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ABSTRACT

In the first part of the paper, we use translog indexes to measure the rate of total factor productivity growth (TFPG) in 80 different sectors of the Brazilian manufacturing industry in the 1970-80 period. In the second part, we conduct both correlation and regression analyses to identify variables associated with differences across sectors in the rate of productivity growth.

TFPG averaged 2.6% p.a. in the seventies and accounted for one-fifth of output growth. Sectors that experienced rapid TFPG were the ones that expanded the share of exports in output, relied more heavily on imported machinery and material inputs, had a more skilled labor force, reduced their capital-output ratios, invested more, had production concentrated in few and young firms, and experienced fast growth of average establishment size.

All in all, the results suggest that TFPG is determined mainly by economic structure. Export orientation, although having a positive and significant influence, does not seem to be the engine of growth that many have postulated. TFPG seems to be mainly associated with industrialization, and the key factors appear to be the capacity to exploit economies of scale, the reliance on industrially concentrated sectors, the ability to have a large proportion of skilled workers in the labor force, and the capacity to keep the stock of capital technologically updated and on a rapidly expanding path.

MEASURING AND EXPLAINING TOTAL FACTOR PRODUCTIVITY GROWTH: BRAZILIAN MANUFACTURING IN THE SEVENTIES[1]

Armando Castelar Pinheiro

1) Introduction

The output of an economic entity depends on the amount of each of the factors used in production and on the productivity of these factors, that is, on the technology used to transform inputs into outputs and on the efficiency with which this technology is used. Changes in output result either from variations in the amounts used of each factor or from changes in total factor productivity (TFP).

Theoretical developments on the study of TFP have a long history, as economists have long been interested on the subject of economic growth. As Nelson(1981) puts it:

> While the conceptual apparatus used today is relatively new, the interest of economists in productivity growth is venerable. Chapter I of the Wealth of Nations is mostly about technological advance and productivity growth, as it is called today. John Stuart Mill, like Karl Marx, was a growth theorist. Alfred Marshall was much interested in long-run economic change.

Since the 1950's, significant improvements have been made in the empirical measurement of productivity growth -- the substitution of TFP for labor productivity as the key variable reflecting technical advance, for instance, dates from this period.[2] Early studies include Mills (1952), Schmookler (1952), Fabricant (1954,1959), Abramovitz (1956), Kendrick (1956,1961) and Solow (1957), just to mention some of the most important.

Most of the work on TFP growth has focused on industrialized economies.[3] It is now common, however, to find similar studies for developing countries. Bruton (1967), Correa (1970), and Elias (1978) measured TFP growth rates for some Latin American countries. Ezaki (1975) obtained estimates for the Philippines; Chen (1979) estimated and compared TFP growth in Hong Kong, Korea, Singapore and Taiwan; Christensen and Cummings (1981) measured TFP growth in Korea; Tsao (1985) obtained similar values for Singapore, while Ikemoto (1986) estimated TFP expansion for nine different developing countries in Asia.

In Table 1, we list some of the results obtained in the literature for both developed and developing countries -- it is clear that TFP growth rates vary considerably across countries and in time. But the values in Table 1 reveal four other facts. First, as suggested by Nadiri (1972), the "contribution of factor productivity is small in developing countries as compared to its critical importance in industrialized countries." Second, TFP growth rates in Asian countries in the sixties and seventies were not very different from the respective figures for Latin American countries in the 1940's and 1950's. The differences are even smaller when one compares the share of TFP in GDP growth. Third, among these two groups of countries substantial variation is observed in the growth of productivity.

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1 - This paper is a summary of Chapter 3 of my Ph.D. dissertation and has benefited from the comments made by Albert Fishlow, Bronwyn Hall, and Sherman Robinson, and from computational support by Marcia Pimentel Pinto.

2 - Indeed, Christensen, Cummings and Jorgenson (1980) credit the concept of total factor productivity growth to "a notable but neglected article by Tinbergen (1942)."

3 - Many interesting reviews have been conducted on productivity growth in industrialized countries. See, for instance, Abramovitz (1952), Solow (1970), Nadiri (1970), Bonelli (1975) and Nelson (1981).

Fourth, countries with higher growth rates also expanded TFP at a faster pace (see also Graph 1).[4] This positive association between TFP and output growth is known as Verdoorn's law.[5] Kaldor (1967) associates this relation to the effects of economies of scale, while Bruton (1967) saw its cause in expanding capacity utilization. Although Verdoon's law is usually discussed in the long run context, a similar behavior was identified for more short run measures. Jorgenson and Griliches (1967, p 272) illustrate how results can vary depending on the point of the business cycle one starts to measure. A comparable result is obtained by Kendrick and Grossman (1980) using quarterly measures of TFP growth.[6]

Most of the results in Table 1 were obtained using aggregate measures, basically at national account levels. In the last twenty years, however, a growing literature has been concerned with estimates of TFP growth at the sector level. Kendrick (1973), Gollop and Jorgenson (1980) and Kurosawa (1984) are representative examples for developed countries. Krueger and Tuncer (1980) for Turkey, Rhee(1980) for Korea,[7] Goldar (1981) and Ahluwalia (1985) for India, Nishimizu and Page (1982) for Yugoslavia, Tsao (1985) for Singapore, Wiboonchutikula (1982) for Thailand, Kuo (1983) for Taiwan, Nishimizu and all. (1985) for Hungary, Page and all. (1986) for Mexico, and Delfino (1988) for Argentina are some of an increasing number of authors who have measured sectoral rates of TFP growth in developing countries.

So far, three studies have tried to gauge the values of TFP growth at the sector level in Brazil. Bonelli (1975) analyzed the 1959-70 period, measuring TFP growth for a 21-sector disaggregation of the manufacturing industry. Braga and Rossi (1988) worked with a two-digit disaggregation, measuring TFP growth in the 1970-83 period with a translog cost function, with further decompositions to take into account the effects of economies of scale and changes in capacity utilization. Finally, Braga and Hickman (1988) evaluated the importance of TFP growth in reducing domestic resource cost (DRC) in the 1970-83 period.[8]

The first objective of this paper is to add to this literature by estimating the rates of TFP growth in the Brazilian manufacturing industry in the 1970-80 period. Our study complements those of Bonelli (1975), Braga and Rossi (1988) and Braga and Hickman (1988) in three important directions: first, by using a three-digit sectoral disaggregation, and thus working with more homogeneous sectors; second, by using census data and an index number for a translog production function that includes material inputs and energy as factors of production; third, by focusing on the 1970-80 period. It is important to note, also, that most of the information used in this paper has never been derived for the Brazilian manufacturing industry. This, by itself, stands as a contribution to the analysis of economic growth in Brazil.

Thus, in the first part of this paper, we estimate the rate of growth of TFP in the Brazilian manufacturing industry from 1970 to 1980 using a three-digit sectoral disaggregation. In section 2 we derive the theoretical model underlying our analysis, and in section 3 we describe the aggregation procedures undertaken to obtain quantity indexes for the output and each of the inputs. Finally, in section 4, we report our estimates for the rates of TFP growth.

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4 - A, C, D, E and L stand, respectively, for Asian, Centrally planned, Developed, European (including Israel and Turkey), and Latin American countries.

5 - Although advanced by Verdoorn (1949), the association between output and productivity growth was explored mainly by Kaldor. See Kaldor (1967) for further discussion of Verdoorn's law, McCombie (1983) and Thirlwall (1983) for a review of Kaldor's growth laws, and Milch (1985) for an analysis of Verdoorn's law as an explanation of the recent productivity slowdown. Note also that Verdoorn's law was originally stated in terms of labor productivity. It is in this way that it was analyzed by Kaldor.

6 - See especially Table 5.1.

7 - Mentioned in Nishimizu and Robinson(1984).

8 - A similar study with changes in DRC was conducted by Nishimizu and Page (1986) for Thailand.

TABLE 1

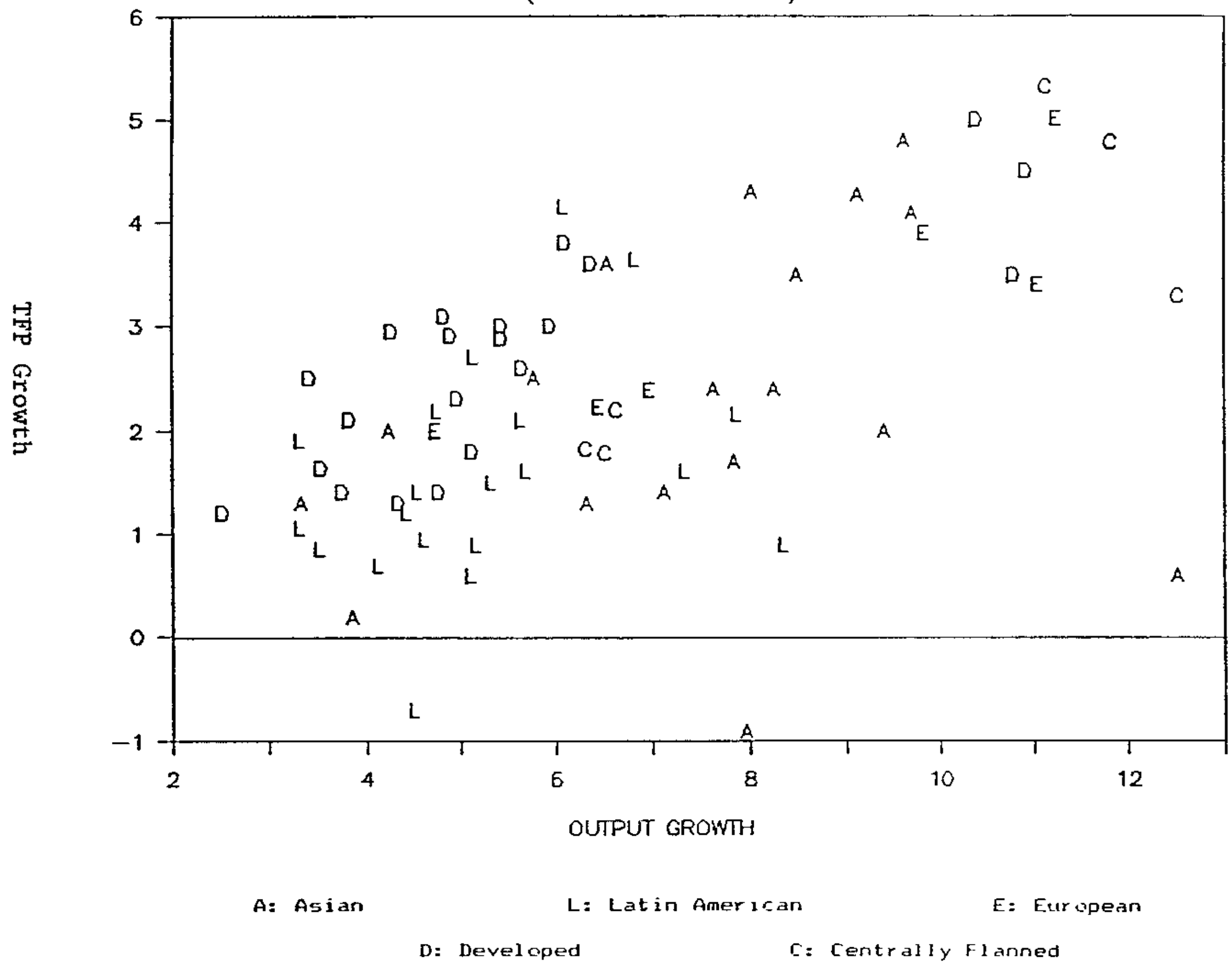
GROWTH RATES OF TFP AND SHARES IN GDP GROWTH FOR SELECTED COUNTRIES
(In percent p.a.)

COUNTRY	PERIOD	GROWTH RATE	% OF GDP GROWTH	COUNTRY	PERIOD	GROWTH RATE	% OF GDP GROWTH
Belgium	1949-59	2.95	69.5	Peru	1940-50	0.90	17.5
Canada	1947-60	3.50	32.5		1950-60	-0.70	-15.6
	1960-73	1.80	35.3		1960-70	1.50	28.3
Denmark	1950-62	1.64	46.7	Venezuela	1950-60	2.15	27.4
France	1950-60	2.90	59.5		1960-74	0.60	11.8
	1960-73	3.00	50.8				
Germany	1950-60	3.60	56.8	Hong-Kong	1955-60	2.40	29.1
	1960-73	3.00	55.6		1960-70	4.28	47.0
Italy	1952-60	3.80	62.7		1970-80	2.00	21.3
	1960-73	3.10	64.6	India	1950-80	1.30	39.1
Japan	1953-65	5.00	48.2		1970-80	0.20	5.2
	1960-73	4.50	41.3	Indonesia	1970-80	2.40	31.5
	1970-80	1.40	29.5	Korea	1955-60	2.00	47.4
Netherl.	1951-60	2.30	46.5		1960-73	4.10	42.3
	1960-73	2.60	46.4		1970-80	3.50	41.2
Norway	1953-65	2.88	53.3	Malaysia	1970-80	1.70	21.7
Sweden	1949-59	2.50	73.5	Philip.	1947-65	2.50	43.5
United	1949-59	1.20	48.0		1970-80	1.30	20.6
Kingdom	1960-73	2.10	55.3	Singapore	1957-70	3.60	55.2
United	1947-60	1.40	37.5		1966-72	0.60	4.8
States	1960-73	1.30	30.2		1972-80	-0.90	-11.3
				Taiwan	1955-70	4.30	53.6
Argentina	1940-50	2.70	52.9		1970-80	4.80	50.0
	1950-60	1.05	31.8	Thailand	1970-80	1.40	19.7
	1960-74	0.70	17.1				
Brazil	1950-60	3.65	53.7	Israel	1952-58	3.90	39.8
	1960-74	1.60	21.9		1950-65	3.40	30.9
Chile	1940-50	1.90	57.6	Ireland	1953-65	2.00	42.6
	1950-60	0.85	24.3	Greece	1951-65	2.39	34.5
	1960-74	1.20	27.3	Spain	1959-65	5.02	44.8
Colombia	1940-50	0.90	10.8	Turkey	1963-75	2.23	34.8
	1950-60	0.95	20.7				
	1960-74	2.10	37.5	Bulgaria	1953-65	3.30	26.4
Ecuador	1950-62	2.18	46.2	Hungary	1953-65	1.78	27.4
Honduras	1950-62	1.40	31.0	Poland	1961-65	2.20	33.3
Mexico	1940-50	4.15	68.6	Romania	1953-65	5.32	47.9
	1950-60	1.60	28.3	U.S.S.R.	1950-62	1.82	28.9
	1960-74	2.10	37.5	Yugoslavia	1953-63	4.78	40.5

Sources: Elias(1978) for Argentina, Brazil, Chile, Colombia,Mexico and Peru. Ikemoto(1986) and sources therein for India, Singapore, Taiwan and all Asian countries in the 1970-80 period. Chenery(1986) and sources therein for the remaining figures.

TFP x OUTPUT GROWTH RATES

(IN PERCENT PER YEAR)



Graph 1

Most of the early studies in TFP growth (TFPG) revealed very impressive results. Abramovitz (1956) estimated productivity growth to account for as much as 90% of the growth in per capita net national product (NNP) in the U.S. from 1869 to 1953. Solow (1957) found TFP to be responsible for 7/8 of the growth of real GNP per man hour in the 1909-49 period. Kendrick's (1961) results revealed that, in the U.S., TFP growth rates were equal to 1.8% p.a and 2.0% p.a for real NNP and the manufacturing industry product, respectively, in the 1899-1953 period. In both cases growth of real factor input was responsible for only half of the growth of output. Kuznets (1966) reported equally impressive results.

TFPG is usually measured as a residual term in the sources of growth model. Yet, as has repeatedly been pointed out in the literature (Abramovitz (1956), Bonelli (1975), Nelson (1981)), this residual term encompasses a lot of effects that could hardly be called a "technological advance" or "advance in knowledge." This is the case for economies of scale, higher capacity utilization, changes in the composition of the stock of capital and of the labor force, reallocation of resources, and so on. Once more Nelson (1981) puts it very precisely:

> Everybody knows that the residual accounts for a hodge-podge of factors, but these are difficult to sort out. If this 'measure of our ignorance' is not completely mysterious, it certainly is not well understood.

It is not surprising, then, that so much effort has been aimed at understanding what causes this residual to vary so much. A first group of studies, pioneered by Denison (1962a,b, 1967, 1974), has focused on squeezing down this measure of our ignorance, as Abramovitz (1956) put it. Input growth rates are redefined to incorporate changes in quality, gains accruing from variations in capital utilization and economies of scale are discounted, while output growth is measured taking into consideration changes in composition. Jorgenson and Griliches (1967), Gollop and Jorgenson (1980), Christensen, Cummings and Jorgenson (1980) and Jorgenson, Gollop and Fraumeni (1987) are some of the important studies along this line. Of late, an increasing number of authors have used cost functions that have capacity utilization as an argument (Caves, Christensen and Swanson (1981), Kwon (1986), Callan (1988) and Braga and Rossi (1988)).

A second group of studies, identified with the work of Kendrick (1973, 1981, and Grossman (1980)) and Terleckyj (1974,1980), tries to explain what causes the residual to vary by means of correlation and regression analyses. This second type of study, also common for developing countries, has been applied to Brazil (Bonelli (1975)), Thailand (Wiboonchutikula (1982)), Korea, Turkey, Yugoslavia and Japan (Nishimizu and Robinson (1984)), Mexico (Page et al.(1986), India (Goldar (1986)), and Argentina (Delfino (1988)), with reasonable success.

In the second part of this paper we inquire into the causes of the cross-sector variance of TFP growth rates in Brazilian manufacturing from 1970 to 1980. In particular, we will try to assess the importance of trade orientation and export performance. For that purpose, we use correlation and regression analyses, as in the second of the methodologies described above.

In section 5 we describe, estimate, and correlate with TFPG a set of explanatory variables. In section 6 we estimate regressions with TFP growth as a linear function of these explanatory variables. Finally, in section 7, we present a summary of the paper's main conclusions.

2) Methodology

Our first objective in this paper is to measure the rate of TFP growth, i.e., the part of real output growth that is not accounted for by changes in real factor input. We start our analysis by defining a production function F(.) that relates output to inputs and time:

$$\ln Y = F(\ln X_1, \ln X_2, \ln X_3, \ldots, \ln X_N, t), \qquad (1).$$

Using expression (1) we can define the growth rate of output at a point in time by:

$$\frac{d \ln Y}{d\, t} = \Sigma_n^N \frac{F\ln Y}{F\ln X_n} \frac{d \ln X_n}{d\, t} + \frac{F\ln Y}{Ft} \qquad (2).$$

The last term on the right-hand side of expression (2) measures the rate of TFPG. To estimate it, all we need to know is rate of growth of output and each of the inputs, and the elasticities of output with respect to each of the inputs. However, unless we know the production function F(.), we will be unable to derive the elasticities we need.

Thus, our first assumption in this section is that necessary conditions for producer equilibrium hold, which allow us to equate the elasticities of output with respect to each of the inputs to their respective shares in total costs. Denoting the price of output by p_Y and the price of input n by p_n, we then have

$$v_n = p_n X_n / p_Y Y = F\ln(Y) / F\ln(X_n), \qquad n = 1, N \qquad (3).$$

Substituting (3) in (2) yields

$$\frac{d \ln Y}{d\, t} = \Sigma_n^N v_n \frac{d \ln X_n}{d\, t} + v_t \qquad (4),$$

where,

$$v_t = \frac{FF(X_1, X_2, \ldots, X_N, t)}{Ft} = \frac{F\ln Y}{Ft} \qquad (5).$$

If there is no change in TFP ($v_t = 0$), (4) defines a Divisia quantity index. It seems reasonable, then, to call v_t the Divisia quantity index of technical change.[9]

Divisia index numbers are consistent in aggregation (i.e., a Divisia index of a Divisia index is a Divisia index),[10] they satisfy Fischer's factor reversal test,[11] and they are exact for any production function that is first order differentiable.[12] Unfortunately, however, Divisia index numbers cannot be used in our problem, since we will be working with changes in TFP between discrete points in time rather than with instantaneous rates of change. Thus, it is necessary to approximate the Divisia index by another index that can be used to measure the change in F(.) from t-1 to t.

When choosing that approximation two different factors must be evaluated. First, we have to choose an index number that is consistent with and, if possible, exact for what we believe is the technology represented by F(.). In this case, unless we have reason to believe that more restrictive specifications are

9 - The Divisia index of technical change was introduced by Solow (1957). See also Gollop and Jorgenson (1980) and Christensen, Cummings and Jorgenson (1980) for further references.

10 - An index number is said to be consistent in aggregation if the result obtained by using the index number iteratively in two or more stages is equal to that obtained when calculating the index in a single step (Vartia (1976)).

11 - An index number satisfies Fisher's factor reversal test if "the product of the price and quantity indexes equal the expenditure ratio for the two periods under consideration" (Diewert (1978)).

12 - The quantity index $Q(p^0, p^1; x^0, x^1)$ is defined to be exact for the positively linearly homogeneous, concave production or aggregator function f(x) if for every $p^0 \gg 0_N$, $p^1 \gg 0_N$, x^0 a solution to the production or aggregator maximization problem $\max_x \{ f(x): p^0.x \leq p^0.x^0,\ x \geq 0_N \}$, and x^1 a solution to the production or aggregator maximization problem $\max_x \{ f(x): p^1.x \leq p^1.x^1,\ x \geq 0N \}$ we have $Q(p0, p1; x0, x1) = f(x1)/f(x0)$ (Diewert (1978)).

reasonable, we should use a superlative index number.[13] Second, we have to keep in mind the nature of the problem for which the index number will be utilized. If, for instance, consistency in aggregation and/or satisfaction of Fisher's factor reversal test are important requirements, a pseudo-superlative index such as the Sato-Vartia, for example, can be a better solution than one of the commonly used superlative index numbers.

There are infinite superlative indexes, and a lengthy discussion of why choosing one over another is beyond the scope of this paper. Three remarks, however, will help understanding our choice. First, to a certain extent, it does not matter which of the superlative indexes we use since they give results that are not very different.[14] Second, from an economic approach, a choice among the indices should rely on some knowledge about the technology represented by F(.), especially of the elasticities of substitution among inputs, for which we had no prior information.[15] Finally, a quick review of the literature will show that the translog index is by far the most widely used index number in studies of TFP measurement.

In this paper we will assume that the production function has a translog specification; that is, that F(.) is defined by

$$\ln Y = a_0 + a'Z + \tfrac{1}{2} Z'A Z \qquad (6),$$

where $Z' = [\ \ln(X_1)\ \ln(X_2)\ \ln(X_3) \ldots\ldots \ln(X_n)\ T\ ]$, a_0 is a constant, $a = [\ a_1\ a_2 \ldots a_n]$ is a vector of parameters, and A is a symmetric matrix of parameters.

The exact index for the translog production function is the translog quantity index,[16] that can be derived from expression (4) by substituting first differences for infinitesimal changes in the values of the logarithms:

$$\ln Y(t) - \ln Y(t-1) = \Sigma_n^N \bar{v}_n\ [\ln X_n(t) - \ln X_n(t-1)] + v_t \qquad (7),$$

where,

$$\bar{v}_n = \tfrac{1}{2}\ [\ v_n(t) + v_n(t-1)\ ] \qquad (8).$$

If there is no technical change between t-1 and t (v_t=0), expression (7) defines a translog quantity index. We refer to v_t as the translog quantity index of technical change.[17]

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13 - An index number is superlative if it is exact for a flexible production function, which gives a local second-order approximation to a generic twice-differentiable function F(.) (Diewert (1976)). In that way, a superlative index is locally less biased, in the sense defined by Dreschler (1973).

