The Brazilian Data Processing Industry - An overview of Technology, Output and Employment

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The Electronics Industry

The Brazilian electronics industry for a short time fended off the worst effects of the generalised economic crisis of 1979/80, maintaining, on aggregate, growth rates above 15% until 1981. Electronic consumer goods have constituted the majority segment of the industry since at least 1977, accounting for between 64% and 56% of the total electronics market. It was the continued expansion of this segment until the end of 1980 which maintained the seemingly high growth overall, and similarly contributed to the gradual market decline of the sector since that time.

The Brazilian Electronics Market - 1977-83 (US$millions)

Sector	1977	1978	1979	1980	1981	1982	1983
Electronic consumer goods	1,370	1,606	1,830	2,174	1,845	2,101	1,930
of which: Radio and TV	1,180	1,381	1,550	1,814	1,500	1,721	1,580
Others*	190	225	280	360	345	380	350
Telecommunications	860	750	793	730	749	776	690
Transmission	20	30	46	50	52	65	60
Computing	160	190	285	305	387	586	560
Instrumentation & control	40	51	54	60	64	70	80
Defense	20	22	26	30	35	45	60
Medicine	20	24	29	30	34	35	50
Total	2,490	2,673	3,063	3,379	3,166	3,678	3,430

Source: Wajnberg (1984;11)

* Includes calculators, Electronic watches, record players, amplifiers without radios.

Telecommunications, the next largest market segment, has seen its share of the total electronics market decline steadily from 1977 (36% of the total) to 1983 (20%). The sector's main customer is the state and thus the decline in sales can be put down to the generalised cuts in government expenditure in the period. Nevertheless, telecommunications remains the second largest segment and, because of its technological importance based on microelectronics, is and will continue to be an integral part of the electronics industry.

Data processing is the area that has grown most significantly in the period 1977-83. Its share in total electronics sales in 1977 was 6% and by 1983 had grown to 16%, making it the third largest market segment.* This growth has been both relative and absolute (barring the period 1982/3) and the rising significance of the sector continues to the present due, no doubt, to the active pursuit of the national informatics industry discussed below.

Wajnberg (ibid.) estimates that in 1983 there were more than 380 companies which comprised the electronics industry - out of a total of 3000 firms in the electrical/electronics sector. These firms employed something in the region of 120,000 people, of whom about 10.4% were graduates.

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* In 1983, the sales of electronic consumer goods, telecommunications, and data processing equipment accounted for 93% of the total electronics market.

Data Processing

Since 1979, the Brazilian computer industry has undergone considerable expansion, both in terms of employment and output. This has been due to the initiation and rapid expansion of the nationally owned (100%) segment of the industry.

Table I - Total Employed

	1981	1982	1984	1984*
National	8,283	12,584	15,734	20,130
Multinational	12,200	11,797	10,010	-

Source: SEI 1984; 49

* estimate

In terms of overall employment, national firms reached 15,734 in 1983 (a figure which was projected to increase to over 20,000 in 1984), representing a 30% increase from 1982-83. Multinational firms on the other hand decreased their employment by 15% in the same period (it is now, 1985, said to be 8 thousand while national firms have 27,000). There is a similar overall picture in relation to the growth of sales of the two market segments.

Table II - Total Receipts

US$ millions

	1981	1982	1983
National	370	558	687
Multinational	670	950	800
Total	1,040	1,508	1,487

SEI 1984.

While total sales dropped by 1.2% in 1982/3, sales by national firms increased by 23%. The market share of national and multinational firms in computers (and peripherals) has moved from the situation in 1979 when multinationals held 77% of the market to a share of 54% in 1983. The concommitant national share of 46% in 1983 is projected to have increased in the last 2 years. Indeed preliminary information shows the sales in 1984 of national firms to have overtaken those of multinationals for the first time. Viz. US$921 million and US$ 759 million respectively (Gazetta Mercantil 17.5.85)*

The high aggregate levels of growth in the national industry are not surprising when we consider that it has started from a low base.

