Faculty Working Paper 93-0180
Political Economy Series #63

Measuring the Performance of a Protected Infant Industry: The Case of Brazilian Microcomputers.

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BEBR

FACULTY WORKING PAPER NO. 93-0180

Papers in the Political Economy of Institutions Series No. 63

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December 1993

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The following is an adaption of the fourth chapter of Luzio [1993]. We wish to thank Werner Baer and William Maloney for much helpful advice. Seminar participants at the Latin American & Caribbean Studies Special Lectures Series from the University of Illinois provided useful comments. The first author also wishes to thank the Tinker Foundation and the Brazilian Council for Research and Development (CNPq) for financial support in connection with this research.

1. Introduction

Until the beginnings of the Collor presidency in 1990, the Brazilian government strongly protected domestic producers of electronics goods. The justification and policies for protecting "informatics" producers changed over the 1970s and 1980s, but the character of the outcome did not. Many anecdotes suggest that the policies failed to achieve their stated goals in many markets. Most observers argue that Brazilian firms did not come close to reaching parity with their potential international competitors (e.g., Reyes et al (1990) and SEI (1988)). These laws and their consequences contain important lessons about how and why government nurturing of high-technology industries may fail (See Luzio [1993] for a review).

In this paper we move beyond the anecdotes that underlie previous studies. We provide and analyze systematic evidence of the performance of Brazilian microcomputer suppliers. We chose to study microcomputers because of their importance in the world data-processing market. In addition, the performance of this industry is better documented than any other. Because the Brazilian domestic market was largely dominated by Brazilian versions of IBM-PCs and Apple clones, we can directly compare the performance of the Brazilian industry with potential international competitors.

Our data set is one novelty of this paper -- it is an eight year time series of price and performance characteristics for all Brazilian-produced microcomputers. Our methods are standard in the economics of technical change: we employ hedonic techniques (Berndt and Griliches [1993]) to evaluate the rate of advance in the industry and to evaluate the performance of the Brazilian industry relative to international standards. These methods are not common to studies of infant industries, perhaps because the necessary data is rarely available. We think that the success of the methods here (and the increasing availability of product market data) may suggest similar applications in related issues of development economics.

Our quantitative analysis provides measures of the industry's development. First, we show that our measure of the Brazilian PC industry's price/performance often advanced at a rate that was comparable to international rates of advance. Second, despite this advance, the Brazilian industry never caught up to the leaders. The prices of domestically produced Brazilian PCs started higher and always stayed higher than their potential international competition. A similar computer model cost between 70 and 100 percent more in Brazil than in international markets. Technical frontiers typically lagged price/performance practices in international markets by at least 3 years and as much as 5. Third, we calculate a lower bound estimate for the opportunity cost of protecting the microcomputer industry rather than opening up to international markets. Forgone buyer surplus was on the order of 143.3 million US dollars per year, or roughly 32.88 percent of the average annual expenditure on domestically produced microcomputers. Fourth, the installation of the Collor regime dramatically affected the performance of Brazilian firms. Brazilian suppliers and buyers reacted quickly to Collor's public promise to dismantle the previous protective informatics policy. Domestic firms slashed prices, shut down inefficient product lines, and those remaining quickly came much closer to international price/performance standards.

To begin with, we briefly review the history of the informatics laws in Brazil. Then we discuss the data and present hedonic analysis of the industry's performance. We finish with a comparison of Brazilian performance against international standards. This comparison leads to an estimate of the opportunity costs to Brazil of protecting their domestic microcomputer industry.

2. A brief history of the informatics laws

In 1977 the Brazilian military government initiated policies designed to protect domestic "informatics" firms, building on a history of protecting other domestic firms (Tigre [1983], Evans [1986]). In contrast with the previous experiences with import substitution (see Baer [1988], [1989], Fishlow [1990]), the informatics policy was characterized by the pursuit of technological autonomy and the almost absolute exclusion of foreign companies[1]. The scope of the protection initially extended to micro and minicomputers, but gradually expanded to a wide variety of data-processing devices and their inputs.

The laws differed in their effectiveness over time and between different types of microcomputer buyers. Large business and public sector buyers could not evade the trade-barrier, because they were too easy a target for enforcement raids. In contrast, smugglers dominated the market for small purchases. In the latter case, the buyer had to rely on an illegal service sector in the event of technical problems. Many anecdotes suggest that the vast majority of individual buyers went elsewhere because the illegal imports were better. By some estimates, smuggling amounted to 65% of the total PC market by 1991 (Chicago Tribune, 11/04/91).

