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FOREWORD

This publication is intended to make available the results of IPEA's research and policy analysis to a broader international audience. It contains a selection of articles published in portuguese over the last three years in the two IPEA's journals – Pesquisa, Planejamento Econômico and Planejamento e Políticas Públicas. Named Brazilian Economic Studies (BES) it had nine volumes published during the period 1975-1985. In this new format we hope that it will fulfill an important role in which refers to the dissemination of IPEA's work abroad.

What is behind the decision to put again Brazilian Economic Studies into press is the growing international interest in distinct aspects of the socioconomic reality of Brazil and the future prospects for the country. It goes beyond the more restrict circle of the so-called "Brazilianists", who developed the capability to overcome the language barrier, to reach a more broad audience. Thus, english texts produced by Brazilians experts and focused on applied research and policy analysis might be on the needs. IPEA could not miss the opportunity to open itself to the international community.

This volume of the new serie put toghether a variety of articles dealing with a wid spectrum of subjects mirrowing the plurality of approvaches and interests that is a distinct mark of the intelectual production of the Institute. There is no intention in selecting a more uniform sit but to offer the readers the opportunity to pick the texts that bitter suit their particular interests.

Even though BES caters to the foreign audience connected with academic and governmental activities, multilateral agencies included, the public in general whith stronger intelectual or business interests in the country may find it to be of source value. From all of them we hope to receive comments and suggestions that will be greatly wellcomed.

Fernando Rezende
President of Ipea

THE EVOLUTION OF WELFARE, POVERTY AND INEQUALITY IN BRAZIL OVER THE LAST THREE DECADES: 1960-1990

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Rosane Silva Pinto de Mendonça[**]

Abstract

The central goal of the study is to evaluate the combined effect on the level of poverty and social welfare of those changes in average income and income inequality which took place in Brazil over the last three decades. Due to the choice of a different methodology the study is able to compute the overall effect on the level of poverty and social welfare of the Brazilian process of inequitable growth without having to specify any particular welfare function, poverty measure or poverty line. The main empirical findings show that despite all the differences among the three decades, they have at least two facts in common: first, inequality increased continuously; second, the changes in poverty and social welfare followed the behavior of growth, improving whenever there was growth and worsening when economic decline occurred. In other words, the impact of increasing inequality was important in mitigating the positive effects of growth, but it was never large enough for reversing them.

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Original version drafted in English.

1. Introduction

1.1 Some basic facts

The Brazilian *per capita* gross domestic product (GDP) for 1990 was about two and a half times greater than its corresponding value for 1960. This corresponds to an average annual growth rate of 3.0%. During this period, very few economies in the world experienced average annual growth rates of such a magnitude. As a matter of fact, among approximately one hundred countries for which the World Bank (1991:204-205) has information on rates of growth,[1] less than 1/4 experienced overage onnual growth rates greater than 3.0 %, between 1965 and 1989. Among Lotin Americon countries, in particular, only Mexico, Ecuador, and Poraguay had *per capita* GDP growth rates equal to or greater than 3.0 % *per* year in this period.

This ropid economic growth, however, was not evenly distributed over time nor it equally benefited all segments of the society. In fact, the rate of growth fluctuates considerably over time and led to a substantial increase in the degree of income inequality: The growth rate in *per capita* GDP fluctuated from 11 % in 1973 to -7 % in 1981 and the Gini coefficient for the distribution of the economically active population with positive income increased from 0.50 in 1960 (Langoni (1973: table 3.6)) to 0.61 in 1990 (Barros, et alii (1993)).

1.2 The trade-off between average income and income inequality

Growth in *per capita* income and increments in the degree of income inequality affect the level of social welfare and poverty in opposite directions.[2] Hence, the sharp increase in income inequality in Brazil during the last three decades contributed to greater poverty and lower social welfare, while the high rate of growth in *per capita* income contributed to smaller poverty and higher social welfore. Despite intense reseorch on income distribution in Brozil, it remains largely unsettle which of these two opposing effects has actually dominate. In other words, it still remoins to be determined whether the Brozilian process of fast ond inequitoble growth was accompanied by greater poverty and lower levels of social welfore. This is precisely the core of the discussion surrounding Fields' (1977) article,[3] which remains, to a large extent, os unresolved today as it was 15 years ago.

1 More precisely, the information is about the growth rate of per capita GDP for the 1965-1989 period. During this period, the Brazilian *per capita* GDP grew at an average rate of 3.5 % *per* year.

2 In this study social welfare and poverty are assumed to be completely determined by the distribution of income. Hence, all other dimensions of poverty and social welfare are ignored. For a precise definition of these concepts, see Section 2.

3 See also the comments by Ahluwalia et al. (1980), Beckerman and Coes (1980) and Fishlow (1980), as well as fields (1980) reply

A large literature was developed around this question. Most studies investigated both the increase in the degree of income inequality and the growth rate in *per capita* income, but all of them were unable to evaluate the combined effect on the level of poverty and welfare.[4] A smaller branch of this literature investigated directly the impact of the Brazilian economic performance on the level of poverty using specific poverty measures and poverty lines.[5] Each of these branches has its own weakness. The studies based on inequality and growth provided no indication on how to find their combined effect on poverty and welfare. The literature on poverty provides no indication of the extent to which their results are robust to the choice of poverty measures and poverty lines.

1.3 Objectives

Accordingly, the central goal of this study is to evaluate the combined effect on the level of poverty and social welfare of those changes in average income and income inequality which took place in Brazil over the last three decades, without relying on any specific social welfare function, poverty measure or poverty line.

As already mentioned, the growth rate in average income and the increments in the degree of income inequality varied substantially over the last three decades in Brazil. So, in addition to investigate their combined effect on the level of social welfare and poverty for all three decades together, we also investigate each decade separately.

Moreover, given the actual increase in inequality, we are going to estimate the smallest growth rate which would be required for poverty to decline and social welfare to improve. This minimum growth rate serves as an indicator of the magnitude of increase in inequality. Hence, it provides a standard to compare the increase in inequality in the three decades. Decades with greater required minimum growth would be those with greater increase in inequality.

1.4 Methodology

The major difference between this study and the previous literature about income distribution in Brazil is methodological. Due to the choice of a different methodology we are able to compute the overall effect on the level of poverty and social welfare of the Brazilian process of inequitable growth, without having to specify any particular welfare function, poverty measure or poverty line. The previous literature was either unable to compute the combined effect or had to rely on the choice of specific poverty measures and poverty lines.

4 The literature is very large, in particular for the 1960-1970 period. For the 1960s the main studies are: Langoni (1973), Fishlow (1972) and Morley (1982). The 1970s are investigated in Denslow and Tyler (1983), Hoffmann and Kageyama (1986) and (1992). Bonelli and Ramos (1992) and Cardoso, Barros and Urani (1993).

5 See Thomas (1982), Pastore, Zilbrestayn and Pagoto (1983), and Rocha (1990).

The major problem with the methodology used in the early literature, was its inability of putting bounds on the trade-off between growth and inequality without having to assume specific function-forms for the social welfare function. However, relatively recent developments in the theory of ranking income distributions by Shorrocks (1983) demonstrate that it is possible to bound the society taste for equality, at least, as long as one is willing to make the quite reasonable assumption that a Pareto improvement will never lead to a reduction in social welfare.[6]

This methodology, as further developed by Foster and Shorrocks (1988a-c), is based on ranking income distributions using the concepts of first and second-order stochastic dominance. This methodology permits to establish easily and once-for-all whether poverty has declined (increased) and social welfare has improved (worsened) for a vast class of social welfare functions, poverty measures and poverty lines. Moreover, this methodology by answering simultaneously how the level of welfare and how the level of poverty has changed demonstrates that these two questions are fundamentally equivalent.

As this study aims to illustrate, the concepts of stochastic dominance are better suited for tracing the evolution of social welfare and poverty over time than more traditional analysis based on the separate analysis of growth and inequality.

All information required to conduct this study is contained in the Brazilian income distribution for the years 1960, 1970, 1980 and 1990.

1.5 Organization

The study is organized in five sections. Section 2 reviews the methodology used in previous studies and the one we are going to use. Moreover, it compares the two procedures, clarifying the advantages of the new methodology. Section 2 also briefly review the concepts of first and second-order stochastic dominance and how they can be used to rank distributions according to levels of social welfare, poverty and inequality.

Section 3 defines which type of income distribution is used throughout the study and how the theoretical criteria for ranking income distributions developed in Section 2 are going to be empirically implemented. Section 4 presents the substantive empirical analysis while Section 5 summarizes our main findings.

6 We say that a Pareto improvement has occurred when the income of all individuals increase or remain constant.

2 Methodology

2.1 Random variables and income distributions

In this study, we are interested in ranking a finite number of random variables and so their corresponding distributions. Each of these random variables is defined over a finite population, which may vary with the random variable. Without any loss of generality, we can assume that all random variables are defined over the same finite population.[7] Let $\Omega = \{1,..., n\}$ denote such finite population. We assume that all points in Ω have equal probability, i.e., P [1}]= 1/n, for i=1,...,n. Positive random variables defined in Ω will be denoted by $X \equiv (X_1, \ldots, X_n)$ or $Y \equiv (Y_1, \ldots, Y_n)$ Let F(X) denote the cumulative distribution function of X, i.e.,

$$F(X, t) = \frac{\# \{i: X_i \leq t\}}{n} \qquad \text{for all } t \geq 0$$

Since all points in Ω have identical probability of occurring, X and Y will have the same distribution if and only if they are permutations of each other. The axiom of anonymity, which we assume to be valid, requires that two random variable should be equivalent in terms of social welfare if they are permutations of each other. As a result, this axiom guarantees that the ranking of random variables can be obtained from the corresponding ranking of their distributions. Alternatively and without any loss of generality, we can restrict the space of random variables to those which are non-decreasing functions, i.e., those for which $X_i \geq X_j$ whenever $n \geq i \geq j \geq 1$. Let $\mathbf{X}$ denote this space of random variables, i.e.,

$$\mathbf{X} \equiv \{(X_1, \ldots, X_n) \in R_+^n : X_i \geq X_j \text{ for all } n \geq i \geq j \geq 1\}$$

Furthermore, note that for all $X \in \mathbf{X}$, whenever $X_1 > X_{i-1}$

$$X_i = \inf\{t: F(X, t) \geq i / n\}$$

i.e., X_i is the (i/n)-quantile of the distribution F(X). So, X has the double role of being both the underlying random variable and the set of (i/n)-quantiles, i=1,...n, of its own distribution, F(X). Hence, in the case of a finite universe with uniform distribution, the random variable and its cumulative distribution function convey precisely the same information. Notice that usually they convey very different information. In other words, in our case, $F: \mathbf{X} \rightarrow F(\mathbf{X})$ is a one-to-one mapping. Both X and F(X) present a complete and concise description of the distribution. This fact is precisely the reason why in the income distribution literature, both X

7 This is possible because we are dealing with a finite number of random variable, each defined over a finite population.

and F(X) are commonly refereed to as the income distribution. We keep with this tradition in referring to any $X \in \mathbf{X}$ as an income distribution.

2.2 Income distribution and income inequality

From the cumulative distribution, F, of any positive random variable with positive and finite mean, it is always possible to obtain its mean μ (F) and its Lorenz curve L(F). Conversely, given any Lorenz curve, R, and any positive number, α, it is always possible to uniquely obtain a cumulative distribution, F, such that $\mu(F) = \alpha$ and L(F)=R. In other words, the pair $(\mu(F),\ L(F))$ is an alternative representatior of F, i.e., $(\mu(F),\ L(F))$ and F convey precisely the same information. Moreover, the fact that R and α can be independently chosen implies that $(\mu(F),\ L(F))$ is a kind of orthogonal decomposition of the information contained in F.

In our finite case,

$$\mu(X) = \frac{1}{n} . \sum_{i=1}^{n} X_i$$

and

$$L(X,j) \equiv \frac{1}{n.\ \mu(X)} . \sum_{i=1}^{j} X_i$$

for j=1,...,n and L(X,0) ≡ 0. Moreover, X and so F(X) can be obtained from the pair $(\mu(X),\ L(X))$ via

$$X_i = n.\mu(X) . (L(X,i) - L(X,i-1)) \quad i=1,...n.$$

If X and Y are two distributions in $\mathbf{x}$ we say that Y is more unequal that X if and only if $X/\mu(X)$ can be obtained from Y/μ (Y) by a sequence of progressive Pigou-Dalton transfers. This condition is equivalent to require that L(X)>L(Y) (Marshall and Olkin (1979, chapter 2). This is one of the fundamental theorems in the measurement of inequality. It implies that all the information about the measurement of inequality. It implies that all the informatian about the degree of inequality in the distribution X is contained in its Lorenz curve, L(X). Moreover, the Lorenz curve contains information only about inequality, in the sense that whenever two distributions have the same degree of inequal ty they must have the same Lorenz curve.

As a consequence, the pair $(\mu(X), L(X))$ represents an orthogonal decomposition of the information in X. $\mu(X)$ captures all the infarmation on the level of X and only this information, whereas L captures all the information on the degree of inequality in X and only this informotion. Due to this foct this decomposition hos ployed o poromount in the literoture on income inequolity.

This decomposition olso helps to clorify the distinction between the distribution of income ond the inequolity in the distribution of income. The distribution of income is given by all the informotion contoined in F(X) or X, while the inequolity in the distribution of income is oll the informotion contoined in L(X). The informotion gop between the two is precisely $\mu(X)$. So, two distributions with the same Lorenz curve but with different meons will not be the identicol, but will necessorily hove the same degree of inequolity.

2.3 Families of welfare functions and partial orderings

Assume that the preferences of the society over income distributions con be represented by o social welfare function $W: X \rightarrow R \equiv (-\infty, \infty)$ and let W denote the set of all such functions. If the relevant social welfore function were known, it would immediotely induce a complete ordering on the spoce of income distributions, X, with X being at least os good as Y if ond only if $W(X) \geq W(Y)$.

Nevertheless, usuolly, we only know o few general properties of the social welfore function, i.e., we only know that $W \in w \subset w$, where $\bar{w}$ is the family of social welfare functions satisfying a prescribed set of properties. The knowledge thot $W \in W$ generates o partiol ordering omong income distributions in X, with X being at leost as good as Y if and only if $W(X) \geq W(Y)$ for all $W \in W$. The smaller the family W is, the thinner the induced partial order generated. If W hos only one element then a complete ordering will be obtoined.

Therefore, our goal is to find the smallest family W, by imposing restrictions on W which command general ogreement. At this point it is convenient to introduce two families of welfare functions, W_1 and W_2. Let W_1 denote the space of all increosing social welfore functions, i.e.,

$$W_1 \equiv \{W: X \rightarrow R: \text{ W is increosing in oll orguments}\}$$

ond let W_2 be the set of all welfare functions $W: X \rightarrow R$ which are Schur-concove, ond increosing in oll orguments.

To define o poverty meosure precisely, let L be the poverty line and $X^T(L)$ be the income distribution censored at L i.e., $X_i^T(L) \equiv \min\{X_i, L\}$ for, i=1,...,n. Bosed on ony welfare function W in W and any poverty line L, we can construct an associoted poverty measure, P *via*

$$P(X,L) \equiv 1 - \frac{W(X^T(L)}{W(L,\ldots,L)}$$

The set of all poverty measures obtained from welfare functions W in W_1 are called monatomic poverty measures and denoted by P_1. Moreover, the set of all poverty measures obtained from welfare functions W and W_2 are called distribution sensitive poverty measures and denoted by P_2.

2.4 The mean-inequality leximin criterion

In section 2.2, we showed that X can be fully described by the pair $(\mu(X), L(X))$. Moreover, we show that the pair $(\mu(X), L(X))$ form an orthogonal decomposition of the information in X: L(X) fully describes the degree of inequality in X and contains no information about its average, while $\mu(X)$ accounts for the average income level and contains no information about inequality.

Now, let us assume that there exists general agreement that equality and economic growth must be preferred to inequality and economic decline. One possibility for capturing this restriction on the space of social welfare functions is to restrict this space to the social welfare functions which can be expressed as

$$W(X) = V(\mu(X), L(X))$$

for some function $V:(R_+ \times L) \rightarrow R$, with V increasing in both arguments. Let W_0 denote the set of all such welfare functions. The fundamental question then becomes: to belong to the class W_0 is all that we should require of a valid social welfare function? In other words, does this restriction capture all the aspects of the assumption that societies prefer equity and growth? The early literature on income distribution clearly answer this question affirmatively (see, for example, Fields (1981)).

Given an affirmative answer to this question, it follows that we should say that X is at least as good as Y if and only if $W(X) \geq W(Y)$ for all $W \in W_0$. This criterion implies that the distribution X is at least as good as distribution Y if and only if $\mu(X) \geq \mu(Y)$. Due to this property, we refer to this criterion as the mean-equality leximin criterion. This criterion is completely agnostic about the trade-off between increases in income inequality and growth in *per capita* income. In fact, ordering constructed along these lines are completely silent about what would be the effect on social welfare of an increase (decrease) in average income accompanied by an increase(decrease) in income inequality. The mean-equolity leximin criterion is very stringent. However, once one have established that X is at least as good as Y using this criterion it follows that $W(X) \geq W(Y)$ for all $W \in W_2$ and $P(X,L) \leq P(Y,L)$ for all $P \in P_2$. Most of the early literature on ranking income distributions were based on the mean-equality leximin criterion.

However, the more recent work on ranking income distribution, initiated by Shorrocks (1983), showed that there are good reasons to believe that the class of sensible social welfare functions is smaller than W_0. The fundamental idea is that the class W_0 does not capture all aspects of the social preference for growth. Besides, the neglected aspects once incorporated imply that many circumstances should be considered a welfare improvement, despite the fact that both the level of income and the degree of inequality increased. To investigate the nature of the problem and Shorrocks's (1983) solution, we will proceed in steps. First, we clarify the difficulties faced by the mean-inequality leximin criterion using the following example.

2.5 Deficiencies with the mean-inequality leximin criterion

Let us consider two income distributions in a economy with two individuals: X=(1,3) and Y=(1,1) . It is clear that X must be preferable to Y since X is a Pareto improvement relative to Y. However, X has a greater degree of inequality than Y. So, not all $W \in W_0$ (i.e., increasing social welfare functions in the (μ ,L) space) will rank X as better than Y. For instance, consider the following three possibilities for the function V:

$$V_1\ (\mu, L) \equiv \mu.(1 - G(L)),$$

$$V_2\ (\mu, L) \equiv \mu.((1 - G(L))^3\ )$$

$$V_3\ (\mu, L) \equiv \mu.(1 - (G(L))^{1/3})$$

where G is the Gini Coefficient, i.e.

$$G(L) = 1 + \frac{1}{n}\ .\{1 - 2.\sum_{i=1}^{n} L_i\ \}$$

Note that G is a decreasing function of L and $0 \leq G < 1$. Therefore, $V_i \quad i = 1,2,3$, is an increasing function of both μ and L so all of them generate valid welfare functions in W_0 . Despite of this fact, V_2 and V_3 have clearly undesirable properties, at least as long as we insist that X must be considered better than Y. In fact, $V_i\ (\mu(X),\ L(X)) < V_i\ (\mu(Y),\ L(Y))$ for i=(2,3) (see table 1).

Table 1

Distribution	L	μ	G	V_1	V_2	V_3
Y=(1,1)	(0,1/2,1)	1	0	1.00	1.00	1.00
X=(1,3)	(0,1/4,1)	2	1/4	1.50	0.84	0.74

The following fact is crucial to understand the nature of the problem: for any given increase in inequality, there always exists a corresponding increase in the average level of income which when combined with the increase in inequality generates a Pareto improvement.[8] In other words, the Pareto criterion does put limits on the strength of the society taste for equality.[9] The mean-equality leximin criterion, however, does not take this limit into consideration.

In our example, the Gini coefficient increases from 0 to 1/4 (see Table 1). It can be shown that, in this case, a 100% increase in average income is the minimal growth necessary to generate a Pareto improvement. If the increase in average income was smaller, the income of the poor would decline. In our example, we compare the distribution Y with $\mu(Y) = 1 \text{ and } G(Y) = 0$ to the distribution X with $\mu(X) = 2 \text{ and } G(Y) = 0.25$. Since the average income double as the Gini coefficient increases from 0 to 0.25, our previous argument would predict that X must be a Pareto improvement to Y that we know is, in fact, the case. Figure 1 presents the minimum value of the average income which would be necessary to generate a Pareto improvement for each given increase in the Gini coefficient.[10] The locus of these points is referred to as the Pareto frontier . All distributions represented by points on the Pareto frontier or above it are Pareto superior to Y.

Figure 1 also presents the indifference curves for the three welfare functions we use in the example. All welfare functions consistent with the Pareto criterion must have indifference curves located everywhere beneath the Pareto frontier. This is the case for the Gini welfare function, V_1 , but not for the other two welfare function, corroborating the fact that these two welfare functions are not consistent with the Pareto criterion.