Nevertheless, this does not conceal the fact that a) the national segment of the industry is increasing its share of operations in both relative and absolute terms, while b) the foreign segment is suffering a concomittant loss.

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* The figures cited were 1.7 and 1.4 trillion cruzeiros which were converted using the average exchange rate for 1984 as cited in Conjuntura Econômica.

A brief history

The development of the Brazilian computer industry is well documented (see particularly Tigre, 1983, Piragibe, 1985) so the summary that follows is contextual and draws extensively on these two texts.

Some 10 years ago, the Brazilian computer market was dominated by foreign firms of which 3 were responsible for 75% of the computers installed in the country (IBM 44%, Phillips 18%, Burroughs 13%). (wainberg, 1984; 55) Other firms included Sperry Rand, Olivetti, NCR and Honeywell. The first computers were installed in the country at the beginning of the 1960's. By 1970, there were 506 installed computers, which grew to 3,845 in 1975. As Piragibe points out, the industry 'was born internationalised' based on the import of final products or, as in the case of IBM and Burroughs, restricted to the final assembly in Brazil of products with high import content. Suffice it to note that the phase of rapid expansion of installed computers corresponded to the period of the "miracle".

The nature of the industry meant that barriers to enty by local firms were high, and that the development of local technology and qualified personnel was inhibited. Government concern and recongition that the computer industry was to be a key area of local 'development' promted the creation in 1974 of Computadores e Sistemas Brasileiros, Cobra (a 'merger' of a private national company, Equipamentos Eletrônicos (EE), the state holding, Digibrás, and the UK firm Ferranti)* to develop and manufacture 'national' computers.

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* There was much dispute at the time between the choice of Ferranti a company whose main line of business is intimately linked with military technology and the Japanese firm Fujitsu whose expertise lay in commercial applications. BNDE, which financed the project, supported the latter, while the navy went for the former. The political make up of that era ensured that the navy won the day and the first computer project (Projeto Guaranys) was applied to military purposes.

As well as being a 'nationalist' project, realised through an articulation of specific political, military, academic and financial interests, the birth of Brazil's computer industry was the result of pressing economic exigencies. In 1974, computers were the third largest item of manufactured imports in value terms (US$98.8 million) which represented a 600% increase in the period 1969/74. The first oil 'crisis' of 1973 began to put a strain on import spending and, thus, the PND II (74/79) the PBDCT II (75/79) set in motion a market reserve policy for small computing systems and peripherals, whereby production could only be carried out by 100% national firms. Four firms (Cobra, Labo, SID, and Edisa) were chosen from 15 proposals 60 manufacture minicomputers (amoungst whom were IBM and Burroughs) and subsequently a fifth (Sisco) was included. These firms were not permitted to manufacture peripherals and, within the parametors of the market reserve, this area was also put to tender, with different firms to make: magnetic disks-rigid and floppy - (Multidigit, Elebra Informática, Microlab, Flexidisk); magnetic tape units (Compart, Globos, Microlab); printers (Elgin, Globus, Elebra Informática, Prológica); video terminals (Scopus, EBC); and "modems" for data transmission (Modata/ Coencisa PARS, CMA, ABC KUHN). Tables III and IV show the most recently available information on manufacturers of computers and peripherals disaggregated by product.

The intervention of the State, first through the policy of market reserve for the computer industry and, subsequently in 1979, setting up the Secretaria Especial de Informática - SEI-gave an unprecedented boost to what was considered a strategic sector. The embrace of state direction lays out the rules of the game for the whole gamut of informatics related activities: microelectronics, teleinformatics, process control, instrumentation, software and related services. The activities/policy instruments of SEI include: import controls, the concession of manufacturing licences to firms, the supervision of demand from public bodies and state companies, and the protection of national companies be they producing minicomputers, micro computers, digital integrated circuits ,

Table III

Principal Suppliers of Complete data processing systems - by Main Product - 1983

Mainframes	- IBM do Brasil Burroughs Sperry Fujitsu (Facom) Honeywell-Bull ABC-Bull
Minicomputers	- Cobra SID Informática Labo Digirede Sisco Edisa Medidata Novadata Gepeto
Microcomputers	- Prológica Scopus Polymax Hewlett-Packard* Itautec Brascom Microdigital EBC Quartzil Kemitron Racimec

* H-P is licensed to manufacture scientific micros and hence is able to circumvent the market reserve.