Since the domestic firms did not produce for export, they produced almost exclusively for large domestic firms and public sector buyers. Table 1 presents the history of the sales of legally-supplied computers. Ten major producers dominated the domestic microcomputer industry throughout the 1980s by supplying around 80 percent of total legally-supplied sales. Brazilian firms specialized in producing reverse-engineered clones of American-firm designs, first the 8-bit designs and then 16-bit designs. Systems using every known hardware architecture became available at one time or another, including those using CP/M operating system, IBM-PC clones using MS-DOS, and clones of Apple corporation's designs. Following the diffusion patterns in the United States, IBM-PC clones based on Intel chips became the dominant design in Brazil by the mid 1980s. Table 2 presents market share of 8 and 16 bit designs.

By the end of the 1980s, the informatics laws were widely perceived as a costly nuisance at best and, at worst, a costly impediment to productivity advance in export-oriented industries,

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[1]For example, foreign companies, such as IBM and Burroughs, were allowed to produce mainframes. But they were completed excluded from the microcomputer sector.

particularly those using numerically controlled machine tools (Kang and Steinmueller [1991]), such as automobile production. The laws had little popular support. During the election campaign of 1990, Collor promised to phase-out protection and dismantle the agencies enforcing the laws by the end of 1992. After his ascension to office, he put these plans into effect, which produced dramatic results. Buyers curtailed their purchases of domestic products because they anticipated easier access to international markets and weak enforcement of the trade barriers. Several domestic firms quickly went into a dramatic decline. Many Brazilian engineers lost their jobs and those who remained eventually became sales representatives of the joint ventures formed with multinational companies.

Fifteen years of informatics policy had clearly failed to develop a domestic industry with technology autonomy and competitive prices. Brazilian firms had not caught up to their international counterparts. Many reasons have been offered for this, such as:

(1) Imported chips and domestically produced peripherals (e.g., hard disks), which constituted a large expense in the basic processor, were costly to obtain (Tigre [1989]).

(2) Domestic content laws forced Brazilian computer manufacturers to use domestic suppliers for inputs. However, the industries that supplied basic microelectronic inputs, such as transistors, capacitors and picture tubes, were highly concentrated and not internationally competitive. Prices were around 2 to 5 times the international levels (Paiva [1988], page 226).

(3) Burdensome bureaucratic requirements and misguided sectorial policies limited competition and the entry of new suppliers (Spiller [1987a, b]). Luzio [1993] contains a more developed discussion of these factors.

3. Data

The data used in this paper come from two sources. Some of it, such as those shown already, comes from reports compiled by the Special Secretariat for Informatics (SEI), the Brazilian agency primarily in charge of enforcing the informatics laws. A compilation of this data can be found in Luzio [1993]. The novel data set in this paper, on the performance of individual computer models, comes from the price lists published by the newspaper A Folha de São Paulo over eight consecutive years. The data set extends over thirty one quarters, from October 1984 to July 1992. In the total there are 2,461 observations on 513 different computer models manufactured by Brazilian firms.

Each observation was described by 47 different variables, 40 of which were dummies. Most of these variables mimic variables used in previous hedonic studies of computers (Berndt and Griliches [1993], Triplett [1989]). The technical characteristics of microcomputers were described by: (1) the amount of megabytes of the hard drive, LHRD (=log(HRD+1)): the number of kilobytes that the floppy disk could read, LFLP (=log (FLP+1)); (3) the amount of random access memory available in kilobytes, LRAM (=log(RAM)); and, (4) the number of other hardware devices, such as back-up tape, LACC (=log(ACC+1). In addition, price variables were computed in two forms: real cruzados (LPBR) and dollars (LPUS)[2].

The dummy variables used were of four types. The first set of dummy variables described technical aspects such as: (6) whether or not the equipment included a monitor, MON (=1 if yes, zero otherwise); (7) the architecture followed, i.e., TAPP (=1 if Apple clone, zero otherwise), TIBM (=1 if IBM-PC clone) and TOTH (=1 if an architecture different than IBM and Apple)[3]; and (8) the number of bytes of the microprocessor, P8 (=1 if 8 bits, zero otherwise), P16 (=1 if 16 bits) and P32 (=1 if 32 bits or more). The second set of dummy variables described any unmeasured quality dimension (e.g., "reputation" and maintenance network) associated with the leading Brazilian producers, that is, the "make effect". The producers were classified in two groups: the top ten

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[2]The real cruzado series was calculated using the IGP-DI price index with 12/1989=100. The exchange rate used to compute the dollar values was the official rate.