Although in our example we could easily identify and remove from the family of valid social welfare functions all those with indifference curves anywhere above the Pareto Frontier, in the general case, it is not immediately clear what would be the nature of the restrictions on the function V which must be imposed in order to ensure that the induced welfare function satisfy the Pareto criterion.[11]

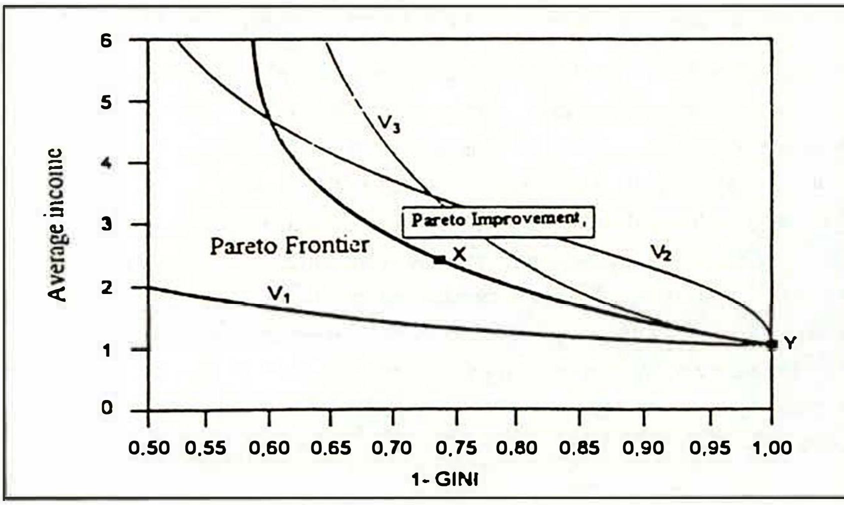
8 How this minimal necessary rate of growth can be obtained will be discussed in the next sub-section.

9 Not surprisingly, however, the Pareto criteria imposes no limits on the strength to the taste for growth.

10 In populations with two individuals, there is a one-to-one mapping connecting Gini coefficients and Lorenz curves. So, without any loss of generality, we can use the Gini coefficient to measure inequality.

11 For additional discussion on the additional restrictions the function V must satisfy, see Section 2.8.

Figure 1
The Trade-off Between Inequality and Average Income



Nonetheless, necessory ond sufficient conditions for compliance with the Pareto criterion can be easily imposed when the social welfare function is defined directly in the space of distributions, X. Hence, we move bock the analysis to the original space, X. In a fundamental way, the movement from the meon-equolity (Lorenz curve) spoce to spoce of distributions, X, is a backward movement. But it is o movement which has proved to be successful.

2.6 First-order dominance and the Pareto criterion

The Pareto criterion estoblishes thot X is ot least as good as Y if and only if $X \geq Y$. It con be easily show that this criterion is equivalent to say that X is ot least as good as Y if and only if $W(X) \geq W(Y)$, for all $W \in \mathcal{W}$ i.e., for all W which is increosing in oll of its arguments.

Hence, the Poreto criterion is equivolent to a simple restriction on the set of social welfare functions, with this being one of the main odvantages of specifying the welfore function directly in the space of income distributions. In fact, the restrictions imposed by the Pareto criterion on the function V defined in the mean-inequality (Lorenz curve) space are for from straightforward.

It can be show that the social welfare functions induced by the V_2 ond V_3 ore not increosing function, i.e., they do not belong to W_1 . For instance.

$$V_2(\mu(X), L(X) = \frac{[3X_1 + X_2]^3}{16(X_1 + X_2)^2}$$

which is a decreasing function on X_2 for all $X_2 < 3.X_1$. More generally, it can be show that all social welfare functions in W_0 are increasing along rays (Shorrocks (1983)), but not necessarily increasing along each coordinate.

To verify the Pareto criterion in the space of distributions is as simple as to verify the mean-equality leximin criterion in the mean-equality space. In fact, to verify whether X is at least as good as Y using the Pareto criterion it is enough to verify whether each components of X is at least as greater as the corresponding components of Y. But this is precisely the definition of first-order (Stochastic) dominance. So the Pareto criterion is equivalent to first-order dominance. The concept of first-order or Pareto dominance is not only easy to apply but also equivalent to a series of important alternative criteria (Foster and Shorrocks (1988-c)).

First, we can be shown that X first-order dominates Y if and only if X can be achieved from Y by a finite sequence (possibly empty) of increments[12]. Since an increment should make an income distribution unambiguously better, so must a sequence of increments. Hence, this alternative characterization of first-order (Pareto) dominance strength its ethical meaning.

Second, it can be shown that X first-order dominates Y if and only if $W(X) \geq W(Y)$ for all $W \in S_1$. Where S_1 is the space of all increasing and additively separable social welfare function. Hence, despite the fact that S_1 is strictly contained in W_1, the extra restrictions satisfied by functions in S_1 do not help to improve out ability to rank income distributions. In this sense, there is no loss in generality in assuming that the social welfare function is separable.

Third, it can be shown that X first-order dominates Y if and only if $P(X,L) \leq P(Y,L)$ for all $P \in P_1$ and $L \in R_+$. In words, X first-order dominates Y if and only of all monatomic poverty measures indicates that X has less poverty than Y independently of the choice of the poverty line. Hence, first-order dominance implies poverty reduction. It can also be shown that if $H(X,L) \leq H(Y,L)$ for all L then X first-order dominants Y, where H is the head-count ratio.

In summary first-order dominance (a) can be easily verified, (b) has a indisputable ethical justification, (c) implies that social welfare will increase whatever increasing welfare functions is chosen, and (d) and implies that poverty will decline whatever is the monotonic poverty measure being used and the choice of poverty line.

We emphasize that the great advantage of first-order dominance criterion over the mean-inequality leximini criterion is the fact that first-order dominance imposes limits on the taste for equality. This property guarantees that some cases where both the degrees of inequality and the average level of income increase are going to be considered a welfare improvement. In fact, given any increase in inequality there is always a minimum level of growth which if exceeded will generate first-order dominance. More specifically, if X has a Lorenz curve L(X)

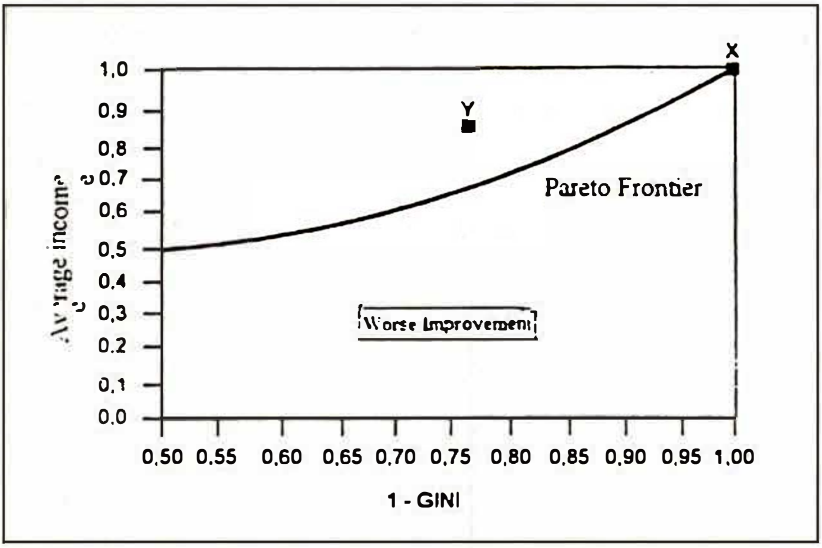
12 We say that X can be obtained from Y by an increment when $X_i = Y_i$ for all $i \neq j$ and $X_j = Y_j + \Delta$, com $\Delta > 0$.

and Y a Lorenz curve L(Y), than for X to first-order dominate Y it is necessary and sufficient that $\mu(X) \geq m.\ \mu(Y)$ where

$$m = \max\{ \frac{L(Y,i) - L(Y,i-1)}{L(X,i) - L(X,i-1)} \quad i = 1,\ldots,n\} = \max\{\frac{Y_i}{X_i} : i = 1,\ldots,n\}$$

Despite all of its nice properties, first-order dominance criterion can not be considered an unambiguous improvement on the mean-inequality leximin criterion. On the one hand, the first-order dominance criterion improves by allowing sufficient large economic growth to offset sufficiently small increments in inequality. But, on the other hand, the first-order dominance criterion alone can not rank simple cases which were possible to rank using the mean-inequality leximin criterion. For instance, if X=(1,1) and Y=(0,5,1,3) we have that $\mu(X) > \mu(Y)$ and L(X)>L(Y) so by the mean-inequality leximin criterion X would be considered an improvement on X. But X and Y are simply not comparable using the first-order dominance criterion. Notice that this is a serious problem, since X can be obtained from Y by making a progressive transfer of 0.3 from the rich to the poor (reaching the distribution (0.8, 1.0)) and then incrementing the income of the poor individual by 0.2. Since both progressive transfers and increments in income should increase social welfare and reduce poverty, we are lead to conclude that X must be considered better than Y. Consequently, the first-order dominance criterion is also seriously incomplete. Figure 2 presents the relevant Pareto frontier for this example. The Pareto criterion considers X better than all distribution represented by a point beneath the Pareto frontier but is not able to compare X with distributions to the Southwest and above the Pareto frontier. The mean-equality leximin criterion, however, ranks X as better than all distribution to the Southwest of X.

Figure 2
The Trade-off Between Inequality and Average Income



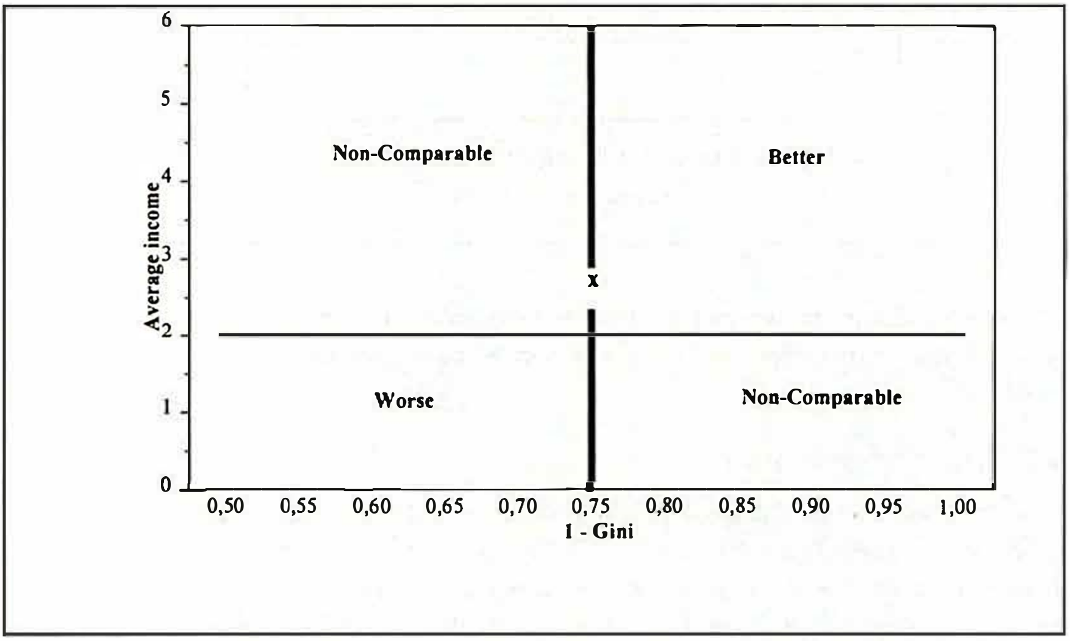
From this discussion it follows that these two criteria are better treated as complements than as substitutes to each other. Hence, out next step will be to consider the properties of the combined criterion.

2.7 The combined criterion

Let us consider X as at least as good as Y when <u>either</u> X first-order dominates Y <u>or</u> $\mu(X) \geq \mu(Y)$ and $L(X) \geq L(Y)$. We referred to this criterion as the combined criterion. Figures 3-5 divide the set of points in the (μ,L) space among those which are better, worse and just non-comparable to the distribution X=(1,3) which has $\mu(X) = 2$, and G(X)=0.25. In each figure the division of the space is based on a different criterion. The complementarity between the two pure criteria is clear from the fact that the region of non-comparable distributions is much smaller for the combined criterion.

Although the combined criteria has a clear advantage over the previous two criteria, it still have some serious deficiencies. To illustrate the nature of the problem, we now have to consider a population with at least three persons. For example let X=(2,2,16) and Y=(1,3,4). Since the income of the median individual is smaller in X than in Y, and the income of the poorest and the richest individuals is smaller in Y, neither X first-order Y nor Y first-dominates X. Moreover, μ (X) > μ (Y), so X and Y can neither be ranked using the mean-equality leximin criterion. Hence, X and Y can not be ranked by the combined criterion. Nevertheless X can be obtained from Y by first making a progressive transfer of 1 unit from the median individual to the poorest to reach the distribution (2,2,4) and then by incrementing the income of the richest individual in 12 units. In sum, the distribution X can be obtained from the distribution Y by a progressive transfer and an increment in income. Since both lead to an improvement in social welfare, X should be considered better than Y. Despite of this fact the combined criterion is unable to compare them[13]. This deficiencies will be completely resolved using the second-order dominance criterion which we introduce next.

Figure 3
The Trade-off Between Inequality and Aveerage Income:
Mean-equality leximin



13 This situation actually occur in the analysis of the evolution of the distribution of income in Brazil to be investigated in the second part of this paper.

Figure 4
The Trade-off Between Inequality and Average Income: First-Order Dominance

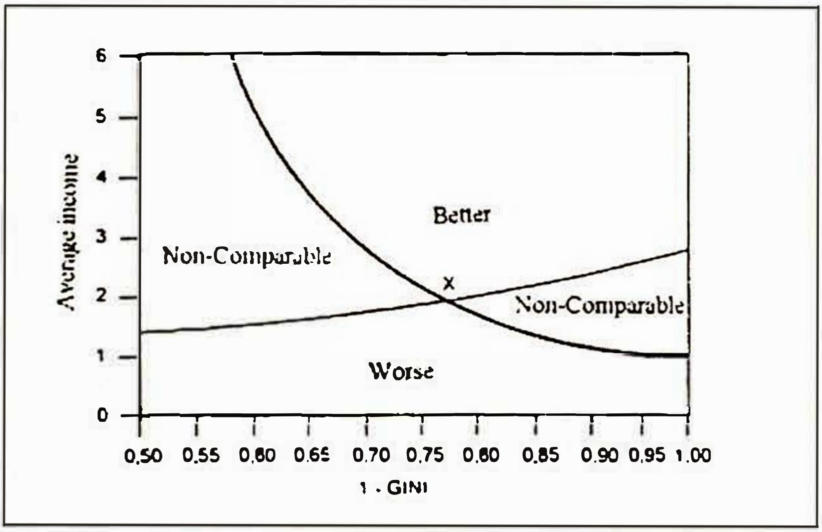
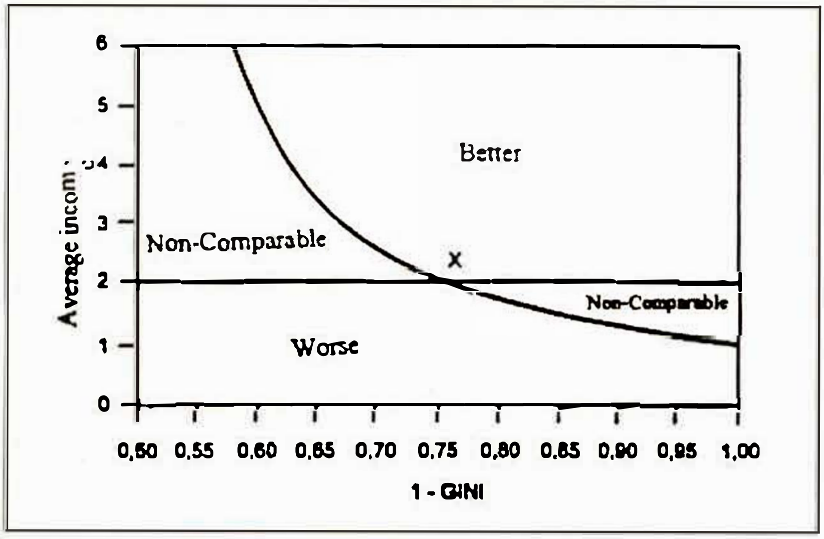


Figure 5
The Trade-off Between Inequality and Average Income: Combined Criterion



2.8 Second-order dominance

In order to define the concept of second-order dominance, let

$$S_i(X) \equiv \sum_{j=1}^{i} X_j$$

for all i=1,...n, and $S(X)=\{S_1(X),\ldots,S_n(X))$. Hence, S(X) is the vector of partial sums of X. Moreover, $S_i(X) = n.\mu(X).L(x,i)$. We say that X second-order dominates Y when $S_i(X) \geq S_i(Y)$ for all i=1,..., n.

From this definition it follows that second-order dominance is easy to verify empirically. However, it does not follow immediately from this definition that second-order dominance provides us with a sensible criterion to rank income distributions. To show that this is indeed the case, we must examine some of its properties.

First, notice that since $S(X)=n.\mu(X).L(X)$, if $\mu(X) \geq \mu(Y)$ and $L(X) \geq L(Y)$ then $S(X) \geq S(Y)$. So, all pair of distributions ranked by the mean-equality leximin criterion are also ranked in the same order by the second-order dominance criterion. In other words, the second-order criterion is a refinement of the mean-equality leximin criterion.

Second, notice that $X \geq Y$ implies $S(X) \geq S(Y)$. Hence, all pair of distributions ranked by the first-order dominance criterion are also ranked in the same order by the second-order dominance criterion. In other words, the second-order criterion is a refinement of the first-order criterion.

Third and as a consequence of the previous results, all pair of distributions ranked by the combined criterion are also ranked in the same order by the second-order dominance criterion. In other words, the second-order criterion is a refinement of the combined criterion.

Fourth, the problematic example presented above, X=(2,2,16) and Y=(1,3,4), is ranked by the second-order dominance in the desirable direction (X second-order dominates Y). This follows from the fact that S(X)=(2,4,20) and S(Y)= (1,4,8). Hence, $S(X) \geq S(Y)$. Actually, it can be proved that X second-order dominates Y if and only if X can be obtained from Y by a sequence of increments and progressive transfers. This result gives a profound ethical justification to use the second-order dominance criterion.

Fifth, it can also be shown that X second-order dominates Y if and only if $W(X) \geq W(Y)$ for all $W \in W_2$. Since Schur-concavity means taste for equality, this property says that second-order dominance is equivalent to consensus among all increasing welfare functions which exhibits taste for equality.

Sixth, it can also be shown that X second-order dominates Y if and only if $P(X,L) \leq P(Y,L)$ for all $P \in P_2$ and all poverty lines $L \in R_+$. Moreover, it can be shown that X second-order dominates Y if and only if $IH(X,L) \leq IH(Y,L)$ for all poverty lines $L \in R$, where IH denotes the *per capita* poverty gap.

Seventh, it can be shown that if $\mu(X) = \mu(Y)$, X second-order dominates Y if and only if $L(X) \geq L(Y)$.

In summary, second-order dominance (a) can be easily verified, (b) has an indisputable ethical justification, (c) implies that social welfare will increase if and only if all increasing social welfare functions with taste for equality increase, (d) implies that poverty will decline whatever is the poverty measure being used and the choice of poverty line as long as the chosen poverty measure is distribution sensitive (i.e., a member of P_2), (e) it reduces to a comparisons of the refinement of all three criterion we introduce previously.

Second-order dominance, by super-imposing taste for equality on first-order dominance, expands the ordering generated by first-order dominance in a better way than does the combined criterion.

As the first-order dominance, second-order dominance also imposes a limit on the taste for equality. In fact, for any given increase in inequality, there always exists an increase in the average income which would generate an improvement in the sense of second-order dominance sense. More specifically, if X has a Lorenz curve L(X) and Y a Lorenz curve L(Y) than for X to second-order dominate Y it is necessary and sufficient that $\mu(X) \geq m.\mu(Y)$ where

$$m = \max\{ \frac{L(Y,i)}{L(X,i)} \ , \ i = 1, \ldots, n\}$$

It can be easily proved that this minimal growth is always lower than the minimal growth required to achieved first-order dominance, demonstrating once again that second-order dominance is a refinement of first-order dominance. As in the case of first-order dominance, also in the second-order dominance, the taste for growth is unbounded, i.e., if $\mu(X) > \mu(Y)$, Y will never dominates X whatever the degree of inequality in both distributions may be. So, in particular, even if in Y all individuals have the same income, while in X all income goes to a single individual, second-order dominance would not permit us to classify X as better than Y.

3. Empirical preliminaries

3.1 Which distribution?

There is not a unique distribution of income. For each country and at each point in time, there are several distributions depending on the concept of income and unit of analysis. For example, we can investigate the distribution of *households* according to their *per capita* income as well as the distribution of the economically active population according to their personal income. These are only two examples, but there are many other possibilities.