Table IV

Principal manufacturers of computer peripherals - by main product - 1983

Disk units (rigid and floppy)	- Elebra Informática Microlab Flexidisk Multidigit
Tape units	- Conpart Basf Brasileira
Printers	- Elebra Informática Digilab Globus Digital Elgin Máquinas
Terminals	- NCR do Brasil Racimec Digilab CMA
Others	- Moddata/Coencisa Elebra Eletrônica Sedasa BK Controles Parks Digitel

process controls, electronic instruments, or the more recent 'superminis'.

Multinational firms are also subject to the influence of SEI in the sense that they cannot interfere in the reserved market, they must have growing indices of 'nationalisation' of their products, and they are also committed to export a portion of the products (which in the case of IBM is 2/3 of total production).

The breadth of (albeit 'passive')* influence of SEI is in itself a factor which makes its activities complex and, at times, highly bureaucratised.** However, a more pressing problem may lie in the growing tension between policies for informatics on the one hand, and quite different policies for the areas of telecommunications and electronic consumer goods on the other. This dilemma is summed up by Piragibe: "The convergence between computers, telecommunications and electronic consumer goods - as a result of the increasing digitalisation of those products based on microelectronics - means that the distinct policy orientations observed in Brazil for these sectors increasingly enter into conflict with each other. This results in the need for a more coherent policy for the "electronics complex" (Piragibe, 1985; 138). The most apparent contemporary example of this growing conflict has been the 'trickle' of informatics firms relocating production in the Manaus Free Zone. Differences of opinion between SEI and SUFRAMA have been temporarily 'resolved' by decree but the basic contradiction between competing policy objectives remains.

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* That is, e.g., R&D activities have been financed by the firms themselves (compare to the US and Japan) and training (until setting up of CTI in 1982).

** 'Red tape' has probably been a conscious and effective method of controlling the free-marketeers in the industry, despite the common complaint of long delays producing inefficiency and reducing competitiveness.

The significance of the above developments bears a direct relation to our research in various ways:

1) The rapid growth of the industry since 1979, gives it a very short, but dynamic, history. Despite this brevity, there are three characteristics which mark the industry out for special attention: fierce competition (albeit in an almost closed economy); rapid and continous technical change; and a marked skill profile seldom found in other industries, namely, a polarization between semi-and unskilled assembly workers and highly skilled technicians/engineers. The industry appears to employ few workers with 'traditional' craft skills.

2) The competitiveness of the computer industry cannot at this stage be assessed without reference to the protective policies of the state. In this sense it will be useful to view the industry within the context of the wider 'infant industry' debate to assess the how, when and why of its growing up. There are various questions here: can the industry gain a competitive edge in international terms? If so, does this depend on the development of a local semiconductor industry? What are the effects of the market reserve on the diffusion of product & process technologies?

3) On labour utilization: there seems to be a marked difference between the strategies of national and multinational firms. The latter horizontalising production through the use of sub-contracted suppliers of parts and components as well as product sub-assemblies, and the latter verticalising production by carrying out the bulk of production under one roof. For this reason we would expect to find a greater concentration of skilled staff in foreign firms. A countervailing tendency may be that while multinationals on aggregate are producing less (since 1981) and employing fewer people, national firms continue to increase production

Process technology in the computer industry

To talk of technical change in the manufacturing process of the computer industry may be a little misleading as a generalisation. This is for two reasons. First, the now significant portion of the industry represented by national companies is still of such a young age that much (though not all) of present fixed capital has been used since the birth of national computer production. Thus, it makes little sense to talk about 'change' however 'modern' the technology embodied in machinery might be. This is turn raises new questions about labour utilisation/skill requirements. Second, the common technological base (microelectronics) for the computer industry brings a new and more complex dimension to the traditional distinction between process and product technology, because: a) the competitiveness of firms can be enhanced both by product innovation and process innovation in terms of quality improvement; b) labour utilisation will be modified by both changes in process technology (be it through labour saving, changes in organisation, or different skill requirements) and in product technology (for example through minitiarisation). While the emphasis of this research is on process technology vis-a-vis labour utilisation, it is clear that some changes in product technology will aso have to be included and observed.