[3] Note that all domestically produced PCs were clones of well-known, typically American, designs. However, there was no Brazilian production of PCs by IBM, Apple, and so on.

producers, BTOP, and the others BOTH. Table 3 includes a list of these characteristics and sample statistics.

The third type of dummies capture time effects on prices. There were 31 time dummies, one for each quarter, defined as Tij, where i is the quarter and j is the year (for example, T384 refers to the third quarter of 1984). Finally, the fourth type of dummy variable describes the age of model. As noted before, there are nine age dummies: Ai, with i being the number of semesters of age, that is, i=0,1,...,8. So a model with A4 equals to one indicates that it has 4 semesters or two years of age. When a model's price is first published, A0 equals to one. Table 4 lists the statistics for those variables.

Exact multicolinearity among some variables imposed restrictions to our analysis. For example, note the following identities:

BTOP + BOTH = 1

P8 + P16 + P32 = 1

TAPP + TOTH = P8

TAPP + TIBM + TOTH = 1

TIBM = P16 + P32

TIBM + P8 = 1

As a consequence, the variables BOTH, P8, TIBM and TOTH were not used in the regressions below. These exclusions affect the interpretation of the coefficients of the remaining variables. For example, the coefficient of TAPP indicates the value of Apple technology relative to other technologies, excluding IBM clones, which is capture by P16 and P32. Moreover, due to the fact that the price of most of the models with technologies other than Apple and IBM did not include a monitor, the coefficient of MON reflects not only the value of a system with a monitor, but also the fact that the computer is either an IBM or an Apple clone.

4. The performance of the Brazilian computer industry

We divide our analysis into two sections. This section performs a standard hedonic analysis of computer model data. The next section compares the Brazilian performance against the US industry, which stands in for international best practice.

We follow standard hedonic techniques for estimating technical change in a differentiated product industry. We estimate an equation of the form:

$$lnY_i=\alpha_i+\gamma_{1i}+\varphi_{0i}+\Sigma\gamma_t D_{ti}+\Sigma\varphi_j A_{ji}+\Sigma B_k \ln X_{ki}+\mu_i \quad (4)$$

where Y_i is the log of the price of computer model i, X_{ki} are its k characteristics, D_{ti} and Ajt are time and age dummies respectively and μ_{it} is iid across observations. We use γ_t to compute an index of the technical change embedded in price, but not accounted for by product characteristics. That is, we estimate P_t/P_1 by $100*\exp(\gamma_t - \gamma_1)$ for all t[4].

As explained above, we use two different price variables. One is standardized in Brazilian cruzeiros and the other in US dollars. Table 5, 6 and 7 present our estimates of the hedonic equation for each different type of price and for the sample with all firms. The estimates of B are not very sensitive to changes in monetary standard, but the estimates of the real price index are, not surprisingly. As in previous estimates on US data (Berndt and Griliches [1993]), characteristics of the computer system positively predict its prices. Among LRAM, LFLP, LHRD and LACC, the estimated coefficients indicate that the RAM memory, hard disk capacity and accessories (for dollar price) contributed most to the price formation.

These estimates are consistent with the producers' complaints about the high costs of microelectronic components and peripherals reported in Luzio (1993). However, since these estimates

[4] As is well known (Berndt [1991]) these indexes are biased estimates of the rate of technical change. To correct for the bias we can employ the approximation used by previous hedonic researchers (Triplett [1989]), i.e., add half of the squared standard error to the estimate before taking the exponential. Because of the low standard errors in our estimates, there is little difference between the biased and unbiased indexes.

are in logs and not levels, one has to be cautious about inferring much about the cost of upgrades in practice. That is, even though the estimates of the LRAM coefficient is greater than LFLP's, an upgrade of RAM memory could raise the price by less than an upgrade of floppy disks. For example, a floppy disk upgrade could involve a jump from 360 Kb to 720 Kb (100% change), while a memory upgrade could move from 640 Kb to 720 Kb. Thus, the final effects on prices of such upgrades would be 9.1% and 4.5% respectively.