14 - That follows from the fact that they are all second-order approximations. As discussed by Diewert (1981), however, the resemblance of the results depends on how much the vector X varies from t-1 to t. In that way, our decision to measure TFP growth using a production function rather than a cost function approach was also a consequence of the fact that from 1970 to 1980 variations in quantities were much smaller than in prices.

15 - The axiomatic approach would probably lead us to Fisher's ideal index number, which besides being superlative(Diewert (1976)), also satisfies the factor and time reversal tests. See Eichhorn and Voeller (1983) for a description of the axiomatic approach. See Hansen and Lucas (1984), especially Tables 1 and 2, for a comparison of index numbers using data for Egyptian external trade in the 1885-1961 period. See Fuss, McFadden and Mundlack (1978), Berndt and Khaled (1979) and Lau (1986) for a discussion on the choice among flexible functional forms.

16 - See Diewert (1981) for a proof. Translog indexes satisfy the time but not the factor reversal test.

17 - The translog index of technical change was introduced by Christensen and Jorgenson (1970). See Jorgenson and Lau (1977), Diewert (1977), Gollop and Jorgenson (1980), Christensen, Cummings and Jorgenson (1980), and Jorgenson (1986) for applications and further discussion.

In addition to assuming producer market equilibrium, we will also assume that the technology of production is characterized by constant returns to scale, such that total cost equals total revenue, or, phrased in another way, such that equal changes in all inputs result in a proportional change in output. Necessary and sufficient conditions for the translog function to be characterized by constant returns to scale are

$$a'1 = 1 \qquad \text{and } A.1 = 0 \qquad (9)$$

where 1 and 0 are vectors whose elements are, respectively, all ones and all zeros. [18]

Both output and inputs are, in our case, aggregates of many outputs and inputs; that is, there are aggregator functions G^Y and G^n (n = 1, N), such that

$$\ln Y = G^Y(\ln Y_1, \ln Y_2, \ln Y_3, \ldots, \ln Y_Q), \qquad (10),$$

$$\ln X_n = G^n(\ln X_n^1, \ln X_n^2, \ln X_n^3, \ldots, \ln X_n^{Mn}), \ n = 1,N \qquad (11).$$

As before, we define Divisia quantity indices of output and inputs, respectively, by:

$$\frac{d \ln Y}{d t} = \Sigma_i^Q \ w_i \cdot \frac{d \ln Y_i}{d t}, \qquad (12),$$

$$\frac{d \ln X_n}{d t} = \Sigma_j^{Mn} \ v_n^j \ \frac{d \ln X_{nj}}{d t}, \quad n = 1,N \qquad (3.13),$$

where,

$$w_{yi} = \frac{F\ln Y}{F\ln Y_i} = q_{yi} \cdot Y_i / q_y \cdot Y, \ i = 1, Q \qquad (3.14),$$

$$v_{nj} = \frac{F\ln X_n}{F\ln X_{nj}} = p_{nj} \ X_n^j / p_n \ X_n, \ j = 1, M_n \text{ and } n = 1, N \qquad (3.15),$$

and where $\{q_{yi}\}$ are the prices of individual outputs, $\{p_{nj}\}$ are the prices of the components of X_n, $\{w_{yi}\}$ are the shares of individual outputs in the value of output and $\{v_{nj}\}$ the shares of individual X_n^j inputs in the value of input X_n.

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18 - Caves, Christensen and Diewert (1982a) derived a translog index of technical change for the case of nonconstant returns to scale. Nelson and Waldman (1983) showed, however, that when the elasticity of scale is not known, it is not always the case that more precise results are achieved with this extended index. Here we limit ourselves to the case of constant returns to scale.

Note also that constant returns to scale imply that the TFP growth rate for the sector is equal to the rate of TFP growth for the average establishment. To see that, define TFP growth for the average establishment.

$TFPG_{AV} = \ln[(Y^t/T^t) / (Y^{t-1}/T^{t-1})] - \Sigma_n^N v_n . \ln[(X_n^t/T^t)/(X_n^{t-1}/T^{t-1})] =$

$= \ln[Y^t/Y^{t-1}] - \Sigma_n^N v_n \ln[X_n^t/X_n^{t-1}] + T^t/T^{t-1} - \Sigma_n^N v_n . [T^t/T^{t-1}] =$

$= \ln[Y^t/Y^{t-1}] - \Sigma_n^N v_n \ln[X_n^t/X_n^{t-1}] = TFPG,$

where T^t is equal to the number of establishments in t, and TFPG and $TFPG_{AV}$ are the rates of TFPG for the sector and the average establishment, respectively.

Once more we have to approximate the Divisia quantity indices by discrete approximations. Translog quantity indexes would be a natural alternative. However, although superlative, translog indexes present three problems. The first and least important for our analysis is that they do not satisfy Fischer's factor reversal test. The second, more relevant here, is that they are not consistent in aggregation. In other words, a translog index of a translog index is not a translog index. The third problem, very important in our case, is that the translog index cannot be obtained when some of the quantities are zero. This reflects the fact that expression (6) is not well-defined when one or more of the X_i's are equal to zero.[19] A solution to this problem is to assume that our aggregator functions are linear functions of the various inputs and outputs.[20]

Both Laspeyres and Paasche index numbers are exact for a *linear production function depending* on whether we use relative prices at the beginning or ending period, respectively.[21] The very significant diversification that took place during the seventies in the set of products manufactured in Brazil, with a consequent diversification of the inputs that were consumed, makes Paasche indexes more appropriate for our analysis.

To derive the Paasche approximation to the Divisia index of output, let us go back to expression (12)

$$\frac{d \ln Y}{d t} = \Sigma_i^Q w_i \frac{d \ln Y_i}{d t} \qquad (12).$$

Since we are working with data at discrete points of time, we have to substitute first differences for instantaneous rates of change. To get the Paasche quantity index we will use share values in the last year:

$$\frac{Y(t) - Y(t-1)}{Y(t)} = \Sigma_i^Q w_i(t) \frac{Y_i(t) - Y_i(t-1)}{Y_i(t)} \qquad (16).$$

We will be assuming here that G^Y and G^n are characterized by constant returns to scale, that is, equal changes in all outputs or inputs result in a proportional change in output or each of the inputs. Constant returns to scale implies that $\Sigma_i^Q w_i(T) = 1$ and expression (16) reduces to

$$\frac{Y(t-1)}{Y(t)} = \Sigma_i^Q w_i(t) \frac{Y_i(t-1)}{Y_i(t)} \qquad (17).$$

We can use expression (17) to derive the more common specification of Paasche quantity index for output:

$$\frac{Y(t)}{Y(t-1)} = \frac{\Sigma_i^Q q_{yi}(t) \; Y_i(t)}{\Sigma_i^Q q_{yi}(t) \; Y_i(t-1)} \qquad (18).$$

An analogous derivation can be used to obtain the Paasche quantity indexes for the inputs from expression (9).

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19 - This is because the translog function is defined only for the positive orthant.

20 - An alternative solution would be to limit the set of products used to estimate the indices to those goods that were produced or consumed in both t-1 and t. That, however, would have required a considerable amount of extra work, with no guarantee of obtaining a better estimate.

21 - See Diewert (1981) for a discussion on the properties of Paasche and Laspeyres index numbers and a proof that they are exact for linear aggregation functions.

The main disadvantage of Paasche indexes is that they are probably more biased than the superlative indexes. In particular, they will tend to overestimate the rate of growth of the output and the inputs being aggregated.[22] Of course, the net effect on TFP growth rates, although smaller than for both real output and real total input, is unknown. Nonetheless, this fact should be kept in mind when using the estimates presented in section 4.

3) Data Base

3.1 - Introduction

The data to be used in our analysis come from the Industrial Censuses of 1970 and 1980.[23] The unit of observation in the Census is the establishment, defined as " the part of the organization that is in charge of industrial activity and has installations and means to produce industrial goods."[24] However, not all observations available in the censuses were utilized in the analysis. To avoid working with too heterogeneous establishments, for which the hypothesis of a common technology would no longer make sense, we adopted a few criteria to select our working sample.

First, only establishments with more than five employees were considered. This is a relatively standard criterion used by IBGE to divide the universe of establishments in a same industrial sector and is based on the observation that very small establishments have technologies of production that differ in too many ways from those of large establishments.[25]

Besides that, we considered only establishments that were active for the entire year. This criterion becomes relevant because the stock of capital was measured by its value at the end of the year. Also in order to enhance homogeneity, we decided to divide the manufacturing industry according to a three-digit classification that resulted, initially, in 112 different sectors.[26]

Although sectors and products were generally defined in a uniform way in both censuses, this was not always the case. For the analysis to be meaningful, however, it is necessary not only that sectors have the same classification but also that they actually cover the same sort of establishments in both censuses. In the same way, the Paasche quantity indexes used to aggregate output and each of the inputs lose significance if products do not have a homogeneous definition in different censuses.

In this way, an extensive and detailed work was undertaken to redefine products and sectors. Some subsectors and products were transferred and/or aggregated to guarantee that the same classification was adopted in both censuses. The standardization of sector and product classification, although in many cases of negligible importance, was crucial to avoid misleading results.

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22 - As we do not know the functions G^Y and G^n, the exact absolute or relative bias is not measurable. Samuelson and Swamy (1974), however, proved that if these functions are homothetic, then the Paasche index will provide an upper bound to the growth of Y and the X_i's. See Hansen and Lucas (1984) for an empirical illustration.

23 - Although a new census was conducted in 1985, no results are as yet available. The 1975 Industrial Census will be used to derive chained indexes of output, consumption of material inputs and energy. Unless otherwise stated, all the data used in this paper was obtained from the Industrial Censuses.

24 - IBGE (1980a).

25 - There is no technical reason, however, for severing the sample at five and not, for instance, at ten employees.

26 - Besides enhancing homogeneity, the three-digit disaggregation will also increase the number of degrees of freedom in the statistical analysis of sections 5 and 6. On the other hand, it forced us to estimate our own indices of output and input growth, and potentially increased the importance of measurement errors that tend to partially cancel out for more aggregate estimates.

Two additional problems forced us to drop some of the remaining sectors. First, in some sectors production and/or consumption of intermediate inputs were, to a large extent, limited to services or products for which there was no information on quantities, preventing the estimation of growth rates for output and/or material inputs. A second problem arose when the implicit price indexes, derived through the division of the expenditures ratios by the quantum index, resulted in values either above or below what we considered to be a reasonable and sensible interval of sectoral inflation.[27] In both cases, whenever available, the respective price index of Fundacao Getulio Vargas was used to derive the output quantum index.

After reclassifying, aggregating and dropping the sectors that presented problems, the number of sectors to be used in our analysis fell to 80. Those sectors, with the code numbers by which they will be referred to in the rest of this paper, are listed in Table A.1. All in all, the establishments to be considered in our analysis were responsible, in 1970, for 91.2% of the output and 90.0% of the employment in the manufacturing industry (excluding miscellaneous products). For 1980 those figures were 93.9% and 89.2%, respectively.

We work with four different inputs: capital, labor, material inputs and energy inputs. Moreover, output and inputs are themselves aggregates. The following subsections describe the aggregation procedures adopted.

3.2 - Output and Value Added

Growth rates of sector aggregate output were defined using a Paasche quantity index defined by

$$\frac{QO^{k,t}}{QO^{k,t-1}} = \frac{\Sigma_i^M \, p_i^t \; x_i^{k,t}}{\Sigma_i^M \, p_i^t \; x_i^{k,t-1}} \qquad (19),$$

where,

p_i^t = average price of product i at year t;[28]

$x_i^{k,t}$ = total output of product i in sector k at year t.

As mentioned before, indexes for the 1970-80 period were obtained by measuring output growth from 1970 to 1975 and from then to 1980, using (19), and after that chaining the results. This procedure was followed in order to minimize the problems with product homogeneity and sector reclassification.[29]

Three items of output required a different treatment: products for which only the value of output was available, industrial services supplied by the establishment (for which we also had data only for the value of output) and products that were produced in t-1 but not in t. For those products "real" quantities

27 - The "definition" of this sensible interval was done with base on price indexes published by Fundacao Getulio Vargas's Conjuntura Economica.

28 - Product classification (i) was defined according to IBGE (1980b) classification. Note that industry-wide rather than sector averages were used, since although establishments are classified for their main product, they also manufacture products classified in other sectors. Overall averages are, therefore, more significant. Prices are factory prices and do not include value added taxes (IPI or ICM), nor trade or transportation margins.

29 - By chaining the index we minimize differences in economic structure, consequently reducing the potential bias and enhancing the coverage completeness of our index. See Drechsler (1973), Szulc (1983) and Hill (1988) for a discussion of advantages and disadvantages of using chained rather than direct indexes.

were defined by price-correcting nominal values. The price deflator associated with the Paasche quantity index defined by (19) was utilized for this purpose. For some sectors for which the above procedure did not yield sensible results, we estimated the growth of output by deflating nominal values with price indexes published by Fundacao Getulio Vargas (FGV).

Value added (VA) was defined as the value of output less expenses with material inputs and energy. Growth rates of value added were obtained using the implicit price index estimated for output (or, when it was the case, the respective price index of FGV).

Growth rates of output and value added for each sector are reported in Table A.2. On average,[30] output and value added grew, respectively, 13% p.a. and 10.0% p.a. in the 1970-80 period, with standard deviations equal to 4.0% and 4.9% in each case (Table 2). It seems interesting to note not only the lower rates of growth of value added but also their higher variance. These characteristics will be reflected directly in the estimates of total factor productivity growth to be obtained in section 4.

3.3 - Capital Stock

The measurement of the stock of capital and/or of its rate of growth has often been the most critical part of the estimation of TFP growth. Two different problems are usually found. First, although it is the volume of capital services that should enter in the production function, it is often the case that we have data only for the stock of capital. Usually two aspects of this problem are addressed in the literature.

The first has to do with changes in the composition of the stock of capital, as the ratio of service to stock varies considerably for different capital goods. Two methods have been used to deal with this problem. The first is to use intuitive, although ad hoc, measures of capital services, such as that proposed by Meller (1976).[31] The second is to use index numbers with variable weights, especially the translog index, to aggregate the different components of the stock of capital.[32] In both cases, an underlying assumption is that the flow of services for a specific capital good is proportional to its stock.

Here, as for the larger part of the studies for developing countries, we assume that the flow of capital services is proportional to the stock of capital. However, we try to evaluate the impact of composition changes by also using the stock of machinery and equipment as an alternative measure.

A second important aspect of the problem is whether or not to consider changes in capital utilization. Although there is a near consensus that the correction is desirable, some authors seem to doubt it can actually be done, while others disagree about how it should be conducted. We will not go into this polemic here, but instead point to three reasons why we will not correct our capital input indexes for variations in utilization rates.[33] First, it is not clear which measure we should use to make such a correction; if the ratio of actual to potential consumption of electricity; or the ratio of current to potential capital utilization, as reported in polls with businessmen conducted by FGV's Sondagem

30 - Unless otherwise stated, all averages and standard deviations reported in this paper were obtained by weighting sector values with their corresponding shares of output. Value-added shares have been used to weight value-added growth and rates of change of value-added total factor productivity.

31 - Meller (1976) has estimated the flow of capital services to be equal to $0.2K_m + 0.13K_b + 0.3K_v + 0.1K_i$, where K_m, K_b, K_v and K_i are the book values of the stock of, respectively, machinery and equipment, structures, transport equipment and inventories. See Braga and Rossi (1986) for an application of this measure.

32 - See Gollop and Jorgenson (1980), Christensen, Cummings and Jorgenson (1980), Christensen and Cummings (1981) and Jorgenson, Gollop and Fraumeni (1987) for applications and further discussion of this procedure.

33 - See Jorgenson and Griliches (1967), Denison (1969), Jorgenson and Griliches (1972a,b), Bonelli (1975) and Norsworthy (1984) for further details on this subject.

Conjuntural. While the former points to a substantial increase in utilization rates from 1970 to 1980, the latter shows a slight decline. Second, if we were to use the first measure, which is actually available at a three digit disaggregation, we would be, as pointed out by Denison (1969), double counting the increase in the consumption of electricity. Finally, our measures of capacity utilization are by far more contaminated with measurement errors than our capital stock variables. The gains from adopting such correction would certainly not be worth the loss in precision. Nonetheless, we also measure the growth of TFP using the consumption of electricity as a proxy for the flow of capital services.

TABLE 2

AVERAGE GROWTH RATES OF OUTPUT, VALUE ADDED AND THE INPUTS IN THE 1970-80 PERIOD

	GROWTH RATE	ELASTICITY W.R.T.		CORRELATION	
		OUTPUT	VALUE ADDED	OUTPUT	VALUE ADDED
Output	13.0 (4.0)				
Value Added	10.0 (4.9)				
Machinery & Equipment	9.3 (5.1)	0.706 (0.034)	0.803 (0.042)	0.565	0.464
Capital Stock	7.5 (4.5)	0.588 (0.030)	0.673 (0.035)	0.634	0.605
Electric Energy	13.2 (6.3)	0.944 (0.040)	1.076 (0.049)	0.520	0.399
All Labor (RL)	6.1 (3.9)	0.461 (0.023)	0.537 (0.026)	0.659	0.703
Paasche Index for All Labor (LP)	5.5 (3.8)	0.514 (0.023)	0.596 (0.026)	0.684	0.713
Labor in Production (RLPROD)	6.3 (3.8)	0.488 (0.024)	0.568 (0.026)	0.673	0.714
Paasche Index for Labor in Production (PIL)	6.7 (3.8)	0.514 (0.023)	0.596 (0.026)	0.684	0.714
Material Inputs	12.5 (4.5)	0.960 (0.027)		0.805	
Energy	6.7 (3.4)	0.513 (0.025)		0.638	

Note: Standard deviations are reported in parentheses.
Source: Table A.2.

A second problem with the measurement of the stock of capital has to do with the question of whether or not the figures available actually reflect its real value. It is probable that in an economy with relatively high inflation rates a significant bias might arise on the reported values of capital, although the figures used here are net of depreciation and corrected to take account of inflation. Two factors tend to diminish the importance of this inflationary bias in the period under analysis. First, inflation in the 1967-79 period was kept under "control" at a relatively low level, at least when compared to contemporary figures. Second, this was a period of very fast growth and high investment rates, i.e., the stock of capital was being renewed at a very fast pace.

In the Brazilian industrial censuses, data for the stock of capital come disaggregated in four components, namely, structures and site; furniture and utensils; transport equipment; and machinery, equipment and installations. We try to deal with the problem of capital measurement by working with three different measures.[34]

Our first measure of the capital stock (CS) includes all these components and is defined by summing up their values after specific price corrections.[35] The results obtained for the growth rate of CS for each sector are presented in Table A.2. On average, CS expanded at 7.5% p.a. with a cross-sector standard deviation of 4.5% p.a.

Our second measure for the stock of capital is the stock of machinery, equipment and installations (M&EQ). This is also our preferred measure for two reasons. First, because its shorter useful life span, both physically and technologically, make potential inflationary bias less probable and significant. Second, since there is no biunivocal relationship between establishments and firms, with larger firms being composed by more than one establishment, the division of the firm's stock of structures and site, transport equipment, and furniture and utensils may be arbitrary -- the very definition of an establishment, however, prevents the same happening with M&EQ.

It is worth pointing out that if capital composition is approximately constant in real terms, then it would make no difference to use only M&EQ to measure its growth. In Table B.5 we report the shares of M&EQ in the capital stock (CS), in nominal terms, for 1970 and 1980. Although they are not constant, the shares are relatively stable for a significant number of sectors.

The stock of machinery, equipment and installations grew at an average rate of 9.3% p.a. in the 1970-80 period, with a standard deviation of 5.1% p.a (values for each sector are reported in Table A.2). The higher rate of growth of M&EQ results from either a smaller inflationary bias or from a change in the composition of the stock of capital.

Our third measure of the growth rate of the stock of capital is the rate of expansion of the total consumption of electricity (EE), including self-generated electric energy.[36] The rate of growth of this variable generally surpassed those of CS and M&EQ by a reasonable margin, as can be seen in Table A.2.

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34 - Some authors have chosen to deal with the problem in a different way. Bonelli (1975) and Neves (1978) used a benchmark estimate for the stock of capital, annual data on investment rates and output, and an elaborate procedure to estimate end-of-the-period values for the stock of capital. A similar method could not possibly be applied here because we did not have the necessary information for all years and with the required degree of disaggregation.

35 - Price indexes obtained in Fundacao Getulio Vargas's Conjuntura Economica were used for the four items: Civil Construction Cost in the City of Rio de Janeiro (column 7) for Structures and Sites; Capital Goods, Machinery and Equipment (column 22) for Machinery, Equipment and Installations; Capital Goods, Transport Equipment (column 21) for Transport Equipment; and Furniture (column 52) for Furniture and Utensils. Fixing in 100 the value of those indexes for December 1980, the respective values for December 1970 were 3.428, 4.771, 5.335 and 3.480.

36 - This inclusion is relevant in our case because in the 1970's there was a general process of substitution of acquired electricity for self-generated electric energy.

On average, EE expanded at 13.2% p.a., faster, therefore, than both value added and output. This result is by no means surprising, given the deep structural changes that took place during the seventies in Brazil, which led to a significant diversification of industry towards more electricity-intensive sectors and technologies. It seems fair to suppose that the rate of growth of EE actually exceeded that of capital.

The standard deviation for EE across sectors reached 6.3% p.a., resulting in reasonably stable coefficients of variation for the three measures, although they were higher than the coefficients of variation for output and value added. But, more important, our three measures for the rate of growth of the stock of capital are consistent for about every sector considered in our analysis. We believe this speaks in favor of the "precision" of our estimates for the growth rate of the capital input.

The elasticities of capital with respect to output and value added fell, respectively, on the (0.59,0.94) and (0.67,1.08) intervals; that is, they remained basically below one (Table 2).[37] The rank of elasticities is the same as for the rates of growth.

3.4 - Labor

Data for the number of employees at each establishment come disaggregated according to sex, skills and whether or not they work directly at the production line. The disaggregation according to skills, however, is more detailed for 1980 than for 1970, which somewhat limits our analysis.[38] More specifically, the 1970 census groups all out-of-production workers in a single total. To better exploit the available data, four variables are used to evaluate the rate of growth of the labor input.

The first, which is more commonly used and will be our preferred measure, is the rate of growth of the number of workers (RL) in each sector, which is reported in Table A.2. On average RL grew at 6.1% p.a. during the 1970's, at a considerably slower pace therefore than output, value added and capital.[39] A standard deviation of 3.9% p.a. for RL implies a higher relative variance than the ones observed for these variables (Table 2).

Our second measure (LP) takes into account changes in skill composition from 1970 to 1980. Three types of labor were considered: (i) workers out of production, and (ii) skilled and (iii) nonskilled (i.e., semiskilled plus unskilled) workers in production. Totals for each sector were obtained by summing up over establishments. Using data aggregated according to this labor classification, the following Paasche index was obtained:

$$\frac{L^{k,t}}{L^{k,t-1}} = \frac{\Sigma_h^H w_h^{k,t} L_h^{k,t}}{\Sigma_h^H w_h^{k,t} L_h^{k,t-1}} \quad (20),$$

where,

$w_h^{k,t}$ = average wage of a worker of type h at sector k in year t.

$L_h^{k,t}$ = number of employees of type h in sector k in year t.

37 - All elasticities reported in this paper are cross-sector least squares estimates.
38 - Since the censuses do not provide information on wages separately for men and women, no distinction according to sex will be made.
39 - Average values and standard deviations for RL and LP were estimated using the share of each sector in total labor force as weights.