In this study, we investigate the temporal evolution of the distribution of the economically active population with positive income according to their personal total income[14]. The choice of this particular distribution is due mainly to two factors. First, this is the distribution used in almost all previous studies about the Brazilian income distribution, in particular in the early studies about the Brazilian income distribution, in particular in the early studies about in the 1960s and early 1970s[15] Second, the information on income in the 1960 Demographic Census was categorical, implying that arbitrary assumptions must necessarily be evoked to compute total family income.

One must keep in mind, however, that mainly in the presence of considerable change in the level of fertility and in the number of earners *per* household, the temporal evolution of this distribution can be quite different from, for example, the temporal evolution of the distribution of all individuals according to their household *per capita* income (see Hoffmann and Kageyama (1986) for evidence on this respect). So, any substantive interpretation of the results of this study has to take careful consideration of this fact.

3.2 Average income by tenth of the distribution

To compare the distribution of income in Brazil in 1960, 1970, 1980 and 1990, we first adjust the monetary units, so that, all estimates are in real cruzeiros of September 1 of 1960.

Second, for each point in time, we compute the deciles of the distribution of income for that year. Based on these deciles, we divide the population in each year into ten groups, with individual i belonging to group j, j=1,...,10, when his/her income is between the (j-1) th and jth deciles[16]. We refer to these ten groups as the tenths of the distribution.

Finally, we compute the average income for each tenth of the Brazilian income distribution for 1960, 1970, 1980 and 1990.

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14 By total personal income we mean the sum of income from all sources: labor earnings, pensions, government transfer, and rents.

15 See Langoni (1973), Fishlow (1972), Fields (1977), Morley (1982) and Bacha and Taylor (1980).

16 Where the zeroth and tenth deciles are defined as being, respectively, the lowest and highest income values attained in the population.

3.3 Ranking the income distributions

Let v(j,t) be the average income of the jth tenth of the income distribution at time t. Based on these, the average income of the poorest 10.k%, population at time t, η (K,t), can be obtained *via*

$$\eta(K,t) = \frac{1}{K}.\sum_{j=1}^{K} V(j,t)$$

with the overall average, μ (t), being then equal to η (10,t).

Moreover, the proportion of the total income appropriated by the poorest 10.k% of the population at time t, λ (K,t), (i.e., the points in the Lorenz curve) are given by

$$\lambda(K,t) = \frac{K.\eta(K,t)}{10.\mu(t)}$$

Based on this information, necessary conditions for the income distributions at time t to dominate the income distribution at time s can be obtained. These necessary conditions for each criterion are presented in Table 2. If we let the number of groups we have divided the population increase to infinity, these conditions become sufficient. In the next section, when we say that the income distribution for time period t dominates the income distribution for time period s by a certain criterion, what we really mean is that the corresponding necessary conditions presented in Table 2 have been fulfilled. We emphasized that these conditions are not sufficient to guarantee the asserted dominance.

4. Empirical results

4.1 Comparing 1960 to 1990

Figure 6 presents the temporal evolution of the average income in Brazil over the last three decades. It reveals that the average income doubled from 1960 to 1990, which is equivalent to an average annual growth rate of 2.5%.

Figure 6
Average Income Level of the Economically Active Population (1960=100)

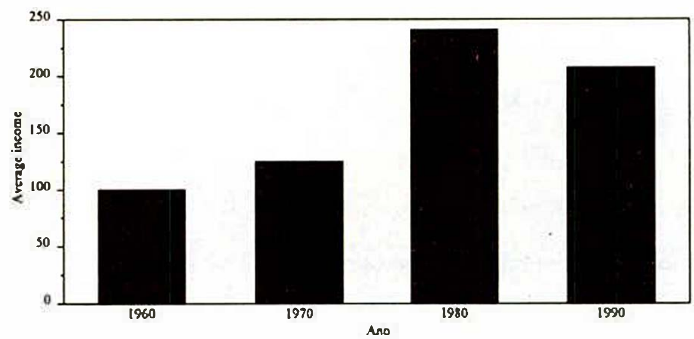
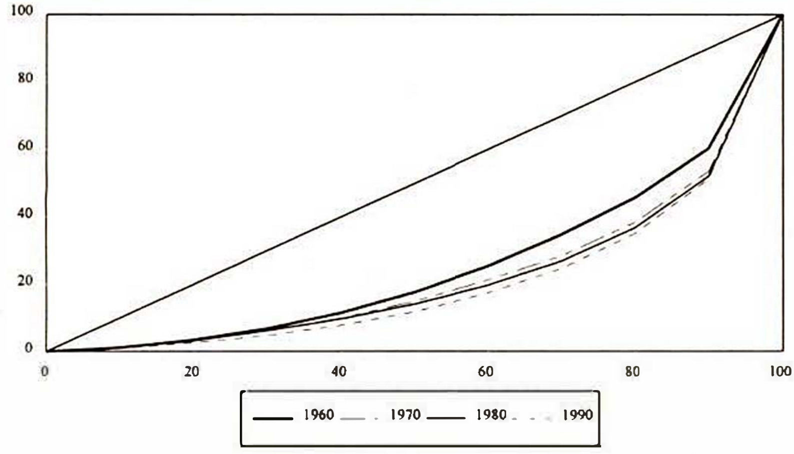


Table 2
Necessary Conditions for the Distribution at time t to Dominate the Distribution at time s

Criterion	Necessary Conditions
Mean-Equality Leximin	$\mu(t) \geq \mu(S)$ and $\lambda(K,t) \geq \lambda(K,S)$ $K = 1,\ldots 10$
First-Order Dominance	$V(K,t) \geq V(K,S),\ K = 1,\ldots 10$
Combined	$\mu(t) \geq \mu(S)$ and $\lambda(K,t) \geq \lambda(K,S),\ K = 1,\ldots 10$
	or $V(K,t) \geq V(K,S),\ K = 1,\ldots 10$
Second-Order Dominance	$n(K,t) \geq n(K,S),\ K = 1,\ldots .10$

Figure 7 presents the temporal evolution of the Lorenz curve over the same period. This figure reveals a clear increase in the degree of inequality. The fraction of the income appropriated by the top 20% increased 11 percentage points going from 54% to 65%, while the fraction of the income appropriated by the bottom 50% declined 6 percentage points going from 18% in 1960 to 12% in 1990.

Figure 7
Lorenz Curve



Source: Demografic Census of 1960,1970, 1980 and PNAD-1990

The fact that the average income the degree of inequality have both increased from 1960 to 1990 implies that the mean-equality leximin criterion can not rank the income distributions at this two points in time. In other words, despite the considerable growth in average income, this criterion is not capable of giving an unambiguous indication on the direction of the change in poverty and social welfare over the last thirty years in Brazil[17]. So, we turn to first-order dominance.

Figure 8 presents, for the period 1960-90, the annual rate of growth of the average income for each tenth of income distribution. This figure reveals that all tenths of the distribution benefited from the economic growth in the period. Hence, the income distribution for 1990 first-order dominates the distribution for 1960. As a result, social welfare unambiguously improve and poverty unambiguously decline.

Figure 8 also reveals that the growth in the period did not benefit all groups equally. The groups located at the lower middle of the distribution (third, fourth, and fifth tenths of the distribution) were those benefited the least. In fact, the poorest 20% experienced rates of growth greater than those for the groups located at the lower middle of the distribution, but considerably smaller than the growth rate for the top tenths of the distribution. From the third

17 Throughout this section, we consider that poverty is measured using an arbitrary distribution sensitive poverty measure evaluated at an arbitrary poverty line. Moreover, we assume that the level of social welfare is the image of an also arbitrary Schur concave increasing social welfare function.

tenth to the top of the distribution the growth rate increases monotonically leading to a great concentration of the gains among the top 30% of the distribution.

Figure 8
Growth Rate of Income: 1960-90

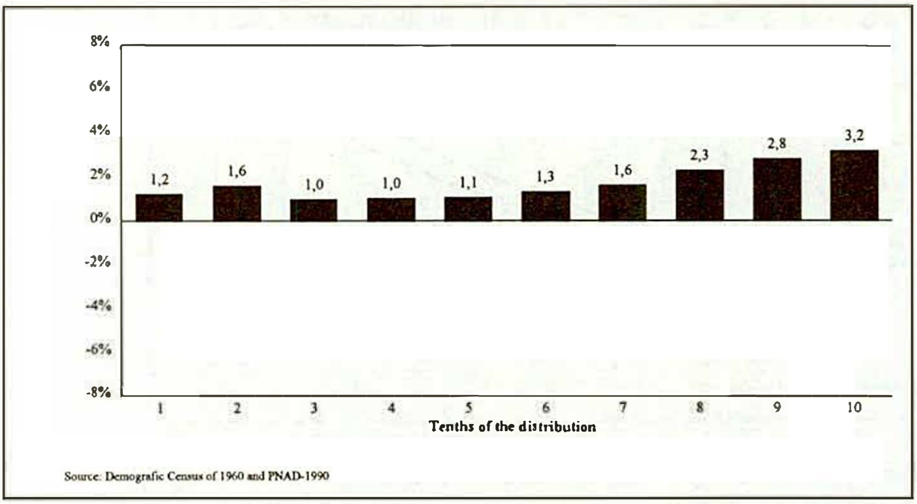
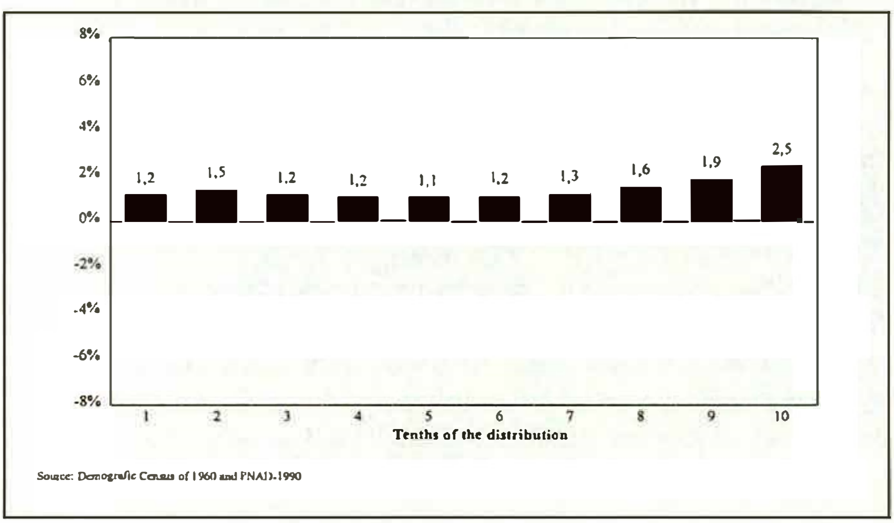


Figure 9

Growth Rate of Income of the Poorest Tenths, 1960-90



The actual average annual rate of growth in the period was 2.5%, while the minimum annual rate of growth necessary to generate first-order dominance is 1.5%. In other words, more that one half of the growth in the period was required (in the first-order sense) just to compensate for the increase in inequality. This fact corroborates the general feeling that the social consequences of the Brazilian process of fast and inequitable growth were rather disappointing.

Since first-order dominance implies combined dominance which, by its turn, implies second order dominance, the income distribution in 1990 dominates the distribution in 1960 in both the combined and second-order dominance criteria.

The second-order dominance criterion is weaker, so to be satisfied it requires less growth than the first-order dominance criterion. In fact, given the increase in inequality in the period, the second-order dominance criterion would require a minimum annual rate of growth of 1.3% in order to be satisfied, whereas, as already mentioned, the actual annual rate of growth was 2.5% and the rate required for first-order dominance is 1.5%. Hence, the minimum rate of growth required for first and second-order dominance are rather similar. This is an indication that most of the increment in inequality was located at the bottom of the distribution.

In addition of not having benefited all groups equally, the Brazilian growth process over these thirty years fluctuated considerable over time. In fact, the average annual rate of growth varied substantially in the three decades: 2.2% in the 1960s, 7.0% in the 1970s and -1.5% in the 1980s. The increase in the degree of inequality was also very unevenly distributed over the period. Therefore, we next investigate each decade separately.

4.2 Comparing 1960 to 1970

Figure 6 reveals thot the average income level increase 25% from 1960 to 1970, which is equivalent to an average annual growth rate of 2.2%. Hence, the growth rate in the 1960s was very similar it the average for the three decades (2.5%).

Figure 7 reveals a sharp increase in the degree of inequality in the 1960s. The fraction of the income appropriated by the top 20% increases 8 percentage points going from 54 % to 62%, while the fraction of the income going to the bottom 50% declined 3 percentage points going from 18% in 1960 to 15% in 1970. The increase in the share of the top 20% is more than 70% of the total increase in the three decades, whereas the reduction in the share of the bottom 50% is approximately half of the total for the three decades. In sum, it is clear that much of the increase in inequality in the last three decades was concentrated in the 1960s.

The fact that both the average income and the degree of inequality increase in the 1960s implies that the mean-equality leximin criterion is also able to rank the Brazilian income distributions for 1960 and 1970. Hence, despite the considerable growth in average income, this criterion is not capable of giving an unambiguous indication on the direction of the change in poverty and social welfare in the 1960s.

As already mentioned, Figures 6 and 7 reveal the growth rate in the 1960s was close to the average for the whole period, while the increase in inequality was much great than the average for the period. These two facts together indicate that poverty may have increase during this period despite the considerable rate of growth. To verify this possibility we first check for first-order dominance.

Figure 10 presents, for the 1960s, the average annual rate of growth of the average income of each tenth of the distribution. This figure reveals that, during the 1960s, the growth process was moderate and benefited all tenths of the distribution except the seventh[18].

The growth in the 1960s was unevenly distributed, as already pointed by Fishlow (1972) and Langoni (1973). Despite the growing inequality, the poorest 30% was not the group which benefited the least. Actually, the gains concentrated at the top and bottom of the distribution being almost non-existent or even negative at the middle of the distribution (fourth, fifth, sixth and seventh tenths). The group which benefited the most was the top 10% of the distribution. The average annual growth rate for this group was almost 4%, which is close to twice the overall rate of growth of income in the 1960s. An intermediate position is occupied by the ninth tenth and the bottom 10%, with rates of growth of 2.6% and 2.1% *per* year, respectively.

The minimum annual rate of growth necessary for the distribution in 1970 to first-order dominate the distribution in 1960 is 2.7%, which is 0.5 percentage point higher than the growth rate actually observed. Hence, during the 1960s the increase in inequality was so intense that despite an average annual growth rate of 2.2%, Pareto improvement was not achieved.

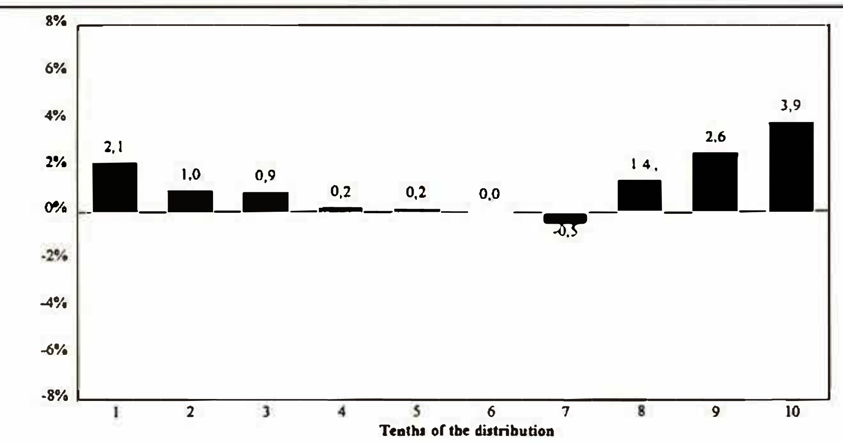
It is worthwhile, at this point, to emphasize that Figure 10 reveals an important characteristic of the Brazilian process of growth during 1960s which has been systematically neglected by previous studies: Despite all increase in inequality, the group which benefited the least from the growth process in the 1960s was not the bottom 30%, but instead the middle 40% of the distribution. Actually, the income of the bottom 10% grew at a rate very close to the average rate for the entire population.[19] The fact that the poorest group gained substantially

18 Note, however, that this negative result for the seventh tenth is sensitive to the choice of the price index (see Tables A9a-c). As a matter of fact, if instead of using the consumer price index (INPC) one uses the general price index (IGP), the estimated rates of growth increase, becoming positive for all tenths of the distribution. Therefore, the income distribution for 1970 does not first-order dominates the income distribution for 1960 if one uses the INPC-MT as the deflator but it does if one uses the IGP.

19 As pointed before, the growth rate for the entire population and for the bottom 10% were 2.2% and 2.1%, respectively.

during the 1960s raises the possibility that the distribution for 1970 might second-order dominates the corresponding distribution for 1960. This is what we investigate next.

Figure 10
Growth Rate of Income: 1960-70

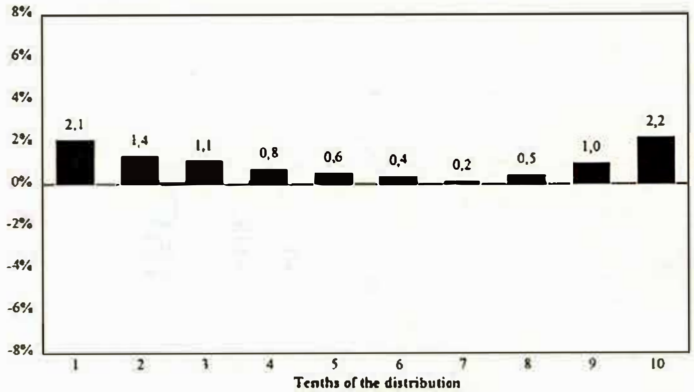


Source: Demografic Census of 1960 and 1970

Figure 11 presents the growth rate of the average income of the poorest tenths of the distribution during the 1960s. This figure reveals that the average income of the poorest j tenths of the distribution increased for all j= 1,...,10. Hence, the income distribution for 1970 second-order dominates the income distribution for 1960. As a result, the level of social welfare increased and poverty declined over the 1960s as claimed by Fields (1977).[20]

20 Fields' (1977) article generated a series of criticisms which mainly try to indicate that the data available was not sufficient rich to prove or disprove that poverty had decline in the 1960s in Brazil (see in particular the comment by Ahluwalia, Duloy, Pyatt and Srinivasan (1980)). Our data is slightly better that the one used by Fields and our results confirm his. However, it is important to recognize that most of the important comments of Ahluwalia, Duloy, Pyatt and Srinivasan (1980:242) about data limitations apply equally well to Fields'data and ours.

Figure 11
Growth Rate of Income of the Poorest Tenths, 1960-70



Source: Demografic Census of 1960 and PNAD-1970

The minimum annual growth rate necessary for the 1970 income distribution to second-order dominates the 1960 distribution is 2.0%, which is considerably smaller that the 2.7% required for first-order dominance and also slightly smaller that the growth rate actually observed (2.2%). Note that the minimal growth rates necessary for first-and second-order dominance in the 1960s (2.7% and 2.0%) were considerably greater that those required for the period as a whole (1.5% and 1.3%). These greater required growth rates corroborates the fact that inequality was increasing at a much faster pace in the 1960s than in the period as a whole.

4.3 Comparing 1970 to 1980

Figure 6 reveals that the average income level increased 97% from 1970 to 1980, which is the equivalent to an average annual growth rate of 7.0%. Hence, most of the growth in the three decades was concentrated in the 1070s.

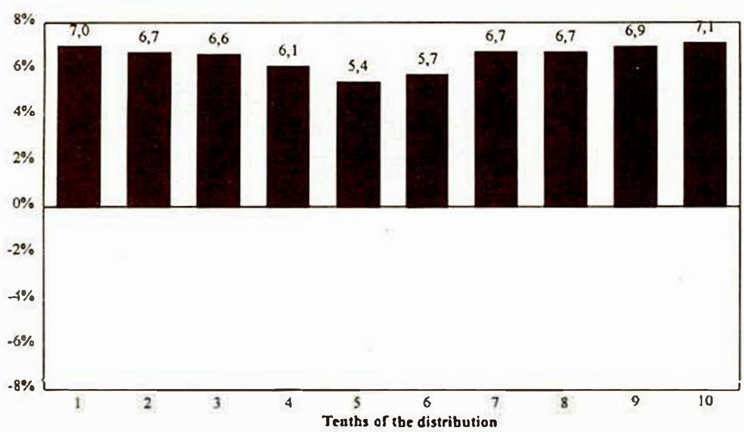
Figure 7 reveals a small increase in the degree of inequality over the 1970s. The fraction of the income appropriated by the top 20% increased only by 1 percentage point going from 62% to 63%, while the fraction of the income going to the bottom 50% declined 1 percentage point going from 15% in 1970 to 14% in 1980. Both changes are very small when compared to the total change in the period. Thus, the 1970s was a decade of very fast economic growth with a very small increase in inequality.