Interpreting the dummy variables of technical characteristics, MON, TAPP, BTOP, P16, P32, requires taking the exponent of the coefficient estimate. For example, the price ratio between a system with and without monitor would be 2.76 (=EXP(1.016)). Note that such a high ratio is due to the fact that MON captures not just the existence of a monitor, but it also distinguishes between machines based on Apple and IBM technologies from other architectures (Sinclair, MSX). In other words, a system based on IBM or Apple technology with a monitor would cost 2.76 times more than a system without monitor and based on different technologies. Such difference may arise because Apple and IBM clones were the most popular systems. In addition, note that a 16-bit machine would cost 1.28 (=EXP(0.25)) more than another with a 8-bit microprocessor. A 32-bit machine would cost 1.91 more than a 8-bit one.

The other set of dummy variables of interest is the one describing the models' ages. The means show that 59.3% of the observations were one-year old or younger. Only 12.7% of the observations were older than three years. Therefore, the majority of the microcomputer models (if proportional to the number of observations) either changed their technical characteristics often and/or they did not survive more than one year in the market, which suggests a high rate of exit. A similar phenomenon was also observed in Berndt & Griliches data on the US microcomputer industry. Rather than display the effect of this phenomenon on the estimated price indexes, as in Berndt and Griliches, we adopt a standard specification that uses only age and year effects. This is the easiest specification to use and our qualitative results are not sensitive to this standardization.

Most of the estimates of the age coefficients indicate that young models were cheaper than old ones. For example, the ratio of the price of a model of one-year old or less to other models is 0.92 (=EXP(-.0.81)), while the ratio of a model of four-year old is 1.39 (=EXP(0.327)). This result suggests that consumers valued models that survived longer years more than new ones. Moreover, new models were sold at a discount relative to older models, which may be a consequence of lower production costs. Alternatively, the discount on new equipments could be a form of remuneration to the consumer willing to take the risk of buying a model whose production could be discontinued after a year. If so, old models had a price premium for the recognition of a long track of marketing success, and therefore a stable maintenance network and resale price.

Table 7 presents the implied price index for each set of estimates. While the price indices fluctuate from one quarter to another, a steady downward decline is evident: -7.958 percent per quarter over all eight years of the sample. Two factors, both representing changes in Brazilian government policy, make an obvious difference:

(1) The freeze of the official Cruzado/Dollar exchange rate from 3/1986 to 9/1986 and from 1/1989 to 3/1989 influenced the price index estimates during those months, which is clearly artificial. Once the freeze was lifted, the ratio of prices resorts back to its old pattern. Moreover, further fluctuations in the price index were provoked by the exchange rate policy of the first years of the 1990s. At that time, the government depreciated the exchange rate faster than the inflation rate and vice-versa (e.g., from 1990 to july of 1992, the cruzeiro depreciated 5,479 percent, while the inflation reached 4,593 percent).

(2) The election of President Collor (and the implied threat to eliminate informatics laws) is also evident. From 1984 to 1990 the rate of implied price decline is -4.587 percent per quarter. After 1990 the rate of implied price decline is -14.96 percent per quarter, with an enormous decline coming

in 1990, right after the election.

These initial results support two conclusions. First, the Brazilian microcomputer industry, like its counterparts all over the world, continued to advance over the entire 8 years. Despite some variation in the measured rate of advance, the rate of advance was rapid overall. Second, the rate of advance significantly accelerated after the beginning of the Collor presidency. This change is consistent with anecdotes about dramatic declines in the domestic firms in the 1990s.

5. The opportunity costs of protection

We use two different standards for measuring the opportunity costs of protection. First, we directly compare levels and rates of change of price/performance in Brazil against similar price/performance measures in the United States, which proxies for best practice world-wide. Second, we estimate the change in consumer surplus that would have occurred in Brazil had they had access to US markets.

5.1 Comparison of Brazilian and international technical advance

We first estimate the relative size of prices in Brazil to US prices, holding constant for system characteristics. We estimate this by taking the average system characteristics of a Brazilian system in 1984 and estimate its price in the US and Brazil by:

$$\frac{P_{US}}{P_{Br}} = e^{[\alpha_{US} - \alpha_{Br} + \ln X_{Br84}(B_{US} - B_{Br}) + D_{Br}(\delta_{US} - \delta_{Br}) + \varphi_{US84}]}$$

We compare this with an estimate of that exact same system's price in the US, using the hedonic estimates of Berndt and Griliches [1993]. We can estimate the relative prices for all years after 1984 by using the implied rates of technical change from the hedonic estimates[5]. This approach has the advantage that we can derive relative estimates even though we do not know the average characteristics of the systems available in the US in each year of interest.

Table 8 shows the price ratios for 1984 and for all subsequent years. In the first year, the US computers were roughly half the price of their equivalent Brazilian counterparts (0.534). By 1988 the ratio was 0.789. Though the prices of Brazilian microcomputers did decline at a rapid rate, they never caught up with their US counter-parts in terms of price performance.