A problem we had to deal with, however, arose from the fact that the disaggregation according to skills is given only for end-of-the-year figures. Before using (20), it was necessary to correct total values to take into consideration variations in the number of employees during the year. Formally:

$$PO_l^{k,t} = (\Sigma_s^{12} PO_{l,s}^{k,t})/12 \qquad (21),$$

$$L_{h,l}^{k,t} = L12_{h,l}^{k,t} (PO_l^{k,t}/PO_{l,12}^{k,t}) \qquad (22),$$

where,

$PO_{l,s}^{k,t}$ = total number of employees in establishment l of sector k at the end of month s of year t;

$L12_{h,l}^{k,t}$ = number of employees of type h in establishment l of sector k at the end of year t.

$L_{h,l}^{k,t}$ = approximate average number of employees of type h in establishment l of sector k in year t.

Results for LP in each sector are reported in Table A.2. On average LP expanded at 5.5% p.a., implying a deterioration in the average quality of the entire labor force.[40] Due to the aggregation adopted, however, this conclusion should be seem with reservations.

Our third and fourth measures -- RLPROD and PIL -- are the equivalents of RL and LP (respectively), calculated using only workers in production. RLPROD expanded at 6.3% p.a., with a standard deviation of 3.8% p.a.[41] Growth rates of PIL over the 1970-80 period averaged 6.7% p.a., with a standard deviation of 3.8%. This implies that the share of workers in production increased and that there was an improvement in the quality of the labor force working directly in production.

The elasticities of labor with respect to output and value added were estimated to lie close to one half (Table 2).[42] These elasticities, when compared to those for capital, seem to suggest that industrial growth in the 1970's was predominantly labor saving.

3.5 - Material Inputs

The procedure followed to estimate the growth of the consumption of material inputs (MI) was similar to the one adopted for output. As before, we used a Paasche index, with products defined according to the classification adopted by IBGE. Although information on consumption of material inputs came disaggregated according to its origin, no distinction was made here between inputs that were domestically produced and those that were imported.[43]

Our analysis of the data showed that the information on quantities consumed of each material input (and the implicit price) was not as reliable as that for goods produced by the establishment. It seems fair to suppose that firms do not keep as good a track of the quantities consumed of each product as they do for output, although data on values can be equally good (or bad). We decided then to use the relative nominal

40 - See footnote 39.
41 - For RLPROD and PIL average values and standard deviations were estimated using as weights the share of each sector in the total labor force in production.
42 - These values are similar to those obtained by Bacha and associates (1972) for the 1949-69 period (0.557 for the manufacturing industry as a whole).
43 - In section 5, however, we try to evaluate the impact of using imported inputs on TFPG.

prices observed for output to derive the Paasche quantity index for the consumption of material inputs,[44] that was defined by

$$\frac{QMI^{k,t-1}}{QMI^{k,t}} = \Sigma_i^M v_i^{k,t} \frac{V_i^{k,t-1}}{V_i^{k,t}} \frac{P_i^t}{P_i^{t-1}} \qquad (23),$$

where,

P_i^t / P_i^{t-1} = relative nominal average price of product i (IBGE (1980b) classification) in year t;

$V_i^{k,t}$ = value of total consumption of material input i in sector k at year t.

$v_i^{k,t}$ = share of product i in the value of material inputs consumed in sector k in year t.[45]

Six items required a different treatment: material inputs for which only the value of consumption was available, industrial services consumed by the establishment (for which we also had data only for the value of consumption), inputs that were consumed in year t-1 but not in year t, other expenses (including publicity and propaganda), lubricants, and other services consumed by the establishment. For those material inputs "real" quantities were defined by price-correcting nominal values. The price deflator associated with the Paasche quantity index defined by (23) was used for the first four items. The price index for Fuels and Lubricants published by Fundacao Getulio Vargas was utilized for lubricants.

The Census provides information on other services of three different kinds: leasing and rent, royalties, and freight and cargo. For leasing and rents a translog price index was built with the price indexes of civil construction and machinery and equipment published by Fundacao Getulio Vargas, using the shares of each component in the stock of capital in 1970 and 1980. For royalties the GDP deflator was used. Finally, for freight and cargo we used a price index that estimates the cost of moving a ton over one kilometer, and which was constructed from data collected by Pinheiro (1981).

In Table A.2 we report the results obtained for the growth rates of MI in the 1970-80 period at sector level. On average MI expanded at 12.5% p.a., that is, slightly less than output, and considerably more than capital and labor. The same pattern is found for most sectors, including some for which the growth of MI actually exceeds that of output. Growth of MI also varied more across sectors, with a standard deviation equal to 4.5%. Finally it is worth noting that the elasticity of MI with respect to output was estimated to be 0.96, reasonably close to and not statistically different from 1. These results reveal that the composition of the input vector changed considerably over the 70's with little or no reduction, on average, in the consumption of material inputs per unit of output.

3.6 - Energy

Two kinds of energy inputs were considered: electric energy and fuels. Electric energy consumed ($EEC^{k,t}$) is defined as the sum of electricity that was acquired ($AEE^{k,t}$) plus that received ($REE^{k,t}$) from

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44 - For some important material inputs that were not domestically produced in 1970 and in 1980, we used their relative nominal prices as long as they were reasonable and sensible, in the sense discussed earlier. For sector 201 (Oil-Refining and Petrochemicals) the increase in the total domestic consumption of oil was used as a proxy for the real increase in the consumption of material inputs.

45 - Values for material inputs include all trade and transportation costs to the industrial establishment, but not value added taxes (ICM and IPI). This procedure is consistent with the fact that those taxes are not paid by the firm but netted out of the total taxes on final products.

other establishments minus the amount of electric energy that was sold ($SEE^{k,t}$) or transferred ($TEE^{k,t}$) to other establishments:[46]

$$EEC^{k,t} = AEE^{k,t} + REE^{k,t} - SEE^{k,t} - TEE^{k,t} \qquad (24).$$

A great variety of fuels, from lumber to alcohol and LPG, were consumed, what led us to use the Paasche quantity index defined below to measure the growth of fuel inputs:

$$\frac{CF^{k,t}}{CF^{k,t-1}} = \frac{\Sigma_q^Q\ p_q^{k,t}\ f_q^{k,t}}{\Sigma_q^Q\ p_h^{k,t}\ f_q^{k,t-1}} \qquad (25),$$

where, $f_q^{k,t}$ is the total consumption and $p_q^{k,t}$ the average price of fuel q at sector k in year t. Since for some of the fuels consumed (fortunately the least important) only the value of consumption was available, a correction was necessary. We assumed that the share of these fuels in total expenses for fuels was the same at current and constant prices.

Electric energy and fuels were aggregated according to the Paasche quantity index defined by [47]

$$\frac{EP^{k,t}}{EP^{k,t-1}} = \frac{1}{S_e^{kt}(EEC^{k,t-1}/EEC^{k,t}) + (1-S_e^{k,t})(CF^{k,t-1}/CF^{k,t})} \qquad (26),$$

where $S_e^{k,t}$ is the share of electricity in total energy costs in year t for sector k.

In Table A.2 we report the results obtained for the growth rates of the energy input (E) in the 1970-80 period, at sectoral level. As was the case for labor, the rates of growth of E were considerably lower than those reached by output and value added for about every sector. Despite the fact that the consumption of electricity grew as fast as output and faster than value added, the growth rate of E averaged 6.7% p.a., with a standard deviation of 3.4%. The significant reduction in the consumption of energy is also illustrated by its elasticity with respect to output, estimated to be equal to 0.51.[48]

4) Total Factor Productivity Growth

Total factor productivity growth (TFPG) is defined as the growth of output (value added) that is not explained by the expansion of real factor input. A polemic exists as to whether one should measure TFPG using a production or a value-added index. Empirically, both procedures have been followed, as many times the necessary data, and therefore the choice, is not there.

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46 - A decision had to be taken on whether or not to include self-generated electricity as a source of electric energy. Although it would have been more correct to do so, this would require that the machinery and equipment used to generate electricity were excluded from the stock of capital. A similar procedure would have to be applied to labor and fuels used to generate this electricity. Since the disaggregation of the data did not allow that, we assumed that electric energy generation, whenever it happened, was a part of the establishment's production process.

47 - Notice that since Paasche indexes are consistent in aggregation we would have obtained an equal result if we had aggregated all energy inputs in a single step.

48 - It is interesting to point out that this reduction in the unitary consumption of fuels took place although the domestic real price of fuel oil did not increase significantly until the second oil shock (Pinheiro (1984a)).

Although for national account measures the problem is not present, the use of value-added indexes for industry or sector derivations depends on the assumption of separability between labor and capital on one side and intermediate inputs on the other. Gollop and Jorgenson (1980) are very convincing in their arguments against such separability: intermediate goods are substitutes for capital and labor and also a means of increasing productivity.[49]

As we continue, it will be clear that our focus is on the more rigorous production function approach. We do report, however, TFP growth rates for value added in order to allow comparisons with similar estimates in the literature. To conclude, we would like to remark that, as pointed out by Fabricant (1984, pg 33)), the two "indexes are not alternative -- and conflicting -- measures of the same events, however; they are measures of change in different, partially overlapping areas of production."

To estimate TFPG we use the index numbers estimated in section 3 and the translog quantity index of technical change implicitly defined by (7). The ratios between the stock of machinery and equipment (M&EQ) and of the number of workers (RL) in 1970 and in 1980 are used, together with the indexes for output, material inputs and energy, to obtain our basic estimates:

$$TFPG^{kt} = \ln \frac{QO^{k,t}}{QO^{k,t-1}} - \Sigma_r^4 \ ½ \ (S_r^{k,t} + S_r^{k,t-1}) \ \ln \frac{QI_r^{k,t}}{QI_r^{k,t-1}} \qquad (27),$$

where,

$TFPG^{kt}$ = total factor productivity growth in sector k, from t-1 to t,

$\frac{QO^{k,t}}{QO^{k,t-1}}$ = quantity index for output (value added) in sector k, from t-1 to t,

$\frac{QI_r^{k,t}}{QI_r^{k,t-1}}$ = quantity index for input r (r = 1 for capital, 2 for labor, 3 for material inputs and 4 for energy) in sector k, from t-1 to t,

$S_r^{k,t}$ = share of input r in output (value added) of sector k in year t.

To estimate the labor share in output and value added we considered not only wages actually paid during the year but also social security and other payroll employer contributions, namely FGTS paid by employers, PIS/PASEP, company maintained social assistance, premium paid to work insurance, and severance pay. For material inputs and energy we estimated the shares as the ratio of expenses with these inputs to value of output and value added. Following a common procedure, and in the absence of better data, we estimated the share of capital in output and in value added by difference such that all shares sum to unity, as is the case with constant returns to scale. In Table A.3 we report the values of the shares of each input in output. Average values and standard deviations for the shares are presented in Table 3.

The share of material inputs in output increased significantly during the 1970's. Since the real rates of growth of MI and output were, on average, about the same, there are three possible explanations for the increase in the share value. First, resource reallocation in the seventies favored sectors with large consumption of intermediate inputs. Second, verticalization decreased in the seventies, with firms producing

49 - In their study of the US economy, Jorgenson, Gollop and Fraumeni (1987) concluded that "the existence of a linear logarithmic value-added function is not rejected for only two manufacturing industries". See also the empirical evidence provided by Deny and May (1977) for the Canadian manufacturing industry.

less of the material inputs they needed. In fact, as discussed by Chenery and Syrquin (1986), these are characteristics of the industrialization process. Third, increases in nominal prices for material inputs significantly exceeded those for output. It is beyond the scope of our work to explain this change in relative prices. Nonetheless we can point out three possible causes for that: first, the increase in oil and coal prices, a consequence of the energy crises of the seventies; second, the change in the relative price of agricultural and manufactured products, which increased by more than half in the period,[50] in part itself a consequence of the increase in productivity levels in the industrial sector; and third, the process of import substitution of intermediate goods, which might have led to an increase in domestic prices due to the imposition of quotas and tariffs on imports.

TABLE 3
INPUT SHARES ON OUTPUT AND VALUE ADDED FOR 1970 AND 1980
(%)

	OUTPUT		VALUE ADDED	
	1970	1980	1970	1980
Labor	14.2	9.5	24.2	21.5
	(6.7)	(5.8)	(8.8)	(9.4)
Capital	44.6	34.8	75.8	78.5
	(11.0)	(10.0)	(8.8)	(9.4)
Material Inputs	38.8	53.6		
	(13.7)	(13.0)		
Energy	2.3	2.1		
	(2.1)	(2.6)		

Note: Standard deviations are reported in parentheses.
Source: Table A.3.

The average share of energy remained approximately constant, despite the increase in prices, which can be explained by the reduction in the relative consumption of fuels. Last but not least, it is interesting to note that the shares of labor and capital in value added remained approximately stable, with a slight increase in the latter from 1970 to 1980.[51]

In Table A.4 we report the growth rates of TFPG for output and value added, respectively, as well as a supply source of growth decomposition of output and value added growth rates. In Table 4 we have the average values and standard deviations of TFP growth rate and its share on output and value added growth. Besides our basic estimate, using our preferred definitions of labor and capital, we also present the values of TFP growth rates obtained using alternative definitions of these two inputs.

TFP growth accounted for about one fifth of the growth of output and 15% of the growth of value added during the 1970's. The sharp increase in the share of material inputs explains why the growth of value added was smaller than of output: had it not happened, growth of TFP for value added would have been larger than for output, as predicted by Fabricant (1984). The higher variance of value added growth rates, on the other hand, explains why the variables on the right-hand side of Table 4 have such high standard deviations.

50 - See Binkert (1989).
51 - It is important to keep in mind that the share of capital as defined here encompasses diverse items, such as working capital costs and wages paid to administrative personnel working in nonproductive establishments of the firm.

TABLE 4
AVERAGE TOTAL FACTOR PRODUCTIVITY GROWTH
IN THE 1970-80 PERIOD (%)

	OUTPUT		VALUE ADDED	
	VALUE	SHARE OF GROWTH	VALUE	SHARE OF GROWTH
Basic Estimate	2.6	20.0	1.5	15.2
	(2.2)	(16.7)	(3.7)	(68.6)
CS	3.1	24.2	2.7	27.1
	(2.3)	(17.6)	(3.5)	(62.4)
EE	1.2	8.9	-1.2	-11.7
	(2.1)	(20.3)	(3.6)	(90.1)
PIL	2.5	19.6	1.4	13.7
	(2.1)	(16.4)	(3.6)	(68.6)
LP	2.7	20.7	1.7	16.9
	(2.2)	(16.8)	(3.7)	(69.4)

Note: Standard deviations are reported in parentheses.
Basic Estimates were obtained from Table A.4.
Other measures were obtained using alternative measures for the growth of labor and capital. Values for each sector can be obtained from the author upon request.

The use of PIL to measure the growth of the labor input yielded results only slightly different from our basic estimate -- this was due to the relatively small changes in the composition of the labor force and to the fact that the average share of labor in output was only 12%. Substituting LP for RL we also get similar results.

The rate of TFPG is more sensitive to the estimate of the capital input growth, especially for value added, with the use of the total consumption of electricity yielding lower values of TFPG. Using CS to measure the growth in capital results in a higher rate of TFP growth, which would be responsible in this case for about one-fourth of output growth and one-fifth of the expansion of value added.

Compared to the results obtained by Bonelli (1975) for the sixties (Table 5), results for output indicate that TFP growth remained about the same, whereas figures for value added suggest that some deceleration took place in the seventies.

In Table 5 we compare our results with those obtained in the literature for other countries. Besides the rate of TFPG, we examine two other variables: the importance of TFP as a supply source of growth in absolute terms and in relation to the contribution of labor and capital. Four observations are warranted.

First, TFP growth in Brazilian manufacturing has been higher than in all other countries considered, with the exception of Korea. As a source of output growth TFP has been as important in Brazil as in Korea.

Second, the structure of real input growth is reasonably similar across countries. That is particularly true for Brazil, Mexico, Singapore, Thailand and Turkey. For industrialized countries (Japan and USA), material inputs account for about three-fourths of real input growth, a result consistent with those of Chenery and Syrquin (1986). Finally, note that in Korea labor accounted for only 3.3% of real input growth, a result in strong contrast with the idea that export promotion is labor intensive.

Third, capital and labor together were responsible for a larger share of output growth than TFP in all cases. A different figure arises, however, when we look at results for sectors (Graph 2.A). For Brazil, Korea, Japan and Mexico, and especially for the first two, TFP surpassed value added as a source of output growth in several sectors.

Finally, we observe that Verdoorn's law was statistically significant for eight of the thirteen cases considered. The association between output and TFP growth was found not to be significant when the latter was either very small or very large. In Graph 2.B we plot the values of the two growth rates for each sector: it is easy to see that Verdoorn's law seems to hold for Brazil.

Verdoorn's law is explained by factors such as the impact on productivity of economies of scale or increased capacity utilization. It illustrates the fact that there are ways to explain the cross-sector variance of TFP growth. In the following section we pursue that kind of analysis in some more detail.

5) Variables Related to Intersectoral Differences in TFPG

Our first objective in this paper was to estimate the rates of growth (or reduction) of total factor productivity, at sector level, in the Brazilian manufacturing industry over the 1970's. According to our basic estimate, TFP grew on average at a rate of 2.6% p.a., with results varying depending on the variables used to measure capital and labor and whether a production or a value-added function was considered.

In addition to the sensibility to the above factors, we observed that the rates of TFPG showed a great variance across sectors, with our basic estimate presenting a standard deviation of 2.2%. Our objective in the remainder of this paper is to find variables that are related to cross-sector differences in TFP change. We focus first on trade-related variables and then turn our attention to other relevant variables.

5.1 - Export Bias

Six variables will be used to measure the sector's export bias in the 1970-80 period: the real rates of growth of total exports (RTEX) and of exports directly accomplished by the establishment (RDEX),* the ratios of total sectoral exports to output (SHTEX) and of exports directly accomplished by the establishment to output (SHDEX), and the rates of growth of SHTEX and of SHDEX.

A positive association should in general be expected between export bias and TFP growth, one that is more positive for direct than for total exports. Three observations are noteworthy in that respect. First, a positive correlation between the growth of exports and TFP may be just a consequence of Verdoorn's law. Second, a negative association for the share variables is possible and should not come as a surprise -- a high value of the share variable may reflect just a natural-resource-based comparative advantage, which implies neither a high level nor a high rate of TFP growth.[53] Finally, the growth in the share of exports in output is the variable that best reflects export bias and therefore is the one for which results will be more revealing.

52 - The price index implicitly defined by (19) was used to deflate nominal values of exports.

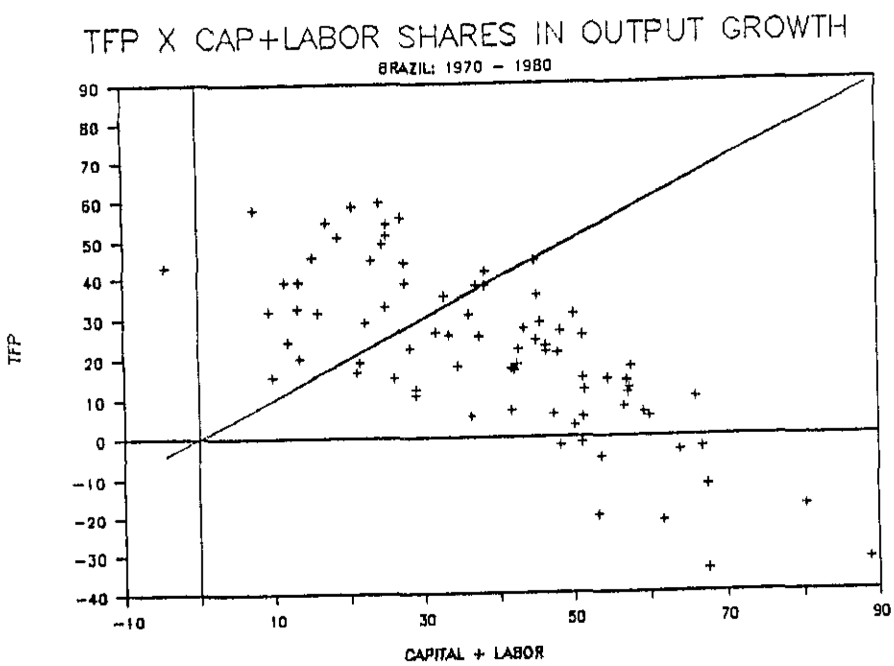
53 - See Teitel and Thuomi (1986) for a discussion of the role of natural-resource-based comparative advantage in Brazilian manufactured exports.

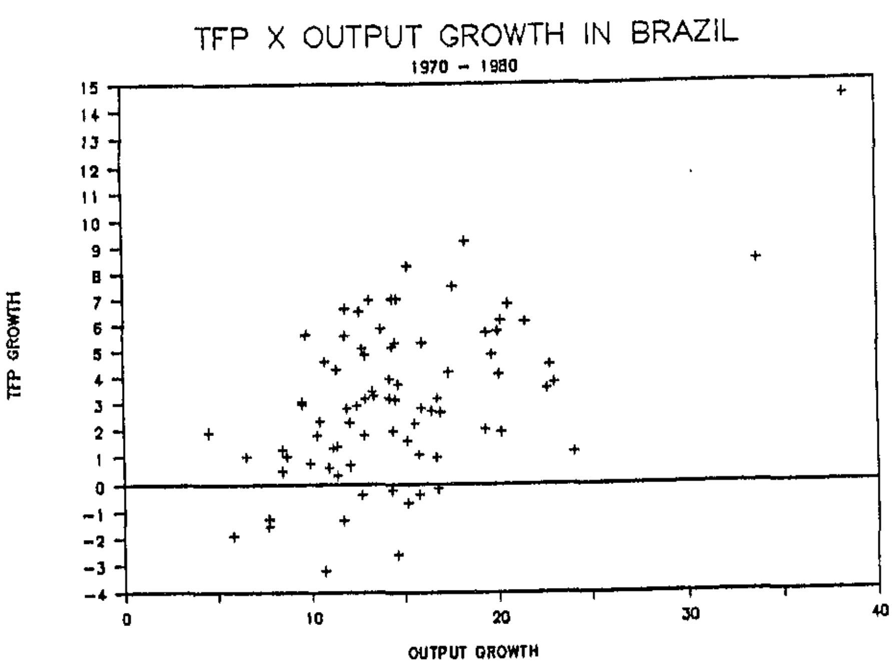
TABLE 5
SOURCES OF MANUFACTURING OUTPUT GROWTH AND CORRELATION BETWEEN OUTPUT AND TFP GROWTH FOR SELECTED COUNTRIES

COUNTRY	OUTPUT GROWTH	TFP GROWTH	TFP/ OUTPUT	MATER. /OUT	LABOR/ OUT	CAP/ OUT	ENERGY /OUT	CORRELA-TION
Argentina+	5.5	0.7	12.8					0.86***
(1955-73)	(9.1)	(8.2)	(167.6)					
Brazil+	8.4	2.5	30.1					0.90***
(1959-70)	(3.7)	(1.9)	(13.4)					
Brazil	13.0	2.6	20.0	45.3	5.0	27.9	1.2	0.55***
(1970-80)	(4.0)	(2.2)	(16.7)	(15.1)	(4.7)	(15.4)	(1.4)	
India+	5.8	0.3	0.1					0.29
(1960-70)	(3.5)	(2.3)	(12.4)					
India+	5.2	-0.6	-0.1					0.34
(1959-79)	(3.1)	(2.4)	(0.6)					
Japan	11.6	2.0	17.6	63.3	6.0	13.0		0.43*
(1955-73)	(3.1)	(1.5)	(11.5)	(11.6)	(3.2)	(6.1)		
Korea	17.9	3.7	20.7	57.3	2.6	19.5		0.05
(1960-77)	(6.6)	(1.9)	(9.7)	(8.4)	(4.4)	(6.4)		
Mexico	7.4	0.7	10.0	51.0	10.0	29.0		0.41*
(1970-80)	(2.4)	(1.1)	(15.2)	(9.2)	(5.2)	(16.5)		
Singapore	8.3	0.1	1.0	54.9	9.7	30.1	3.3	0.34*
(1970-80)	(7.4)	(4.7)	(1067)	(826)	(257)	(267.7)	(50.0)	
Thailand	16.4	0.7	4.2	63.4	6.2	26.2		-0.04
(1963-76)	(6.4)	(1.5)	(12.9)	(13.4)	(4.7)	(10.2)		
Turkey	10.7	1.3	12.4	52.3	5.1	30.2		0.59**
(1963-76)	(5.4)	(1.7)	(12.7)	(10.1)	(3.7)	(10.8)		
USA ++	3.8	0.5	13.6	64.7	10.9	10.9		0.44**
(1949-79)	(1.4)	(0.9)	(33.0)	(31.5)	(5.8)	(13.9)		
Yugoslavia	9.8	0.5	4.9	80.2	6.9	8.0		0.20
(1965-78)	(3.6)	(1.0)	(22.6)	(19.0)	(36.0)	(24.4)		

Note: Numbers in parentheses are cross-sector standard deviations.
+ These measures are based on value-added functions and are not directly comparable to the remaining results.
++ Approximate averages, using shares in output value as weights.
*, **, *** significant at 10%, 5% and 1%, respectively.
Sources: Delfino(1988), Bonelli(1975), Goldar(1986), Nishimizu and Robinson(1984), Jorgenson, Gallop and Fraumeni(1987), Page et al.(1986) Tsao(1985), Wiboonchutikula(1982).