Three areas of microelectronics related innovation can be identified as being crucial to the computer industry.

1) the use of computer aided design (CAD) for project development
2) Automation of component insertion
3) automation of product testing procedures.

To take the last first, product testing is usually the first part of the manufacturing process to be automated. The most immediate gains of automated testing are in standardisation of product quality. Non-automated testing techniques rely on time consuming location of faults by an operator who tests each point of connection on, say, a mounted and soldered printed circuit board (PCB). When a fault is located, the PCB would be handed to a skilled technician who determines the nature of the fault (e.g. bad connection, non-functioning component, etc) and rectifies it.

Automated testing has the knowledge of the skilled technician embodied in a programmable machine. The PCB is simply placed on a sensor (contact plate) by the operator, any faults will be detected and located virtually simultaneously and registered on the CPU or printed with details of defects to be repaired. Such a system can be up to 95% accurate (compared to something in the region of 60% for the case of manual testing). A software package will probably be supplied with the machine and hence there is less need for sophisticated programmers within the firm.

Automated testing, thus, is skill saving, time saving and enhances quality standardization.* In short, with automated testing, both skill and labour requirements are potentially decreased. It also raises the possibility of a skill shift the manufacturers to machinery suppliers.

The second important area of process innovation is in the automation of assembly itself, particularly the labour intensive stage of mounting components onto PCBs. While the diffusion of automated assembly is limited in Brazil** - two

* At least 3 firms in Brazil are using this method of automated testing: IBM, Cobra and Elebra. The cost of such machines - an estimated US$300,000 in the US and up to three times as much in Brazil - is clearly a limiting factor to their diffusion.

** Again machinery costs, along with relatively cheap labour and small scale of production, would seem to be limiting factors.

firms to our knowledge use automated insertion (SID and Philco), although this does not deny the possibility of more users - there are a number of reasons why diffusion may increase. Primarily, automation increases product quality and hence enhances the competitiveness of user firms. Alongside this, there can be a reduction in inventories, increased productivity (up to 10 or 12 times faster than manual insertion), and, of course, this increased productivity/quality can be obtained with less labour.

The typical manual process involves a series of semi-skilled (usually women) assemblers, inserting components one by one into PCBs, component leads are crimped and then soldered either manually or, when the board is filled with components ('populated'), passed through hot solder bath.

In contrast, automated insertion machinery requires only one operator to produce greater output. Components are sequenced onto a continuous tape or, alternatively, in 'dual in line packages' (DIPS) which are plastic tubes containing the required components. The tapes or DIPs then feed the programmable insertor which in turn 'populates' the PCB. Some machines can handle large components of up to 60 leads while others can only insert smaller components, the rest being inserted manually. To get an idea of the speed of these machines, suffice it to point out that they can insert anything from 4,500 to 16,000 components per hour, with a very short down-time (some 5 minutes) due to change over of PCB specifications.

Alongside the rapid miniaturisation of components (i.e. more functions packed into the same area of 'chip'), another interesting development has been the substitution of surface mounted or leadless devices for axial lead components.*

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* Leadless components were developed by the Japaneses and have been in widespread use in the US for the last 2 years.

Thus the components are now placed on the surface of the PCB secured by an adhesive flux and then soldered. This process can only be done by machine and may be one of the rare case in electronics assembly where the nature of the product dictates the use of automation as opposed to manual assembly. To our knowledge the assembly of these leadless components is not yet carried out in Brazil, except by Philco in São Paulo.