Another way to illustrate this is shown in figure 1. It compares the estimated price/performance marks for both the US and Brazil over the years we have estimates. It is possible to see how many years Brazilian microcomputers' prices/performance were behind US prices/performance for equivalent systems. Brazil's 1985 price/performance represented the mid-1981 price/performance in the United States. By 1990, Brazil's price/performance in was more than five years behind best practice in the United States. The gap widened from 1984 to 1990, with exception of 1988-1989 in which the exchange rate is manipulated, as noted above. It fell considerably after 1990, as expected, reducing the technology gap to 4 years.

5.2 Consumer surplus estimates

We consider an alternative method for quantifying the opportunity costs of protection. We provide an estimate of the change in consumer surplus that would result from opening up the Brazilian market to cheaper outside imports. We do not wish to suggest that our estimate is exactly right. Rather, we wish to show that with a fairly simple and plausible model, the magnitude of lost consumer surplus must be large. We are convinced that any other estimate will show results of the

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[5] We checked this procedure against the obvious alternative: using the mean system characteristics for 1985, 1986, and so on, and then computing the implied prices for the US thereafter. We found no substantial differences in the estimates, so we only show one set.

same magnitude or more.

We adopt methodology first developed by Griliches [1958] and extended by Flamm [1987]. Under a constant elasticity demand curve, $P = aQ^{-\epsilon}$, a second order Taylor expansion for the gain in consumer surplus from a decrease in prices from P_0 to P_1 is

$$CS = kP_0Q_0[1-(k\frac{\varepsilon}{2})] \tag{3}$$

where, ϵ is the absolute value of the price elasticity of demand; and k is the yield, or the gain from the (marginal or average) cost reduction caused by the new technology. Thus, the yield k in the year i would be:

$$k_i = 1 - \frac{P_{USi}}{P_{Bri}} \tag{4}$$

Even though the price ratio cannot be observed accurately, we used the 0.53 benchmark ratio. The yield for the subsequent years can be approximated using the rate of price change between the hedonic indexes in the United States and Brazil from 1984 to 1988, when the Berndt and Griliches [1993] study ends. For example, the yield of moving from the market reserve to free imports in 1985 would be:

$$k_{85} = 1 - \frac{P_{US85}}{P_{BR85}}$$

where,

Before reporting the results it is important to call the attention to the fact that this estimate of

$$\frac{P_{US85}}{P_{BR85}}=0.53\frac{(1-\frac{\Delta P_{HedoUS85-84}}{P_{HedoUS84}})}{(1-\frac{\Delta P_{HedoBr85-84}}{P_{HedoBr84}})}$$

the opportunity costs of the informatics laws is likely an underestimate of the true gains from bringing down barriers to foreign competition. First, consumer surplus is a partial equilibrium measure of opportunity costs, which ignores the general equilibrium benefits to downstream users of improved micro-computers (e.g., long-run changes in investment behavior). Second, constant price elasticity of demand is a strong assumption for a growing market undergoing rapid technical change. It provides no estimate of the benefit from increases in the variety of models available or an extension in the capabilities of models. Third, we use Flamm's estimates of the elasticity of demand for all computing equipment, estimated on US data. His estimates are on the order of -1.5. More elastic demand for PCs alone, as is likely due to competition from smuggled PC's and other types of computers, would result in a much higher benefit from price decline than we estimate. Nonetheless, this measure provides a lower-bound ball-park estimate of the opportunity costs from a change in prices. Moreover, this methodology has not been used by any previous study that we are aware of.

Table 9 presents the results. The consumer surplus ranged from 79.6 to 277.0 million dollars, during 1984-88, which are large amounts compared to the total expenditure on legal sales each year for the same period, which range from 126 to 745 million dollars. Over the whole period, the lost consumer surplus comes to 716.4 million or 33 percent of total expenditure on legal systems.

It is not possible to make a similar prediction about producer surplus without information about the elasticity of domestic supply or the levels of domestic costs of supply and how it changed over time. Standard analysis only suggests that the absolute value of the gains to producers will be a fraction of the losses to consumers. Even if that fraction is around fifty percent, our estimates suggest that Brazilian firms received a large benefit from the protection.

In sum, these figures demonstrate the large costs associated with protecting this industry. Not only did the Brazilian firms remain less efficient than international standards, but their product improved at a slower rate. The opportunity costs to users of protecting this industry had to be large.