Graph 2


TFP X CAP+LABOR SHARES IN OUTPUT GROWTH
BRAZIL: 1970 - 1980
TFP
CAPITAL + LABOR


TFP X OUTPUT GROWTH IN BRAZIL
1970 - 1980
TFP GROWTH
OUTPUT GROWTH

In Tables B.1 and B.2 we report the values of SHDEX and SHTEX for each sector.[54] On average, exports accounted for a small share of output in 1970, both for direct and total exports (Table 6). The expressive growth of exports in the 1970's, which averaged 23% for direct and 26% for total exports, led to an increase in those shares to, respectively, 5.3% and 10.3% in 1980. For all variables, however, values varied significantly across sectors, resulting in standard deviations close to the shares and rates themselves. It is interesting to note, on the other hand, that the ratio of direct to total exports decreased from about two-thirds in 1970 to half in 1980.

In Table 6 we show the estimated correlations between the export-bias variables and the rate of TFPG. Perhaps the most interesting conclusion is that, as anticipated, the sign and the significance of the relationship between exports and TFP growth depend on how we define export bias. TFP growth and the rate of export growth are, as predicted, positively and significantly correlated both for total (TEXP) and direct (DEXP) exports.[55]

The results change somewhat when the shares of exports are used to measure export bias. The correlation between the share of exports in 1970 and TFP growth in the ensuing decade is significantly negative for both total and direct exports. This possibly reflects the concentration of exports in 1970 in more traditional sectors whose comparative advantage was natural-resource-based. Slower growth of productivity in these sectors was probably a consequence of other circumstances that not trade orientation. For the 1980 shares the correlation is positive for direct exports and negative for total exports, although not significant for either of the two.

Sectors that managed a larger increase in their shares of direct exports seem to have also performed better with respect to TFP increases, as is implied by the correlation of TFP growth with the relative (RSHDEX) and the absolute (CSHDEX) changes in the SHDEX.[56] For total exports the correlations are negative but not at all significant.

These results seem to support our prior expectations. First, export bias and TFP growth do seem to be positively associated. Second, the share of exports in output may be in certain cases negatively correlated with TFP growth. Third, it is not clear what is the direction of causality between export bias and TFP growth.

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54 - Values for direct exports were obtained directly from the Industrial Censuses. For total exports we used the values in dollars reported in Carvalho and Haddad (1981) and FUNCEX, multiplying them by average values of the exchange rate. A more aggregate classification had to be used for total exports to make sector definitions in different sources compatible. A similar procedure was adopted for the share of imports in domestic supply.

55 - The reciprocals of the growth rate and of the share of direct exports were used because for some sectors direct exports in 1970 were equal to zero.

56 - The "R" and the "C" "operators" stand, respectively, for the real rate of change and for the absolute real change of a variable.

TABLE 6
AVERAGE VALUES OF EXPORT VARIABLES AND CORRELATIONS WITH TFP GROWTH
(In percent)

VARIABLE	AVERAGE VALUE*	CORRELATION +	VARIABLE	AVERAGE VALUE*	CORRELATION +
SHDEX70	2.3 (2.3)	-0.23 (-2.10)	SHTEX70	3.4 (3.4)	-0.30 (-1.81)
SHDEX80	5.3 (6.0)	0.08 (0.69)	SHTEX80	10.3 (9.9)	-0.17 (-0.98)
CSHDEX	3.0 (4.6)	0.24 (2.18)	CSHTEX	6.9 (8.2)	-0.02 (-0.12)
R(1/SHDEX)	-8.0 (18.0)	-0.21 (-1.92)	RSHTEX	11.7 (14.0)	-0.10 (-0.59)
SHDEX70/ SHDEX80 (a)	0.43 (0.98)	-0.25 (-2.28)	SHTEX80/ SHTEX70 (a)	3.0 (17.5)	-0.07 (-0.42)
R(1/DEX)	-16.6 (16.0)	-0.26 (-2.34)	RTEX	26.3 (16.5)	0.11 (0.64)
DEXP70/ DEXP80 (a)	12.8 (26.0)	-0.28 (-2.55)	TEXP80/ TEXP70 (a)	10.3 (69.0)	-0.02 (-0.11)

Note: See text for definition of variables.
* Standard deviations reported in parentheses.
\+ t-values reported in parentheses.
(a) in absolute values.
Source: Tables B.1 and B.2.

5.2 - Import Bias

After examining the influence of export bias on TFPG, we turn our attention to the other side of the trade balance and focus on the sectors' import bias. Two sort of variables will be considered here. The first are related to the import bias in product markets and to the extent that the degree of import substitution and competitive pressures in these markets influenced the rate of TFPG in Brazil during the 1970's. Here we will be worried with the share of imports in the domestic supply of final goods (SHIMP), defined as the ratio of total imports to imports plus the domestic supply of domestically produced goods (output minus exports).

On average, imports were responsible, in current prices, for 7% of the domestic supply of goods in both 1970 and 1980 (values for individual sectors are reported in Table B.2).[57] Figures for each sector, however, varied considerably, as revealed by standard deviations in Table 7.

57 - See footnote 54. Note that since the share of exports in output increased from 1970 to 1980, a stable value for SHIMP implies that the ratio of imports to output decreased in the 1970's.

TABLE 7
AVERAGE VALUES OF IMPORT BIAS VARIABLES AND
CORRELATIONS WITH TFP GROWTH

VARIABLE	AVERAGE VALUE* (%)	CORRELATION +	VARIABLE	AVERAGE VALUE* (%)	CORRELATION +
SHIMP70	7.0	0.24	SHIMI70	12.8	0.17
	(10.5)	(1.46)		(16.0)	(1.53)
SHIMP80	7.0	0.10	SHIMI80	15.0	0.39
	(8.4)	(0.60)		(21.2)	(3.79)
CSHIMP	0.0	-0.27	CSHIMI	2.2	0.37
	(6.3)	(-1.62)		(9.0)	(3.47)
RSHIMP	0.0	-0.36	RSHIMI	1.6	-0.12
	(11.1)	(-2.25)		(13.4)	(-1.01)
SHIMP80/	1.0	-0.28	SHIMI80/	1.2	-0.13
SHIMP70 (a)	(2.7)	(-1.68)	SHIMI70 (a)	(3.5)	(-1.15)
SHINV70	28.6	0.21	ROY70	0.18	0.17
	(17.6)	(1.92)		(0.36)	(1.55)
SHINV80	17.9	0.08	ROY80	0.05	0.04
	(12.7)	(0.73)		(0.14)	(0.32)
CSHINV	-10.7	-0.11	CROY	-0.13	-0.12
	(15.8)	(-1.01)		(0.35)	(-1.10)
RSHINV	-4.6	-0.09			
	(8.8)	(-0.76)			
SHINV80/	0.63	0.01			
SHINV70 (a)	(2.1)	(0.07)			

NOTE: See text for definition of variables.
* Standard deviations reported in parentheses.
+ t-values reported in parentheses.
(a) In absolute values.
Source: Tables B.1 and B.2.

The correlation between TFPG and SHIMP was positive for both 1970 and 1980 values, although not significant in any case. On the other hand, TFP growth and changes in the share of imports in domestic supply were negatively correlated for the 1970's. Despite the fact that the correlation was not significant for the absolute change in the shares (CSHIMP), it is significant at a 10% level for the ratio of shares (SHIMP80/SHIMP70) and at a 5% level for the average annual rate of change in SHIMP from 1970 to 1980 (RSHIMP).

These results seem to suggest that import substitution in Brazilian manufacturing industry did not affect the rate of TFPG in a negative way during the 1970's. On the contrary, it seems to have been the case that sectors in which import substitution took place were also the ones to manage a higher rate of TFP growth.

Imports are also a source of supply of inputs of production, which defines a kind of import liberalism different from the one discussed above. Import liberalism in factor markets with import restrictions in product markets is one of the main characteristics of many export-promotion experiences like the one in South Korea (Frank, Kim and Westphal (1975)).

As shown by Terlerckyj (1974,1980) and Kendrick and Grossman (1980), technological progress embodied in intermediate and capital goods is a leading factor explaining cross-sector differences in TFP growth in the U.S. In a developing country, these effects should be reflected through the imports of inputs, as expenses with R&D are comparatively lower in these countries.

Three variables will be used to measure the degree of import liberalism, each focusing on a different factor market: the share of imports in the consumption of material inputs (SHIMI), the share of imports in the investment in machinery and equipment (SHINV), and the ratio of royalties to profits (ROY).[58]

Imports were responsible for 12.8% and 15% of the average expenses with material inputs in 1970 and 1980, respectively.[59] The correlation between SHIMI and TFPG has the positive expected sign for both 1970 and 1980, although statistically significant only in the second case. By the same token, sectors that have managed an absolute increase in the share of imported material inputs (CSHIMI) seem also to have been the ones with a higher rate of TFP growth. Interestingly enough, the correlations are negative, although not significant, for both measures of relative changes in SHIMI (Table 5).

Both the shares of imports on investment in machinery and equipment (SHINV) and the ratio of royalties to profits (ROY) decreased from 1970 to 1980. TFP growth was positively correlated with SHINV and with ROY, both for 1970 and for 1980. Only for SHINV in 1970, however, is the correlation statistically significant. It is interesting to note that these results support the idea that the import substitution process in the 1970's, concentrated in intermediate and capital goods, was not so deleterious to TFP growth.

5.3 - Revealed Comparative Advantage

Revealed comparative advantage (RCA) is defined as the ratio of the sector's net exports (exports minus imports) to the sector's total trade flow (exports plus imports).[60] Values of RCA for each sector are reported in Table B.2. On average, RCA was equal to -0.46 in 1970 and to 0.17 in 1980, reflecting especially the significant expansion in export volume during the 1970's.[61]

Noh (1987) found a positive and significant association between the ratio of change in RCA and TFP growth for the textile sector in Japan and Korea. For the iron and steel sector the association was positive for Japan and negative for Korea, although not statistically significant for any of the countries.

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58 - Expenses with royalties can give some idea of expenses with the acquisition of technology and, in the case of Brazil, a measure of the use of imported technology. See Braga and Matesco(1986) and Braga and Willmore (1988).

59 - To a great extent, this increase in SHIMI was due to an increase in the price of raw materials imported by Brazil, notably oil. Note also that imports in 1980 were also influenced by the abnormally low rate of idle capacity and the speculation process that took place against the devaluation of the exchange rate at previously announced rates.

60 - See Balassa (1965) for a more detailed definition and Balassa (1984) for some recent empirical results.

61 - Weights here are the shares of each sector in total trade flow.

Our results are also surprising. TFPG and RCA are negatively correlated for both 1970 and 1980, and both correlations are statistically significant at a 5% level. Interestingly enough, CRCA is positively correlated with TFPG, although not in a significant way.[62]

5.4 - Trade Strategies

Trade bias, broadly understood, is often advanced as an explanation for cross-country variations in TFP growth. The same theoretical arguments usually discussed at country level also apply to specific sectors, and therefore trade bias could be an explanation for the cross-sector variance observed in TFP growth rates.

Recently, Nishimizu and Robinson (1984) have tried to explain time-series variation in TFP growth by relating annual sectoral rates with variables that reflect the nature of the trade strategy adopted in the sector. They tested and accepted the hypothesis that "import substitution regimes seem to be negatively correlated with TFPG, whereas export expansion regimes are positively correlated with TFP change."

Evidence from studies focusing on cross-sector differences in TFP growth is more controversial. Wiboonchutikula (1982) observed that TFP growth in Thailand had been faster in export-oriented than in import-substituting sectors. On the other hand, Handoussa, Nishimizu and Page (1986) found that in Egypt there was "an important asymmetry in the consequences of the reforms [undertaken since 1973] between the rapidly expanding import substitution sector with high productivity growth and the stagnant traditional export sector."

Goldar (1986) obtained a negative and significant coefficient for the share of import substitution as a demand source of growth in a regression which sought to explain the cross-sector variance in TFP growth in Indian manufacturing during the 1959-79 and the 1960-70 periods. Delfino (1988), however, found the correlation between these two variables to be positive, although nonsignificant, for the case of Argentina in the 1955-73 period.

To estimate the demand sources of growth we depart from

$$CY = SHIMP^{t} \,.\, CDD + CTEXP + CSHIMP \,.\, DD^{t+1} \qquad (28),$$

where DD is the domestic demand for domestically produced goods, the "C" "operator" stands for absolute real changes in the values of the variables, and the equation is valid for all sectors.

Import substitution (last term on the right-hand side of equation (28)) accounted, on average, for just 2.6% of the expansion of output in the 1970-80 period for the 80 sectors in our analysis, while export expansion (middle term of the right-hand side of expression (28)) was responsible for 14.0% of the increase of production. For both measures, but especially for import substitution (IS), there was a great deal of variation in these shares across sectors (Table B.3).[63]

62 - Note that these results support the idea that comparative advantage in Brazilian manufactured exports was natural resource based. It does suggest, however, that this scenario changed somewhat during the seventies.

63 - For the 1975-80 period, when the process of import substitution was more intense, Bonelli (1985) estimated that, for the whole manufacturing industry, IS accounted for 8.3% and export expansion (EXE) for 14.4% of the expansion of output. Note that averages for the two variables were obtained using as weights the sector's share of total absolute change in output, which explains why IS had a positive impact on output despite the average value of CSHIMP being zero for the period (Table 7).

TABLE 8

DECOMPOSITION OF GROWTH OF MANUFACTURING DEMAND, REVEALED COMPARATIVE ADVANTAGE AND CORRELATIONS WITH TFP GROWTH

VARIABLE	AVERAGE VALUE*	CORRELATION +	VARIABLE	AVERAGE VALUE* (%)	CORRELATION +
RCA70	-0.46	-0.48	Import	2.6	0.27
	(0.56)	(-3.20)	Substitution	(9.3)	(1.630)
RCA80	0.17	-0.40	Export	14.0	0.01
	(0.53)	(-2.51)	Expansion	(14.1)	(0.045)
CRCA	0.63	0.19	Domestic	83.4	0.34
	(0.44)	(1.12)	Demand	(14.1)	(2.094)
			Expansion		

NOTE: See text for definition of variables.
* Standard deviations reported in parentheses.
* t-values reported in parentheses.
Source: Tables B.2 and B.3.

After multiplying the shares of IS and EXE by the sector's rate of output growth, we correlated them with TFP growth, obtaining positive but not significant correlations (Table 8). In fact, as equation (29) shows, the two variables together do not explain more than 7.3% of the cross-sector variance in the rates of TFPG:

$$TFPG = 2.851 + \underset{(1.544)}{0.337}\, IS - \underset{(-0.065)}{0.010}\, EXE \qquad R^2 = 0.0725 \qquad (29).$$

These results contrast with those of Nishimizu and Robinson (1984). They found that "overall, substantial portions of the variation in TFP growth rates are 'explained'" by IS and EXE. Our results also contrast with those of Goldar (1986). On the other hand, they are consistent with those of Handoussa, Nishimizu and Page (1986) and of Delfino (1988).

Although confusing, the contradiction among results is more apparent than real. Three factors tend to mitigate its importance. First, results vary from country to country and even from one period to another -- we have seen in Table 5, for instance, that Verdoorn's law was very significant for some countries, though not for others. Moreover, while both Korea and Singapore have pursued export-oriented strategies, TFP growth was high in the former and close to zero in the latter. Second, time-series correlation, as found by Nishimizu and Robinson (1984), is neither necessary nor sufficient for a cross-sector correlation to exist.[64] This result will also be relevant later when analyzing other explanatory variables. Third, our measure of trade orientation is different from that used by Goldar (1986) and Delfino (1988), and therefore results are not directly comparable. Using the same definition adopted here and by Nishimizu and Robinson (1984), the correlation for India remains negative, but becomes nonsignificant for both periods, while for Argentina a positive and significant association arises between TFP growth and import substitution.

64 - A trivial example will suffice to show this proposition. Let TFP_{it} and X_{it} be the values of, respectively, total factor productivity and an explanatory variable in sector i and year t. Now assume that

$$TFP_{it}/TFP_{it-1} = 1 + a_i + u_{it}$$
$$X_{it}/X_{it-1} = 1 + b_i + v_{it}$$

TABLE 9

REGRESSIONS USING TRADE RELATED VARIABLES TO EXPLAIN THE CROSS-SECTOR VARIANCE IN TFP GROWTH

VARIABLE	REGRESSION+				
	1	2	3	4	5
Constant	3.213	2.912	2.462		1.848
SHDEX70/ SHDEX80	-0.433 (-2.204)	-0.417 (-2.147)	-0.390 (-1.988)	-0.462 (-2.334)	-0.447 (-2.313)
CSHIMI	0.086 (3.406)	0.086 (3.455)	0.082 (3.248)		
ROY70		1.419 (1.613)	1.304 (1.469)	0.444 (0.479)	0.556 (0.624)
SHINV70			0.016 (0.989)	0.025 (1.590)	0.022 (1.393)
SHIMIBAR				0.076 (3.083)	
SHIMI80					0.068 (3.678)
R^2	0.185	0.212	0.222	0.213	0.249
Adj. R^2	0.175	0.192	0.191	0.182	0.219
D.F.	77	76	75	75	75

NOTE: See text for definition of variables.

+ Numbers in parentheses are t-values.

After examining each of the trade-related variables individually, we try in Table 9 to see how much of the cross-sector variance in TFPG we are able to explain with these variables.[65] The regressions basically confirm the conclusions reached in our simpler correlation analysis. Export bias -- measured by the expansion in the share of direct exports in output -- and import liberalism in material input markets have a positive and significant association with TFP growth. Import bias in both technology and machinery markets are positively, although not very significantly, correlated with the rate of TFPG. Together, the trade variables explain about one-fourth of the cross-sector variance of TFPG.

$E(v_{it}) = E(u_{it}) = 0$

$COV(v_{it},v_{jt}) = COV(u_{it},u_{jt}) = 0,$ for i=j.

Then, the fact that the time-series covariance between TFP and X growth rates (= $COV(v_{it},u_{it})$) is different from zero, for all or some of the sectors, does not imply, nor is implied by, the fact that cross-sector covariance (=$COV(a_i,b_i)$) is not zero.

65 - Note that differences in sector aggregation precluded the use of SHIMP, IS, EXE and RCA.

All in all, these results suggest that the association between trade and TFP growth in Brazil has been positive and significant during the 1970's, but that by itself it is not sufficient to explain why the rates of TFP growth varied so considerably among sectors. We turn our attention now to variables more related to the sectors' industrial structure.

5.5 - Composition of the Labor Force

In section 4, we tried to evaluate the impact of changes in the skill composition of the labor force by measuring the growth of the labor input with Paasche indexes that took into account differences in workers' qualifications. It was suggested, however, that the overwhelming number of nonskilled workers could somehow mask the importance of changes in the skill composition of the labor force. Furthermore, these indexes said nothing about the importance of different compositions of labor force across sectors. Finally, it was not possible to take into consideration the sex composition of the labor force since wages were not reported separately for male and female workers.

In this section, we try to overcome these problems and evaluate the impact of the sex composition and of different skills on TFPG. Two variables will be used for that purpose: the male participation in the labor force (MP) and the participation of skilled workers in the labor force directly working in the production line (SW). Values for these variables in each sector are reported in Table B.4. On average, 84.5% of all employees were males in 1970, a figure that diminished to 80.9% in 1980.[66] The average value of SW, on the other hand, increased from 3.4% in 1970 to 4.5% in 1980, while its cross-sector variance fell (Table 10).

TABLE 10
AVERAGE VALUES OF LABOR COMPOSITION VARIABLES AND
CORRELATIONS WITH TFP GROWTH

VARIABLE	AVERAGE VALUE*	CORRELATION +	VARIABLE	AVERAGE VALUE*	CORRELATION +
MP70	84.5	0.03	SW70	3.4	0.37
	(17.0)	(0.23)		(3.0)	(3.47)
MP80	80.9	0.07	SW80	4.5	0.27
	(18.5)	(0.65)		(2.6)	(2.51)
RMP	-0.43	0.14	RSW	2.8	-0.10
	(0.76)	(1.29)		(5.6)	(-0.85)
CMP	-3.6	0.15	CSW	1.1	-0.11
	(4.5)	(1.34)		(2.4)	(-1.01)

NOTE: See text for definition of variables.
* Values in parentheses are standard deviations.
+ Numbers in parentheses are t-values.
Source: Table B.4.

66 - Those shares are higher than but comparable to the ones observed for the American manufacturing industry in 1950 and in 1976, which were, respectively, 74.3% and 70.5% (Kendrick and Grossman (1980)).

MP and TFPG are positively correlated for both 1970 and 1980 values, as are the absolute and relative changes of this variable in the 1970's. Although of the expected sign, none of these correlations are statistically significant. These results differ from those obtained by Bonelli(1975) and by Kendrick and Grossman (1980). In both studies a negative correlation was estimated between MP and TFPG,[67] a result that Kendrick and Grossman (1980,p108) credit to the possibility that "industries with higher proportions of women may be the more 'enlightened' type of industries that are more prone to take advantage of technological and managerial advances". Kendrick and Grossman' (1980) correlation for changes in MP, however, are positively and significantly correlated.

For the skill composition of the labor force, the results are somewhat different. Both SW70 and SW80 are positively and significantly correlated with the rates of TFPG.[68] On the other hand, both RSW and CSW are negatively correlated with TFPG, although not significantly.

Two observations are noteworthy with respect to these results. First, they are consistent with the notion that changes in the composition of labor force played a minor role in expanding output in the seventies. Second, they support the hypothesis that TFP growth was faster in some "enlightened" sectors, as measured by a larger share of skilled workers in the labor force.

