and Brazil*, p. 78.

77. *Data News*, 1 November 1983, p. 6, and ibid., 24 July 1984, p. 4; *O Estado de São Paulo*, 13 January 1984, p. 23.

78. Tigre, *Technology and Competition*, p. 144.

## Conclusion

By mobilizing its material and ideological resources against IBM and other MNCs, Brazil successfully demonstrated that it could determine its own computer policy. In establishing its domestic computer industry, Brazil started out with one "national champion"; only then did it call upon domestic private enterprises to enter the field. It developed assertive institutions to create computer policy, initiated import controls to allow the domestic industry to develop, and carefully established pragmatic guidelines that avoided radical conceptions of autarchy. The guerrillas, whose ideology infused their technical know-how with norms and policy directions, supported the domestic computer model infailingly. Despite, or maybe even because of, the removal or circumvention of some individuals and institutions that originally determined the industry's policies and technology, the computer industry maintained its momentum.

Institutions such as CAPRE, Cobra, the Federal Data-Processing Service, and even *Dados e Idéias* were crucial not only because of what they did but also because they gave the guerrillas a base. Institutions were able to achieve outcomes because of their political power, but the definition of their goals, means, and policy agendas stemmed from the collective understanding that united individuals within and often among these institutions.

SEI's replacement of CAPRE severed SEI's dependency on its founders—Pelúcio, the BNDES, FINEP, and the Group. The Model CAPRE had developed remained vigorous after CAPRE's extinction because it was able to generate its own institutions, domestic companies, and pressure groups, and thus prove its viability to the nationalists within the CSN.

Crucial to the understanding of how the pragmatic antidependency guerrillas succeeded in making the Model operational is the fact that technological and political factors reinforced each other as much as ideological and institutional actions did. For example, in the 1970s computer technology became increasingly accessible and inexpensive; capital was available both to buy such technology and to (re)produce it locally; and earlier programs (such as that initiated by Cobra) to improve Brazilian computer technology were flourishing. Market, technology, political, and international forces combined with purposive actions, ad hoc choices and coalitions, and reactions by the MNCs to shape Brazil's domestic computer industry.

Brazil's actions may be compared with those of India, one of the few developing countries other than Brazil successfully to challenge the MNCs in the computer market. It is no coincidence that India and Brazil decided to reduce their dependency in the same field. For both countries recognized early on the importance of technological autonomy. In both countries a national ideology acted on forces of change and modernization to bring about independence from the MNCs in the computer field. Moreover, out-

comes in both cases seem to have been strongly affected by the actions of ideologically motivated intellectual guerrillas acting within state institutions.[79]

To consider Brazil's computer policy and industry a roaring success would be more than premature. Some companies may still fail, and the government's commitment to the domestic computer industry may falter in the face of political and economic changes. As long as Brazil continues to rely on foreign production of semiconductors, it will remain somewhat technologically dependent. Further, SEI's actions with regard to the superminicomputers show that overcoming dependency is not an overnight affair. A developing country can close the technological gap with foreign technology; yet if the gap widens again, a developing country may have to take political, industrial, and technological action both to close the gap and to calm the resulting consumer and political unrest.[80]

But, if we take Brazil's technological development as the main indicator of the success of its computer policy, we can say that Brazil now enjoys a more developed electronics and computer R&D base, has a critical mass of scientists and technologists in the computer field, and possesses know-how in the areas of technological management, production, and engineering. Furthermore, in some cases Brazil's computer policy forced MNCs to accede to joint ventures, a policy many MNCs had previously avoided. In this regard, Brazil's computer policy created an example for other sectors and other nations.

The Brazilian computer case thus strengthens the claims by advocates of bargaining theory—as reformulated to include high-technology sectors—that developing countries that skillfully mobilize their resources vis-à-vis MNCs can reduce industrial and technological dependence. It also strikes a blow to theorists of structural dependency by demonstrating that, as important as the political and economic domestic and international constraints on a country are, ideological resources can outweigh them.

Furthermore, though the motivation to achieve autonomy is important, this case shows that elites in developing countries are not united in favor of taking nationalist pro-autonomy measures at the expense of MNCs. Thus, those who wish to understand motives should start at the level of elites (and their ideologies) rather than at the state level. Only by taking a close look at Brazilian elites and their ideologies could we identify the pragmatic antidependency guerrillas and their crucial role in Brazil's computer policy.

The guerrillas, in turn, suggest the existence of a "subversive elite,"[81] one

79. Despite all these similarities, the technological and practical outcomes differed in both countries: IBM adapted to Brazil's new reality but left India altogether.

80. I thank Manuel Fernando Lousada Soares (Informatics and Communication Coordinator, $CNP_q$) for calling my attention to this process.

81. The term *subversive* is not intended to be derogatory. I mean it metaphorically to convey the process by which people who hold certain ideas can influence political action.

whose members share beliefs about the nature of politics and economics which differ from those usually defined as belonging to the elite. Members of this elite have a resource that makes them very valuable: knowledge. This subversive elite succeeds in transferring its ideas to the individuals and institutions in power. It is an elite by virtue of its ability—sometimes overt, explicit, and direct, and other times indirect—to affect the predisposition of policy makers. "Rather than dictating specific policy moves, these predispositions influence behavior by shaping and coloring the way new information is processed."[82]

Brazil's pragmatic antidependency guerrillas fully qualify as a subversive elite. And because of the authority they have acquired in their own country, and in the regional and international forums in which they represent their country, "the process that in the realm of science and technology is known as the protracted sequence from invention to innovation often takes remarkably little time in Latin America with respect to economic, social and political ideas."[83] Ideological elites such as Brazil's pragmatic antidependency guerrillas have the ability to mobilize the collective beliefs, expectations, and concepts that are ultimately responsible for institutional action.[84]

82. Odell, *U.S. International Monetary Policy*, p. 63.

83. Albert O. Hirschman, "The Turn to Authoritarianism in Latin America and the Search for Its Economic Determinants," in David Collier, ed., *The New Authoritarianism in Latin America* (Princeton: Princeton University Press, 1979), pp. 86–87.

84. Stephen Toulmin, *Human Understanding: The Collective Use and Evolution of Concepts* (Princeton: Princeton University Press, 1972), p. 289.