6. Conclusion

Personal computers were but one of many industries covered by the informatics laws in Brazil. It is an important and interesting case, because it is representative of all industries that grew up under the import protection. It also offers us an opportunity to understand the costs of protecting an industry, since there were well-documented international standards.

We found that the Brazilian PC industry advanced at a rate that was comparable to international rates of technical advance (or slightly slower), but the prices of legal Brazilian PCs started higher and stayed higher than their potential international competition. Technical frontiers perpetually lagged price/performance practices in international markets by three years and as much as five. The opportunity cost of following this protective policy rather than opening up to international markets (i.e. forgone surplus) was on the order of 716.4 million US dollars, or roughly a third of the total expenditure on domestically produced micro-computers.

Further work should consider the efficacy of import protection of high-technology in light of these costs. Government policy for encouraging high-technology firms may have less costly approaches available, such as direct subsidies to research and development. In addition, further research should identify which aspects of the protection influenced the costs borne by Brazilian consumers of PCs. Luzio [1993] contains such a study.

Table 1
Total Value (Millions of Real Cr$)[6]
and Quantity Produced of Small-Size Computers Compared to Microcomputers (referred as "Micros")

Year	Total Value of all small computers	Total value of Micros	%	Total Units of small computers	Total units of Micros	%
1980	18.61	13.59	73	1414	614	43
1981	31.52	22.69	72	2307	1516	66
1982	62.69	52.03	83	23432	22459	96
1983	54.07	46.5	86	56464	55711	99
1984	70.37	63.33	90	90101	89272	99
1985	146.43	108.36	74	158429	157338	99
1986	240.41	189.92	79	185875	183056	98
1987	118.14	98.06	83	141072	138874	98
1988	215.54	140.1	65	72208	70534	98
1989	259.21	189.22	73	95408	92461	97
1990	223.68	163.29	73	102452	99020	97

Source: The figures were computed based on data from SEI (1987, 1989), DEPIN (1991).

[6]The real Cr$ values were calculated based on the accumulated index of inflation (IGP with 1980 = 100), in order to avoid eventual distortions caused by currency depreciation from government's macroeconomic policies.

Table 2
Quantity Produced[7] and Value (Millions of Real Cr$)
of Microcomputers Produced

Year	Value 8 bit	%	Value 16 bit	%	Units 8 bit	%	Units 16 bit	%
1985	68.65	63	34.97	32	147603	94	9735	6
1986	59.2	31	124.17	65	144900	79	38156	21
1987	18.05	18	71.78	73	92032	66	46842	34
1988	9.64	7	126.67	90	21350	30	48930	69
1989	10.36	5	158.58	84	14875	16	75366	82
1990	22.81	14	120.49	74	20830	21	71938	73

Source: Real values were computed based on SEI (1989) and Depin (1991). Note that the percentage values refer to the total of the microcomputer sector from Table 2.1.

[7]The number of units produced changed dramatically from 1987 to 1988 due to the difference in the sample of firms. Thus, the table should be analyzed in relative rather than absolute terms.

Table 3
Mean, Standard Deviation, Minimum and Maximum Values of Characteristics Variables

Variable	Mean	Std. Dev.	Min. Value	Max. Value
PBR	530,060	491,480	4,724	4,964,000
PUS	3889.5	3189.3	30	27,460
RAM	666.8	710	2	4096
FLP	405.4	265.6	0	1000
HRD	9.3	16.2	0	160
ACC	0.04	0.2	0	1
MON	0.831	0.375	0	1
TAPP	0.118	0.323	0	1
TIBM	0.7725	0.419	0	1
TOTH	0.109	0.312	0	1
BTOP	0.2372	0.426	0	1
BOTH	0.763	0.426	0	1
P8	0.228	0.419	0	1
P16	0.729	0.445	0	1
P32	0.044	0.215	0	1

Table 4
Statistics of the Age Dummies

Variable	Mean	Std. Dev.
A0	0.170	0.376
A1	0.255	0.436
A2	0.168	0.373
A3	0.085	0.279
A4	0.057	0.232
A5	0.031	0.173
A6	0.014	0.116
A7	0.010	0.098
A8	0.117	0.107

Table 5
Results from Regression (4) for All Manufacturers

Variable	PUS$	PBR
Constant	4.639* (0.126)	10.203* (0.137)
LRAM	0.361* (0.020)	0.361* (0.020)
LFLP	0.091* (0.007)	0.084* (0.007)
LHRD	0.136* (0.007)	0.136* (0.007)
LACC	0.443* (0.07)	0.031* (0.001)
MON	1.016* (0.046)	1.053* (0.046)
TAPP	0.437* (0.045)	0.451* (0.045)
BTOP	-0.033 (0.025)	-0.030 (0.025)
P16	0.250* (0.054)	0.266* (0.054)
P32	0.626* (0.083)	0.647* (0.083)
R-Square	0.811	0.805
No. Obs.	2567	2567

Note: * indicates that the estimate is statically different than zero for 1% significance level.