5.6 - Capital Related Variables

As with the labor, changes or differences in the composition of the stock of capital have been cited as being responsible for the growth of output.[69] To represent the composition of the stock of capital we use the ratio of the stock of machinery, equipment and installations to the total stock of capital (M&EQ/CS).

Cross-sector differences in M&EQ/CS do not seem to have been a determinant of TFP growth during the 1970's, as suggested by the significance of the correlations in Table 11. The increase of M&EQ/CS from 56.5% in 1970 to 60.8% in 1980, for the average values, however, seems to have exerted a negative effect on the growth of TFP. It is possible, however, that the negative and significant correlations between TFPG and R(M&EQ/CS) and C(M&EQ/CS) are due, in fact, to some bias resulting from the use of M&EQ to evaluate the stock of capital.

Newer vintages of capital embody more recent technology and are therefore supposed to be more productive than older machinery and equipment. To evaluate the impact of the age composition of the stock of capital we used the ratio of investment in machinery and equipment to M&EQ (ILM) and to CS (IL). As we would expect, these variables are positively correlated with TFPG. Only for ILM70 is the correlation not significant (at 5%).

Capital intensity is represented here by the ratios of M&EQ and CS to both value added (M&EQ/VA and CS/VA) and output (M&EQ/OUT and CS/OUT). While differences in sectoral values of these variables were not significantly correlated with TFPG, a negative and significant correlation arose for the relative and the absolute changes in their values.

There are four possible explanations for these results. First, firms "overinvested" in the seventies as a rational reaction to the cheap and abundant credit made available by the government for the acquisition of machinery. Second, many of the projects undertaken in the second half of the 1970's were not yet operative in 1980, although huge investments had already taken place.[70] Third, capital intensity is a

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67 - The correlations were statistically significant only for Kendrick and Grossman (1980).

68 - A similar result was obtained by Bonelli (1975) for the 1960's.

69 - See Christensen, Cummings and Jorgenson (1980).

70 - See Castro and Souza (1984) for a further discussion of this issue. See Goldar (1986, p157) for a discussion of a similar process in India during the 1960's.

barrier to entry in the industry and in this respect could have a negative impact on the growth of TFP. Finally, it is possible that measurement errors biased the results.

TABLE 11

AVERAGE VALUES OF CAPITAL RELATED VARIABLES AND CORRELATIONS WITH TFP GROWTH

VARIABLE	AVERAGE VALUE*	CORRELA-TIONS+	VARIABLE	AVERAGE VALUE*	CORRELA-TIONS+	VARIABLE	AVERAGE VALUE*	CORRELA-TIONS+
(M&EQ/	0.57	0.06	ILM70	0.25	0.15	RRCS70	1.5	-0.19
/CS)70	(0.13)	(0.57)		(0.11)	(1.36)		(0.7)	(-1.68)
(M&EQ/	0.61	-0.09	IL70	0.14	0.23	RRCS80	1.9	0.28
/CS)80	(0.14)	(-0.82)		(0.04)	(2.06)		(1.0)	(2.54)
R(M&EQ/	0.9	-0.27	ILM80	0.31	0.33	RRRCS	2.4	0.61
/CS)	(1.2)	(-2.45)		(0.10)	(3.12)		(4.9)	(6.85)
C(M&EQ/	0.04	-0.24	IL80	0.18	0.22	CRRCS	0.4	0.49
/CS)	(0.06)	(-2.20)		(0.05)	(1.96)		(0.8)	(5.01)
(M&EQ/	0.35	0.17	(M&EQ/	0.21	0.25	RRM&EQ70	2.8	-0.18
/VA)70	(0.19)	(1.50)	/OUT)70	(0.11)	(2.27)		(1.7)	(-1.62)
(M&EQ/	0.30	-0.19	(M&EQ/	0.13	-0.08	RRM&EQ80	3.3	0.33
/VA)80	(0.18)	(-1.70)	/OUT)80	(0.07)	(-0.68)		(2.0)	(3.04)
R(M&EQ/	-1.5	-0.60	R(M&EQ/	-4.7	-0.53	RRRM&EQ	1.7	0.63
/VA)	(4.0)	(-6.68)	/OUT)	(3.8)	(-5.50)		(4.9)	(7.21)
C(M&EQ/	-0.05	-0.43	C(M&EQ/	-0.08	-0.37	CRRM&EQ	0.5	0.57
/VA)	(0.17)	(-4.17)	/OUT)	(0.10)	(-3.54)		(1.4)	(6.05)
(CS/	0.59	-0.19	(CS/	0.35	0.29			
/VA)70	(0.25)	(1.72)	/OUT)70	(0.15)	(2.68)			
(CS/	0.49	-0.23	(CS/	0.22	-0.08			
/VA)80	(0.26)	(-2.06)	/OUT)80	(0.10)	(-0.68)			
R(CS/	-1.8	-0.59	R(CS/	-4.5	-0.51			
/VA)	(3.9)	(-6.48)	/OUT)	(3.5)	(-5.25)			
C(CS/	-0.10	-0.52	C(CS/	-0.13	-0.47			
/VA)	(0.25)	(-5.44)	/OUT)	(0.13)	(-4.66)			

Note: For value added variables, value added weights were used.
* Standard deviations reported in parentheses.
+ t-values reported in parentheses.
Source: Table B.5.

A last capital-related variable that is of interest is the rate of return on capital, which is defined as the value of capital "costs" (share of capital times output) over the value of the stock of capital (RRCS) and over the value of machinery and equipment (RRM&EQ). The results suggest that a negative and barely significant correlation prevailed between the rates of return in 1970 and the ensuing growth in productivity. Higher productivity growth seems to be definitely (and positively) correlated with the growth of the rate of return, with more lucrative sectors in 1980 being the ones that managed faster growth in TFP.

5.7 - Size

By assuming that the underlying production function F(.) is characterized by constant returns to scale, we automatically transferred to the residual term any impact economies of scale might have had on output growth. To assess the importance of the economies-of-scale effect we use the growth rate of the size of the average establishment in the sector (RSIZE) in the 1970-80 period.[71] We expect RSIZE to be positively correlated with intersectoral differences in TFPG.

We also examine the correlations for the size of the average establishment (SIZE). SIZE should also have an impact on growth accruing from scale economies and the tendency for larger firms to make higher investments in R&D and technology absorption,[72] and better management and financial capabilities. On the other hand, a large value for SIZE is a powerful barrier to entry and, ceteris paribus, it means a less competitive environment.

In Table B.6, we report the values of SIZE for each sector in 1970 and 1980 in current cruzeiros. On average, SIZE grew at 7.4% p.a., in real terms, with a standard deviation of 3.5%. As expected, there was a positive and significant correlation between TFPG and RSIZE. For SIZE, the correlations were also positive but not statistically significant.[73]

5.8 - Capital Utilization

Another potentially relevant variable to explain the cross-sector variance of TFP growth rates is the change in the degree of capital utilization ($CU^{k,t}/CU^{k,t-1}$). To gauge the degree of capital utilization we use a common measure in the literature,[74]

$$CU^{k,t} = \frac{EE^{k,t}}{PEM^{k,t}.NH^{t}} \qquad (30),$$

$EE^{k,t}$ = total consumption of electric energy in sector k in year t (including self-generated electricity),

$PEM^{k,t}$ = total power of electric machinery in sector k and year t,

NH^{t} = number of hours in year t.

71 - The price index implicitly defined by (19) was used to deflate nominal values.

72 - See Braga and Matesco (1986) and Braga and Willmore (1988) for a further discussion of this issue.

73 - In Kendrick and Grossman (1980) the level of output is also not correlated to TFP growth rates. It is noteworthy, on the other hand, that Bonelli (1975) reached results for the sixties that were just the opposite of ours, that is, a significant correlation for the SIZE variable (in 1959) and a nonsignificant correlation for RSIZE.

74 - See Jorgenson and Griliches (1967) Bonelli (1975) and Kim and Kwon (1977).

Average capacity utilization increased from less than 25% to almost 50% over the 1970's (Table 12). Although the prevailing increase in CU observed for the sectors in Table B.6 seems in accordance with the predominant increase in TFP for most sectors, neither the values of CU at the extreme years nor its rate of change showed a positive correlation with TFPG. Nonetheless, the correlations are not significant.

In addition to the problems discussed in section 3.3, three factors can possibly explain these somewhat surprising results. First, the time-series correlation that is supposed to exist between the two growth rates [75] does not imply a cross-sector correlation.[76] Second, our measure of CU is especially prone to measurement errors.[77] Moreover, the growth in the intensity of electricity consumption reflects more than increased capacity utilization. Third, the rate of capacity utilization is mainly determined by the type of production process used in the sector, and therefore is not so sensitive to incentives to increase or decrease productivity.[78]

5.9 - Age Structure

We define the age structure of the sector as the share of output produced by establishments founded in the five years preceding the census (AGE). The AGE variable is a measure of the extent of learning by doing and of training on the job accumulated by the establishment. Moreover, older establishments have already proved themselves in the market: surviving firms are, supposedly, the ones that in the past were able to increase productivity at a faster pace. Therefore, we expect AGE to be negatively associated with TFPG.

The reasonably high investment rates prevailing in the 1970's were certainly behind the higher age concentration verified for 1980, which was 2.2 percentage points larger than the one observed in 1970. As expected, AGE, RAGE and CAGE are all negatively correlated with TFPG, although none in a significant way (Table 12).[79]

5.10 - Industrial Concentration

We measure the degree of industrial concentration (IC) in each sector as the share of output that was produced by the largest twenty establishments. It is usually pointed out that firms in more concentrated sectors will have a higher tendency to undertake investments in innovation,[80] which should enhance productivity. On the other hand, concentration is a barrier to entry and in more concentrated sectors one should have, everything else being the same, less competitive environments. As those two effects work in opposite directions, it is not very clear what to expect for the correlation between IC and TFPG.

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75 - Noh (1987) found a positive and significant time-series association between growth of productivity and of capacity utilization for the iron and steel industries in Japan and Korea. For the textile industry, however, the association was not significant for either country, and had a negative sign in the case of Japan.

76 - See footnote 64.

77 - It is interesting to see, in this way, that the correlation between TFP and CU growth rates obtained by Bonelli (1975), although positive, was barely significant.

78 - See Kendrick and Grossman (1980) for further discussion and results.

79 - Note that Bonelli (1975) found this correlation to be negative and significant.

80 - See Braga and Matesco (1986) and Braga and Willmore (1988) for some empirical evidence in Brazil.

As seen in Table 12, average industrial concentration decreased by about 5.5 percentage points from 1970 to 1980. Moreover, highly concentrated sectors were able to obtain larger increases in TFP, as illustrated by the positive and significant correlations between IC and TFPG for both 1980 and 1970.[81]

TABLE 12
AVERAGE VALUES OF OTHER RELEVANT VARIABLES AND
CORRELATIONS WITH TFP GROWTH

VARIABLE	AVERAGE VALUE*	CORRELATION +	VARIABLE	AVERAGE VALUE*	CORRELATION +
SIZE70	7560	0.09	IC70	54.7	0.34
	(10098)	(0.75)		(23.3)	(3.15)
SIZE80	469046	0.06	IC80	49.2	0.32
	(690426)	(0.57)		(21.1)	(2.99)
RSIZE	7.4	0.48	RIC	-1.1	-0.01
	(3.7)	(4.79)		(2.0)	(-0.05)
CU70	23.3	-0.04	CIC	-5.5	-0.05
	(15.6)	(-0.34)		(10.0)	(-0.44)
CU80	49.8	-0.06	PROF70	44.6	0.04
	(45.6)	(-0.57)		(11.0)	(0.37)
RCU	7.9	0.00	PROF80	34.8	0.37
	(6.0)	(-0.03)		(10.0)	(3.55)
CCU	26.5	-0.07	RPROF	-2.5	0.37
	(28.2)	(-0.62)		(2.4)	(3.52)
AGE70	15.2	-0.05	CPROF	-9.8	0.33
	(7.8)	(-0.42)		(9.2)	(3.13)
AGE80	17.4	-0.15	RELTFPB	58.1	0.22
	(7.2)	(-1.39)		(13.8)	(2.02)
RAGE	1.4	-0.17	RELTFPM	53.3	0.22
	(5.5)	(-1.49)		(14.3)	(2.03)
CAGE	2.2	-0.09			
	(7.5)	(-0.76)			

Note: See text for definition of variables.
* Standard deviations reported in parentheses;
\+ t-values reported in parentheses.
Source: Table B.6.

81 - See Bonelli (1975), Kendrick and Grossman (1980), Goldar (1986) and Delfino (1988) for some interesting results using industrial concentration to explain the cross-sector variance of TFP growth.

5.11 - Profitability

The sector's rate of profit (PROF) is defined here as the share of capital in output. The higher the profitability of an establishment, the higher its capacity to self-finance expenditures on innovation and R&D. The positive association found between TFPG and PROF should, therefore, be expected. As was the case with the rate of return to capital, however, this correlation also reflects the positive effect of TFPG on profitability.

5.12 - Relative Total Factor Productivity

TFP translog indexes have been used in a series of studies to make bilateral comparisons of productivity levels between different countries.[82] Although base invariant, the translog index defined by (7) is not circular.[83] To overcome this problem Caves, Christensen, and Diewert (1982b) proposed a translog multilateral TFP index, which can be used in our problem to measure the relative sector TFP:[84]

$$\ln(TFP_k)-\ln(TFP_j)= (\ln(TFP_k)-\ln(TFP_0))- (\ln(TFP_j) -\ln(TFP_0)) \quad (31),$$

where,

$$\ln(TFP_k)- \ln(TFP_0) = LN(Y^k/Y^0) - 1/2 \; \Sigma_r^R \; (v_r + v_0).\ln(X_r^k/X_r^0) \quad (32),$$

and Y stands for output, v_r for the input shares, X_r for the inputs' quantities,

$\ln(Y_0) = 1/K \; \Sigma_k^K \ln(Y_k)$, $\ln(X_r^0) = 1/K \; \Sigma_k^K \ln(X_r^k)$, and $v_0 = 1/K \; \Sigma_k^K v_k$.

We determine the relative TFP (RELTFP) of each sector by setting the value of TFP for the most productive sector equal to 100. In Table B.6 we present the values of RELTFP for both the bilateral (RELTFPB) and the multilateral (RELTFPM) translog indexes. On average, TFP was equal to 58% and 53% of the sectors' maximum in 1970, for the bilateral and multilateral indexes respectively. Despite this difference in average values, which is partly explained by the use of an extreme value as the reference point, the two indexes are quite equivalent, with the correlation between them being equal to 0.993. Not surprisingly, then, both variables get the same positive and significant correlation with the rate of TFPG in the 1970's (Table 12).

It is interesting to note that these results imply that instead of a catching-up process, the 1970's witnessed a widening in the gap between TFP levels of different sectors.[85] A possible explanation seems to rely on the fact that the seventies saw a deepening of the industrialization process that favored the less traditional and more efficient sectors of the economy.

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82 - The same index of expression (28) can be used for that purpose, with differences now being measured "geographically" rather than over time. This procedure was used, among others, by Jorgenson and Nishimizu (1978) and Noh (1987). See Ikemoto (1986) for multilateral country comparison using the bilateral translog index.

83 - An index number I(.) is said to be circular or transitive if and only if
$I(p^W,p^V; x^W,x^V) = I(p^W,p^Z; x^W,x^Z) \; I(p^Z,p^V; x^Z,x^V)$.

84 - See Bateman, Nishimizu, and Page (1988) for an application of multilateral translog indexes to examine productivity differentials across regions in Yugoslavia. See Dreschler (1973) and Caves, Christensen and Diewert (1982b) for further discussion on circular index numbers.

85 - It is worth mentioning that Ikemoto (1986) reached an opposite result for his comparison with Asian countries, confirming what he called Gerschenkron's borrowed technology hypothesis.

6) Explaining Cross-Sector Differences in TFPG

In section 5 we defined and estimated a set of variables that we believed had influenced the rate of TFPG of 80 different sectors of the Brazilian manufacturing industry during the 1970's. After that we tested the hypothesis that each of them could, individually, explain part of the cross-sector variance of TFPG. In this section we advance in our analysis to see how much of this variance those variables are able to explain together. Only variables that were significantly correlated with TFPG will be considered.

Regression 1 in Table 13 shows that about one third of the cross-sector variance of TFPG can be explained by the rate of change in the sectors' average establishment size and by the initial skill composition of the labor force. Adding IC70 raises the regression R^2 to 35%, with regression 3 showing that the degree of industrial concentration in 1970 was a more important determinant of TFPG than its average value (ICBAR).[86]

Relative TFP, as measured by the multilateral translog index of section 5.11, keeps its relevance as an explanatory variable in the multiple regression set up, as shown by the difference of almost eight percentage points between the coefficients of determination of regressions 2 and 4.[87] The RAGE variable enters our multiple regression with a negative sign, but the impact on the explanatory power of our regression and the coefficient of the variable are not statistically significant.

Regression 6 suggests that the capacity of renewing one's stock of M&EQ was a determinant factor in explaining why rates of TFP varied across sectors. Notice that although the increase in the coefficient of determination from regression 5 to 6 is small, the coefficient of ILMBAR [88] is statistically significant.

The ratio of direct export shares introduced in regression 7 gives a discrete contribution to the explanatory power of our regression, raising the value of R^2 from 46% to 53%.[89] On the other hand, the import-bias variables introduced in regressions 8 to 12 show a positive but not very significant impact on the rate of TFPG. Together they raise the coefficient of determination by 3.5 percentage points, about half the increase achieved by the export-bias variable.[90]

In regression 13 we introduce the absolute change in male participation in the labor force, but the variable shows no statistical significance, nor, as reflected by the adjusted R^2, much explanatory power: the one-percent point increase in the value of R^2 is fully offset by the loss of degrees of freedom.

In regressions 14 and 15 we introduce two additional capital related variables. Considered by itself the change in capital composition during the 1970's seems to have worked against the increase in productivity. When changes in capital intensity are also considered, however, the impact of R(M&EQ/CS) turns positive, although statistically negligible. The results in regression 15, on the other hand, confirm the negative association between increases in capital intensity and TFP growth.

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86 - ICBAR = (IC70 + IC80)/2.

87 - Using the bilateral index the increase in R^2 is even larger. In fact, all regressions of Table 13, but the last, for which there is no change, present a higher R^2 when relative TFP in 1970 is measured with the bilateral translog index. The differences are, however, small.

88 - ILMBAR = (ILM70+ILM80)/2.

89 - Note that the variable is equal to the share in 1970 over the share in 1980, which explains the negative sign of its coefficient.

90 - It may be argued that the order the variables enter the regression makes all the difference, but an examination of the t-values will show that the significance of the import-bias variables is in fact small. Nonetheless, since it seems that multicollinearity is present in our problem, it is impossible to reach more definitive conclusions.

TABLE 13
CROSS-SECTOR REGRESSIONS EXPLAINING TFP GROWTH

VARIABLE	REGRESSION +							
	1	2	3	4	5	6	7	8
RSIZE	0.299	0.285	0.278	0.276	0.272	0.258	0.277	0.286
	(4.569)	(4.396)	(4.200)	(4.425)	(4.398)	(4.211)	(4.759)	(4.839)
SW70	0.362	0.290	0.306	0.331	0.305	0.259	0.210	0.192
	(3.199)	(2.468)	(2.612)	(3.005)	(2.735)	(2.296)	(1.958)	(1.753)
IC70		0.025		0.028	0.029	0.030	0.030	0.030
		(1.927)		(2.140)	(2.260)	(2.329)	(2.494)	(2.458)
ICBAR			0.225					
			(1.640)					
RLTFPM				0.056	0.056	0.059	0.055	0.050
				(3.358)	(3.387)	(3.612)	(3.564)	(3.010)
RAGE					-0.040	-0.021	-0.032	-0.031
					(-1.286)	(-0.674)	(-1.061)	(-1.017)
ILMBAR						4.621	4.684	4.465
						(1.822)	(1.957)	(1.854)
SHDEX70/ SHDEX80							-0.498	-0.482
							(-3.163)	(-3.040)
SHINV70								0.013
								(0.909)
R^2	0.318	0.350	0.342	0.428	0.440	0.464	0.530	0.535
Adj. R^2	0.309	0.333	0.325	0.405	0.410	0.428	0.491	0.490
D.F.	77	76	76	75	74	73	72	71

NOTE: See text for definition of variables.
+ Numbers in parentheses are t-values.

TABLE 13 (Cont.)
CROSS-SECTOR REGRESSIONS EXPLAINING TFP GROWTH

VARIABLE	REGRESSION +						
	9	10	11	12	13	14	15
RSIZE	0.288	0.299	0.273	0.274	0.274	0.272	0.276
	(4.924)	(4.967)	(4.651)	(4.558)	(4.602)	(4.612)	(5.019)
SW70	0.148	0.189	0.013	0.051	0.012	0.008	-0.022
	(1.320)	(1.529)	(0.014)	(0.346)	(0.085)	(0.056)	(-0.170)
IC70	0.029	0.032	0.025	0.025	0.025	0.025	0.004
	(2.441)	(2.561)	(2.074)	(2.027)	(1.959)	(2.021)	(0.305)
RLTFPM	0.049	0.050	0.055	0.051	0.054	0.053	0.024
	(3.006)	(2.991)	(3.257)	(3.067)	(3.067)	(3.009)	(1.290)
RAGE	-0.036	-0.034	-0.038	-0.039	-0.038	-0.053	-0.025
	(-1.200)	(-1.125)	(-1.280)	(-1.271)	(-1.226)	(1.662)	(-0.823)
ILMBAR	4.984	5.914	5.410	4.726	5.432	4.933	4.809
	(2.066)	(2.203)	(2.253)	(1.949)	(2.241)	(2.041)	(2.130)
SHDEX70/	-0.487	-0.493	-0.527	-0.506	-0.529	-0.468	-0.344
SHDEX80	(-3.098)	(-3.125)	(-3.346)	(-3.198)	(-3.318)	(-2.882)	(-2.200)
SHINV70	0.011	0.012	0.012	0.011	0.011	0.013	0.017
	(0.793)	(0.858)	(0.859)	(0.787)	(0.831)	(0.949)	(1.346)
ROY70	1.108	1.038	0.900	1.029	0.903	0.785	0.660
	(1.505)	(1.396)	(1.216)	(1.390)	(1.211)	(1.059)	(0.951)
CSHIMI		-0.023					
		(-0.798)					
SHIMI80				0.024			
				(1.009)			
SHIMIBAR			0.044		0.044	0.037	0.021
			(1.577)		(1.562)	(1.314)	(0.794)
CMP					0.007	0.000	0.037
					(0.137)	(0.001)	(0.799)
R(MEQ/						-0.277	0.070
/CS)						(-1.613)	(0.366)
R(MEQ/							-0.269
/VA)							(-3.281)
R^2	0.550	0.554	0.565	0.556	0.566	0.582	0.640
Adj. R^2	0.499	0.497	0.509	0.499	0.503	0.514	0.576
D.F.	70	69	69	69	68	67	66

NOTE: See text for definition of variables. + Numbers in parentheses are t-values.

Altogether, the variables considered in regression 15 were able to explain about two-thirds of the total cross-sector variance in the rates of TFPG. Our adjusted R^2's are, therefore, of the same order of magnitude of those obtained by Kendrick (1973), Terleckyj (1974,1980), Kendrick and Grossman (1980), Goldar (1986) and Page et al. (1986).

The unexplained part of TFP variance can be credited to the set of relevant factors kept out of our analysis due to lack of data. Expenses with research and development, found in many studies to be a critical variable in explaining the cross-sector variance of TFP growth, could not be examined due to lack of necessary data.[91] The impact of this variable, however, was partially accounted for by SHIMI, SHINV and ROY.