Since both the average income and the degree of inequality have increased in the 1970s, the mean-equality leximin criterion can not rank the Brazilian income distribution for 1970 and

1980. In other words, despite the impressive rate of growth in the period and the modest increase in inequality, this criterion is not capable of giving an unambiguous indication about the direction of the change in poverty and social welfare over the 1970s in Brazil. We then turn to first-order dominance.

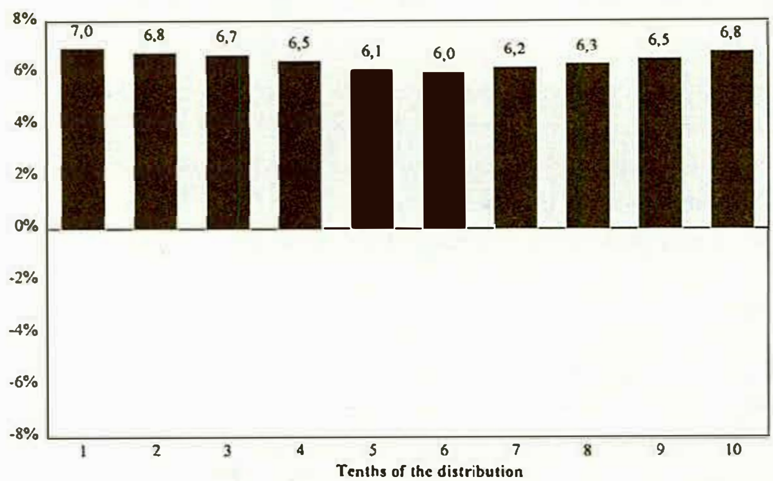
Figure 12 presents, for the period 1970-80, the annual rate of growth of the average income of each tenth of the income distribution. This figure reveals that all tenths of the distribution largely benefited from the economic growth in the period. Hence, the income distribution for 1980 clearly first-order dominates the distribution for 1970. As a result, social welfare unambiguously improve and poverty unambiguously decline.

Figure 12
Growth Rate of Income: 1970-80



Source: Demographic Census of 1970 and 1980

Figure 13
Growth Rate of Income of the Poorest Tenths, 1970-80



Source: Demografic Census of 1970 and 1980

This figure also reveals that the growth in the period was almost evenly distributed. But, some disparities are noticeable. As in the 1960s, also in the 1970s, the growth rate was smaller at the middle of the distribution. In fact, the fifth and sixth tenths of the distribution were the only groups experiencing annual rates of growth inferior to 6%. Also similarly to the 1960s, during this period the bottom 10% experienced a growth rate above average, being the group with the second largest growth rate (7.0% per year, on average). In the 1970s, as in 1960s, the top 10% was the group with the highest rate of growth, 7.1% *per* year.

The minimum annual rate of growth necessary to generate first-order dominance was small, 1,3%, compared to the growth rate in the decade, 6,8%. In other words, most of the growth in the 1970s was used to reduce poverty and improve welfare, with less than 20% of the growth being devoted to compensate for the small increase in inequality. Therefore it is hard to argue that the Brazilian development process in the 1970s could be characterized as an extreme case of inequitable growth without any social progress, as it has been characterized by many authors. Notice that this minimum rate of growth is 1/2 of the one required to compensate the increase in inequality in the 1960s, corroborating the idea that the increase in inequality was much more pronounced in the 1960s than in the 1970s.

Since first-order dominance implies combined dominance which implies second order dominance, it follows that the income distribution in 1980 dominates the distribution in 1970 in both the combined and the second-order criteria. However, since the second-order dominance criterion is weaker it would require less growth to be satisfied than first-order dominance. In fact, the increase in inequality in the 1970s requires an annual growth of just 0.8% for the distribution for 1980 to second-order dominate the distribution for 1970, while to ensure first-order dominance a growth rate of 1.5% was required. The substantial difference between these minimum required growth rates incites that most of the increase in inequality was not located at the bottom of the distribution.

4.4 Comparing 1980 to 1990

Figure 6 reveals that the average income level declined 14% from 1980 to 1990, which is the equivalent to an average annual growth rate of -1.5%. Figure 7 reveals a clear increase in the degree of inequality in the 1980s, with the fraction of the income appropriated by the top 20% increasing by 2 percentage points going from 63% to 65%, while the fraction of the income appropriated by the bottom 50% declined 2 percentage points going from 14% in 1980 to 12% in 1990. The change at the bottom of the distribution is similar to the one observed in the 1960s, whereas the change at the top is much smaller. In sum, the 1980s was a decade of economic decline accompanied by an increase in inequality.

Since both the average income level and the degree of equality have decrease in the 1980s, the mean-equality leximin criterion ranks the Brazilian income distributions at 1980 as better than the one at 1990. In other words, this criterion gives us an unambiguous indication that the level of social welfare unambiguously declined and poverty unambiguously increased in the 1980s. Since, the mean-equality leximin does not implies Pareto dominance and also to take a more desegregated view of this decline in welfare, we turn to first-order dominance.

Figure 14 presents, for the period 1980-90, the average annual rate of growth of the average income of each tenth of the distribution. This figure reveals that during the 1980, a negative growth rate for all tenths of the distribution led to a worsening of the distribution of income in the first-order dominance sense. Hence, the mean-equality leximin and the first-order dominance criteria agree.

Moreover, Figure 14 reveals that the losses in income were far from evenly distributed. Contrary to the previous two decades, in the 1980s the losses were heavily concentrated at the bottom of the distribution. For instance, the mean income of the bottom 10% declined at a rate of 5.1% *per* year which is, at least, three times greater than the overall rate of decline in income in the 1980s.

Figure 14
Growth Rate of Income: 1980-90

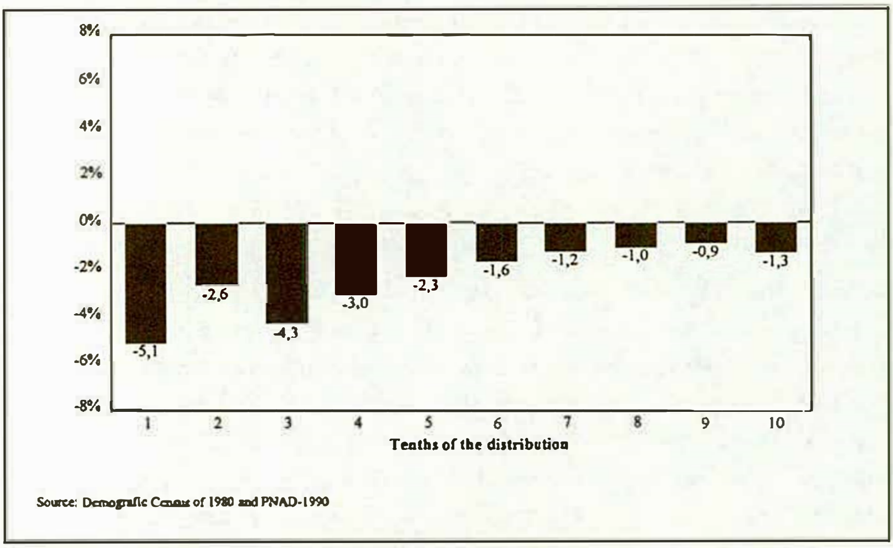
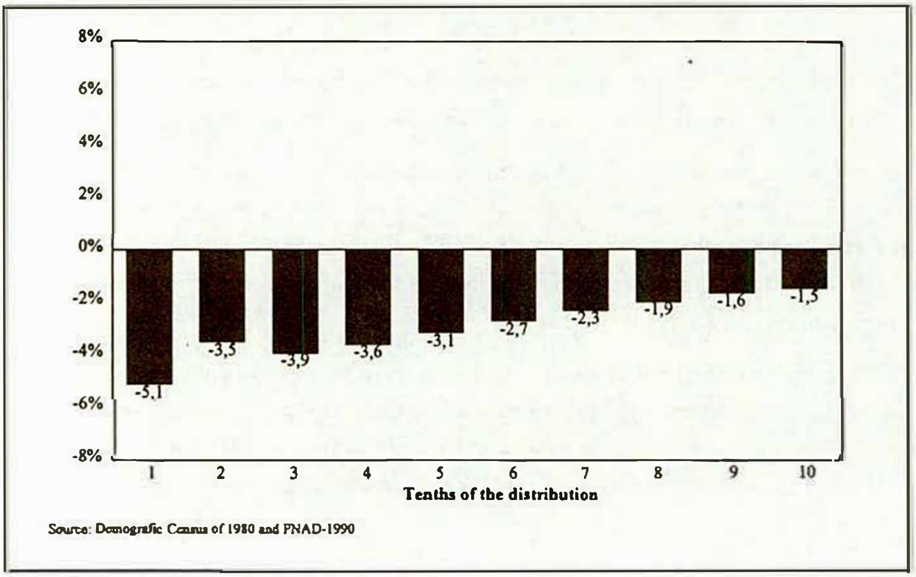


Figure 15
Growth Rate of Income of the Poorest Tenths, 1980-90



The minimum annual rate of growth necessary to guarantee first-order dominance was very large, 3.8%, compared to the minimum required for the other decades. Since the increase in inequality in the 1980s was very concentrated in a few groups, it is natural that it would require a very fast growth process for increasing poverty and declining social welfare to be avoided. Nevertheless, instead of growth, the 1980s saw a process of economic decline leading, therefore, to a unambiguous increase in poverty and decline in social welfare.

Since first-order dominance implies combined dominance which by its turn implies second order dominance, it follows that the income distribution in 1980 dominates the distribution in 1990 in both the combined and the second-order criteria. Hence, for the first time in this study all criteria agree.

Since second-order is weaker than first-order dominance, second-order dominance requires less growth to be satisfied. But in fact, for the 1980s, the reduction is very small. Given the increase in inequality, the second-order dominance criterion would require an average annual growth rate of 3.6% to be satisfied, while to ensure first-order dominance a growth rate of 3.8% was sufficient. The insignificant difference between these minimum required growth rates indicates that most of the increase in inequality was located at the very bottom of the distribution.

In summary over the 1980s the Brazilian economy went through an uneven process of economic decline with most of the losses being concentrated among the groups at the very bottom of the distribution. As a consequence, social welfare declined and poverty increased. These outcomes contrast sharply with those for the previous decades and for the period as a whole.

5. Summary

Tables 3 and 4 summarize the main empirical findings of the this study. Table 3 reveals that the degree of inequality increased continuously over the three decades, while growth was positive in the first two decades and negative in the third (1980s). Overall, both the average income level and the degree of inequality increased. The second order dominance criterion indicates that economic growth was fast enough to compensate for the deleterious effects of increasing inequality, leading to an overall improvement in social welfare and poverty. Although the combined effect on poverty and social welfare was favorable, the sharp increase in inequality reduced dramatically the social advantages of growth. Almost 2/3 of the growth was required to compensate the inequality increase.

Table 3
Summary of the Changes in the Income Distribution in
Brazil: 1960-1990

Criterion	1960-90	1960-70	1970-80	1980-90
Rate of growth	2.5	2.2	7.0	-1.5
Change in the fraction of income appropriate				
Top 20%	11	8	1	2
Bottom 50%	- 6	- 3	- 1	- 2
Minimal growth rate required for				
First-order dominance	1.5	2.7	1.3	3.8
Second-order dominance	1.3	2.0	0.8	3.6

There were fundamental differences in the evolution of the average income level and the degree of income inequality over the last three decades. In the 1960s there was moderate growth accompanied by a sharp increase in inequality. Despite the sharp increase in inequality the impact of growth dominated leading to reductions in poverty and improvements in social welfare. The increase in inequality, though, made the improvements in poverty and welfare much smaller than it would have been if inequality had remained constant.

Table 4
Summary of the Inter-Temporal Ranking of income Distributions
Brazil: 1960-1990

Criterion	1960-90	1960-70	1970-80	1980-90
Mean-equality leximin	ambiguous	ambiguous	ambiguous	worsen
First-order dominance	improve	ambiguous	improve	worsen
Combined	improve	ambiguous	improve	worsen
Second-order dominance	improve	improve	improve	worsen

In the 1970s average income grew very fast and inequality increased only slightly. The result was a large reduction in poverty and improvement in social welfare, with only a small fraction of growth being required to compensate for the increase in inequality.

In the 1980s average income declined and inequality increased substantially. All four criteria agree that the level of poverty increased and the level of social welfare declined. The social consequences of this decade were exacerbated by the fact that, contrary to what occurred in the other two decades, in the 1980s most of the increase in inequality hit the very bottom of the distribution.

Despite all the differences among these three decades, they have at least two facts in common. First, inequality increased continuously. Second, the changes in poverty and social welfare followed the behavior of growth, improving whenever there was growth and worsening when economic decline occurred. In other words, the impact of increasing inequality was important in mitigating the positive effects of growth, but it was never large enough for reversing them.

In summary, there was never in Brazil a period of growth with increasing poverty and declining social welfare. Hence, this situation continuous to be just a theoretical possibility.

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CHAPTER 2

MINIMUM WAGE, INCOME DISTRIBUTION AND POVERTY IN BRAZIL

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Abstract

This paper seeks to evaluate empirically the potential contribution of policies that raise the real value of the minimum wage to mitigate distribution inequality and poverty in Brazil. In addition to characterizing minimum waged workers' profile according to their personal attributes and position in the distribution spectrum, simulations of the impact on the level of employment are made, in accordance to different assumptions, to measure reduction in inequality and poverty should the minimum wage be raised by 25%. The conclusion drawn is that such impact is negligible and that, although very low minimum wage rates in the recent past call for a recovery of their value, a more determined action to redistribute income in the country demands more than this, including mandatorily the adoption of other policies and instruments.

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1. Introduction

Brazil as a society is characterized by a high degree of income concentration. Given the relatively low level of per capita income, this inequality translates directly into a significant contingent of poor. Needless to say, virtual economic stagnation over more than a decade has contributed to an increase in the size of this group, and growing social tension is already a threat to Brazil's political and economic stability.

Even though the reversal of this bleak picture requires structural changes in the workings of the economy, changes that take time to produce concrete results, the need to adopt urgent measures to improve income distribution and to reduce the incidence of poverty, even at the expense of longer-lasting results, has taken a prominent place on the political agenda of several segments of Brazilian society.

Because changes in relative prices in the economy are a way to produce modifications in the income distribution profile, policies aimed at increasing the real value of the minimum wage are some of the most emphasized short-term mechanisms among those usually considered.

The main goal of this study is the empirical evaluation of the impact of minimum wage policies on the amelioration of poverty and the reduction of income inequality in Brazil. In order to achieve this goal we first portray the minimum wage earners in terms of personal attributes, labor market aspects, and position in the income distribution. Next we implement a series of simulation exercises that empirically evaluate the effects of increases in the minimum wage on poverty and the reduction of inequality, under a set of hypotheses about the workings of the labor market.

2. Minimum wage, income distribution, and poverty

Hammermesch (1993) argues that minimum wage policies can be regarded as a tax levied on firms, its value being equal to the difference between the minimum wage and the wage that would otherwise be paid to the workers who benefit from it. Contrary to what usually happens, this tax is not collected by the government, but is directly transferred to the beneficiaries instead. From this standpoint, the minimum wage policies can also be regarded as subsidies that favor a specific group of otherwise low-paid workers.

Therefore, when the government creates or changes the real value of the minimum wage, it is also creating or changing a tax or a subsidy. This approach to minimum wage policies is helpful in clarifying the allocative and distributive implications associated with these policies. The allocative implications are related to the social costs of minimum wage policies, in particular their effects on employment for unskilled labor. The distributive implications are intimately related to the ultimate goal of such wage policies, in other words the promotion of social and economic equity, via the legal assurance of satisfactory earnings and consumption levels for workers and their families.

Our interest in this study focuses upon the impact of minimum wage policies on income distribution and poverty. Such an approach falls to a certain degree in line with the tradition of Brazilian literature on the subject, which tends to consider the minimum wage primarily as a subsidy. The opposite aproach is taken in the Northern hemisphere, where the literature emphasizes the allocative effects underlying minimum wage policies. An explanation for this contrast, at least in part, is found in the low value of the minimum wage in Brazil, and even more important, the fact that the real value of the minimum wage has been decreasing over the last three decades. In this context, it is likely that the employment effects associated with a raise in real minimum wage values are not as important as in the Northern hemisphere, although not negligible by any means.

The important message behind Hammermesch's approach is that the distributive effects of a minimum wage policy depend on their allocative effects, which cannot be put aside in any meaningful analysis of such policies. The higher the demand elasticity for unskilled workers, the greater the costs to be paid by them in the case of an increase in the minimum wage, either in the form of unemployment or in the form of lower wages paid out in the unprotected sector of the economy.

This last point, the effects of changes in the minimum wage on the informal or unprotected segment, has been intensively debated in the Brazilian literature. This segment, which includes the self-employed and employees without labor cards[1] who are not protected by current legislation, encompasses a large contingent of workers in Brazil. Hence, the distributive effects of a minimum wage policy will be heavily dependent upon the indirect impact on the informal sector.[2]

The issue of how the minimum wage impacts the unprotected sector is subject to different interpretations. The partial-coverage models show that the imposition of a minimum wage may lead to a drop or rise in wages for the unprotected sector. The basic model demonstrates that, in the absence of unemployment, a raise in the minimum wage induces a migration from those who have lost their jobs in the protected sector to the unprotected sector, causing a fall in the equilibrium wage in this last sector. A different result is produced by models that admit the existence of job searches. Under such models, the individual may prefer to stay unemployed and look for a new job in the protected sector, to the degree that the expected value of his/her

1 Translator's note: Mandatory documents for all workers in Brazil.

2 As it will be seen in the next section, 20% of the urban EAP received the equivalent of the minimum wage in 1989. Among them only 54% had labor cards, while 14% were self-employed and 32% did not have the proper work permits. The proportion of employees without labor cards increases considerably when we consider the group of workers receiving even lower wages.

future wage is higher than the current wage in the unprotected segment. Even those in the unprotected sector may quit their jobs and look for a position in the formal sector, making an increase in the wages for the informal sector possible.[3]

There is another hypothesis in the Brazilian literature that supports the idea of a positive relation between the minimum wage and the earnings in the informal sector. According to this school, the minimum wage would work as a reference in determining the wages of those who work in the informal sector (the so-called "efeito farol", or beacon effect).[4] Aside from the theory's weakness on theoretical grounds, as it assumes that prices are not competitively set in the informal sector, there is no empirical evidence supporting the views espoused by the theory. As a matter of fact, more detailed empirical work on this issue [Velloso (1988)] does not validate the hypothesis in question.

Assuming that the effects of increases in the minimum wage on employment are small, it is possible to approach the issue of how the minimum wage (wmin) affects distribution and poverty as if it were a subsidy. It then becomes simple to show that the distributive impact will be larger to the degree that the individuals who benefit from the minimum wage are poorer, i.e., the more progressive the policy is. This issue has been stressed in the recent literature. The key question here is to find the correlation between being a wmin earner and belonging to a poor family. If this correlation is high, the minimum wage policy may be very effective as an instrument to reduce poverty and inequality.

Several studies developed during the second half of the 70s [Gramlich (1976), Bell (1981), Kniesner (1981), and Johnson and Browning (1983), among others] examined the issue of deciding who the potential beneficiaries of such policy might be. All the authors find a modest effect of minimum wage increases on income distribution and poverty, the reason being a low correlation between receiving the minimum wage and being part of a poor family. In other words, minimum wage legislation may be successful at helping workers with low wages, but not necessarily low-income families. The reasons for this are related to the great presence of secondary workers, particularly women and youth, among the wmin earners. Although these people as individuals earn low wages, their family per capita income is not necessarily low.

Given the importance of the impact of changes in wmin on inequality and poverty, empirical evidence drawn from the Brazilian economy will be inspected in the next section. Before doing that, however, we will take a look at the evolution over time of the real value of the minimum wage in Brazil over the last decade.

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3 The model with no employment effect is discussed in Welch (1974) and Gramlich (1976). The model with unemployment, and the derivation of the conditions for a wage increase in the informal sector, can also be found in Gramlich (1976) and in Mincer (1976).

4 See Souza and Baltar (1979) and Wells and Drobny (1982) for details.

2.1 Evolution over time of the minimum wage

The graph that follows shows the evolution of the real value of the minimum wage during the 80s, based on the nominal value deflated by the respective consumer price index (INPC) for that wage in August of each year.

After a period of relative stability at the beginning of the decade, the minimum wage fell sharply in 1983, as a consequence of the acceleration in the inflation rates that year.[5] When the new government took power in 1985, there was a recovery of the wage's real value, that was strengthened by the general price freeze that occurred in 1986 (the so-called "Plano Cruzado").

The renewed inflationary pressures that followed the price freeze caused another drop in the real value of the minimum wage, which went down by around 30% in 1987. In August of that year the National Wage Floor Plan [*Piso Nacional de Salários*] was created, as an instrument designed to free the minimum wage from its role as a reference for the wage formation for some skilled labor categories, thus allowing the policies governing the formulation of the minimum wage policy a greater degree of freedom . That change generated a new period of recovery that, despite the boost in inflation, lasted until 1989. The real increase in minimum wages for this two-year period came close to 25%, but was not enough to raise the wage's real value back to the level observed in 1986. Finally, the government transition in 1989, which brought about a new stabilization plan, caused another sharp fall in the minimum wage, which reached its minimum value for the decade in 1990.