Table 6
Estimates of Age Coefficients

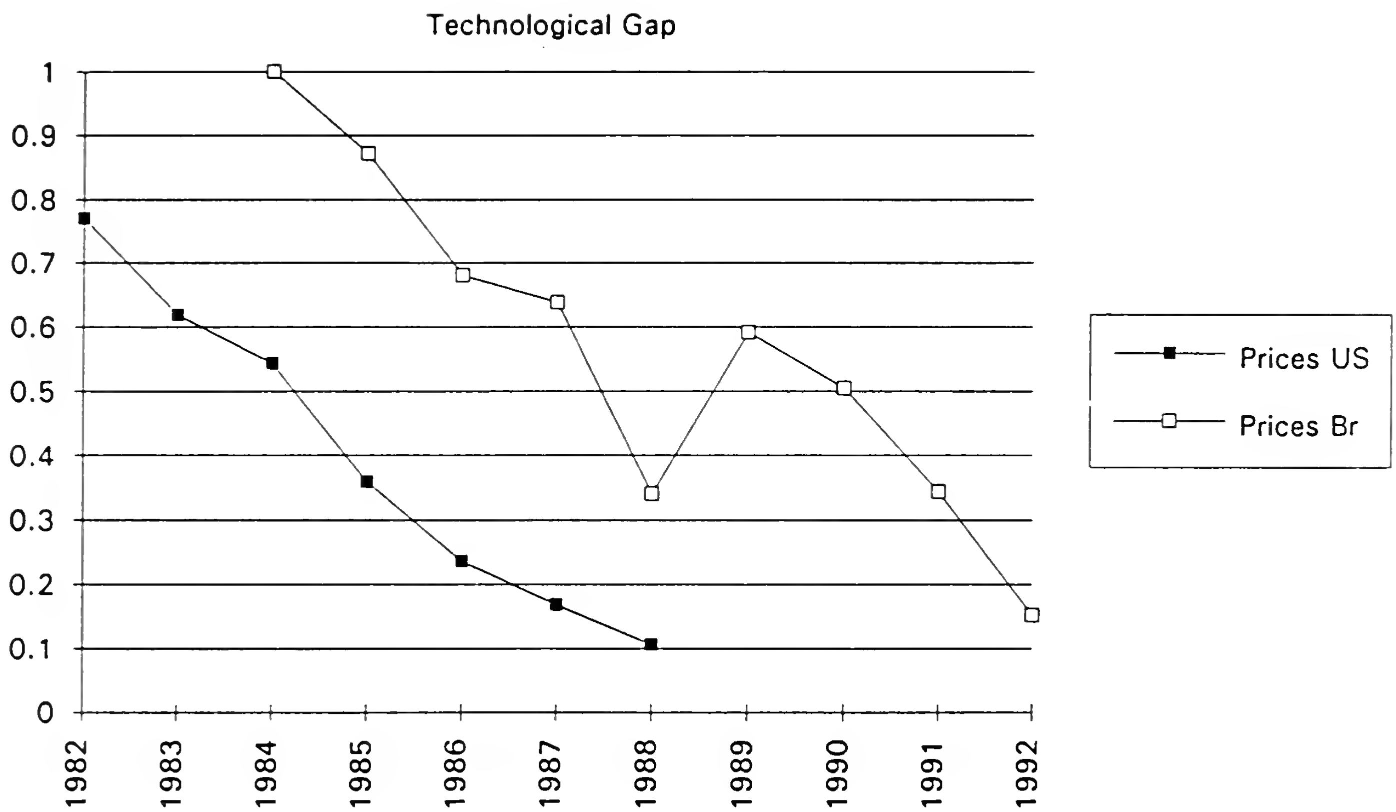
Variable	PUS	PBR
A1	-0.031 (0.025)	-0.030 (0.025)
A2	-0.081* (0.029)	-0.081* (0.029)
A3	-0.058 (0.037)	-0.056 (0.037)
A4	0.012 (0.044)	-0.013 (0.044)
A5	-0.029 (0.058)	-0.030 (0.058)
A6	0.021 (0.083)	0.019 (0.083)
A7	0.297* (0.098)	0.295* (0.098)
A8	0.327* (0.092)	0.330* (0.092)

Note: (*) indicates that the estimate is statically different than zero for 1% significance level.