Despite the cost of automating component insertion and the required scale of production to justify it, another factor inhibiting automation in this area seems, at least in the opinion of one supplier of such machinery, to be the high labour displacement effect. Whether this is the case or not, it may be that a rise in wage costs will prompt a greater diffusion of automated assembly. This is particularly so bearing in mind the concommitant quality and productivity gains. An alternative to the high speed/high volume automated insertion machinery in the use of robots for insertion. IBM's pilot robot project at Sumaré is a case in point. While a robot lacks the speed of the former machines, it has similar standards of production quality and the added advantage of greater flexibility.

The use of computer aided design (CAD), while not directly linked to production as such - or as yet, since CAD/CAM is the logical outcome of such technological developments - will play an important role in the computer industry. The extent of diffusion in Brazil is not known although multinational firms currently use such equipment. While dispensing of the work of skilled drafting employees, CAD also demands the creation of new skills to operate the system. The concern in Brazil at present is to be able to supply such people in sufficient numbers.

Employment and Output

We have seen that total revenues of the computer industry in 1983 was US$1,487 million, employing a total of 25,744 people. To make any sense of these figures it is necessary to disaggregate them.

The little information on employment available to date concerns the national sector of the industry (i.e. 15,734 functionaries). In 1983, the 5 largest national companies employed 38.9% of the total, while the 10 largest companies accounted for 58.1%. (Cobra, Elebra, Itautec, Prológica, Scopus, SID, Splice, Microlab, Dismac, Edisa, in order of employment levels) (SEI, 1984; 50). The average employment for national firms in 1983 was 291 (with a wide range from 7 to 2,300 people). The rapid rise from a level of 4,028 functionaries in 1979 to 1983 levels illustrates the expansion of the industry.

The following 2 tables, despite their short time span, give an idea of the evolution of employment by level of education and by type of activity.

Table V

Absolute (and percentage) Distribution of employees by level of education*

	1979		1980		1981		1982		1983		1984**	
Primary	484	(12)	871	(12)	1160	(14)	2517	(20)	3336	(21.2)	4086	(20.3
Secondary	2018	(50)	3632	(50)	4224	(51)	6040	(48)	7883	(50.1)	9964	(49.5
Graduates	1534	(38)	2760	(38)	2899	(35)	4026	(32)	4516	(28.7)	6080	(30.2
Total	4036	(100)	7264	(100)	8283	(100)	12584	(100)	15734	(100)	20130	(100)

Source: SEI, 1984; 51

* Figures rounded - ** Estimated

The most apparent trend of this percentages is that the share of graduates is decreasing in direct relation to the increase of the share of employees with primary education. The expansion of production in the last five years, demanding more production workers would be the immediate cause. This can be seen from the relative increase of absolute figures for primary and graduate employees (1982/3 = 32% & 12% respectively)

Table VI

Employment by activity and educational level - 1983

Employees 1983 (%)		Activity	Education					
			Primary		Secondary		Graduates	
1,998	(12.7%)	Sales & Marketing	44	(2.2%)	1,015	(50.8%)	939	(47 %)
3,304	(21%)	Admin.	317	(9.6%)	2,025	(61.3%)	962	(29.1%)
6,231	(39.6%)	Production	2,810	(45.1%)	2,723	(43.7%)	698	(11.2%)
1,841	(11.7%)	Technical assistance	101	(5.5%)	1,165	(63.3%)	574	(31.2%)
2,045	(13%)	Product Development	37	(1.8%)	830	(40.6%)	1,178	(57.6%)
315	(2.0%)	Human Resources	25	(7.9%)	130	(41.1%)	160	(51%)

Source: SEI, 1984.

The second table shows that the largest segment of the firms' employment is in production (39.6%)*. If we disregard administration, then the next largest segment is product Development. In terms of the present research, these are the two most important areas of activity (note that technical assistance is taken to be post-sales). Production activities are obviously crucial since, any change in process technology will be felt most directly here. From the above data, we see that the share of graduates in production

* This share has been increasing. In 1980, production accounted for 31.7% of the total workforce, 1981 35.1%, 1982 37.2%.

is relatively low (11.2%), while there is an approximately equal share between people of primary and secondary education. Without more details on skill categories, salaries and so on, we can assume for the moment that those of primary schooling will be involved in unskilled (and possibly semi-skilled) assembly work and other activities such as packing, loading, etc., while those of secondary schooling will undertake assembly work, as well as being technicians, maintainance staff and so on. The large increase in production staff is also indicative that the national firms have yet to reach full production capacity (see table V below), thus the absorbtion of labour should not be mistaken as a linear process of expansion. Far this we need to have time series data on productive labour absorbtion to measure its growth and compare this to the growth of output (more precisely the value added) of the industry. This measure of labour productivity will have to be treated with caution since a part of any expected increase will undoubtedly be due to the increased scale of production and to the process of learning in what still is an 'infant industry'.