Despite the indisputable drop in the real value of the minimum wage during the 80s, there are some caveats to be made about that evolution, especially when one attempts to associate the drop to a deterioration in the living standards of the poor. First, the value of the minimum wage was unified nationally in 1985, taking its highest regional value (prevailing in the South and in the Southeast) as the new national value. Therefore, the other regions experienced an increase, and not a decline, for the period.[6] Second, the degeneration of close to 10% between 1985 and 1989 is, at least partially, offset by the changes introduced by the new Constitution in 1988: among other things, the number of hour worked per week was reduced from 48 to 44, and a vacation bonus was created.

Finally, it is important that the real value of the minimum wage be kept in mind. All other things being equal, the higher the minimum wage, the greater its impact on income distribution and reduction of poverty, as the number of workers being paid wages close to it increases. Also, the higher the minimum wage, the more responsive the demand for unskilled labor to

5 The annual inflation rate jumped from 100% to 200% that year.

6 It is true that we still observe a drop if we evaluate the weighted average, the weights being the number of wmin earners in each region, but the results are not as pronounced as when we take the highest national value.

changes in its value. On the other hand, the share of secondary workers in the labor force may be affected, though the direction of such changes cannot be predicted: if the income effect prevails, secondary workers will decrease and the minimum wage policy will become more progressive; the opposite occurs if the substitution effect is dominant.

3. The minimum wage earners

In this section we will identify the profile of the potential beneficiaries of minimum wage legislation, in terms both of their personal attributes and also in terms of the characteristics of the segments of the labor market where they work. This examination will encompass urban areas in Brazil, based on information drawn from the PNAD household survey of 1989.

PNAD data provides a detailed characterization of wmin workers, as well as comparisons with other groups of interest. In this study we consider minimum wage earners to be employees with labor cards or public servants whose hourly wages fall into the 0.75-1.25 minimum wage/hour bracket. For the purpose of comparisons, we define a group of low-income earners as one encompassing all workers, including those who do not have access to labor cards or the self-employed, whose incomes fall into that interval. We have also inspected the characteristics of the EAP as a whole, and the subset formed by the employees with labor cards (and public servants). This way we can compare not only the profile of wmin earners to that of low-income earners, but also to the class of workers protected by legislation and to the entire universe of workers.

The graphs that follow help us to understand the earnings structure for 1989 and, therefore, the relevance for low-wage earners. Such workers represent 19.4% of the EAP, and there is a contingent encompassing 12.6% of the EAP that earns less than the minimum wage.

The composition by income strata compared to the position by occupation[7] clearly shows that employees without labor cards are in the worst position: they are significantly over-represented among the low-income earners (27.9% against 19.4% for the EAP), and also among those who make less than the equivalent of the minimum wage (36.2% and 12.6%, respectively). The self-employed are under-represented in the minimum wage group (13.9%), though slightly over-represented in the very low-income strata (14.9%). Finally, the protected workers, i.e. those with labor cards, are slightly under-represented among the minimum wage earners (17.9%) and account for a negligible share of the very low-income group (close to

7 The employees without labor cards represented 22.2% of the sample in 1989, those with labor cards accounted for 58.7%, and the self-employed constituted 19.1% of EAP.

3%).[8] Almost 80% of these workers make more than the minimum wage, the largest percentage among all categories (the average for the EAP is 68%).

These distributions convey important information, as they indicate that minimum wage coverage is very limited, both in terms of protected workers who receive that wage (employees with labor cards with earnings in the minimum wage range represented approximately 10% of the total in 1989, i.e. around 4 million individuals), as well as in terms of the percentage of the EAP making less than that amount (particularly the unprotected employees) — 12.6%.

We can also see in the graphs that the largest part of the wmin earners group, plus those making less than the minimum, are formed by secondary workers (not heads of the family). The fact that secondary workers tend to be over-represented in this group is much more apparent for the Northeast, where 60% of the people are low or very low-income earners, compared to just 20% in São Paulo.

We next investigated the personal attributes and job characteristics of low-income earners. In order to simplify the analysis, we considered only four groups: the EAP as a whole, the share of EAP holding labor cards (the *formal* or *protected* sector), the low-income earners, and the minimum wage earners.

3.1 Personal attributes

The composition of the four groups broken down by personal attributes is shown in Table 1. There we can identify important differences among workers in these groups, especially between wmin earners and the EAP as a whole.

While in the EAP and in the formal sector the percentage of women is under 37%, it goes up to 42% among the low-income workers, and reaches 45% for the universe of individuals who earn the minimum wage. These figures make it clear that women are over-represented among low-income earners, and particularly so among wmin earners.

Another point that emerges from Table 1 is the over-representation of young people among low-income earners: the 10-19 age group accounts for 23.9% of such workers and just 14.9% of the EAP, whereas the 20-29 age group is the most intensely represented category among wmin workers. Another way of approaching this aspect is via the evaluation of the percentage of prime-age workers (25-50 years old) in each group: they are approximately 57% of the EAP, but no more than 45% of the wmin workers. If we look at the age composition by gender, we

8 In fact we shouldn't expect any protected worker to be receiving less than the minimum wage, which would be illegal. The small percentage found in this condition is probably due to misreporting in earnings and/or hours worked, or even to lags in the process of updating wages on the part of the firms.

find that, even though wmin earners are predominantly young individuals for both sexes, their over-representation is sharper among males.

Taken together, the wmin workers' profile by gender and age has important implications for the evaluation of minimum wages policies. As stressed by Reis (1989), the fact that those who receive the minimum wage are primarily the young and female, who are likely to be secondary workers, tends to undermine the potential distributive and poverty reduction effects of these policies. This inference is reinforced by the distribution of wmin earners by their family condition. While 50% of the EAP are workers who are heads of the family, the proportions falls to just above 1/3 in the case of low-income and wmin earners, confirming the idea that secondary workers constitute the majority of this group. It is worth pointing out that the family condition by gender is rather different: while 2/3 of males are heads of their families, this proportion goes down 1/5 for females. Male heads-of-families, however, are under-represented among wmin earners, which is not the case for female heads-of-families.[9] This is yet another suggestion that ususally women are secondary workers in the labor force. All in all, the important result to be emphasized here is that *almost 2/3 of the workers that earn the minimum wage are not the heads of their families*.

Regarding education, we can easily see that the average level of schooling of wmin workers is well below that for the EAP. Besides, the access to labor cards among the low-income workers creates an even stronger difference: the proportion of workers with at most some elementary schooling is 32.4% in the formal sector, 43.7% in the EAP, 49.5% for the wmin earners, and 57.5% for the low-income workers. The percentages for individuals with at least some high school education are, respectively, 39.6%, 29.1%, 16.4%, and 12.4%.

Regarding ethnic background, there is an obvious over-representation of blacks and mulattoes in the midst of low-income earners. Access to labor cards does not produce significative differences, and the percentages of blacks and mulattoes among low-income and wmin workers are very similar (even though they are under-represented in the formal sector of the economy).

In sum, with regard to personal attributes, the wmin worker profile reveals a large presence of women, young people, secondary members of the family, those who are poorly-educated, and blacks or mulattoes.

9 In other words, women are over-represented among wmin workers, but not in the subset of female heads-of-families. Regarding the men, they are under-represented among wmin eamers, but male heads-of-families are even more under-represented.

3.2 Characteristics of the jobs

Table 2 makes it possible to analyze the wmin earners' profiles in terms of certain labor market characteristics such as geographic region, area of residence (metropolitan or not), occupation and sector of activity. The main results are discussed below.

As to geographic regions, included here in order to capture differences in the workings of Brazil's regional labor markets, there is a clear dichotomy between São Paulo and the other states of the Southeast (henceforth called the East, for the purpose of simplicity) or the Northeast. The last two account for around 2/3 of the low-income and wmin earners, against only 44% of the EAP and 40% of the formal sector. On the other hand, there is an evident under-representation of these workers in São Paulo: the largest Brazilian labor market (30% of the EAP and 35% of the formal EAP) represents no more than 18% of low-income and wmin earners. In the cases of the South and the frontier region (the North plus the Midwest) there is no indication of either over- or under-representation.

An interesting byproduct of Table 4 is the result that, while the *degree of formalization* is equal to 0.59 on average, it reaches 0.68 in São Paulo. It should be mentioned that, though admittedly weak, this constitutes evidence in favor of the thesis that the imposition of a legal minimum wage becomes less restrictive the more dynamic the market is. Therefore, the adoption of a nationally unified minimum wage has distinct effects in each region, as the nature of their labor markets are not the same. Thus, the adoption of the so-called *regional minimum wages*, i.e., different values for the minimum wage by region, could be a superior strategy, as it would allow greater tailoring of the regional wage to the characteristics of each market.

Table 1
Profile of Minimum Wage Workers in Brazil
Personal Attributes — 1989

	EAP (%)		Formal Sector (%)	
	ALL	Low-Income	ALL	Minimum Wage
GENDER				
Male	63.1	58.1	63.3	55.4
Female	36.9	41.9	36.7	44.6
AGE				
10-19	14.9	23.9	10.3	20.9
20-29	31.2	32.6	35.7	37.6
30-39	25.6	18.5	28.1	18.8
40-49	16.3	12.6	16.5	12.6
50-64	10.5	10.4	8.8	9.4
65+	1.6	1.9	0.7	0.9
EDUCATION				
Illiterate	10.6	15.9	5.9	12.3
Elementary	33.1	40.1	26.5	36.5

(cont...)

(continued)

	EAP (%)		Formal Sector (%)	
	ALL	Low-Income	ALL	Minimum Wage
Intermediate	27.2	31.7	28.0	34.9
High School	18.7	11.5	24.8	15.1
College	10.4	0.9	14.8	1.3
HOUSEHOLD				
Head	46.0	66.9	52.6	68.0
Secondary	54.0	66.9	52.6	68.0
FAMILY				
Head	49.1	37.1	50.5	36.5
Secondary	50.9	62.9	49.5	63.5
Ethnic group				
White	58.9	47.4	63.8	44.8
Black	5.9	8.6	5.5	8.7
Mulatto	34.6	43.4	30.1	42.4
Asian	0.6	0.1	0.6	0.1
MALE				
- Age				
10-19	14.4	26.9	10.1	23.6
20-29	30.2	32.3	34.4	37.7
30-39	25.4	15.8	26.0	16.2
40-49	16.3	10.9	16.7	10.6
50-64	11.6	11.3	9.9	10.6
65+	2.1	2.7	0.9	1.4
- Family				
Head	66.2	49.0	68.6	49.0
Secondary	33.8	51.0	31.4	51.0
FEMALE				
- Age				
10-19	15.7	19.7	10.7	17.5
20-29	32.7	32.9	38.1	37.4
30-39	25.8	22.4	28.1	22.1
40-49	16.2	15.0	16.1	15.2
50-64	8.7	9.3	6.9	7.7
65+	0.9	0.8	0.3	0.2
- Family				
Head	20.0	20.7	19.4	21.0
Secondary	80.0	79.3	80.7	79.0

The information pertaining to status in occupation reveals that workers without labor cards account for nearly 1/3 (32%) of low-income earners, and no more than 33.3% of the EAP. At the same time the wmin workers account for just over half of the low-income earners. These results confirm the caveat presented by Reis (1989), who stated that knowledge regarding the impact of changes in the minimum wage on the earnings of the workers without labor cards is vital to any evaluation of this policy as an instrument for reducing poverty and inequality.

It is interesting to note that low-income earners are under-represented in the metropolitan areas, but this does not happen for the wmin workers *vis-à-vis* the EAP. Of course this is due to a sharp over-representation of self-employed workers, and particularly of employees without labor cards, in the non-metropolitan areas.

Finally, the distribution by sector of activity indicates, unsurprisingly so, over-representation of low-income workers in the light industry, construction, trade, services, and agricultural sectors of the economy. These segments employ a much higher proportion of wmin workers than of employees with labor cards.[10] In absolute terms, we observe that services (30.6%), trade (17.8%), light industry (15.9%), and public administration (13.7%) are the activities that employ most of the wmin workers.

In sum, we can say that low-paying jobs are more common in the Eastern and Northeastern regions, in non-metropolitan areas, and in the services and trade sectors, among those sectors that do not offer access to labor cards. With specific regard to the minimum wage, the same remarks hold true, although in a more conservative fashion.

Table 2
Profile of Minimum Wage Workers in Brazil
Job Characteristics — 1989

	EAP (%)		Formal Sector (%)	
	ALL	Low-Income	ALL	Minimum Wage
REGION				
South	14.9	14.9	16.1	15.8
São Paulo	29.9	17.9	34.6	18.0
East	24.4	31.6	24.8	34.5
Northeast	19.6	24.1	14.8	22.1
Frontier	11.2	11.5	9.6	9.6
AREA				
Metropolitan	44.5	38.4	50.9	43.4
Non-Metropoliton	55.5	61.6	49.1	56.6
POSITION IN OCCUPATION				
Employee (labor cards)	58.7	54.2	100.0	100.0
Employee (no card)	22.2	32.0	-	-
Self-Employer	19.1	13.7	-	-
SECTOR OF ACTIVITY				
Heavy Industry	10.3	5.8	15.5	7.9
Light Industry	9.0	12.3	11.1	15.9
Construction	7.7	9.2	5.1	6.6
Trade	14.1	16.7	12.1	17.8
Financial services	3.0	0.4	4.8	0.5
Transportation	4.9	2.9	5.5	3.1
Services	29.7	34.9	19.6	30.6
Public Adm.	13.6	7.5	23.2	13.7
Agriculture	6.5	8.9	2.2	3.0
Others	1.1	1.4	0.8	0.7

4. Income distribution and minimum wage earners

In this section we will investigate the position of the wmin earners vis-à-vis income distribution, in order to make it possible to develop a feeling about the potential distributive impact of minimum wage policies, since the more concentrated in the lowest strata they are, the higher the distribution and poverty reduction effects of this policy will be.

10 Since labor relations in the services, construction, and agriculture sectors are typically not very formal (0.39%, 0.39%, and 0.20%, respectively), there is no over-representation of wmin workers *vis-à-vis* the EAP in these segments.

We will first examine the income size distribution by using breakdowns per status in occupation and condition in the household. Though interesting *per se*, this is not the most adequate distribution if we are concerned with individual welfare.[11] This is so because when we take the individual as a unit of analysis we are disregarding the household structure, which is relevant for matters involving distribution, given that the household constitutes a common unit, of an eminently distributive nature, of earnings and consumption. Thus, it follows that the appropriate income concept when assessing aspects relating to poverty, inequality, and welfare is that of *per capita* household income. An evaluation along such lines will constitute the second part of this section.

4.1 The size distribution of income

When we consider the EAP holding labor cards, as well as the subset of heads-of-household in the EAP, we find that wmin earners (and low-income workers) are in fact confined to the lowest strata of the distribution: 90% of them, in both cases, are located in the lowest quintile, and the percentage above the median is very small[12] (see Table 3).

When we consider the EAP as a whole, we observe that low-income earners are positioned slightly higher than before: now close to 90% of them are in the second, third, and fourth deciles, with less than 5% in the first one. Possible reasons for these differences are:

Table 3
Wmin Workers and the Size Distribution of Income — 1989

Decile	EAP (total)				EAP(WC)		EAP(HH)
	LC	NLC	SE	LI	HH	MW	LI
1	1.9	6.3	15.0	5.0	2.9	37.1	21.7
2	26.6	38.1	31.0	30.1	27.6	45.2	51.9
3	51.6	34.0	18.0	41.4	38.0	14.6	20.1
4	16.6	18.0	24.8	18.1	23.0	2.5	5.5
5	2.7	2.9	7.7	3.4	6.4	0.5	0.7
6	0.5	0.5	3.6	1.0	2.0	0.1	-
7	0.0	-	-	0.0	0.0	-	-

LC: Employees with labor cards;
NLC: Employees with no labor cards;
SE: Self-employed;
LI: Low income earners;
HH: Heads-of-household.

[11] This is true even assuming that income is a good proxy for the level of welfare.

[12] The variability in the position of wmin earners in the distribution is due to two factors: a) their remuneration varies between 0.75 wmin/hour and 1.25 wmin/hour, and b) there are differences in the number of hours worked per week/month.

a) there are several workers, especially among the self-employers and the employees with no labor cards, earning less than the minimum wage -- as previously indicated;

b) the low-income workers, particularly among the employees, work more hours than average.

Finally, it should be pointed out that the distribution of low-income self-employed workers is rather distinct from the overall pattern, its concentration being much higher in the first and fourth to sixth deciles. Once again, a high variability in the workday may be the explanation for this peculiarity.

4.2 The household *per capita* income distribution

We can see in Table 4 that, regarding household per capita income distribution, while close to 1/3 of wmin and low-income workers are above the median, less than 15% of them are in the first quintile of the distribution, and around 4% are in the top quintile. It becomes clear that, as far as the household per capita income is the variable considered, the distributive impact of the minimum wage, whether or not its effects are limited to labor card holders, is severely undermined by losses to higher income strata.[13]

If we restrict ourselves to the group of workers that are heads-of-household, we find a rather different picture: almost 27% of them are located in the lowest quintile of the distribution, only 20% are above the median and less than 1% are in the top two deciles. This point confirms the inference that low-income earners who belong to households that are better situated in the income distribution are, in fact, secondary workers. As about 1/3 of low-income earners are heads of household (see previous section), it is immediately obvious that close to 85% of the individuals whose incomes are in the wmin range and are above the median of the household per capita income distribution are not heads of the household.[14]

It is worth noticing that the remarks above do not change when we consider the income from all sources, rather than merely labor earnings. The only exception that deserves to be mentioned is the increase in the concentration of low-income heads-of-household in the bottom quintile, from 27% to 41%, indicating that these units constitute an important nucleus of poverty.

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13 In other words, contrary to the usual belief, it is not the poor households which profit the most, nor are they the vast majority of those who benefitted from increases in the minimum wage, as there are a significant number of non-poor households who also take advantage of such increases.

14 When the head of the household is a worker, this household is almost surely poor, which means that the other members of the household are not likely to be in a better position in the labor market, at least as far as earnings are concerned.

One point that has to be stressed relates to great similarityies between the way low-income earners are distributed when they have labor cards and when they don't. This evidence is important, and to some extent surprising, as it allow us to infer that even in cases when workers in the informal sector do benefit from raises in the wmin, the increase in the distributive effects of such policy may not be as high as we could expect: besides constituting a much smaller contingent of workers, the people in question have similar characteristics regarding their position in the income spectrum.

As it has been observed in the analysis of the size distribution of income, the low-income workers that are self-employed are more concentrated in the lower income strata than the rest of the EAP (without a higher concentration in the upper strata, as had previously been the case).

In summary, the fact that around 35% of the potential beneficiaries of increases in the minimum wage belong to the richest half of Brazilian households has meaningful consequences for the evaluation of a minimum wage policy, as it may substantially reduce its favorable impact on the income distribution in two distinct ways: a) it diminishes the number of poor who will actually profit from it, and b) it ends up helping households which do not need and should not receive this kind of aid.

Table 4
Wmin Workers and the Household *Per Capita* Income
Distribution — 1989

			Labor	Earnings					Income	From	All	Sources
Decile	LIM*	LC	NLC	SE	EAP	HH	LIM*	LC	NLC	SE	EAP	HH
1	0.13	0.44	1.15	2.57	1.00	1.66	0.25	6.53	7.13	12.6	7.64	16.5
2	0.30	13.3	12.8	20.4	14.2	25.3	0.41	13.7	13.9	16.4	14.2	24.5
3	0.46	16.6	17.1	19.0	17.1	23.2	0.58	15.5	16.3	16.7	15.9	19.4
4	0.64	18.4	18.4	18.6	18.5	20.7	0.79	16.0	16.6	16.7	16.2	13.6
5	0.85	15.3	15.2	14.3	15.1	11.1	1.01	16.5	15.7	12.9	15.7	11.2
6	1.17	15.9	15.2	10.2	14.8	10.6	1.35	13.5	12.5	10.1	12.6	7.15
7	1.60	9.54	9.40	6.90	9.07	4.60	1.86	8.77	9.08	7.60	8.68	3.99
8	2.41	5.97	6.58	5.48	6.16	2.20	2.74	5.41	4.88	4.26	5.13	2.33
9	4.21	3.03	2.98	1.83	2.83	0.96	4.93	2.95	3.13	2.13	2.92	1.10
10	271	1.41	1.18	0.71	1.24	0.30	1649	1.17	0.84	0.68	1.02	0.30
20-	0.30	13.7	14.0	23.0	15.2	26.9	0.41	20.3	21.1	28.9	21.8	41.0
50+	271	35.9	35.3	25.1	34.1	18.7	1649	31.8	30.4	24.8	30.3	14.9
20+	271	4.44	4.16	2.54	4.07	1.26	1649	4.12	3.97	2.81	3.94	1.40

LC: Employees with labor cards;
NLC: Employees with no labor cards;
SE: Self-employed;
HH: Heads-of-household;
LIM+: Upper bound (as a multiple of the minimum wage);
===: Poverty Line.