Four other variables that possibly influenced TFP growth rates unevenly across sectors in the seventies are the structure of capital ownership,[92] the proportion of sales made to the government,[93] the degree of cyclical fluctuations in output,[94] and effective rates of protection.[95] Finally, the unionization rate and the proportion of man-days that remained idle due to work stoppages are variables that, although of probably lesser importance in the Brazilian manufacturing during the seventies, had shown to be important in other countries.[96]

7) Final Remarks

Our main objectives in this paper were, first, to estimate the rate of TFPG from 1970 to 1980, and, second, to see if we could explain what caused this rate to vary from one sector to another. In particular, we were interested to know whether there is any evidence, at sector level, that trade orientation affects total factor productivity growth.

Our methodology was based on the use of translog indexes of technical change, and we considered the cases of both translog production functions and translog value-added functions. Four inputs were considered for the first case: capital, labor, material inputs and energy. In section 3.3 we described our data set and the way index numbers were obtained for output, value added and each of the inputs.

But for material inputs, which had a growth rate very similar to that of output, all inputs in the 1970's experienced a reduction in their consumption per unit of output, for the total of the manufacturing industry. When taking into account the skill composition of the labor force in the production line, we verified that there has been an improvement in the quality of the labor input.

From 1970 to 1980 the share of material inputs in output increased by about 14.8 percentage points. This increase is due entirely to a change in relative prices. Both the prices of imported inputs (oil, coal, and other raw materials) and of agricultural prices increased in the period relatively to the price of

91 - See Terleckyj (1974,1980), Kendrick (1973), Bonelli (1975), Kendrick and Grossman (1980), Griliches (1984), and Griliches and Litchenberg (1984) for results and further discussion.

92 - Bonelli (1975) found positive and very significant correlations between the share of foreign firms in both sales and capital assets and TFP growth. Moreover, Braga and Matesco(1986) and Braga and Willmore (1988) show that capital ownership is correlated with the amount of expenses with R&D in Brazil. However, the literature suggests that there is no evidence of differences in efficiency in production between transnational enterprises, private firms and state enterprises in Brazil (See Pinheiro 1989d).

93 - See Terleckyj (1974,1980) for empirical results.

94 - Kendrick and Grossman (1980).

95 - See Page et all. (1986).

96 - Kendrick (1973), Kendrick and Grossman (1980) and Goldar (1986).

domestically manufactured goods. In part, of course, that reflected the increase in productivity in the manufacturing sector. Finally, it is possible that the policies adopted in the second half of the 1970's to foster the substitution of imported intermediate goods have also contributed to this change in relative prices.

Total factor productivity (TFP) expanded at 2.6% p.a. and was responsible for 20% of the rate of output growth in the 1970's. When the index for value added is used these values drop to 1.5% and 15.2%, respectively. Compared to other results obtained for Brazil these figures suggest that if a deceleration in TFP growth took place from the sixties to the seventies, it was not very large.

In addition, we saw that TFP growth in Brazilian manufacturing surpassed that of the countries for which we had comparable results, with the exception of Korea in the 1960-77 period. As a source of output growth, however, TFP was as important in Brazil as in Korea. Still in our international comparison we saw that Verdoorn's law was present in eight of the thirteen cases tested.

Results for TFP growth do not vary much when changes in the skill composition of the labor force are considered. Alternative measures for the growth of the capital input, however, result in significant changes on the rates of TFPG. The average value for TFP growth varies from 1.2% p.a. to 3.1% p.a., depending on whether the consumption of electricity or the total stock of capital are used as proxies for the capital input.

The relation between TFPG and export bias was found to depend significantly on the variable used to define the latter. In particular, for 1970 we observed a negative and statistically significant correlation between the share in output of both direct and total exports and TFP growth. This result can possibly be explained by the fact that manufactured exports in 1970 were still very much concentrated in traditional sectors, for which slower growth of output, lower degree of industrial concentration, less skilled labor force and smaller investments in R&D may have depressed TFP growth in the 1970's. On the other hand, if we use the Michaely/Fishlow definition of export bias, that is, the extent to which the growth of exports exceeds that of output, we reach very different results. For direct, although not for total, exports a positive and statistically significant correlation was found between the increase in the share of exports in output and the growth of TFP. This suggests that a positive association exists between export orientation and growth of TFP, but that it is of a disequilibrium nature, with gains in productivity being of a once-for-all kind.

Results on the import side support, broadly speaking, the conclusions discussed above. Import bias in factor markets seems to have been positively associated with TFP growth: sectors in which imports of material inputs, of machinery and equipment and of technology played a major role were also the ones with higher growth of TFP. On the other hand, evidence from product markets indicates a positive, although not always significant, correlation between import substitution and TFP growth. As with exports, this positive association may be reflecting the fact that import substitution in the 1970's took place in industrially concentrated sectors, which experienced high investment rates and fast output growth. That highlights the conclusion that the association between trade strategies and TFP growth can be period- and country-specific.

Although changes in the skill composition of the labor force had little impact on TFP growth, differentials across sectors were significantly associated with TFP growth. Despite having the correct signs, correlations for the sex composition of the labor force were not statistically significant.

Two important conclusions emerge from the correlation analysis with capital related variables. First, sectors that presented a higher ratio of investment to the stock of capital also had a higher rate of TFP growth, reflecting the positive impact of technology embodied in newer vintages of capital. Second, sectors that experienced larger increases in their capital intensities fell behind in the growth of TFP. Four possible explanations were raised: (i) that cheap credit led to inefficient over-investment, (ii) that in many sectors investments undertaken in the second half of the 1970's were not yet productive in 1980,

(iii) that capital intensity was a barrier to entry and decreased competition among firms, and (iv) that measurement errors biased the results.

Economies of scale, as measured by the rate of growth of the average establishment size, were found to have had a positive and very significant impact on the rate of TFP growth. On the other hand, no significant correlation was obtained for the levels and rates of change of capital utilization. Learning by doing was found to enhance TFP growth: sectors with a higher proportion of new establishments experienced lower rates of TFPG. The correlations obtained were not, however, statistically significant. Profitability and TFP growth showed to be positively and significantly correlated, a result that speaks in favor of the consistency of our estimates. Industrial concentration was found to have had a positive and statistically significant impact on TFP growth, a result that is widely consistent with findings of studies for both Brazil and other countries. Finally, relative TFP in 1970 was positively correlated with ensuing rates of TFPG, implying that TFP gaps among sectors tended to widen during the 1970's.

Altogether, our trade-related variables were able to explain about one-fourth of the total cross-sector variance of TFP. Grouping all our relevant variables in a single regression, we explained about two-thirds of the cross-sector variance in TFP growth rates. The values of our adjusted R^2's are comparable to those obtained in other successful studies. All in all, the regression results suggest that the industrial structure variables, such as industrial concentration, economies of scale, skill composition of the labor force and vintage composition of the stock of capital, were the main determinants of the growth of TFP.

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TABLE A.1

LIST OF SECTORS

Sector Number	Sector Description
101	Stones for Civil Construction
102	Lime
104	Ceramics
105	Cement
106	Cement Products and Artefacts
107	Glass
108	Prepared Non-Metallic Minerals
109	Miscellaneous Products of Nonmetallic Minerals
110	Iron and Steel
111	Nonferrous Metals
113	Metallic Structures
114	Iron and Steel Artefacts
115	Metal Stamping
116	Metal Tanks & Recipients
117	Cutlery, Hand Tolls, Hardware & Guns
121	Special Industrial Machinery
122	Industrial Machinery for Hidraulic & Termic Installations
123	General Industrial Machinery
124	Machin.& Equip. for Agricultural Use
125	Machin.& Equip. for Office and Domest. Use
126	Clocks, Whatches & Cronometers
127	Tractors and Earth-Moving Machines
131	Equipment for Electrical Energy
132	Electrical Material Exclusive Vehicules
133	Lamps
134	Electrical Material for Vehicules(Excluding Train Engines)
135	Electrical Appliances
137	Electronic Material
138	Communication Equipment
141	Naval Industry
142	Railway Stock
143/4	Automobiles, Trucks, Buses and Parts
145	Bycicles
147	Aircrafts
148	Other Vehicules
15	Wood
161	Wood Furniture
162	Metallic Furniture
163	Upholstery
172	Paper
173/5	Paper Products
18	Rubber
19	Leather and Hides

TABLE A.1 (Cont.)

LIST OF SECTORS

Sector Number	Sector Description
200	Chemical Elements & Compositions
201	Oil-Refining & Petrochemicals
202	Artificial Threads & Resins
204	Raw Vegetable Oils
205	Natural, Artificial and Synthetic Aromatic Concentrates
206	House Cleaning Products and Pesticides
207	Pigments(Coloring Matter), Paints & Solvents
208	Fertilizers
209	Other Chemical Products
211	Pharmaceuticals
221	Perfumary
222	Soaps
223	Candles
231	Plastic Sheets
232	Plastic Products for Industrial Use
233	Plastic Products for Domestic Use
241/3	Spinning and Weaving of Fibers
244	Other Textile Artifacts
245	Special Textile Products
251	Clothing
252/6	Hats and Garments for Professional Activities
253	Footwear
254/7	Clothing Accessories and Other Clothing Products
260	Agroindustry
261	Canned & Preserved Fruit & Vegetables
262	Meat Products & Animal Fats
263	Fish & Other Sea Products
266	Candies & Chocolates
267	Bakery Products
268	Pasta & Cookies
269	Vegetable Oil & Fats and Miscellaneous Food Products
271/3	Alcoholic Beverages
274	Nonalcoholic Beverages
28	Tobacco
291	Print & Publishing of Newspapers, Books, Manuals & Periodicals
292	Print & Publishing Teaching, Industrial & Commercial Materials
299	Other Printing and Publishing Services

TABLE A.2

AVERAGE ANNUAL GROWTH RATES OF OUTPUT, VALUE ADDED, CAPITAL, LABOR, MATERIAL INPUTS AND ENERGY (%)

			CAPITAL			LABOR					
Sector	Output	VA	CS	M&EQ	EE	RL	LP	RLPROD	PIL	MI	E
101	12.8	12.4	7.4	9.0	12.7	3.5	3.77	3.1	3.5	9.0	1.9
102	10.7	8.5	16.2	23.7	19.8	2.3	2.30	1.1	1.6	10.7	8.1
104	11.4	10.6	8.5	10.6	13.4	6.2	5.57	6.4	7.0	15.7	7.7
105	14.2	8.4	4.4	7.1	11.2	-2.0	0.98	-2.1	-1.2	18.4	6.6
106	16.8	14.9	16.5	18.8	20.1	10.7	11.45	11.0	11.3	18.1	10.1
107	14.4	12.6	4.5	6.2	12.6	3.5	3.17	3.7	4.3	10.2	6.9
108	33.7	32.5	24.7	29.7	25.8	10.2	11.01	9.9	11.3	21.9	18.2
109	15.8	14.1	15.2	18.5	13.7	12.2	9.73	13.6	14.4	15.6	12.3
110*	15.2	9.2	13.0	14.5	13.8	6.6	6.18	6.6	6.8	14.3	8.0
111	16.8	10.1	4.7	5.8	14.7	5.0	3.14	6.0	6.2	18.7	10.4
113	16.5	15.8	9.7	12.2	14.5	12.9	12.67	12.9	12.5	14.5	13.0
114	11.4	11.4	9.4	11.3	13.1	7.0	6.41	7.3	7.9	12.9	8.7
115	15.8	12.6	12.0	14.1	16.8	10.1	8.96	10.3	10.6	16.6	11.0
116	12.9	11.5	5.1	8.2	7.7	5.5	3.47	5.9	6.1	12.6	2.9
117	14.4	13.1	11.3	12.8	16.0	8.1	7.63	8.2	9.4	14.8	10.3
121*	15.6	13.1	11.4	13.3	12.7	8.8	8.24	8.7	8.9	15.8	7.1
122*	19.3	18.1	16.4	20.0	19.9	12.1	11.43	12.1	12.4	16.4	10.4
123*	15.7	15.0	13.9	16.0	16.2	9.7	8.78	9.9	10.0	17.7	6.9
124	15.9	13.7	9.5	12.0	19.2	7.5	6.48	7.5	8.0	16.4	5.2
125	16.0	13.5	6.6	7.6	11.4	7.5	6.11	7.9	7.7	15.2	4.4
126	21.5	22.2	15.0	11.8	19.8	12.8	11.30	13.1	14.5	30.1	13.4
127	14.7	14.8	6.0	6.7	11.4	7.6	5.85	7.7	7.8	18.1	11.0
131*	14.6	12.4	8.3	10.4	14.7	8.4	6.83	8.4	8.3	13.4	8.9
132	14.6	13.0	3.8	4.4	14.8	6.5	4.27	6.8	6.9	9.0	8.6
133	11.9	8.8	0.2	3.4	5.6	5.6	3.50	6.5	6.6	12.7	5.6
134	15.2	12.9	0.7	0.7	10.7	4.2	2.70	4.5	4.8	14.4	5.1
135	13.8	11.1	1.9	4.9	6.7	3.9	2.92	3.9	4.2	13.0	0.3
137	23.0	21.1	14.8	18.2	14.5	10.6	11.63	10.6	11.3	25.6	10.2
138	15.2	12.9	9.8	14.1	11.1	10.0	7.57	11.0	10.7	20.7	8.5
141*	18.4	15.3	3.0	5.5	15.1	7.9	5.89	9.3	9.3	12.7	11.7
142*	19.7	19.6	16.2	12.5	16.4	14.6	13.75	15.6	16.1	16.8	8.4
143/4	9.6	5.9	0.9	1.9	7.2	3.2	1.82	3.5	3.5	12.1	2.2
145	24.0	21.6	23.6	21.9	24.2	15.8	15.96	16.3	17.2	27.2	18.8
147	38.3	38.3	17.2	16.2	28.4	19.0	16.34	22.5	21.2	50.4	19.7
148	22.8	25.1	13.2	16.2	22.4	13.6	11.69	14.6	15.0	22.5	9.6
15	7.7	3.3	9.9	10.2	15.0	6.5	6.08	6.5	6.8	9.0	4.6
161	12.8	9.7	10.0	13.8	15.9	6.5	5.68	6.7	7.1	10.2	6.8
162*	10.7	7.6	2.6	5.5	13.7	3.2	2.46	3.5	4.0	7.4	4.7
163*	14.5	10.2	8.8	7.9	11.4	6.5	5.73	7.0	7.6	10.0	4.3
172	9.6	6.2	2.0	2.1	5.5	0.5	-0.43	0.8	1.3	12.4	5.2

TABLE A.2 (Cont.)

AVERAGE ANNUAL GROWTH RATES OF OUTPUT, VALUE ADDED, CAPITAL, LABOR, MATERIAL INPUTS AND ENERGY (%)

			CAPITAL			LABOR					
Sector	Output	VA	CS	M&EQ	EE	RL	LP	RLPROD	PIL	MI	E
173/5	20.2	19.1	9.9	11.5	21.2	8.4	7.76	8.4	9.2	15.2	15.1
18	14.3	9.5	7.6	8.2	9.9	5.1	3.59	6.2		14.6	4.2
19	7.7	4.9	8.0	11.2	9.3	5.3	4.43	5.4	5.7	9.4	5.3
200	14.3	10.7	13.1	14.6	14.1	6.1	4.98	6.5	6.8	17.4	10.7
201*	11.9	10.4	9.5	12.1	15.7	0.8	-1.04	1.6	0.5	7.2	8.6
202	19.4	13.3	5.1	5.7	12.4	4.8	4.00	5.6	6.0	22.3	7.4
204	11.1	1.8	7.0	8.3	9.8	0.3	0.15	0.0	0.4	11.2	10.0
205	13.3	11.1	3.8	9.1	34.1	-0.9	1.10	-1.2	1.7	14.7	0.9
206*	20.6	17.8	12.6	14.3	14.0	4.4	3.16	5.2	6.1	11.5	5.8
207	11.4	7.4	1.0	2.5	12.2	3.6	2.69	4.0	4.3	11.9	6.5
208*	17.0	8.8	9.1	7.9	8.5	5.4	5.71	4.7	5.0	19.6	7.6
209*	22.6	17.3	14.2	18.0	17.4	9.3	8.47	8.7	9.6	21.4	10.2
211	11.9	8.1	2.9	3.6	6.8	0.5	-0.42	2.3	3.1	9.8	1.5
221	10.5	6.4	4.8	8.5	8.3	2.1	1.13	3.3	3.8	8.6	2.8
222	10.3	6.4	7.9	9.6	7.9	3.8	2.27	3.8	3.9	8.2	4.0
223	17.6	16.6	0.1	5.7	12.7	7.4	4.93	7.8	8.1	11.4	3.9
231	13.4	8.6	7.1	9.8	14.1	6.1	5.42	6.5	7.1	10.4	10.5
232	20.1	16.5	13.0	17.0	18.1	11.5	10.51	11.7	12.3	15.7	10.0
233	9.9	8.6	7.8	8.4	12.8	7.5	4.72	7.8	8.3	11.0	11.9
241/3	6.5	2.3	0.5	1.5	9.1	0.6	-0.28	0.8	1.1	9.9	4.8
244	12.6	11.8	2.0	5.4	8.7	1.1	-0.05	1.2	1.6	8.0	4.1
245	12.9	9.6	2.2	3.5	9.3	1.7	0.92	1.9	2.5	12.0	5.6
251	20.1	21.8	12.6	15.8	47.7	12.7	10.95	13.3	13.7	12.1	11.3
252/6	17.4	13.0	11.2	13.4	16.2	11.8	11.49	17.5	18.2	12.3	5.5
253	10.9	9.8	9.0	10.3	14.8	8.3	6.95	8.6	9.0	11.4	9.5
254/7	11.7	7.4	11.3	15.3	18.3	10.3	8.98	9.6	10.0	12.1	11.6
260*	12.5	9.9	4.5	4.1	9.2	4.4	3.47	4.1	4.6	12.2	3.9
261	12.7	9.6	11.4	14.7	15.1	10.1	9.30	11.3	11.8	12.2	6.2
262	8.5	5.7	6.9	10.5	13.0	6.3	5.97	6.5	7.0	6.4	4.8
263	8.4	3.8	4.9	6.9	12.1	6.0	6.54	6.1	7.2	10.0	4.1
266	5.8	2.8	6.8	8.6	10.4	3.6	2.91	4.1	4.7	8.2	4.8
267	14.6	12.3	14.3	17.3	18.0	12.3	12.31	11.2	11.2	20.4	12.7
268	12.1	13.5	7.6	10.3	10.3	7.1	6.47	7.3	7.9	13.2	7.6
269	12.1	7.8	5.4	7.2	10.3	4.4	4.63	4.4	4.9	11.5	4.7
271/3	8.7	5.8	6.0	10.7	11.0	-0.9	-0.54	-0.6	0.4	7.7	5.1
274	14.4	11.6	6.9	10.9	13.5	2.5	2.74	3.1	3.9	9.7	-4.5
28	4.5	2.7	-0.2	-0.5	10.3	0.4	-0.26	0.8	1.8	7.0	1.0
291	9.8	9.5	3.9	5.0	6.8	0.7	1.33	1.3	2.8	4.8	-3.5
292	13.2	12.7	5.7	7.1	10.0	2.7	1.68	4.4	4.7	6.1	3.8
299	20.2	17.9	18.6	21.7	26.0	14.2	12.59	13.3	13.9	16.4	20.6

NOTE: * FGV price indexes were used to estimate output and value added growth rates for the sector.
See Section 3 for description of variables.

TABLE A.3

SHARE OF CAPITAL, LABOR, MATERIAL INPUTS AND ENERGY IN OUTPUT

	CAPITAL		LABOR		MATERIAL INPUTS		ENERGY	
Sector	1970	1980	1970	1980	1970	1980	1970	1980
101	42.7	46.0	26.6	20.6	23.7	28.6	7.0	4.7
102	42.4	39.4	17.3	9.4	29.1	35.3	11.3	15.9
104	44.2	47.5	31.0	22.3	15.0	18.7	9.9	11.5
105	55.0	35.4	9.7	2.8	20.4	43.1	14.9	18.7
106	39.4	34.1	17.5	14.1	41.4	50.4	1.6	1.4
107	47.0	42.4	23.3	17.5	21.6	30.1	8.0	10.0
108	41.4	47.7	23.1	11.3	28.1	34.7	7.4	6.3
109	50.3	42.8	17.0	15.5	27.4	37.2	5.3	4.5
110	34.3	18.8	9.6	6.9	52.0	70.3	4.2	3.9
111	34.7	21.0	14.7	6.4	46.0	69.3	4.6	3.4
113	27.4	28.9	28.3	23.6	43.0	46.4	1.3	1.2
114	35.5	40.5	22.6	17.5	40.1	40.7	1.8	1.3
115	39.6	29.3	18.3	14.4	40.6	55.2	1.5	1.1
116	38.9	38.2	22.5	16.0	36.9	44.7	1.7	1.1
117	50.0	48.4	25.8	19.3	22.0	30.3	2.2	2.0
121	51.2	39.7	22.4	19.4	25.1	40.1	1.3	0.8
122	44.4	40.3	21.9	19.5	32.7	39.6	1.0	0.6
123	43.6	40.4	29.4	23.3	25.5	35.5	1.6	0.8
124	46.7	42.4	20.9	13.4	30.9	43.5	1.5	0.7
125	55.1	45.6	18.9	14.2	25.0	39.8	1.0	0.5
126	54.7	76.2	28.9	11.9	15.9	11.6	0.6	0.3
127	53.0	58.2	12.2	7.8	34.0	33.4	0.8	0.5
131	46.6	38.0	21.4	18.4	30.9	42.9	1.0	0.8
132	40.4	37.1	15.9	11.6	42.6	50.4	1.2	0.8
133	71.6	51.9	13.5	12.4	12.7	34.4	2.2	1.3
134	47.0	43.5	22.1	13.0	29.3	42.6	1.6	0.9
135	52.9	46.3	20.8	11.6	25.4	41.7	1.0	0.4
137	65.6	59.2	17.9	12.0	15.3	28.3	1.1	0.5
138	49.2	46.7	18.2	8.4	32.2	44.8	0.5	0.2
141	57.7	48.5	23.3	13.9	17.9	36.6	1.1	1.0
142	53.9	42.0	17.0	28.1	27.8	28.5	1.2	1.5
143/4	50.0	36.6	15.9	10.5	32.9	52.2	1.1	0.7
145	58.6	52.4	16.9	9.5	23.4	37.4	1.1	0.7
147	46.1	62.7	44.8	28.5	7.4	7.9	1.6	0.9
148	41.0	57.8	21.0	16.8	36.3	24.8	1.7	0.5
15	62.3	39.1	18.0	14.1	16.4	44.8	3.2	2.1
161	46.0	36.3	24.2	16.8	28.5	46.2	1.4	0.8
162	47.5	38.0	21.0	13.6	30.2	47.6	1.3	0.9
163	45.7	31.9	16.3	10.2	37.1	57.6	0.9	0.4
172	42.8	34.7	16.2	8.8	33.9	52.1	7.1	4.5

TABLE A.3 (Cont.)