In the area of Product Development, we can see that the majority of personnel are graduates (57.6%) and the rest are nearly all of secondary education (40.6%). The former represent 8% of the total of people engaged in the industry. It will be important to distinguish the skill requirements in this area and the extent to which they are satisfied since the extent to which new products can be developed (and the 'learning' process which accompanies this) will determine the competitiveness of firms. In this sense, the two key areas of competitiveness can be identified as being in product innovation and product quality (i.e. the quality of production). Both these aspects have the twin attributes of being dependent, to a greater or lesser degree, on a) the type and quality of labour inputs, and b) technological inputs.

Data on Multinational firms are fragmentary. When we refer to these firms, it is with a certain degree of caution since information has to be pieced together from a variety of sources. The firms in the mainframe business are: IBM (the undisputed leader, with up to 80% of the national mainframe market), Burroughs, Hewlett-Packard, Bull, and Honeywell (the latter two being, joint ventures with ABC and Telematic respectively).

These firms today employ an estimated 8 thousand people, which amounts to a 20% decrease since 1983, when the level was 10,010 people. If the former figure is to be believed then the decline in employment (and output) which started in 1981 has become more than a temporary reorganisation of multinational strategies in Brazil. We know that gross sales have also declined, however, at this stage it is not possible to say if this is the only reason for decreasing employment.

In terms of the output of the industry, the picture is complicated by the different measures used. SEI, for example, uses gross receipts as a measure of output, equating this with total sales. While this gives a global picture of the relative weight of individual firms within the industry, it only gives an approximation of the actual value of production and, much less, of the value added in the industry. An additional problem to the use of total receipts as a measure of production is the actual market structure of the computer industry. Thus, out of total commercialisation of computers and peripherals (in the national sector) in 1983, only 41.6% of transactions were in direct sales: other transactions included indirect sales, leasing, rental, and OEM (inter-firm). In fact, the share of direct sales has been decreasing since 1980 (from 47.5% to 41.6%), while leasing arrangements have increased from 5.0% (1980) to 27.0% (1983). Thus, in addition to including services, the figures for total receitps also run the risk of double counting- such as in the case of the lease of a system and then its subsequent sale to another customer in the same year.

Another way of calculating output is to take the number of units produced by the firms and multiply by the price of these goods to consumers. This measure seems to give a more satisfactory measure since to some extent it avoids the above problems although it cannot be treated as a measure of value added.

Table VII gives an aggregate picture of output in recent years as well as an estimate of imports by the two productive segments. Remembering that national and multinational markets are quite different in Brazil, there are some clear trends. IBM and Burroughs' production (for the domestic market and for export) has been declining since 1980. The causes for this (and their declining imports) is put down by the firms themselves to the reserve market policy. This may be only half the story, however. Certainly imports have become bureaucratically harder to obtain for these firms, but, since they produce mainframe computers outside the reserve market domain, it would seem reasonable to argue that foreign companies have other reasons for decreasing production. The mainframe market, while not stagnant, is limited by the massive cost of such equipment to consumers and it is becoming apparent worldwide that most lucrative makets are now with smaller computer systems (particularly micros). That foreign firms are denied this market, despite producing the equipment elsewhere (viz. the IBM-PC) may, without wishing to be conspiratorial, be reason enough to encourage the partial relocation of production activities.