5. Simulation exercises

In the previous sections we identified the main attributes of wmin workers, as well as the characteristics of their jobs and their position in the income distribution. The main results indicate that a good deal of the potential distributive impact of policies geared to increasing the real value of the minimum wage could be undermined by the fact that a substantial part of wmin workers are secondary workers, and belong to families that are not poor (about 1/3 of them are found in families whose per capita income is above the median).

The task at hand in this section is to simulate the actual impact of increases in the wmin on income distribution and anti-poverty measures. Needless to say, this is a typical exercise of the sort where one needs a lot of strong and simplifying hypotheses, usually of a controversial nature. Thus, it is worth pointing out that this is no more than an accounting exercise aimed at giving one a general idea regarding how increases in the wmin may trickle through the labor market structure under distinct settings to produce alterations in inequality and poverty. It is not meant to provide definite and/or precise answers to such points, but merely to serve as a preliminary evaluation that may work as a reference point for the discussion regarding the efficiency of such policies.

With this caveat in mind, we now list the main hypotheses underlying the simulations:

a) in all simulations we assumed a real increase of 25% in the real value of the minimum wage, in such a way that every worker in the formal sector making less than 1.25 minimum wages would now earn exactly that wage. Additionally, we considered that no one above that mark would have her/his wage increased as a consequence of the change in wmin, and that workers in the informal sector of the economy would not benefit from minimum wage increases either, *i.e.*, the minimum wage is not to be used by the entire economy as a wage indexation benchmark;

b) an extremely important parameter for the evaluation of the distributive impacts of increases in the minimum wage is the "elasticity" of the demand for labor in the protected sector. There is no study available in the Brazilian literature that could give us a clue as to this matter. Therefore we opted to choose a broad range of possible values — 0, 0.2, 0.5 and 1.0 — for the response of the demand for unskilled labor (understood here as the kind of labor provided by workers with less than complete primary, or elementary, schooling),[15] always assuming no unemployment effect for skilled labor in the formal sector (*i.e.*, for those workers with at least complete elementary schooling);

c) in the case were there was an employment effect in the protected sector, we worked with the expected value of the *new* wage of those who were initially earning the minimum wage. The

[15] Less than 8 years of schooling.

adoption of this neutral procedure was done in order to avoid the problem of determining those who would lose their jobs and those who would keep them. Thus, the expected wage of wmin earners after the increase in its value is given by:

$$E[w_f] = 1.25\ \pi\ +\ (1-n)w_i^{after},$$

where:

$E[w_f]$: the expected value of the wages of wmin earners in the formal sector after the increase in the minimum wage;

π : the probability of keeping one's job in the formal sector;

w_i^{after} : mean wage of unskilled labor in the unprotected sector after the increase in the minimum wage.

d) the determination of the new average wage for unskilled labor in the informal sector was done under the assumption of a unit price elasticity of labor demand, in such a way that the total amount of income would remain the same. Therefore, the new average wage for these workers is given by:

$$w_i^{after} = w_i^{initial} * [N_{iu}^{initial} / (N_{iu}^{initial} + (1-\pi)N_{if}^{initial})]$$

where:

$w_i^{initial}$: initial mean wage for unskilled labor in the informal sector;

$N_{iu}^{initial}$: the initial number of unskilled wmin workers in the informal sector;

$N_{if}^{initial}$: initial: the initial number of unskilled wmin workers in the formal sector.

e) of course some tax scheme for financing such increases would have to be generated. This discussion, though interesting, is beyond the scope of the exercise. We may simply assume an inflation tax which will take care of the problem. In this case there is no qualification or correction to be made in terms of the distributive impact, as only the relative incomes matter. For the evaluation of poverty and indigence reduction, the respective poverty and indigence lines have to be increased the same percentage amount as the increase in total income generated by the rise in the minimum wage.

Two points are worth noticing. First, implicit in the above framework is the hypothesis of no changes in employment. Everyone who is unemployed in the formal sector gets a job in the informal sector. Second, even though this may cause substantial changes in the value imputed to those who lost their jobs in the protected sector and migrated to the informal segment of the economy, the wage of those unskilled workers already in that sector was simply corrected by the fraction [wi after/wi initial]. The idea, again, is to be neutral about who was affected the most and who had suffered up to that point.

Regarding the interpretation of the results generated by the equation, it would be helpful if we had a reference point for use in evaluating the strength of the distributive and poverty/indigence reduction impacts of wmin policies, as it is hard to develop a feeling with which to judge them as being small or significant, merely out of nothing. A parallel exercice was carried out to cover the issue. The basic idea was to simulate what would happen if instead of transferring income to wmin earners we somehow managed to transfer the same number of resources to those in the bottom tail of the distribution, i.e., if we were able to exclusively increase the incomes of the poor.[16]

The *negative income tax* exercise was implemented in two steps. First we determined what the level of income and the respective percentile of the distribution associated to it would be, up to which it would be possible to bring every individual poorer than that, in such a way that the total increase in nominal income required to do so would be equal to that generated by the raise in the minimum wage. Next we made the income of all individuals below that mark equal to it.[17]

In both cases, and for all the labor demand *elasticities* (e) here considered, we evaluated the new Gini coefficient and the Theil T index, as well as the PO (or H, the headcount index), P1 (or PG, the poverty gap), and P2 poverty and indigence measures, and compared them to the values actually measured. The results for 1989 are described in the following Table 5.

Table 5
Results of the Simulation

		Inequality		Poverty				Indigence			
		Theil T	Gini	PO	I	P1	P2	PO	I	P1	P2
Original		0.8304	0.6174	0.298	0.421	0.125	0.074	0.113	0.415	0.047	0.030.
e=0											
	MW	0.8179	0.6120	0.284	0.409	0.116	0.068	0.101	0.418	0.042	0.027
	%	-1.5	-0.9	-4.5	-2.8	-7.2	-8.3	-10.9	0.9	-10.1	-7.9
	IT-	0.8083	0.6073	0.298	0.306	0.910	0.040	0.050	0.091	0.005	0.001
	%	-2.7	-1.6	-	-27.4	-27.4	-45.7	-55.4	-78.0	-90.2	-98.0

(cont...)

16 Such procedures roughly correspond to the negative income tax policy that is pretty much in the middle of the debate on antipoverty policies nowadays.

17 In other words, we truncated the bottom tail of the distribution at that income level, thus reducing inequality and, at least, the intensity of poverty and indigence.

(continued)

		Inequality			Poverty				Indigence		
e=0.2											
	MW	0.8188	0.6124	0.285	0.411	0.117	0.068	0.102	0.419	0.043	0.028
	%	-1.4	-0.8	-4.3	-2.3	-6.6	-7.5	-10.1	1.1	-9.2	-7.0
	IT-	0.8096	0.6080	0.298	0.333	0.099	0.042	0.057	0.103	0.006	0.001
	%	-2.5	-1.4	-	-20.9	-20.9	-43.4	-49.7	-75.1	-87.5	-97.2
e=0.5											
	MW	0.8201	0.6130	0.287	0.412	0.118	0.069	0.104	0.418	0.043	0.028
	%	-1.2	-0.7	-3.6	-2.2	-5.7	-6.4	-8.5	0.9	-7.6	-5.7
	IT-	0.8116	0.6090	0.298	0.343	0.102	0.044	0.068	0.116	0.008	0.001
	%	-2.3	-1.4	-	-18.6	-18.6	-39.9	-40.3	-71.9	-83.2	-95.6
e=1.0											
	MW	0.8224	0.6140	0.289	0.416	0.120	0.070	0.106	0.421	0.455	0.029
	%	-1.0	-0.6	-2.9	-1.3	-4.1	-4.4	-6.3	1.3	-5.0	-3.3
	IT-	0.8145	0.6105	0.298	0.357	0.106	0.048	0.113	0.126	0.014	0.003
	%	-1.9	-1.1	-	-15.1	-15.1	-34.3	-	-69.6	-69.6	-91.3

There we can see that, even in the most favorable case[18] (e equal to 0), the distributive impact of a substantial increase in the minimum wage — 25% — is rather small: the Gini coefficient falls a meager 0.003 points, from 0.617 to 0.614, which amounts to a percentage decrease of just 0.9%. If instead we consider the Theil T, the results are still very modest: it falls from 0.830 to 0.822, or 1.5% (the difference is because the Theil T is more sensitive to the lower tail than the Gini coefficient).

These impacts are progressively narrowed when we account for possible reductions in the level of employment in the formal sector induced by real increases in the minimum wage. For the case of unitary *elasticity* they are cut to about 2/3 of the original decrease (the reduction in the Gini coefficient comes down to 0.6%, whereas the decrease in the Theil T index falls to 1.0%).

The results are a bit more significant when we consider the poverty and indigence measures. For the very reason that these indices take into account only the bottom of the distribution and, despite some spillovers to higher strata, it is there that most of the wmin earners are, the improvements become more sizable in this case. In the simulation that considers no losses of jobs in the formal sector, an increase of 25% in the minimum wage results in a decrease in the percentage of poor from 29.8% to 28.4%, and the percentage of indigents goes down from 11.3% to 10.1%; whereas in the simulation where 25% of the unskilled wmin workers lose their jobs in the protected sector, the new percentage of poor is

18 Of course the situation where the increase in the minimum wage somehow is translated into increases in higher wages could produce different results. We do not consider this case here.

equal to 38.9% (about 2/3 of the reduction achieved for e=0), whereas the percentage of indigents is reduced to 10.6% (almost half of the decrease obtained for e=0).

Regarding the poverty gap (P1 index), we found a decrease of between 4,1% and 7,2% for the poor, and between 5.0% and 10.1% for the indigent. The P^2 index is the one that reveals the largest improvements, in the interval between 4.4% to 8.3% for the contingent of the poor and between 3.3% and 7.9% for the indigent.[19]

For the sake of developing an idea regarding the efficiency of the wmin policy in promoting equality and reducing poverty and indigence, as well as regarding the undermining of these goals caused by the spillovers to higher income strata, we can compare the previous results with those that would have been produced were the same amount of resources given directly to the poorest individuals/families. We can see in the table, under the label *IT*, that the improvements in the distribution would be almost twice as large as in the case of minimum wage polices: the Gini coefficient goes down by something between 1.1% and 1.6%, and the fall in the Theil T is in the 1.9%-2.7% range.[20]

In this kind of simulation there is no reduction in the number of poor, for the simple reason that the total amounts of funds are not high enough to bring the poor up to the poverty line, but only enough to bring them to the income level corresponding to the 10th-11th percentile. Therefore, no poor crosses the poverty line.[21] The differences appear when we incorporate other dimensions of poverty into the measurement, specifically intensity (P1) and inequality (P2). From Table 5 we can see that the poverty gap narrows about 3.5 times more in the case of IT- than for the wmin boosting policies. Similar, but even more acutely so, is what takes place for P2: the drop in this index is 5 to 8 times greater when income transfers are handed directly to the poor than when one resorts to rising wmin policies. Of course the striking difference between the effects of the two policies on P2 comes as no surprise, given that this index accounts for the heterogeneity among the poor, and the IT-kind of policy is equivalent to censoring the lower tail of the distribution.

19 It is interesting to notice that the improvements in P1 are larger than those in P0 for the poor, the opposite occuring in the case of the indigent. This result basically reflects the fact that the relation between the average income of the poor (indigent) and the poverty (indigence) line (1-l) behaves differently: it goes up with the increase in the minimum wage for the former and goes down for the latter (*i.e.*, most of those who benefit from the increase in the wmin are very close to the indigence line). In both case this relation goes down with the degree of unresponsiveness of the demand for skilled labor to the increase in wmin.

20 It is important to realize at this point that the reductions in the inequality indices for the IT – simulation, though much larger than in the wmin simulation, are still modest. This is due basically to the low values of the minimum wage in Brazil, which cause a small amount of transfers even when it is increased by 25%. It is not necessarily true, however, that the distributive effects would increase substantially for higher values of the minimum wage, as in this case the impact of wmin policies on the demand for unskilled labor should of larger magnitude too.

21 In other words, you either eliminate poverty or leave the number of poor unchanged in this exercise. The second option prevailed here.

If instead of looking at the poor we consider the indigent, we can see from Table 5 that the reductions in the indices are substantial: the percentage of indigent is cut to half in the basic simulation (e=0), I is reduced by 78%, whereas P1 and P2 are virtually eliminated.

The somewhat weak impact of increases in the minimum wage on the degree of inequality and poverty, together with the significant differences obtained through a scheme of income transfers made directly to the poor, together confirm the existence of severe transfers of income to the more favored family units under the first policy. Therefore, some of the beneficiaries are not those originally targeted, which contributes to reducing the impact on poverty (as such beneficiaries are not really poor) and increases the degree of inequality (as such people may actually belong to rich families, which enhances inequality). The picture becomes bleaker when one considers the generation of unemployment via the imposition of higher minimum wages. In this case, not only do we have leaks, but also the production of losers — those who fail to keep their jobs in the protected sector and end up in low-paying positions in the informal segment of the economy. This phenomenon ends up contributing to the undermining of the potential effects of minimum wage policy even more, while casting doubts on the adequacy of such policies in achieving their goals.

6. Summary and conclusions

In this study we sought to describe the main characteristics of workers who earn the minimum wage (and/or its equivalent) in urban Brazil, using 1989 as the reference year. The characteristics we focused upon are related to personal attributes — gender, age, education, and ethnic roots, among others —, the jobs minimum wage earners hold — such as sector of activity, status in occupation, and region —, and their position in the income distribution.

Among the more important conclusions of the analysis is the identification of the groups that are over-represented in the class of minimum wage earners: women (45% against 37% in the EAP), and secondary workers (63.5% against 50.9% overall). These results have strong implications for the distributive and poverty alleviation effects of minimum wage policies, as they tend to reduce their magnitude. They also have important implications for the very concepts underlying such policies, as the subsistence of the family is the parameter usually taken as a baseline for the determination of the legal value of the minimum wage.

Another important finding confirms the results previously obtained by Reis (1989), and relates to the position of these workers in the income spectrum. We found that 35% of minimum-wage workers belong to families that are above the median of the household per capita income distribution. Thus, increases in the minimum wage do not accrue only and necessarily to the poor, and a significant fraction of the workers that take advantage of such increases do not actually need this kind of help.

This leakage, needless to say, may severely undermine the distributive and poverty-reduction effects of such policies, and reinforce a pessimistic view about the role of the minimum wage in promoting such goals. This does not mean that one should deny the existence of positive effects, but just that they are limited, so much so that other distributive policies should be considered and pursued.

In the final part of the study we empirically evaluated the reach of minimum wage policies, under a set of simplifying hypotheses, as well as for a range of demand *elasticities* for unskilled labor in the formal sector of the economy. The general pattern was a very shy response in terms of inequality, poverty, and indigence measures to increases in the minimum wage: in the most favorable situation (no one would lose their jobs in the formal sector as a consequence of the raise), a real increase of 25% in the value of the minimum wage would reduce the Gini coefficient by just 0.9%, and the percentage of the poor and indigent by no more than 4.5% and 10.9%, respectively. These figures compare to a reduction of 1.6% in inequality and 55.4% in indigence when the same funds were instead directly transferred to the poorest.

Overall, we may say that even though minimum wage policies may be an interesting instrument for protecting labor, as is fiercely defended by some, it is very difficult to justify the implementation of increases in the minimum wage on the basis of their distributive and poverty reduction impacts. It seems that the costs associated with the adoption of minimum wage increases may very well overshadow the potential benefits from this front. Thus, alternative policies aimed at making income distribution more egalitarian and at directly alleviating poverty, whether by income transfers or through structural policies, should be strongly considered.

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CHAPTER 3

DISTRIBUTIONAL OBJECTIVES AND DISCRIMINATORY PRICES FOR PUBLIC UTILITIES*

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Abstract

This article derives optimal discriminatory prices for a public monopoly, where distributional objectives and constraints on the deficit are taken into account. Also discussed is the interplay of variables such as demand price elasticity and the considerations of welfare in the process of discriminating tariffs among households. In addition, an analysis is carried out of the way in which certain facts of economic development, such as the reduction of inequality in income and the immigration of the population to urban centers, affect the setting of public service rates. The article also illustrates how welfare considerations implicit in current rate structures can be revealed and examines how sensitive the price ratios charged are to the distributional goals.

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1. Introduction

Public utilities (such as water, sewage, and electricity companies) in developing countries have used discriminatory pricing as an instrument for the redistribution of income, aiming at supporting low-income households by helping their access to basic services. These monopolies owned by the government adopt a pricing policy that sets unit rates that rise in accordance with the quantity of their products consumed. The idea is to favor the consumption of poor households, charging them a lower price, compensated by charging a higher price to other consumers; that is to say, there is the implicit assumption of a positive relationship between the quantities of these services consumed and household incomes.

There are no studies available that examine these pricing policies in detail to see how close or far they are to achieving their proposed objectives, and there are doubts as to the role of income redistribution that they effectively have in relieving poverty in these countries.

As public monopolies, these companies should pay due attention to social problems, in contrast to what we ought to expect from a private monopoly, which would use discriminatory pricing for the purpose of maximizing profits. In pursuing a social goal, these companies are frequently led to pay less attention to their financial management. In Brazil, for example, although there exist legal norms laying down that their social objectives must not impair their financial health, these companies have run chronic deficits. These financial losses are due not just to poor management of their pricing structure, but also to the fact that nominal price increases to allow for the effects of the corrosion of prices by inflation have become not just a financial question but a political one too, making their implementation more difficult. Financial transfers from the government have covered the deficits, since most of these companies belong to the state governments.[1]

The objectives of this article are: first, to derive optimal discriminatory prices to be charged by a public monopoly, taking into account the distributional objectives and restraints on deficits; second, to examine how these discriminatory prices charged are likely to be affected by changes taking place to the distribution of income; and third, to show how considerations of relative welfare, implicit in current rate structures, can be disclosed and how sensitive price ratios are to distributional choices made by the government. The chief theoretical developments are set out in section 2. In Section 3 an analysis of the adjustments required to discriminatory prices in response to changes in income distribution is given. Section 4 contains a brief description of the institutional background to the pricing practices of public service companies in Brazil. In section 5, questions of the evaluation of the welfare considerations implicit in

1 This makes the low prices paid by some consumers dependent not just on internal cross-subsidies (that is to say, between the consumers of the public service), but also on the subsidy financed by taxpayers. As some poor households are both public service consumers and taxpayers, the net benefit of this pricing policy should be evaluated.

current pricing structures are examined, together with the sensitivity of price ratios to different considerations. The final section summarizes the main conclusions of this article.

2. The theory of setting public prices and discriminatory prices

Pigou (1920), as quoted by Tirole (1988), distinguishes between three basic types of discriminatory pricing:

a) First degree discrimination – the seller charges a different price per unit for the goods; this price is precisely the consumer demand price, that is to say, the purchaser's reserve price for that unit, removing all the consumer's reservation surplus.

b) Second degree discrimination – where the seller lacks complete information on the consumer's preferences, but is still able to remove the consumer's excess in charging different prices for different blocks or packages of the number of units sold: the seller charges the same price for the number of units included in a given block, setting a price equal to the demand price that the purchaser wishes to pay for this block of units; it should be noted that the discrimination is imposed when the consumer himself chooses the quantity that he wishes to buy.

c) Third degree discrimination – this type is based on the possibility that the seller has to separate his customers into different groups, according to their capacity to pay different prices; the different prices that the customers pay are not necessarily related to the various quantities that they buy, but the discrimination is imposed by the seller.

Tirole (1998, page 135) states that the most important difference existing between second and third degree discrimination is that the latter is used as a direct signal identifying demand (such as age, occupation, and location), while in the second degree the discrimination works by self selection by the consumers themselves of the quantities desired.

In this article we are interested in deriving a rate structure that discriminates between households according to their income (this is the signal mentioned by Tirole); we assume that the public utility can group its customers according to their incomes (for example: poor and non-poor households) and can charge a different rate (third degree discrimination) to each group.

Various important articles discussing the theory of public pricing and taxation have neglected the idea of discriminatory pricing by public companies and its relationship with income distribution;[2] Feldstein (1972a) draws attention to the fact that these articles do not refer to the question of the distributional features of public price setting [see Baumol and Bradford (1970), Lerner (1970), Dixit (1970) and Boiteaux (1956)]. In an attempt to fill this gap, Feldstein developed a model in which the consideration of equitable distribution is specifically introduced in setting the prices of two goods produced by a public utility; this is done by definition of a parameter called "the distributional characteristic of the good *i*" (*Ri*), which is a weighted average of the marginal social utilities, in which the marginal social utility of each household is weighted by the quantity of the good *i* bought by the household; it can be shown that *Ri* has a higher value for an item of basic necessity than for a luxury good and that *Ri* is inversely proportional to the elasticity income of the demand for a good.[3] The values of *Ri* have an important role in determining the relative price ratios of two goods, but, unfortunately discriminatory pricing in this model does not have the sense which interests us in this article, that is to say, different prices being charged to different households for the same goods: in the Feldstein model all consumers of the same good pay the same price. His distributional parameter only has the role of making the relative price of an item of basic necessity lower in terms of the relative price of the other good produced by the same public utility.