SHARE OF CAPITAL, LABOR, MATERIAL INPUTS AND ENERGY IN OUTPUT

	CAPITAL		LABOR		MATERIAL INPUTS		ENERGY	
Sector	1970	1980	1970	1980	1970	1980	1970	1980
173/5	30.2	33.2	17.9	10.9	50.9	54.7	1.0	1.2
18	49.1	31.9	13.6	9.2	35.2	57.8	2.1	1.2
19	41.1	31.1	16.0	12.8	41.0	54.6	1.9	1.6
200	49.3	37.3	11.3	6.8	30.5	49.4	8.9	6.5
201	40.7	41.4	8.9	1.8	48.1	54.6	2.4	2.2
202	49.1	33.1	16.9	5.6	31.1	59.3	3.0	2.0
204	54.6	22.4	4.2	2.1	39.4	73.5	1.8	2.0
205	67.1	59.2	13.4	6.7	18.9	33.8	0.6	0.3
206	67.5	56.0	7.6	3.6	23.9	40.0	1.0	0.5
207	52.9	37.7	11.3	6.9	34.6	54.1	1.2	1.3
208	54.1	26.9	6.8	2.5	37.6	69.9	1.5	0.6
209	55.0	38.0	13.8	6.1	29.0	54.7	2.2	1.1
211	73.7	53.1	14.1	9.0	11.5	37.3	0.7	0.6
221	64.8	44.2	10.0	7.4	24.7	47.9	0.6	0.5
222	41.1	27.9	6.6	5.3	51.1	65.5	1.1	1.2
223	27.9	29.9	14.5	9.2	56.4	60.0	1.2	0.9
231	55.0	35.7	10.0	6.5	33.7	56.6	1.2	1.3
232	49.3	34.2	19.2	16.4	29.4	47.9	2.0	1.5
233	52.2	49.2	19.6	14.9	26.6	34.4	1.6	1.5
241/3	42.7	29.2	16.7	10.4	38.7	59.0	1.9	1.4
244	31.3	36.3	27.3	18.2	39.9	44.5	1.4	1.0
245	38.2	31.4	15.8	8.6	44.7	58.9	1.3	1.1
251	28.0	38.0	16.3	13.2	55.2	48.5	0.6	0.3
252/6	63.9	39.0	16.3	15.9	18.4	44.4	1.4	0.7
253	38.1	37.8	23.1	17.2	38.0	44.4	0.9	0.5
254/7	51.6	31.6	16.7	14.5	31.1	53.3	0.6	0.6
260	33.1	25.4	5.1	5.1	60.2	68.3	1.5	1.2
261	56.9	42.9	9.5	7.4	31.8	48.3	1.7	1.3
262	20.6	16.1	5.6	4.1	72.7	79.1	1.1	0.7
263	59.7	34.1	12.2	12.5	25.7	51.6	2.4	1.9
266	46.1	35.9	13.2	8.7	39.2	54.2	1.5	1.2
267	43.6	24.5	11.5	20.3	41.8	51.1	3.1	4.1
268	31.8	37.5	11.1	11.2	54.4	48.5	2.6	2.8
269	38.1	26.2	6.0	3.7	54.3	69.0	1.6	1.1
271/3	46.7	40.0	19.3	10.6	31.7	46.5	2.3	2.8
274	48.1	40.0	20.0	13.3	28.9	44.6	2.9	2.2
28	53.9	46.6	11.0	7.9	34.6	45.0	0.6	0.6
291	37.9	48.1	30.1	18.5	30.9	33.0	1.1	0.4
292	37.1	41.2	28.6	21.5	33.3	36.6	1.0	0.7
299	46.7	36.2	31.6	28.5	20.6	33.2	1.2	2.1

Note: See Section 4 for description of variables.

TABLE A.4

TFP GROWTH AND SOURCES OF OUTPUT AND VALUE ADDED GROWTH IN THE 1970-80 PERIOD

	DECOMPOSITION OF OUTPUT GROWTH						DECOMPOSITION OF V. A. GROWTH			
Sector	TFP GROWTH	TFP /OUT	CAP /OUT	LABOR /OUT	MAT INP /OUT	ENERGY /OUT	TFP GROWTH	TFP /VA	LABOR /VA	CAP /VA
101	5.1	42.2	31.6	6.7	18.6	0.9	4.9	41.7	10.2	48.0
102	-3.2	-31.6	86.0	2.9	32.3	10.4	-8.5	-105.1	6.6	198.5
104	1.4	12.5	42.6	14.9	22.7	7.3	1.5	14.8	21.9	63.3
105	3.9	29.3	23.3	-0.9	40.2	8.1	2.2	26.8	-2.8	75.9
106	-0.2	-1.1	40.7	10.4	49.1	1.0	-1.2	-8.9	22.1	86.8
107	7.0	51.7	19.9	5.3	18.7	4.5	6.7	56.2	9.1	34.7
108	8.4	28.9	40.0	5.8	21.4	4.0	6.6	23.4	9.5	67.2
109	-0.4	-2.6	53.9	12.8	32.1	3.9	-2.3	-17.7	22.6	95.1
110	1.5	10.9	25.4	3.7	57.7	2.2	-3.0	-33.9	17.7	116.2
111	3.2	20.4	10.1	3.3	63.7	2.5	4.2	43.5	13.4	43.0
113	2.7	17.6	21.2	20.6	39.7	1.0	2.9	19.5	39.6	40.9
114	0.3	3.1	37.6	12.5	45.5	1.2	1.5	13.6	21.6	64.8
115	1.0	7.0	30.9	10.8	50.3	0.9	-0.2	-1.7	26.4	75.3
116	3.2	26.2	25.1	8.4	40.0	0.3	3.8	35.3	16.2	48.5
117	1.9	14.4	44.1	13.0	26.9	1.5	1.6	12.9	19.8	67.3
121	2.2	15.1	39.2	12.1	33.1	0.5	1.1	9.0	21.6	69.4
122	2.0	11.4	43.8	13.4	31.0	0.5	0.6	3.7	22.5	73.8
123	0.9	6.3	42.6	16.6	33.9	0.5	2.0	14.0	26.8	68.9
124	2.8	18.7	34.3	8.3	38.2	0.4	2.6	20.3	15.4	64.3
125	5.3	35.8	24.9	8.1	31.0	0.2	5.4	42.3	14.0	43.6
126	6.1	31.2	37.4	12.6	18.5	0.3	8.7	43.3	14.5	42.3
127	3.7	26.7	26.4	5.4	41.0	0.5	7.2	52.0	8.1	39.9
131	3.1	22.6	30.9	11.9	34.1	0.6	2.4	20.3	22.2	57.5
132	7.0	51.3	12.3	6.3	29.5	0.6	7.4	60.4	13.4	26.1
133	5.5	49.4	18.4	6.3	25.0	0.8	4.7	55.9	11.4	32.7
134	8.2	58.1	2.3	5.1	34.1	0.4	10.5	86.4	9.3	4.3
135	5.8	45.1	18.3	4.7	31.8	0.0	6.0	56.9	8.7	34.5
137	3.7	18.0	50.3	7.2	24.1	0.4	3.7	19.3	10.0	70.6
138	-0.7	-5.0	44.7	8.9	51.2	0.2	-0.3	-2.5	16.5	85.9
141	9.2	54.7	16.8	8.4	19.3	0.7	8.3	58.4	13.7	28.0
142	4.8	26.8	31.3	17.0	24.2	0.6	5.5	31.0	24.3	44.7
143/4	3.0	33.2	8.7	4.5	53.3	0.2	3.6	62.9	12.6	24.5
145	1.1	5.3	51.0	9.0	34.0	0.7	0.7	3.6	14.2	82.2
147	14.5	44.8	25.2	19.7	9.7	0.7	16.5	50.8	21.6	27.6
148	4.4	21.4	36.2	11.7	30.2	0.5	8.0	35.8	16.0	48.2
15	-1.3	-17.5	66.7	13.7	35.5	1.6	-5.6	-173.0	47.3	225.6
161	1.8	14.8	44.0	10.7	30.0	0.6	-1.5	-15.6	22.4	93.2
162	4.5	44.6	22.2	5.3	27.4	0.5	2.7	36.3	12.1	51.6
163	5.3	39.0	21.6	6.1	33.1	0.2	2.5	25.3	16.4	58.3
172	2.9	32.3	8.8	0.6	55.1	3.2	4.4	72.0	1.8	26.1

TABLE A.4 (Cont.)

TFP GROWTH AND SOURCES OF OUTPUT AND VALUE ADDED GROWTH IN THE 1970-80 PERIOD

	DECOMPOSITION OF OUTPUT GROWTH						DECOMPOSITION OF V. A. GROWTH			
Sector	TFP GROWTH	TFP /OUT	CAP /OUT	LABOR /OUT	MAT INP /OUT	ENERGY /OUT	TFP GROWTH	TFP /VA	LABOR /VA	CAP /VA
173/5	6.1	33.5	18.7	6.3	40.7	0.8	7.5	43.0	14.2	42.7
18	3.2	22.9	23.9	4.3	47.6	0.5	1.8	20.3	12.2	67.5
19	-1.5	-20.8	51.8	9.9	57.9	1.2	-4.3	-90.4	30.8	159.7
200	-0.2	-1.7	44.1	4.0	47.8	5.8	-2.1	-20.7	9.9	110.8
201	2.8	24.6	44.6	0.4	31.7	1.7	-0.4	-3.7	0.9	102.7
202	5.7	31.9	12.9	2.9	51.2	1.0	7.1	56.7	7.5	35.9
204	1.3	12.4	29.1	0.1	56.7	1.7	-5.6	-309.4	1.4	405.5
205	3.4	27.5	44.2	-0.7	29.0	0.0	3.0	28.9	-1.1	72.2
206	6.8	36.1	43.9	1.3	18.5	0.2	3.8	23.2	2.1	74.7
207	4.3	39.5	10.4	3.0	46.4	0.7	4.5	62.9	8.3	28.9
208	2.6	16.9	19.6	1.6	61.5	0.5	1.1	12.5	6.2	81.3
209	3.5	17.2	37.8	4.3	39.9	0.8	0.7	4.4	9.4	86.2
211	6.6	58.9	20.1	0.5	20.4	0.1	4.7	60.1	1.0	38.9
221	2.3	23.4	44.6	1.8	30.1	0.1	-1.1	-16.8	4.6	112.3
222	1.8	18.2	32.4	2.3	46.7	0.5	-2.2	-35.3	8.9	126.3
223	7.4	45.9	9.9	5.2	38.7	0.3	9.4	60.8	13.5	25.8
231	3.3	26.0	33.7	3.9	35.4	1.0	-0.6	-7.2	11.0	96.2
232	4.0	22.0	35.8	10.6	30.7	0.9	1.0	6.8	21.5	71.7
233	0.7	7.7	43.5	13.2	33.8	1.8	0.4	5.1		
241/3	1.0	15.9	8.6	1.2	73.1	1.2	1.0	44.6	6.8	48.7
244	6.5	55.0	15.0	2.1	27.6	0.4	7.5	67.9	3.9	28.3
245	4.8	39.5	9.8	1.7	48.4	0.5	6.2	67.3	4.7	28.0
251	5.7	31.3	26.5	9.7	32.3	0.3	5.9	29.8	19.0	51.2
252/6	4.1	25.7	40.2	11.2	22.6	0.3	0.0	0.4	22.5	77.1
253	0.6	5.3	35.8	15.5	42.8	0.6	0.2	1.8	39.9	47.1
254/7	-1.3	-11.8	53.6	13.9	43.7	0.6	-5.9	-83.0	38.7	144.3
260	2.9	24.6	9.9	1.9	63.1	0.4	5.5	57.5	6.8	35.7
261	-0.4	-3.2	57.1	6.8	38.6	0.8	-3.9	-42.4	15.1	127.3
262	1.3	15.5	22.6	3.6	57.8	0.5	-3.7	-66.9	22.8	144.1
263	0.5	5.9	38.5	8.9	45.5	1.1	-2.7	-73.4	34.3	139.0
266	-1.9	-33.9	60.5	6.9	65.4	1.1	-4.5	-163.8	26.6	237.1
267	-2.6	-19.4	39.8	13.4	63.0	3.2	-2.9	-25.4	33.1	92.3
268	0.7	5.8	29.7	6.7	56.1	1.7	3.6	28.5	13.2	58.3
269	2.2	19.5	19.7	1.8	58.4	0.5	0.9	11.9	7.4	80.7
271/3	1.0	12.0	53.0	-1.6	35.0	1.5	-1.7	-30.5	-3.8	134.4
274	5.1	38.4	34.0	3.1	25.4	-0.9	2.7	24.9	6.2	68.9
28	1.9	43.5	-5.4	0.9	60.9	0.1	3.0	112.6	2.4	-15.0
291	5.6	60.1	22.4	1.8	16.0	-0.3	5.7	63.1	2.8	34.1
292	6.9	56.0	21.7	5.3	16.7	0.2	6.7	56.2	8.6	35.2
299	1.9	10.2	44.2	21.7	22.2	1.7	-0.4	-2.7	34.0	68.7

NOTE: See Section 4 for description of variables.

TABLE B.1

TRADE RELATED VARIABLES: SHARE OF DIRECT EXPORTS IN OUTPUT, SHARE OF IMPORTS IN THE CONSUMPTION OF MATERIAL INPUTS, SHARE OF IMPORTS IN THE INVESTMENT IN MACHINERY AND EQUIPMENT, AND RATIO OF ROYALTIES TO PROFIT

	SHDEX		SHIMI		SHINV		ROY	
Sector	1970	1980	1970	1980	1970	1980	1970	1980
101	0.27	1.40	0.03	0.31	11.2	1.8	0.062	0.024
102	0.16	0.01	0.00	0.00	14.7	0.4	0.000	0.090
104	0.69	3.98	3.77	4.22	34.3	2.2	0.120	0.016
105	0.00	0.57	0.00	0.00	68.4	2.3	0.000	0.000
106	0.00	0.29	4.87	0.71	9.7	5.7	0.550	0.092
107	4.58	2.95	16.88	14.80	29.6	16.2	0.792	0.004
108	0.71	4.56	0.53	2.27	76.7	0.9	0.265	0.204
109	1.28	3.77	4.42	7.12	4.1	14.1	1.131	0.000
110	2.89	3.73	1.32	2.54	32.0	12.7	0.032	0.008
111	0.94	1.92	15.15	16.28	26.7	16.2	0.849	0.003
113	0.07	2.49	0.38	1.47	55.3	4.1	0.143	0.047
114	0.19	2.06	3.78	1.00	33.2	28.3	0.084	0.075
115	0.13	0.74	8.66	2.93	40.8	17.5	0.137	0.009
116	0.24	3.15	1.10	0.71	18.1	9.8	0.047	0.014
117	2.41	10.20	17.77	7.78	14.0	37.0	0.012	0.001
121	0.50	4.33	17.13	9.41	70.0	47.7	0.424	0.038
122	0.73	3.78	7.25	9.55	19.7	20.2	0.431	0.083
123	2.39	6.68	8.90	7.99	31.0	22.8	0.554	0.247
124	0.90	6.10	3.79	3.56	1.4	6.7	0.253	0.004
125	4.28	7.24	8.93	6.41	11.5	8.1	0.293	0.146
126	0.59	4.20	11.90	44.28	24.9	64.6	0.538	0.000
127	3.64	15.18	9.20	13.25	73.9	20.1	0.416	0.000
131	0.62	2.70	20.60	19.46	32.4	14.4	0.048	0.069
132	0.55	1.90	33.12	17.23	38.5	16.1	0.314	0.015
133	2.48	2.59	10.53	21.47	50.2	70.6	0.002	0.000
134	0.25	3.43	12.07	5.19	39.5	24.1	0.383	0.079
135	0.51	7.17	13.55	12.55	15.2	8.9	0.269	0.139
137	9.90	13.37	36.35	54.13	49.2	48.8	0.435	0.006
138	1.93	4.36	11.76	18.49	32.0	37.0	0.074	0.030
141	0.00	18.58	7.89	14.69	13.7	4.7	0.058	0.040
142	0.00	9.91	3.09	9.79	2.8	54.0	0.422	1.244
143/4	0.33	10.98	6.00	4.61	31.2	16.6	0.111	0.070
145	0.25	2.83	8.85	25.55	0.0	78.4	0.007	1.851
147	0.00	25.14	0.00	84.88	52.3	46.3	0.111	0.000
148	0.03	29.58	0.26	6.36	8.5	0.0	0.000	0.000
15	5.75	7.15	0.81	0.88	45.1	13.5	0.016	0.006
161	0.83	0.88	0.29	0.14	16.0	3.4	0.011	0.012
162	1.10	0.71	0.84	0.68	11.1	2.9	0.176	0.071
163	0.02	0.10	1.29	0.83	33.6	2.5	0.452	0.079
172	1.36	3.93	7.90	3.24	21.7	7.1	0.009	0.033

TABLE B.1 (Cont.)

TRADE RELATED VARIABLES: SHARE OF DIRECT EXPORTS IN OUTPUT, SHARE OF IMPORTS IN THE CONSUMPTION OF MATERIAL INPUTS, SHARE OF IMPORTS IN THE INVESTMENT IN MACHINERY AND EQUIPMENT, AND RATIO OF ROYALTIES TO PROFIT

	SHDEX		SHIMI		SHINV		ROY	
Sector	1970	1980	1970	1980	1970	1980	1970	1980
173/5	0.13	2.59	0.91	3.02	61.6	19.6	0.023	0.441
18	2.03	2.43	9.86	10.00	45.5	11.8	0.030	0.002
19	8.73	13.32	2.22	1.49	30.2	20.6	0.077	0.000
200	0.76	1.31	11.31	15.18	17.7	13.8	0.087	0.058
201	0.11	0.53	47.70	66.91	18.5	17.5	0.086	0.042
202	0.47	1.91	32.11	14.38	30.6	17.2	1.876	0.073
204	15.75	36.24	0.02	3.80	2.4	4.8	0.018	0.000
205	0.35	6.05	34.77	42.25	17.7	38.3	0.000	0.000
206	0.28	3.63	19.57	43.14	45.3	5.1	0.001	0.045
207	0.38	0.74	26.83	19.52	13.3	2.5	0.167	0.102
208	0.22	0.04	55.57	48.40	3.0	14.2	0.155	0.005
209	1.86	5.57	23.56	20.62	3.3	8.4	0.528	0.151
211	0.72	2.48	39.34	42.18	30.9	17.7	0.251	0.028
221	0.10	1.26	6.27	7.30	36.5	3.5	0.099	0.021
222	0.00	1.19	8.27	7.28	19.4	19.3	0.100	0.041
223	0.03	1.81	2.58	0.00	6.4	0.7	0.031	0.213
231	0.10	3.56	19.86	6.33	31.0	24.1	0.051	0.059
232	0.17	0.52	9.08	6.90	30.9	9.2	0.067	0.007
233	0.06	1.27	6.97	5.55	26.6	2.8	0.086	0.001
241/3	2.72	6.26	2.46	0.76	47.7	41.2	0.026	0.001
244	0.36	1.02	4.72	1.31	22.4	44.5	0.005	0.000
245	0.65	6.03	0.96	5.21	59.6	61.0	0.047	0.006
251	0.50	1.82	0.11	0.09	28.1	9.6	0.166	0.082
252/6	0.48	4.23	11.13	6.72	18.4	30.2	0.000	0.000
253	4.10	18.03	1.31	3.16	25.7	13.1	0.077	0.010
254/7	0.57	3.68	0.06	0.53	12.8	17.9	0.002	0.000
260	4.73	11.27	16.14	3.43	9.0	13.7	0.006	0.001
261	5.39	8.50	4.29	6.04	13.4	27.9	0.023	0.005
262	3.33	9.30	0.54	1.36	7.5	7.9	0.064	0.000
263	21.47	23.13	0.02	6.31	18.8	1.2	0.000	0.000
266	0.15	7.57	1.41	0.36	56.1	36.5	0.000	0.073
267	0.00	0.13	0.08	0.33	44.5	14.0	0.010	0.006
268	2.23	1.68	0.89	1.12	39.0	42.0	0.009	0.036
269	6.47	9.32	0.96	1.59	13.3	14.0	0.044	0.060
271/3	0.67	0.86	18.29	24.16	10.7	26.7	0.190	0.002
274	0.01	0.19	0.09	0.89	32.1	4.4	0.004	0.006
28	1.60	12.95	0.08	0.51	28.5	12.7	0.006	0.000
291	0.24	0.41	20.72	41.30	81.5	73.9	1.858	0.329
292	0.15	0.61	1.52	0.85	63.9	27.5	0.010	0.011
299	0.00	0.23	4.65	9.70	47.6	44.8	0.182	0.000

Note: See Sections 5.1 and 5.2 for description of variables.

TABLE B.2

TRADE RELATED VARIABLES: SHARE OF TOTAL EXPORTS IN OUTPUT, SHARE OF TOTAL IMPORTS IN DOMESTIC SUPPLY, AND REVEALED COMPARATIVE ADVANTAGE

Sector	SHDEX		SHIMP		RCA	
	1970	1980	1970	1980	1970	1980
Cement and Artefacts	0.0	0.4	2.0	0.1	-1.00	0.64
Glass	4.6	9.7	9.1	7.4	-0.36	0.15
Other Nonmetallic Minerals	0.3	3.7	0.8	2.0	-0.51	0.31
Iron and Steel	5.2	5.1	7.3	3.1	-0.17	0.25
Nonferrous Metals	0.4	2.6	23.2	18.4	-0.98	-0.79
Other Metallurgical Products	1.2	6.0	10.9	5.4	-0.82	0.06
Machin.& Equip. for Industrial Use	4.7	13.1	40.8	26.9	-0.87	-0.42
Machin.& Equip. for Agricultural Use	1.5	6.2	16.7	2.4	-0.85	0.46
Mach.& Equip. for Off. and Domest. Use	10.9	15.9	19.4	8.8	-0.33	0.32
Tractors and Earth-Moving Machines	4.2	18.3	35.4	6.2	-0.85	0.55
Equipment for Electrical Energy	0.7	3.1	16.5	13.3	-0.93	-0.65
Electrical Material	1.6	4.5	9.0	10.9	-0.72	-0.44
Electrical Appliances	0.9	2.0	44.2	9.7	-0.98	-0.69
Electronic Material	2.3	10.6	16.4	33.4	-0.78	-0.62
Naval Industry	3.0	8.9	21.3	5.2	-0.79	0.28
Automobiles, Trucks, Buses and Parts	0.5	11.1	1.7	2.3	-0.54	0.68
Railway Stock and Other Vehicles	1.0	22.0	46.2	39.5	-0.98	-0.40
Wood	7.0	11.3	0.3	1.4	0.94	0.80
Furniture	0.4	0.7	0.0	0.1	0.78	0.74
Cellulose and Paper	0.2	10.8	5.9	4.3	-0.93	0.46
Rubber	1.7	5.0	1.7	5.2	0.01	-0.03
Leather and Hides	10.1	15.2	0.4	1.6	0.93	0.83
Chemical Elements & Compositions	9.1	7.2	52.8	43.4	-0.84	-0.82
Oil-Refining & Petrochemicals	1.3	2.9	6.0	5.3	-0.65	-0.30
Artificial Threads & Resins	0.2	4.3	16.2	9.0	-0.98	-0.37
Other Chemical Products	7.1	24.3	15.6	12.3	-0.42	0.39
Pharmaceuticals	0.9	2.6	5.1	9.2	-0.72	-0.59
Perfurmary, Soaps & Candles	2.6	2.6	1.1	1.2	0.41	0.38
Plastics	0.0	1.5	0.6	0.2	-0.89	0.74
Textiles	2.2	6.7	1.5	0.5	0.19	0.87
Clothing	0.6	2.0	1.1	0.3	-0.32	0.73
Footwear	3.1	19.9	0.0	0.1	0.99	0.99
Food	6.8	27.9	1.8	8.1	0.60	0.63
Beverages	4.3	8.5	1.9	4.5	0.41	0.32
Tobacco	0.6	41.4	0.0	0.4	0.95	0.99
Printing & Publishing	0.4	1.1	2.5	1. 8	-0.74	-0.22

Source: Carvalho and Haddad(1981) and FUNCEX.
Note: See Sections 5.1 to 5.3 for description of variables.