National firms, while not yet aiming at export markets in any significant way,* have increased their domestic market production by 183.5% in the period 1980-83. At the same time, and predictably, imports have also increased. Judging from table VIII, 1983 marks a significant point in the development of the industry since it is the time when near full capacity was reached in many of the equipment segments. Whether this capacity has since increased, and whether production has kept pace with it is not yet known. But this will be a consideration in relation to the levels of employment that now exist in the industry.

For the data that we have, there seems to be little correlation between the growth of production and the growth of employment, at least in the national segment for which we have basic information on productive employment. In fact, if

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* Projections for 1984, however, are in the region of US$18.4 million (or 3.0% of total sales) according to SEI (1984: 41).

Table VII

Production Value (US$millions) in the Brazilian Computer Industry

1) For Domestic Market

	1980	1981	1982	1983
National	255	264	456	468
Multinational*	41.8	74	134.6	92.1
Total	296.8	338	590.6	560.1

2) For Export

National	-	1.2	1.0	1.8
Multinational*	211.7	247.8	210.7	157.3
Total	211.7	249	211.7	159.1
3) Total Value	508.5	587	802.3	719.2

Imports by major computer firms (US$millions)

National	-	42.6	44.9	46.2
Multinational*	-	261.9	209.6	154.8
Total	-	304.5	254.5	201

Source: Wajnberg, (1984; 63)

* IBM and Burroughs

Table VIII

Evolution of Production in the Data Processing Indu

Equipment	No. of manufac- turers	Production capacity 1982
Minicomputers	6	1,530
Professional Micros	18	6,000
Personal Micros	18	45,500
Word Processors	2	1,000
Serial Printers	4	23,000
Line Printers	2	3,000
Magnetic Disks	6	11,600
Floppy Disks	5	52,000
Magnetic Tapes	3	1,070
Video Terminals	8	11,670
Data Entry Terminals	1	1,800
Financial Terminals	7	35,100

Source: Wajnberg (1984;64)

* Includes diverse types of terminals

Table VIII

Evolution of Production in the Data Processing Industry - product units - National firms

Equipment	No. of manufacturers	Production capacity 1982	Actual Production of Units 1979	1980	1981	1982	1983	1984 (1st. 6 months)
Minicomputers	6	1,530	750	800	791	973	801	335
Professional Micros	18	6,000	2	75	186	2,555	5,583	3,866
Personal Micros	18	45,500	16	539	1,330	18,294	45,549	23,340
Word Processors	2	1,000	--	--	--	--	569	248
Serial Printers	4	23,000	96	1,588	2,148	8,512	16,228	11,051
Line Printers	2	3,000	32	1,133	970	1,128	1,288	1,455
Magnetic Disks	6	11,600	220	694	1,120	2,036	2,397	851
Floppy Disks	5	52,000	218	2,339	4,244	15,468	14,813	12,866
Magnetic Tapes	3	1,070	318	618	903	685	744	286
Video Terminals	8	11,670	2,566	4,998	4,121	6,822	11,173	9,319
Data Entry Terminals	1	1,800	1,636	1,421	1,187	462	7,916*	2,546
Financial Terminals	7	35,100	--	--	1,356	11,061	25,176	6,220

Source: Wajnberg (1984;64)

* Includes diverse types of terminals

anything, the value of production per production worker seems to be on a downward trend.

Table IX

Production value per production employee in the national segment of the computer industry - (US$000's)

	1980	1981	1982	1983
Production Value (A)	255,000	263,200	457,000	469,8000
Production employees (B)	2303	2907	4681	6231
Output/employee A/B	110.7	91.2	97.6	74.4
Index (1980=100)	100	82	88	68

Source: Table VII and Table VI

As can be seen from the above table, production value per employee has not again reached the level of 1980 which could indicate that the productivity of the sector is falling. This, however, is a generalisation made on shaky foundations. First because of the very short time span, but principally because there is no certainty that the data are compatible, taken as they are from separate sources. Also, the large increases in employment in the period are more a result of increasing capacity utilization and, without further verification, the values for production calculated may be more due to the vaguaries of dollar exchange rates. Nevertheless, it is interesting to note that there does not yet seem to be a set pattern of output and employment in what is still a period of 'learning' for the computer industry.

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