In two other articles, Feldstein again uses the distributional characteristic of a good for setting public prices. In Feldstein (1972b) too, in which he is interested in studying equity and efficiency in the context of discriminatory prices for a set of goods, his conclusions cannot be transposed to justify price discrimination, since the optimal price derived in his model is a single price for all consumers of the same good; in Feldstein (1972c) a model is adopted that allows discriminatory prices between households and private producers, that is to say, the price to be paid by the former differs from that to be paid by the latter (the households pay the same price and the private producers pay a different price). Once again, his notion of discriminatory prices is not that in which we are interested, as described by Pigou, in other words, the difference in prices charged to the same type of consumer for a good produced by a public utility.

Le Grand's article (1975) seeks to reply to the question of how discriminatory pricing results from a welfare maximization model for setting the price of a good produced by a public utility,

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2 Throughout this article, discriminatory pricing must be understood to be the same good being sold at different prices to different consumers. Although Philips (1985) does not agree with this definition, it is correctly applied to the type of goods being considered here, since each unit is perfectly homogeneous, that is to say, there is no difference in the production cost or in the quality, the location of the consumer is not taken into account in setting prices and there are no uncertainties involved.

3 Using Feldstein's notation:

$$R_i = \frac{N}{Q}\int_0^{\infty} qi(y)u'(y)f(y)dy$$

where *N* is the total number of households; *q* is the quantity of the good *i* acquired by a household with an income *y*; *u'(y)* is the marginal social utility of one dollar for a household with an income *y*; *f(v)* is the relative density function for the household's income; and G_i is the total quantity acquired of the good *i*.

when different welfare weights are attributed to the household's utility. Some of the theoretical results we obtain in the present article [expressions (3), (4) and (5)] coincide with the Le Grand's conclusions, since his model and ours have much in common: a function of social welfare is defined by aggregating the households' utilities and, then, this function is maximized with the constraint of equilibrium between public companies' costs and revenue. What distinguishes the present article is the fact that our assumptions allow the additional inclusion of the role that some important variables have in the process of discriminatory pricing, such as household income, the aversion to inequality of income, the parameter of economies of scale in the production function and the number of poor households, not touched on in Le Grand's article.

The conclusions in Roberts article (1979) – although they are dedicated to the determination of non linear prices, that is to say, the derivation of optimal prices that vary in accordance with the quantities that consumers buy – allow prices to be determined in accordance with the socio-economic conditions of consumers, that is to say, meeting the distributional objectives. Our model shares some of the characteristics of the Roberts model, yet is simpler and uses a less complex methodology.[4]

To simplify the analysis, let us make the following assumptions:

Assumption 1: The economy produces two types of goods: Good 1 is produced by a public utility and sold to consumers at discriminatory prices; good 2 is a composite product, including all the other goods and services sold in this economy.

Assumption 2: the households can be grouped in K homogeneous subsets in accordance with their monthly income; each one of the n_j households that make up group j, where $j = 1, \ldots, K$, receives the same income Y_j.

Assumption 3: Each household of the j type has a utility function: $U_j = U(X_{1j}, X_{2j})$ (1)

where X_{1j} and X_{2j} are the quantities of goods 1 and 2 respectively that are consumed.

Assumption 4: The government wishes the public company to set prices that maximize the social welfare function.

$$W = W(U_1^1, \ldots, U_1^{n1}, U_2^1, \ldots, U_2^{n2}, \ldots, U_k^1, \ldots, U_k^{nk}) \tag{2}$$

4 The Roberts model uses a continuous income distribution, while our model opts for a distribution in sections; our exercise in maximization is achieved using the Kuhn-Tucker conditions, while the Roberts model is maximized with the Pontyryagin maximum principle; our model uses price as a control variable, while the approach chosen by Roberts consists of maximizing with respect to the cost function and the marginal price.

subject to the constraint that its costs less its revenues, that is to say, its deficit, is equal to a fixed amount D.

Assumption 5: The public utility cost is a function of the total quantity of good 1 produced, that is to say:

$$C = C(X_1) \tag{3}$$

where:

$$X_1 = \sum_{j=1}^{K} n_j X_{1j} \tag{4}$$

and

$$X_{1j} = X_{1j}(P_{1j}, P_2, Y_j) \tag{5}$$

is the quantity of good 1 bought by the j type household, P_{1j} and P_2 are the prices paid for both goods.

Since the government's objective is for prices of good 1 to be set in such a way that social welfare is maximized, subject to the constraint that the transference of financial resources from the government to cover any deficit may not exceed a specified amount, we can write the function to be maximized as:

for:

$$L = W + \mu[\bar{D} - C(X_1) + R(X_1, P_{1j})] \text{ for } j = 1, \ldots, K \tag{6}$$

where $R(X_1, P_1)$ is the public company's income and μ is the Lagrange multiplier for the financial balance constraint.

Assuming that L is a concave function, the Kuhn-Tucker conditions for a maximum of L are:[5]

$$\partial L / \partial P_{1j} \leq 0 \tag{7}$$

for

$$P_{1j} . \partial L / \partial P_{1j} = 0 \text{ for } P_{1j} \geq 0 \tag{8}$$

5 The concavity of L results from the assumptions of the welfare function and the convexity of the cost and income functions.

ond

$$\partial L / \partial \mu \geq 0 \tag{9}$$

for

$$\mu . \partial L / \partial \mu = 0 \ for \quad \mu \geq 0 \tag{10}$$

Let us call $\partial W / \partial Uj = wj$ (the welfare weight ottributed to the household type j´s goin in utility). We know thot:

$$\partial U_j / \partial P_{1j} = -\lambda_j X_{1j} \tag{11}$$

where λ_j is the marginal utility of income for household type j, then we can soy thot the first order conditions for o moximum ore:

$$\frac{\partial L}{\partial P_{1j}} = -n_j \sigma_j X_{1j} + \mu n_j \left[-m . \frac{\partial X_{1j}}{\partial P_{1j}} + (X_{1j} + P_{1j} \frac{\partial X_{1j}}{\partial P_{1j}}) \right] \leq 0 \ for \quad j = 1, \ldots, K \tag{12}$$

for $j = 1, \ldots, K$, where $m = \partial C / \partial X_1 j$, the marginal cost of production, ond σ_j ($\sigma_j = w_j . \lambda_j$) is j´s marginal social utility of income;

ond:

$$\frac{\partial L}{\partial \mu} = \bar{D} - C(X_1) + \sum_{j=1}^{K} n_j X_{1j} P_{1j} \geq 0 \ for \quad j = 1, \ldots, K \tag{13}$$

For o non negative P_{1j} we must hove $\partial L / \partial P_{1j} = 0$. Then, equoting the expression (12) to zero ond dividing it by n_j ond X_{1j} we find thot marginal social utility of income is:

$$\sigma_j = \mu \left[\frac{m \varepsilon_{1j}}{P_{1j}} + 1 - \varepsilon_{1j} \right] for \quad j = 1, \ldots, K \tag{14}$$

where $\varepsilon_{1j} = -\frac{\partial X_{1j}}{\partial P_{1j}} . \frac{P_{1j}}{X_{1j}}$ (thot is to soy, demond price elasticity of the good 1 for the j household).

Expression (14) can be used to define the price P_{1j} and the price ratio P_{1i}/P_{1j}, respectively, as:[6]

$$P_{1j} = \frac{m}{1+\dfrac{\sigma_j - \mu}{\mu \varepsilon_{1j}}} \quad for \quad j=1,\ldots,K \tag{15}$$

$$\frac{P_{1i}}{P_{1j}} = \frac{1+\dfrac{w_j \lambda_j - \mu}{\mu \varepsilon_{1j}}}{1+\dfrac{w_i \lambda_i - \mu}{\mu \varepsilon_{1i}}} \tag{16}$$

Expression (15) shows that the optimal price to be charged to the j household can be equal to, lower or higher than the marginal cost, depending on whether $\sigma_j \gtreqless \mu$. Since $d_i = w_j\lambda_j$, that is to say, that the marginal utility of income can be modified by the weight that the planner attributes to the marginal utility of income of j, λ_j, effectively the determination of the fact that P_{1j}, is equal to lower or higher than the marginal cost depends on the value attributed to w_j, that is, the price derived for j type households in accordance with welfare weight attributed to their gain in utility. The possibilities are:

a) if $w_j > \mu / \lambda_j$ then $P_{1j} < m$;

b) if $w_j < \mu / \lambda_j$ then $P_{1j} > m$; and (17)

c) if $w_j = \mu / \lambda_j$ then $P_{1j} = m$.

It is important to note the role played by the demand price elasticity: in case a, increasing values for ε_{1j} makes P_{1j} lower, while in case b increasing values for ε_{1j} makes P_{1j} higher. This means that, the less essential the service is to the household j, the lower is the price P_{1j} relative to the marginal cost if $w_j > \mu / \lambda_j$, and the higher is P_{1j} if $w_j < \mu / \lambda$ in case c increasing elasticities do not affect the optimal price, since its value will always be equal to the marginal cost.

Expression (16) allows us to examine how different values taken by the households' demand price elasticities for this good or service and their welfare weights affect the price ratio P_{1i}/P_{1j}.

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6 Expression (15) is identical to Le Grand's (5), since the first order condition $\partial L / \partial P_{1j} = 0$ is not dependent on the number of households in each group. It should be noted that the solution to P_{1j} (that is to say, those prices that also satisfy the public utility's financial restriction) requires replacing both P_{1j} and X_{1j}, in expression (13) respectively, and its solving in terms of P_{1j}.

Let us examine the following four cases with possible values assumed for the demand price elasticity of the i and j households and the relative weights $w_i / w_j = 1$ and $w_i / w_j > 1$. In the second case ($w_i / w_j > 1$), we are assuming that the government has decided to attribute a higher welfare weight to household i than that attributed to household j, in such a way that it benefits i in the price schedule used by the public utility; the i households (the poor), have a higher marginal income utility than the j households (the non-poor), that is, $\lambda i > \lambda_j$.

Demand price elasticities	Weights	
	$w_i = w_j$	$w_i > w_j$
$\varepsilon_{1i} < \varepsilon_{1j}$	Case A	Case B
$\varepsilon_{1i} > \varepsilon_{1j}$	Case C	Case D

It should be noted that the difference in demand price elasticity between the *i* and *j* households is explained by their different incomes, that is to say, $\varepsilon_{1i} = f(Y_j)$.

Cases B and D, in comparison with cases A and C, are situations in which we assume that the welfare weight of the poor has been increased; hence, by expression (16) it is clear the higher *wi* is, other things being equal, the lower will the price ratio $P_l i/P_l j$ be, that is to say, the lower will $P_l i$ be relative to $P_l j$.

Let us examine cases A and C first:

Case A:

If

$$\frac{w_j \lambda_j - \mu}{\mu \varepsilon_{1j}} = \frac{w_j \lambda_i - \mu}{\mu \varepsilon_{1i}} \tag{18}$$

then $P_{li} = P_{lj}$. But for P_{li} to equal P_{lj} we need to have:

$$\frac{w_j \lambda_i - \mu}{w_j \lambda_j - \mu} = \frac{\varepsilon_{1i}}{\varepsilon_{1j}} \tag{19}$$

This equality is impossible, since $\lambda i > \lambda j$ and $\varepsilon i < \varepsilon j$. Therefore, the prices cannot be equal.

We can prove that P_{li} cannot be greater than P_{lj} for the same reason. The only possible result is that the price for the poor is lower than the price paid by the rich.

As we mentioned previously, for case B, this smaller price charged to the poor can be reduced by increasing the welfare weight attributed to them.

Case C:

For this case we have $\varepsilon i / \varepsilon j > 1$. In this case we can have either $P_{1i} = P_{1j}$, and $P_{1i} > P_{1j}$, or $P_{1i} < P_{1j}$; the equality or the inequality of these prices depends on the values taken by the ratios:

$$\frac{\varepsilon_{1i}}{\varepsilon_{1j}} \text{ and } \frac{w_i \lambda_i - \mu}{w_j \lambda j - \mu} \tag{20}$$

If λ_i is greater than λj, makes the latter ratio equal to the ratio of elasticities, both prices will be equal. If that ratio is greater than the ratio of elasticities, the price paid by the poor will be lower, if it is smaller, P_{1i} will be greater.

Note that increasing the welfare weight attributed to the poor (case D) will affect these results in the following ways:

If $P_{1i} = P_{1j}$: the price paid by the poor will become smaller if:

$$\frac{w_i \lambda_i - \mu}{w_j \lambda_j - \mu} > \frac{\varepsilon_{1i}}{\varepsilon_{1j}} \tag{21}$$

If $P_{1i} < P_{1j}$: the smaller price paid by the poor will become smaller if the government increases their welfare weight; this result is explained by the fact that the ratio that contains the welfare weights has its value raised in relation to the elasticity ratio.

If $P_{1i} > P_{1j}$: the price paid by the poor will be reduced; it may be that this price becomes lower than that paid by the non-poor. This variation depends on the value assumed for w_i and on how this affects the value assumed for the ratio in which it appears, in comparison with the elasticity ratio.

2.1 Analysis of a special case: the Cobb-Douglas utility function

Some of the important relationships can be explained in this analysis when the consumer utility function referred to in Assumption 3 is specified. Let the utility function be represented by a Cobb-Douglas function:

$$U_j = X_{1j}^{\alpha} . X_{2j}^{1-\alpha} \text{ for } j = 1, \ldots, K \tag{22}$$

where X_{1i} and X_{2j} are the quantities of goods 1 and 2 consumed by the j type of household and α is a parameter of the function that measures the importance of good 1 (the good produced by a public utility), where $0 < \alpha < 1$. This utility function implies an indirect utility function as follows:

$$V_j = Y_j \,/\, (rP_{1j}^{\alpha} P_2^{1-\alpha}) \ for \ \ j = 1,\ldots,K \tag{23}$$

where $r = (1 - \alpha)^{\alpha-1} / \alpha^{\alpha}$.

Using the Roy´s identity, the demand function for X_1 is derived as:

$$X_{1j} = (\alpha Y_j) / P_{1j} \tag{24}$$

And, thus, we have $\varepsilon_{1j} = 1$, a drawback of the Cobb-Douglas utility function.

The social welfare function (SWF) is in the ioselastic form, representing here the SWF referred to in Assumption 4, that is to say:

$$W = \sum_{j=1}^{K} n_j \frac{V_j^{(1-\rho)}}{1-\rho} \tag{25}$$

where ρ is the aversion to welfare inequality parameter.[7]

The planner's evaluation of the consumer j 's utility gain or his welfare weight, w_j is the first product of the social welfare function with regard to the utility of j.

Then:

$$w_j = \partial W / \partial V_j = \left[\frac{1}{rP_2^{1-\alpha}}\right]^{-\rho} Y_j^{-\rho} P_{1j}^{\alpha\rho} \tag{26}$$

The public utility cost function, referred to in Assumption 5, will be assumed as being in the form:

$$C(X_1) = F + mX_1^{\theta} \tag{27}$$

where F is the fixed cost, m is a constant and θ is the economies of scale parameter of the production function. The marginal cost is $\theta m X_1^{\theta-1}$; when $\theta = 1$, the marginal cost is m.

The function to be maximized is the same expression (6) and the first order conditions for a maximum are:[8]

7 The value ρ lies in the interval $[1, +\infty]$; depending on the value taken by this parameter, the expression (25) represents a utilitarian or Bernouli-Nash or Rawls SWF. This function is strictly concave when ρ is > 0, since this implies decreasing welfare weights attached to the social welfare function.

$$\frac{-\alpha n_j Y_j^{(1-\rho)} P_{1j}^{[-\alpha(1-\rho)-1]}}{[r P_2^{(1-\alpha)}]^{(1-\rho)}} = \mu\left[\alpha \theta m n_j X_1^{(\theta-1)} Y_j P_{1j}^{-2}\right] \tag{28}$$

$$\bar{D} = F + m\alpha^{\theta}\left[\sum_{j=1}^{K}(n_j Y_j P_{1j}^{-1})\right]^{\theta} - \alpha \sum_{j=1}^{K} n_j Y_j \tag{29}$$

for j = 1,..., K.

The price P_{1i} *for* $i = 1,\ldots, K$ can be found solving (28) and (29):

$$P_{1i} = \frac{m^{1/\theta}\,\alpha\left[\sum_{j=1}^{K} n_j Y_j^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}}\right] . Y_i^{\frac{\rho}{(1-\alpha)+\alpha\rho}}}{\left[\bar{D} - F + \alpha \sum_{j=1}^{K} n_j Y_j\right]^{1/\theta}} \tag{30}$$

The household i's level of consumption at the price P_{1i} is found using expression (30) in the demand function $X_{1i} = \alpha Y_i P^{-1}_{1i}$:

$$X_{1i} = \left[\frac{\bar{D} - F + \alpha \sum_{j=1}^{K} n_j Y_j}{m^{1/\theta} \sum_{j=1}^{K} n_j Y_j^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}}}\right] . Y_i^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}} \quad for \quad i = 1,\ldots,K \tag{31}$$

Note that the price and quantity formulas are two exponential functions, dependent, among other factors, on the value assumed for the aversion to inequality parameter ρ. The exponents in the expressions (30) and (31) are ratios with the same denominator $(1 - \alpha) + \alpha P$. This denominator is positive, since $0 < \alpha < 1$ and $\rho \geq 0$. Then, the sign of the numerator of the exponent depends on the value of ρ. It is easy to see that P_{1j} is a constant function when $\rho = 0$ (the same price for all the Y_j) and an increasing function of the incomes for $\rho \neq 0$ (the prices increase with the incomes of the households). With regard to the quantity function, the expression (31) shows that this function can be both constant (the same quantity demanded for all the Y_j), when $\rho - 1$, and rising, when $\rho > 1$, or falling (lower quantities demanded as incomes rise), when $\rho < 1$.

Using the expression (30), we can derive the price ration P_{1i} / P_{1j} as:

8 The product $\partial R / \partial P_{1j}$ is equal to zero since $\varepsilon_{1j} = 1$.

$$\frac{P_{1i}}{P_{1j}}=\left[\frac{Y_i}{Y_j}\right]^{\frac{\rho}{(1-\alpha)+\rho\alpha}} \tag{32}$$

and we see that if $Y_i < Y_j$, then P_{1i}/P_{1j}, since the exponent is positive in the expression.[9] In other words, the price differentials are a function of the inequalities of income: the higher the inequality (Y_i is smaller than Y_j), the smaller P_{1i} will be in relation to any P_{1j}.

Assuming constant returns to scale ($\theta = 1$) and no aversion to inequality ($\rho = 0$) in the price formula (30), the optimal price will be the same for all the households, equal to:

$$P_{1i}=P_{1j}=\frac{m}{1+\dfrac{\bar{D}-F}{\alpha\sum_{j=1}^{K}n_j Y_j}} \quad for \quad i\neq j, i, j=1,\ldots,K \tag{33}$$

and we can see that the traditional prescription of charging a price equal to the firm's marginal cost will be relevant only if $\bar{D} - F = 0$. For any $\bar{D} > F$, the price should be lower than the marginal cost.

The mathematical expressions (30) and (32) are useful in showing that a discriminatory rate schedule set by a public monopoly can be a necessary instrument in maximizing social welfare; unless the social welfare function is of the utilitarian type (that is, $\rho = 0$, what presupposes that the price ratio in the expression (33) is equal to 1 and $P_{1i} = P_{1j}$ for any j, (regardless of how unequal the households' incomes may be), the prices must differ among consumers.[10]

In the presence of large income inequalities in a population, we should expect the government to use a social welfare function that aggregates the utilities of the individuals, applying decreasing weights as household incomes rise. In this case, that is , when ρ is not equal to 0, in contrast to the Ramsey rule, the prices must differ, in spite of the fact that both consumers will have demand price elasticities equal to 1, as we can see in expression (32).

In the case of adoption of a Rawlsian social welfare function ($\rho = \infty$) , the price to charged to a poor household (those that have an income Y_1, where $Y_1 < Y_2 < \ldots < Y_k$) will be smaller than that set by a utilitarian social welfare function, as expected: expression (32) shows that the ratio of

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9 It can be shown that the right hand side of the expression (32) tends toward $(Y_i / Y_j)^{1/\alpha}$, a positive value, when ρ tends toward ∞ and tends to 1 when ρ tends to 0.