TABLE B.3

DECOMPOSITION OF MANUFACTURING DEMAND GROWTH (%)

Sector	IMPORT SUBSTITUTION	EXPORT EXPANSION	DOMESTIC DEMAND EXPANSION
Cement and Artefacts	2.47	0.55	96.98
Glass	2.36	11.53	86.11
Other Nonmetallic Minerals	-1.60	5.01	96.59
Iron and Steel	5.51	5.01	89.48
Nonferrous Metals	6.16	3.20	90.64
Other Metallurgical Products	7.47	7.79	84.75
Machin.& Equip. for Industrial Use	17.71	15.35	66.94
Machin.& Equip. for Agricultural Use	18.53	7.59	73.88
Machin.& Equip. for Off. & Domest. Use	13.63	17.35	69.01
Tractors and Earth-Moving Machines	39.14	23.17	37.69
Equipment for Electrical Energy	4.29	3.95	91.76
Electrical Material	-2.63	5.57	97.06
Electrical Appliances	47.45	2.38	50.17
Electronic Material	-19.51	11.77	107.75
Naval Industry	19.70	10.27	70.04
Automobiles, Trucks, Buses and Parts	-0.99	18.12	82.86
Railway Stock and Other Vehicles	7.71	25.22	67.07
Wood	-2.26	15.00	87.27
Furniture	-0.09	0.88	99.21
Cellulose and Paper	2.14	13.65	84.21
Rubber	-4.76	6.13	98.63
Leather and Hides	-2.36	19.89	82.47
Chemical Elements & Compositions	12.67	6.59	80.73
Oil-Refining & Petrochemicals	1.09	3.64	95.27
Artificial Threads & Resins	8.64	5.15	86.21
Other Chemical Products	4.41	30.29	65.30
Pharmaceuticals	-6.11	3.40	102.71
Perfurmary, Soaps & Candles	-0.14	2.55	97.60
Plastics	0.57	2.01	97.43
Textiles	2.04	11.32	86.64
Clothing	0.98	2.26	96.77
Footwear	-0.17	29.14	71.03
Food	-10.85	43.21	67.64
Beverages	-4.30	11.06	93.25
Tobacco	-0.98	115.10	-14.12
Printing & Publishing	1.18	1.55	97.28

NOTE: See Section 5.4 for definition of variables.

TABLE B.4

LABOR RELATED VARIABLES: MALE PARTICIPATION IN THE LABOR FORCE AND SHARE OF SKILLED WORKERS IN LABOR FORCE IN PRODUCTION

	SHARE OF MALES		SKILLED WORKERS			SHARE OF MALES		SKILLED WORKERS	
Sector	1970	1980	1970	1980	Sector	1970	1980	1970	1980
101	98.9	96.3	70.1	69.6	173/5	0.67	2.43	0.85	3.14
102	99.4	96.9	87.5	84.8	18	0.34	2.26	2.78	4.57
104	85.8	83.1	88.3	70.7	19	0.65	2.16	1.47	2.58
105	98.9	98.9	97.2	94.5	200	2.42	5.55	5.36	6.46
106	97.2	95.5	97.0	94.6	201	1.46	2.33	11.44	9.89
107	88.5	86.2	86.9	88.2	202	1.26	3.10	4.28	5.43
108	96.9	96.7	96.8	95.0	204	0.72	4.53	2.06	4.01
109	82.0	79.3	80.2	75.8	205	2.21	4.07	5.33	15.62
110	98.4	97.4	81.9	73.1	206	2.81	3.41	2.87	5.89
111	95.2	93.7	90.5	87.9	207	3.12	3.97	6.14	7.08
113	97.9	96.5	97.5	95.3	208	5.70	4.32	3.41	4.39
114	88.0	84.2	92.1	86.8	209	1.77	3.88	4.34	7.39
115	77.5	78.7	57.9	53.2	211	2.63	3.26	6.55	9.55
116	94.6	88.7	50.7	48.5	221	1.59	2.35	3.96	5.13
117	89.7	81.4	89.7	84.2	222	1.10	4.11	3.58	3.82
121	97.0	94.7	80.1	68.8	223	2.99	4.05	0.56	1.78
122	95.5	93.0	86.6	83.2	231	4.39	5.21	2.08	4.09
123	96.3	95.0	79.1	68.1	232	4.15	4.44	1.43	3.17
124	97.6	95.1	61.0	57.3	233	2.04	4.03	1.93	3.61
125	90.4	87.5	52.8	52.2	241/3	5.71	4.80	0.86	1.59
126	70.0	58.1	44.8	50.9	244	0.46	6.49	0.70	2.09
127	97.5	95.5	65.2	78.2	245	6.77	7.29	1.04	3.83
131	87.3	83.9	25.1	19.4	251	6.13	5.77	0.62	1.97
132	81.5	71.8	50.7	51.9	252/6	4.07	4.45	0.06	2.21
133	53.0	61.8	66.2	58.8	253	3.91	4.10	0.53	1.62
134	81.7	69.3	45.8	38.3	254/7	2.28	3.20	0.64	1.98
135	79.2	70.5	78.0	72.6	260	2.84	3.78	1.22	3.17
137	45.5	49.5	64.8	50.5	261	3.89	5.87	1.19	2.83
138	61.6	43.6	84.4	68.1	262	4.39	3.78	0.82	2.67
141	98.4	98.1	51.4	52.9	263	3.42	4.08	1.05	2.72
142	98.5	98.1	51.6	53.2	266	3.04	4.95	0.54	2.70
143/4	94.6	91.1	95.4	82.1	267	3.21	3.26	0.72	1.20
145	92.1	85.1	60.9	55.8	268	0.87	2.40	0.73	2.31
147	94.8	95.4	90.9	86.7	269	15.48	7.52	2.29	3.99
148	97.0	78.1	93.0	88.5	271/3	1.86	3.16	1.57	5.23
15	96.9	91.2	92.4	87.2	274	0.64	2.19	1.92	4.72
161	95.1	86.0	50.3	49.4	28	0.82	2.43	1.25	3.71
162	94.6	86.0	88.0	79.2	291	0.94	3.30	7.36	15.69
163	80.4	68.5	82.2	77.1	292	1.05	2.73	1.84	2.91
172	88.2	85.4	88.6	80.2	299	1.51	3.36	4.60	6.94

Note: See Section 5.5 for description of variables.

TABLE B.5

CAPITAL RELATED VARIABLES: SHARE OF MACHINERY IN THE STOCK OF CAPITAL, INVESTMENT-CAPITAL RATIOS, CAPITAL-OUTPUT RATIOS, AND RATES OF RETURN ON MACHINERY AND EQUIPMENT

	M&EQ/CS		ILM70		M&EQ/OUTPUT		RRM&EQ	
Sector	1970	1980	1970	1980	1970	1980	1970	1980
101	49.4	51.9	0.36	0.24	0.75	0.67	1.16	1.33
102	36.0	60.8	0.38	0.37	0.37	0.53	3.16	1.21
104	49.6	52.2	0.33	0.27	0.64	0.46	1.39	1.99
105	58.6	67.2	0.47	0.18	0.91	0.36	1.03	1.48
106	43.3	46.4	0.39	0.31	0.27	0.30	3.31	2.44
107	59.4	60.5	0.30	0.37	0.50	0.28	1.59	2.47
108	53.8	72.2	0.53	0.08	0.88	0.92	0.87	0.72
109	56.8	65.1	0.22	0.22	0.27	0.24	3.31	2.73
110	63.3	65.2	0.15	0.40	0.32	0.29	1.67	0.98
111	62.7	63.1	0.23	0.25	0.47	0.15	1.17	2.22
113	45.3	48.3	0.53	0.28	0.39	0.25	1.55	2.40
114	64.9	69.5	0.26	0.30	0.39	0.28	1.39	2.08
115	63.9	71.5	0.20	0.25	0.37	0.25	1.67	1.65
116	47.5	54.9	0.28	0.23	0.29	0.19	2.86	3.74
117	67.1	69.2	0.20	0.28	0.32	0.27	2.35	2.60
121	62.3	65.5	0.28	0.27	0.39	0.30	2.11	2.05
122	46.4	53.4	0.29	0.30	0.28	0.24	3.44	3.09
123	60.5	65.4	0.25	0.26	0.43	0.34	1.67	1.81
124	49.3	53.9	0.38	0.37	0.30	0.17	3.19	4.74
125	58.1	56.9	0.24	0.28	0.31	0.17	3.07	4.78
126	81.4	54.5	0.15	0.50	0.31	0.14	2.14	9.80
127	66.2	64.0	0.27	0.22	0.34	0.15	2.33	5.98
131	48.7	50.7	0.24	0.42	0.32	0.21	2.95	3.61
132	63.0	59.5	0.33	0.36	0.33	0.15	1.95	4.06
133	65.8	82.4	0.17	0.25	0.36	0.15	3.00	4.22
134	69.4	62.6	0.30	0.35	0.43	0.13	1.58	5.29
135	46.5	53.3	0.39	0.34	0.28	0.11	4.13	7.76
137	59.5	70.4	0.42	0.39	0.24	0.17	4.66	5.06
138	47.1	58.7	0.34	0.41	0.16	0.09	6.45	9.18
141	37.9	38.6	0.15	0.24	0.47	0.18	3.25	7.10
142	62.9	41.5	0.08	0.26	0.33	0.38	2.60	2.70
143/4	65.6	66.0	0.27	0.32	0.38	0.16	2.03	3.41
145	74.9	70.3	0.09	0.32	0.23	0.16	3.34	4.66
147	47.5	36.6	0.77	1.23	0.70	0.23	1.39	7.58
148	43.6	46.4	0.26	0.16	0.34	0.15	2.79	8.25
15	47.0	42.6	0.30	0.38	0.42	0.35	3.14	2.64
161	37.9	45.3	0.31	0.33	0.25	0.22	4.86	3.64
162	43.0	47.4	0.32	0.37	0.28	0.16	3.97	4.99
163	50.0	40.1	0.31	0.63	0.18	0.12	5.04	6.49
172	71.8	66.4	0.17	0.23	0.72	0.31	0.83	1.68

TABLE B.5 (Cont.)

CAPITAL RELATED VARIABLES: SHARE OF MACHINERY IN THE STOCK OF CAPITAL, INVESTMENT-CAPITAL RATIOS, CAPITAL-OUTPUT RATIOS, AND RATES OF RETURN ON MACHINERY AND EQUIPMENT

	M&EQ/CS		ILM70		M&EQ/OUTPUT		RRM&EQ	
Sector	1970	1980	1970	1980	1970	1980	1970	1980
173/5	62.4	66.2	0.26	0.29	0.33	0.18	1.48	2.77
18	68.7	66.4	0.27	0.29	0.27	0.18	2.62	2.71
19	45.3	52.5	0.29	0.24	0.31	0.27	2.93	2.16
200	72.7	76.9	0.14	0.17	0.67	0.53	1.01	0.91
201	73.3	83.7	0.15	0.18	0.45	0.16	1.22	3.07
202	76.1	75.0	0.15	0.14	0.88	0.22	0.73	1.99
204	58.9	58.1	0.16	0.28	0.21	0.14	4.43	2.80
205	33.0	45.5	0.46	0.43	0.22	0.11	9.13	11.33
206	49.6	50.4	0.25	0.19	0.22	0.15	6.31	7.64
207	52.2	51.5	0.22	0.45	0.37	0.14	2.76	5.36
208	50.4	39.0	0.18	0.32	0.19	0.07	5.51	10.16
209	47.7	56.0	0.24	0.32	0.27	0.15	4.27	4.68
211	45.9	42.2	0.27	0.38	0.23	0.19	7.12	6.54
221	42.6	54.4	0.43	0.45	0.16	0.14	9.47	5.71
222	55.1	57.1	0.22	0.35	0.15	0.13	5.14	3.62
223	38.0	57.8	0.20	0.40	0.42	0.15	1.75	3.52
231	60.6	70.0	0.26	0.51	0.29	0.19	3.15	2.69
232	58.4	74.9	0.32	0.32	0.39	0.30	2.18	1.55
233	72.5	70.5	0.30	0.29	0.38	0.25	1.91	2.81
241/3	66.7	67.2	0.20	0.25	0.45	0.21	1.43	2.05
244	52.2	65.5	0.26	0.27	0.45	0.25	1.33	2.18
245	74.2	77.5	0.32	0.27	0.32	0.13	1.59	3.14
251	49.7	57.2	0.74	0.31	0.15	0.11	3.80	5.84
252/6	46.5	49.9	0.48	0.41	0.22	0.18	6.19	4.25
253	55.7	55.4	0.28	0.44	0.22	0.14	3.08	4.76
254/7	46.7	56.7	0.38	0.23	0.14	0.13	7.71	4.34
260	53.6	44.9	0.15	0.45	0.24	0.19	2.60	2.96
261	46.2	55.0	0.35	0.32	0.21	0.16	5.86	4.78
262	33.8	40.0	0.39	0.43	0.15	0.11	3.99	3.65
263	35.9	37.7	0.84	0.34	0.65	0.44	2.58	2.05
266	59.6	64.6	0.28	0.38	0.30	0.22	2.60	2.54
267	49.0	56.2	0.20	0.15	0.20	0.33	4.44	1.32
268	51.3	58.7	0.26	0.28	0.31	0.30	1.98	2.14
269	52.6	54.3	0.20	0.40	0.21	0.12	3.48	4.13
271/3	42.7	57.1	0.24	0.24	0.55	0.46	1.98	1.52
274	40.1	50.6	0.25	0.37	0.61	0.55	1.97	1.45
28	64.1	56.6	0.33	0.15	0.29	0.20	2.88	4.22
291	55.8	55.1	0.27	0.33	0.26	0.20	2.58	4.39
292	66.9	69.9	0.19	0.25	0.43	0.34	1.29	1.71
299	64.0	75.9	0.33	0.27	0.32	0.37	2.31	1.30

NOTE: See Section 5.6 for definition of variables.

TABLE B.6

AVERAGE ESTABLISHMENT SIZE, CAPACITY UTILIZATION, AGE STRUCTURE, INDUSTRIAL CONCENTRATION, AND RELATIVE TOTAL FACTOR PRODUCTIVITY

	SIZE*		RSIZE	CAP. UTIL.		AGE STRUCT.		IND. CONC		RELAT. TFP	
Sector	1970	1980		1970	1980	1970	1980	1970	1980	BIL.	MULT
101	408	12869	7.11	10.0	19.3	35.6	29.1	20.6	17.6	86.6	83.9
102	485	33406	9.88	20.0	39.5	39.1	22.8	63.9	62.4	56.0	52.0
104	308	11774	3.99	21.6	28.7	17.7	18.5	45.1	37.9	78.8	76.9
105	32379	951002	1.86	48.3	70.9	6.9	21.6	82.0	45.4	82.5	86.2
106	725	21114	3.28	12.8	25.1	30.8	33.4	44.8	30.5	55.2	49.5
107	3139	159631	11.51	40.5	82.5	14.7	9.1	73.1	65.9	73.7	71.4
108	699	54527	21.04	19.3	31.6	32.9	29.1	51.1	44.3	100.0	100.0
109	1234	77897	9.55	50.2	31.8	19.6	10.4	77.0	77.6	50.0	45.4
110	10251	531818	9.30	33.4	69.9	6.2	12.3	54.5	47.5	64.9	59.6
111	4197	222634	8.56	113.1	244.3	15.6	9.2	63.9	43.7	76.0	71.7
113	1828	61849	4.89	16.8	16.8	27.8	32.2	70.9	52.7	65.3	56.2
114	1252	62795	6.78	12.6	18.4	13.8	14.5	40.7	32.5	72.0	65.6
115	2339	103737	5.80	7.4	19.0	13.4	12.6	40.0	33.4	65.7	60.0
116	746	24782	5.92	5.8	20.6	24.2	15.9	38.4	38.8	57.5	50.9
117	1426	79879	10.50	11.6	24.4	6.5	17.2	69.4	66.7	58.8	53.7
121	3583	116700	3.97	11.2	15.7	5.5	14.8	75.1	51.2	53.9	48.4
122	1587	101415	11.30	10.4	14.6	24.6	21.8	41.2	33.5	47.8	41.5
123	1539	83125	9.13	9.9	18.3	12.0	15.1	27.9	24.3	64.9	58.3
124	1243	112823	13.39	4.8	13.5	11.4	18.7	49.0	55.7	51.5	45.8
125	4802	203834	8.82	8.4	23.3	11.4	10.6	64.6	47.0	50.4	46.2
126	3543	242176	6.72	22.3	26.9	14.4	39.4	100.0	96.8	58.8	54.9
127	7581	416459	8.49	15.4	18.1	22.2	13.6	86.2	82.0	55.1	50.9
131	3293	139542	7.11	13.3	23.2	16.3	24.7	57.0	44.4	52.7	47.1
132	3864	164693	8.54	17.6	35.7	25.2	16.1	57.1	38.1	61.9	56.5
133	13666	531845	7.68	52.5	38.6	8.8	0.1	100.0	99.9	49.1	49.0
134	3105	232459	14.19	20.0	32.6	6.8	18.2	77.2	78.9	68.7	63.9
135	2715	158300	10.77	15.5	26.5	13.2	9.5	68.1	68.6	44.0	39.1
137	6588	215999	6.81	16.2	69.4	9.6	29.1	90.5	59.2	40.4	38.1
138	4724	359522	10.38	2.1	29.7	9.4	16.9	71.0	62.0	35.6	30.3
141	2954	170828	13.08	11.1	33.7	8.2	6.0	90.5	87.1	47.5	43.5
142	6510	228012	9.04	7.8	12.6	4.5	17.4	92.9	78.8	51.8	47.1
143/4	6306	242016	5.17	16.2	28.4	8.7	13.1	74.8	61.5	59.8	55.5
145	2188	364274	19.70	12.2	50.7	2.8	32.9	94.0	95.5	51.1	47.9
147	2358	202888	19.30	11.8	23.8	29.1	3.3	99.9	95.4	74.9	71.3
148	477	67808	16.92	6.8	22.6	24.4	26.9	74.6	86.9	56.4	50.0
15	459	19716	3.39	12.2	16.8	31.3	24.7	12.9	16.7	50.5	48.5
161	417	18837	8.30	5.7	13.3	30.3	21.7	15.1	15.3	46.9	41.0
162	1007	49074	9.06	8.1	21.5	20.6	15.1	47.8	50.6	51.5	46.3
163	694	50545	13.16	6.5	28.9	24.6	24.4	63.2	44.9	45.7	40.5
172	8130	401382	6.56	34.7	45.7	17.4	13.6	61.4	57.5	86.6	85.0

TABLE B.6 (Cont.)

AVERAGE ESTABLISHMENT SIZE, CAPACITY UTILIZATION, AGE STRUCTURE, INDUSTRIAL CONCENTRATION, AND RELATIVE TOTAL FACTOR PRODUCTIVITY

	SIZE*		RSIZE	CAP. UTIL.		AGE STRUCT.		IND. CONC.		RELAT. TFP	
Sector	1970	1980		1970	1980	1970	1980	1970	1980	BIL	MULT
173/5	1668	119755	14.15	5.5	31.5	14.1	13.8	52.1	68.5	76.4	71.6
18	2801	140246	9.90	22.3	22.2	10.4	6.1	72.5	65.0	55.7	51.3
19	1226	60428	5.87	9.3	14.2	6.7	14.2	42.2	29.7	57.1	51.9
200	3537	271307	12.14	70.4	217.8	11.0	27.8	47.3	42.6	81.6	81.2
201	37188	2387729	2.06	36.8	108.4	15.4	17.6	91.2	82.3	64.4	57.7
202	21661	883473	4.93	39.2	62.1	9.2	23.1	89.9	46.3	88.4	86.2
204	5145	344586	10.33	16.8	25.9	20.3	45.1	38.7	59.9	42.1	37.1
205	3653	245351	13.03	24.0	25.8	14.2	0.7	94.0	94.3	24.3	20.7
206	2890	261390	17.30	22.5	22.8	15.5	29.4	68.0	74.4	31.8	28.1
207	5233	288555	8.38	15.3	20.5	11.1	8.8	61.4	55.8	49.6	44.6
208	5531	855842	16.01	34.2	55.8	28.1	35.1	67.8	53.8	35.9	30.4
209	1683	167118	15.89	24.4	1.8	16.8	20.9	51.5	38.2	39.1	33.9
211	6085	219470	11.40	33.3	48.5	5.4	11.0	42.8	39.4	26.5	24.4
221	5677	192247	7.74	17.8	23.1	7.4	11.0	83.6	83.6	27.1	23.6
222	2778	126250	8.13	20.0	34.9	5.3	9.7	73.1	70.7	42.7	36.9
223	842	27172	8.13	19.8	19.4	13.8	15.4	90.7	72.3	69.1	63.2
231	7528	161272	0.86	19.3	33.7	19.6	11.5	81.6	53.0	50.7	46.9
232	1281	64977	11.96	17.4	35.7	22.7	16.2	48.3	34.4	65.0	61.2
233	1192	50549	4.45	28.1	37.9	16.8	12.6	78.2	65.0	62.4	58.3
241/3	2979	142352	5.62	21.5	38.9	14.8	12.3	23.6	18.8	76.9	74.0
244	1262	49564	8.94	18.3	15.7	8.5	14.4	62.3	55.2	82.1	75.1
245	4472	239015	9.99	19.8	29.6	23.7	13.5	79.1	82.3	68.2	63.0
251	1069	38123	7.82	16.0	11.9	31.7	26.1	21.9	24.7	55.8	49.2
252/6	784	36693	10.50	4.3	16.4	40.3	18.4	77.8	52.9	38.7	36.2
253	673	38391	6.48	7.0	19.6	21.2	20.1	29.3	30.3	59.3	52.9
254/7	728	25797	2.89	18.3	19.8	21.1	21.1	56.7	53.2	29.7	27.8
260	1975	63496	8.41	15.6	26.5	18.8	19.1	27.2	17.5	59.1	54.1
261	1576	76081	6.07	17.4	32.5	23.8	17.0	64.7	50.9	39.0	35.1
262	4576	213642	4.64	20.9	31.5	22.5	18.6	32.1	26.8	53.3	46.1
263	2110	105960	7.13	18.6	44.0	29.2	13.4	57.0	57.6	57.7	55.6
266	2820	148976	4.63	17.5	21.9	3.9	6.1	70.7	70.5	56.3	51.6
267	229	3824	1.83	15.1	53.0	33.9	27.2	8.0	9.4	52.3	48.4
268	1623	43883	5.21	30.9	45.7	10.2	11.0	48.8	44.4	68.0	63.5
269	3564	175932	7.71	18.5	32.3	20.8	22.1	39.6	31.7	51.2	45.6
271/3	1497	217043	10.84	21.7	33.7	9.4	13.6	77.0	72.7	62.2	57.2
274	1217	68637	15.13	16.2	30.9	15.4	20.7	53.7	43.5	67.1	63.1
28	14025	339730	0.48	28.0	6.7	2.9	29.5	90.0	91.9	51.6	47.8
291	2808	88139	5.99	11.1	38.5	9.1	18.1	58.2	58.7	49.7	41.7
292	451	15637	8.61	4.7	23.3	19.3	14.9	22.8	34.3	83.0	77.0
299	780	23383	5.79	22.0	23.4	24.4	14.5	53.0	39.7	57.6	51.2

Note: See Sections 5.7 to 5.12 for description of variables.
* In thousands of current cruzeiros.

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