Table 7
Summary of Regression Results for Time Dummies
(Both Dollars and Real Cruzeiros)

Variable	Estimate	Hedonic Index	% Change	Estimate	Hedonic Index	% Change
T484	0 (0)	1	-	0	1	-
T185	0.095 (0.131)	1.015	1.517	0.099 (0.131)	1.105	10.45
T285	0.063 (0.132)	0.905	-10.86	0.040 (0.132)	1.041	-5.77
T385	0.001 (0.134)	0.794	-12.27	-0.077 (0.133)	0.926	-11.04
T485	-0.018 (0.122)	0.771	-2.83	0.074 (0.122)	1.077	16.31
T186	-0.138 (0.124)	0.673	-12.74	-0.171 (0.124)	0.843	-21.75
T286	0.080 (0.120)	0.776	15.31	-0.012 (0.119)	0.989	17.34
T386	0.019 (0.118)	0.666	-14.24	-0.088 (0.118)	0.414	-58.17
T486	-0.031 (0.118)	0.609	-8.52	-0.158 (0.117)	0.854	106.49
T187	-0.160 (0.118)	0.502	-15.58	-0.334* (0.116)	1.396	63.49
T287	-0.21** (0.117)	0.450	-10.38	-0.408* (0.116)	0.665	-52.36
T387	-0.409* (0.117)	0.350	-22.18	-0.578* (0.114)	0.561	-15.66
T487	-0524* (0.115)	0.302	-13.73	-0.727* (0.114)	0.484	-13.79
T188	-0.644* (0.117)	0.261	-13.59	-0.904* (0.116)	0.405	-16.24
T288	-0.543* (0.121)	0.266	2.10	-0.820* (0.121)	0.417	3.012

T388	-0.600* (0.119)	0.235	-11.71	-0.874* (0.118)	0.417	0
T488	-0.513* (0.121)	1.048	345.63	-0.814* (0.120)	0.443	6.19
T189	-0.540* (0.125)	0.811	-22.65	-0.884* (0.124)	0.413	-6.79
T289	-0.466* (0.122)	0.741	-8.64	-0.983* (0.122)	0.374	-9.39
T389	-0.894* (0.127)	0.433	-41.52	-1.346* (0.126)	0.260	-30.46
T489	-0.672* (0.123)	0.486	12.27	-1.221* (0.123)	0.295	13.29
T190	-0.872* (0.124)	0.356	-26.82	-1.512* (0.123)	0.221	-25.2
T290	-0.332* (0.122)	0.548	53.90	-1.148* (0.122)	0.317	43.84
T390	-0.595* (0.122)	0.383	-30.11	-1.412* (0.121)	0.244	-23.16
T490	-0.800* (0.123)	0.288	-24.89	-1.544* (0.122)	0.214	-12.35
T191	-1.339* (0.123)	0.152	-47.02	-1.858* (0.122)	0.156	-27.01
T291	-1.169* (0.126)	0.170	11.76	-1.864* (0.125)	0.155	-0.51
T391	-1.367* (0.126)	0.134	-21.28	-2.055* (0.125)	0.128	-17.46
T491	-1.817* (0.126)	0.082	-38.60	-2.408* (0.126)	0.090	-29.69
T192	-1.782* (0.128)	0.082	-0.650	-2.428* (0.129)	0.088	-2.04
T292	-1.892* (0.129)	0.07	-13.90	-2.494* (0.129)	0.083	-6.34
%AQGR a			-7.958	%AQGR a		-7.497
%AQGR b			-4.587	%AQGR b		-6.641
%AQGR c			-14.96	%AQGR c		-9.352



Technological Gap
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Prices US
Prices Br

Table 8
Consumer Surplus Calculations (in millions of US dollars)

T	Sales	Ratio	k	CS	% GNP
1984	126.54	0.534	0.466	79.579	0.033
1985	383.87	0.633	0.367	179.382	0.070
1986	745.57	0.697	0.303	276.944	0.100
1987	644.00	0.844	0.156	112.145	0.039
1988	279.17	0.789	0.211	68.343	0.024

Source: Sales quantities reported in SEI (1987, page 76), SEI (8/1989, page 28) and DEPIN (1991, page 56).

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