10 As shown by the expression (16), this inequality $P_{1i} = P_{1j}$ when $\rho = 0$ for $Y_i \neq Y_j$ will not hold in utility functions for which $\varepsilon_{1i} \neq \varepsilon_{1j}$.

prices will be higher when $\rho = 0$ (the utilitarian function) than when $\rho = \infty$, since in the first case $P_{1i} / P_{1j} = 1$ and in the second, $P_{1i} / P_{1j} = (Y_i / Y_j)^{1/\alpha}$, a value smaller than 1.[11]

It is clear that, as expected, the higher the value of the subsidy D given by the government, the lower the prices for all consumers will be. Of course, any financial crisis affecting the government's budget may affect the source of financing of the public utility, which will require prices to be increased for all consumers.

It is interesting to note that, in the particular case of the Cobb-Douglas utility function, the characteristics of the cost function have no importance in the determination of relative prices charged to the households; these depend only on the ratio of the households' incomes and on the parameters α and ρ, as seen in expression (32). However, cost characteristics affect the absolute price level, considering that $\partial P_{1j} / \partial \theta > 0$, as seen in equation 30. Thus, an increase in production requiring a larger input ratio for any input (for example, a production capacity expansion giving rise to a rise in fixed costs) will demand a proportional increase in the prices charged to all households, keeping their price ratios unchanged.

3. Evolution of public utility prices: development implications

As seen in section 2, a policy of discriminatory prices established by a public utility can be theoretically justified when the economy shows inequality in the distribution of income and the government wishes to apply different weights to the welfare of consumers. If economic development reduces income inequality, then the economic justification for discriminatory prices becomes less important and we should expect to see income redistribution policies give way to social programs whose primary aim would merely be to protect against extreme poverty and to provide subsistence in the case of incapacity.[12]

Current development problems found in Third World countries, particularly in Brazil, caused by economic recession and by high rates of inflation, make the management of the pricing policy of public utility companies more complex financially:

a) in the case of inflation, there is a tendency to avoid the necessary price adjustments, not just because this is unpopular, but also because increases in the rates feeds the inflationary process. Certainly, in avoiding the required increases, the public company incurs greater losses to be financed by government subsidies, which, in turn, may cause more inflation, perpetuating the need to raise the prices of public services. Inflation and the recession are problems that hit household incomes and the result of this situation is a process of expanding the number of

[11] The higher the aversion to inequality parameter ρ, the smaller the price paid by the household i, since $\partial P_{1i} / \partial \rho < 0$.

[12] According to Barr (1987, page 46), for those who share libertarian views of society, such as Freidman and Hayek, this is the only distributional role that governments should play in any situation.

poor households in the population, with a perverse effect on the revenues of the public company;

b) recession means not just growing unemployment, business failures, and its social consequences, but also lower public resources for expanding public services in urban areas, where most of the population of these countries is concentrated; we know also that medium and large urban centers in Third World countries exert a strong attraction on immigrants from backward regions, expanding the need to satisfy the demand for basic public services to be provided to low income consumers.

All the above problems, by enlarging the number of poor consumers to be served by a public utility, require adjustments to be made in the rate structure for its services in such a way to ensure its financial viability. Let us examine the conditions under which prices should or should not change when the number of poor households is increasing; let Y_p, n_p, and P_{1p} be the income of poor households, their number, and the price they are charged for consuming the good or service 1, respectively. Our conclusions will be based on the analysis provided by expressions (30), (32), and (33), which were derived assuming that the utility function is a Cobb-Douglas one.

3.1 Conditions leading to P_{1p} being constant

The price P_{1p} should not change if it is equal to the marginal (and the average) production cost. This situation occurs when there are constant returns to scale ($\theta = 1$), the social welfare function is utilitarian ($\rho = 0$, then $P_{1p} = P_{1j}$) and the public utility receives a financial transfer from the government that is equal to its fixed cost ($\overline{D} = F$), in these circumstances, $\partial P_{1p} / \partial n_p = 0$.

What makes this outcome implausible is not so much the possibility of all these conditions coinciding, but the doubtful assumption that the government applies equal social welfare weights to different groups when inequalities of income are getting larger.

3.2 Conditions that require a change in the price P_{1p}

a) P_{1p} should rise if it is less than the marginal (and the average) cost of production. This happens in the same circumstances mentioned in Subsection 3.1, except when the government pays a subsidy greater than the company's fixed cost ($\overline{D} > F$), which gives rise to $\partial P_{1p} / \partial n_p > 0$. The need to raise the price of the service is clear: the deficit increase more sharply with an increase in n_p and $\overline{D}$ remaining constant; b) if the conditions are the same as those referred to in a), but $\overline{D} < F$, then the price P_{1p} is higher than the marginal cost (that is to say, prices are covering not just the variable costs, but also part of the fixed cost). In this case, the number of consumers added allows prices to fall. That is to say, $\partial P / \partial n_p < 0$; and c), in case of increasing the marginal cost of production ($\theta > 1$) we have $\partial P_{1p} / \partial n_p > 0$, since the numerator of P_{1p} in expression (30) will rise more than the denominator, which will require a price increase, with the rest remaining constant. This result is also very clear: the rise in the cost must be met through greater revenues, that is to say, a higher price.[13]

Our above conclusions refer to the effects on $P_{1p,}$ but since all public service prices are interconnected, as seen in expression (32), when this price needs to be changed, all the others will also change; this variation is required to keep the price ratio P_{1i} / P_{1j} constant. The value of this ratio depends on the income ratio Y_i / Y_j and on the values assumed for ρ and α, the parameters of aversion to inequality and for the importance of the good 1 in the welfare of households, respectively, other things being equal.

As seen previously, economic problems and demographic changes that affect income distribution can have a heavy impact on the financial health of a public company, requiring additional funds from the government (a higher $\overline{D}$) and/or from consumers (higher prices) to finance a bigger deficit. These higher prices will require adjustments to the quantities consumed, reducing the level of welfare enjoyed by households. In terms of distribution, the lowering of total social welfare will be due more to the reduction in welfare suffered by the poor, forced to adjust to a lower level of consumption.

4. Institutional aspects of public utility pricing in brazil

Basic urban services in Brazil, such as electricity, water, sewage, and gas, are supplied chiefly by companies owned by the government. These companies belong to state governments, which are responsible for their management. The federal government, through its specialized agencies, regulates various aspects to do with the working of these companies, including their price setting policies. Federal regulatory control is in accordance with the broad concentration of financial and political power in the hands of the central government, developed since the mid 1960s.

In all the urban services referred to earlier, the regulatory agencies lay down that public utilities must charge discriminatory prices to consumers, as a way of benefiting some of them. This is the case, for example, with water, waste disposal, and electricity services.

Current legislation for the water and waste disposal sector lays down that rates must be established taking into account both the financial circumstances of consumers and the companies' need for financing. This general principle seeks to achieve a compromise between the principle of charging consumers what they can afford to pay and the principle of preserving the financial health of the company. To achieve the financial objective, this company must

13 One possible reason why the marginal cost rises could be the fact that, in general, the added population, in those urban centers tends to live on the outskirts at some distance from existing public service networks: the extension of these networks is costly and will supply less densely populated areas of the city.

generate operating revenues that cover the running and investment costs.[14] Besides recommending different average rates for residential, commercial, industrial and public consumers, federal regulations institute specific guidelines for the household sector, such as:

a) the monthly bill, including the consumption of water and waste disposal of those households that consume up to 10 cubic meters, may not be greater than 50% of the value of Treasury Bonds;[15]

b) the rates per cubic meter must increase as consumption increases, that is to say, the price schedule must show a progressive rate structure, in such a way that the consumption of the poorest households receives a cross-subsidy.

Table 1
Rates for the residential consumption of water in Paraná (Sanepar), 1987

Monthly residential consumption of water (in cubic meters)	Rate per unit of consumption * (in Cr$)
0 to 10	1.57
11 to 15	1.45
16 to 25	1.87
26 to 50	2.59
More than 50	3.61

Source: Companhia de Saneamento do Paraná
* Price to be charged for consumption exceeding the lower limit of the consumption category.

The rates of the electricity companies are set by the DNAEE – the National Department of Water and Electrical Power –, and agency of the Ministry of Mines and Energy. The agency also discriminates between consumers by charging different prices; for residential consumers, the basic rate was NCr$ 1,530.34 per mwh in January 1990, but with the following reductions in this rate:[16]

For consumption up to 30 kwh	70%
From 31 to 100 kwh	40%
From 101 to 200 kwh	35%
From 201 to 300 kwh	5%
More than 300 kwh	0%

14 In other words, revenues should be sufficient to pay the cost of inputs plus depreciation and other financial costs, together with the rate of return on the investment (a maximum of 12% a year). Effectively, the process of setting an average rate that has this property is a very complex task, in particular in an inflationary context, with little control of costs and depending on federal approval to adjust prices. This is at the root of the chronic deficits of these companies.

15 The reason for the choice of linking the amount of the bill to the value of Treasury Bonds is not known; naturally, the idea was to avoid using a monetary value that would soon become derisory through the effects of inflation. Nonetheless the value depends on the monetary policy implemented by the government and has no connection with the consumer's social condition.

16 Brazil, Ministry of Mines and Energy, National Department of Water and Electrical Power, Decree No. 02 of Jan 9th, 1990. Diário Oficial da União, January 10th, 1990, pages 638-640.

These rate structures will be used in the next section as cases for disclosing the ideas adopted by the planners on how to aggregate the utilities of consumers.

5. Rate structures and implicit social welfare weights

The discriminatory pricing policies operated by public utilities providing public services in Brazil result from rules laid down by normative federal agencies and from the consensus existing among public policy decision makers that such a policy is socially justifiable, in view of the low income levels of a large segment of the population.

No written justification is to be found for the discriminatory pricing adopted by these public utilities. It seems that the decision to establish their rates was taken in an arbitrary manner in the past, taking into account only the financial aspects of the question, without a clear and well established set of social welfare goals to be achieved. There are no explicit social welfare weights that can be questioned, and the only way of analyzing them consists of estimating their values by calculating the weights implicit in the price differences. The objective of this section is to apply the theoretical results of this article to give an example of how the weights used by the electricity and water/sewage companies in Brazil can be estimated. We shall apply the price differentials present in the rate structures of the electricity and water/sewage services given in the preceding section.

The consistency of government intentions would require the use of the same set of social welfare weights for different population groups, when the programs are of the same nature; the degree of aversion to inequality (ρ) shown by the government should not vary between the programs. Certainly, this is a parameter to be monitored by the government, allowing it to lower its value when economic development makes the problem inequality of income less important. We see no reason to use different sets of weights for essential urban public services, such as the availability of residential electricity, and water and sewage, when the income conditions of consumers remain unchanged.

We can illustrate how the ratio of social welfare weights can be estimated, using the ratio of weights implicit in the Cobb-Douglas utility function.[17] Thus, using expression (26), we can write the ratio of social welfare weights as:

$$\frac{w_i}{w_j}=\left[\frac{Y_j}{Y_{ip}}\right]^{\rho}\cdot\left[\frac{P_{1i}}{P_{1j}}\right]^{\alpha\rho} \qquad (34)$$

[17] In the following exercise, we shall assume that the rates charged were optimally determined and that the utility function is that which was correctly employed to generate the rate structure.

The ratio w_i / w_j is affected by two factors – the income ratio Y_i / Y_j (where, for the sake of argument, $Y_i > Y_j$) and the price ratio P_{1i} / P_{1j} – and by the parameters ρ and σ. Its elasticity of income ratios is determined by the value of ρ, the aversion to inequality parameter; the higher the aversion to inequality, the higher the variation in the relative weight attributed to the welfare gain of the household i in relation to that attributed to the gain in j, given a variation of 1% in this income ratio. Its elasticity of price ratio is equal to $\alpha\rho$; once again, the parameter ρ plays the role of affecting the weight ratio although its influence may be altered by α $(0 < \alpha < 1)$, the parameter that measures the importance of this good in determining the welfare of the household; thus, the elasticity of the price ratio w_i / w_j will be a value between 0 and ρ, excluding these extreme values.

It should be noted that, for a given price ratio (for example, 1.37/3.61 = 0.38 in the Sanepar rate structure, or 0.30/1.00 = 0.30 in the DNAEE structure) and for constant ρ and α values, expression (34) is an exponential function. As such, the value of w_i / w_j changes positively as Y_j/Y_i: a) in the same proportion, if $\rho = 1$; b) less than proportionally, if $0 < \alpha < 1$; and c) more than proportionally, if $\rho > 1$.

Through expression (34), knowing that $0 < \alpha < 1$ and assuming that $P_{1i} < P_{1j}$, we can estimate that the ratio of social welfare weights applied by those public utility companies in Brazil is included in the following interval:[18]

$$\left[\frac{Y_j P_{1i}}{Y_i P_{1j}}\right]^{\rho} < \frac{w_i}{w_j} < \left[\frac{Y_j}{Y_i}\right]^{\rho} \qquad (35)$$

Table 2 shows the values calculated for the above welfare weights interval for selected incomes and for some levels of aversion to inequality, if the price ratio is equal to 0.38 (Sanepar) and 0.30 (DNAEE).

[18] This interval depends on the assumptions made as to the Cobb-Douglas type of utility function for households and as to the use of an ioselastic social welfare function by the government; undoubtedly, it cannot be generalized and its estimates will depend on the function that represents most appropriately the behavior of households and how the government evaluates the social welfare of each group of households.

Table 2
Estimated values for the ratio of welfare weights implicit in the rate structures of Sanepar and of the DNAEE for selected income ratios (Y_j / Y_i) and chosen levels of inequality aversion*

Y_j / Y_i	Level of inequality aversion			
	$\rho = 0{,}1$	$\rho = 0{,}5$	$\rho = 1{,}0$	$\rho = 2{,}0$
Sanepar				
1	0,90-1,00	0,61-1,00	0,30-1,00	0,14-1,00
5	1,06-1,17	1,37-2,24	1,90-5,00	3,61-25,00
10	1,14-1,25	1,94-3,16	3,80-10,00	14,44-100,00
15	1,19-1,31	2,38-3,87	5,70-15,00	32,49-225,00
20	1,22-1,35	2,75-4,47	7,60-20,00	57,76-400,00
25	1,25-1,38	3,08-5,00	9,50-25,00	90,25-625,00
Y_j / Y_i	Level of inequality aversion			
	$\rho = 0{,}1$	$\rho = 0{,}5$	$\rho = 1{,}0$	$\rho = 2{,}0$
DNAEE				
1	0,88-1,00	0,54-1,00	0,30-1,00	0,09-1,00
5	1,04-1,17	1,22-2,24	1,50-5,00	2,25-25,00
10	1,11-1,25	1,73-3,16	3,00-10,00	9,00-100,00
15	1,16-1,31	2,12-3,87	4,50-15,00	20,25-225,00
20	1,19-1,35	2,44-4,47	6,00-20,00	36,00-400,00
25	1,22-1,38	2,73-5,00	7,50-25,00	56,25-625,00

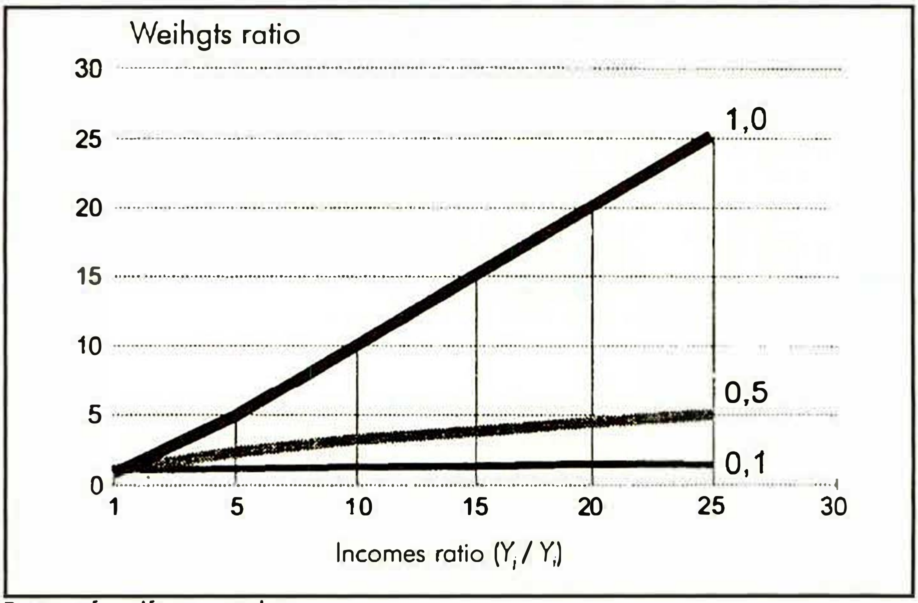
*For price ratios of 0,38 and 0,30 of Sanepar and DNAEE, respectively.
Note: In the estimate of the interval: the lower estimate refers to $\alpha = 1$; the upper refers to $\alpha = 0$.

Let us assume that the importance of the public utility service to the social welfare of household (α) can be measured by its relative share in the household's total monthly expenditure. In this case, experience shows that the average value of α for public utility services such as water/sewage and electricity is quite low, varying from 0.001 and 0.03, that is to say, quite close to zero. [19] Taking into account that the value of α is practically zero for this type of public service, the ratio w_i / w_j given by expression (34) depends practically just on the income ratio, and is, therefore independent of rates charged by the public utility. Thus, in this special case, the objective of estimating the social welfare weights through prices is frustrated, and nothing can interfere based on the prices set by these companies. In this case, these weights will vary in function with the income differentials Y_j and Y_i and the level of aversion to inequality (ρ) adopted by the government. This means that in the interval given by the expression (35) the relevant limit is that given by (Y_j / Y_i), in other words, the upper limit of that expression. Thus, the estimated values for the implicit welfare weight are identical for Sanepar and for DNAEE for different values of inequality aversion.

[19] According to data from the 1985 Household Budget Survey, spending on water/sewage represents between 0.1% and 1.2% of the household's total spending in Rio de Janeiro, Brazil; in the case of electricity, its spending varies between 1.2% and 3.2%. Source: Brazilian Institute for Geography and Statistics Foundation, *Household Budget Survey*, special tables.

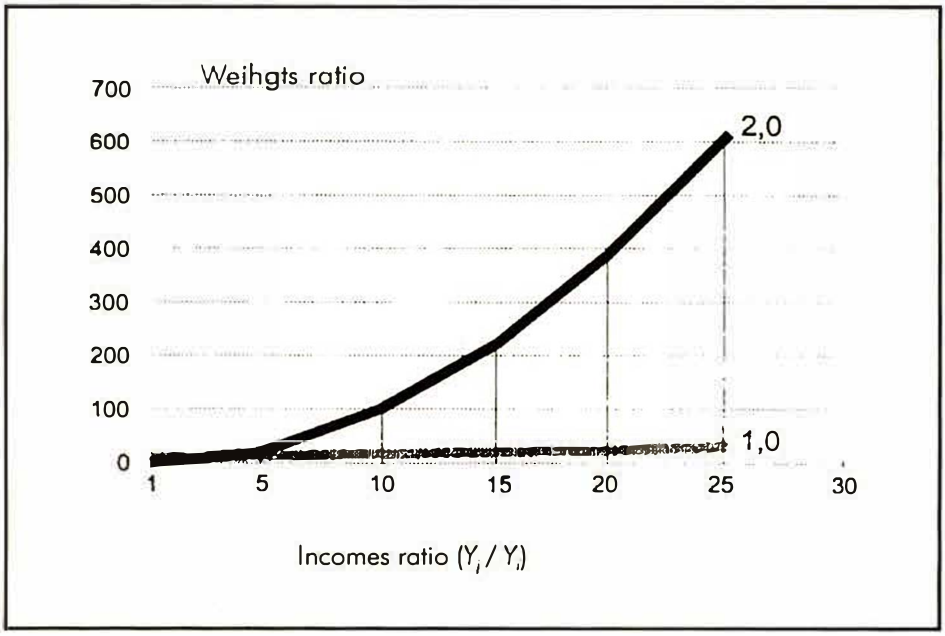
Charts 1 and 2 show the values estimated for the ratio of social welfare weights calculated in Table 2. This serves to show graphically how this ratio varies when the income differentials become greater and how the social weights diverge for higher levels of inequality aversion in the distribution of income. These charts also serve to give an idea of the approximate value of the ratio w_i / w_j for intermediary values of Y_j / Y_i, that were not shown in Table 2.

Chart 1



Ratio of welfare weights

Chart 2
Ratio of welfare weights



6. Distributional objective and price sensibility

Optimal prices are very sensitive to distributional objectives set by the government. The objective of this section is to confirm this statement by examining how prices vary in function with chosen values assumed for the aversion to inequality parameter.

To make the analysis simpler, let us assume that the *i* and *j* households have the same demand price elasticity, equal to 1, and that their social welfare weights are different, with that for the *i* households (the poor) being higher, that is to say, $w_i > w_j$.

Let us assume that the price differential paid by Sanepar consumers (Cr$ 1.37 / Cr$ 3.61) is related to an income ratio of 0.04, in other words, those households that pay the higher rate enjoy an average income 25 times higher than the average received by the low consumption households.[20]

To calculate the price ratio compatible with a given value assumed for the aversion to inequality parameter, we can write expression (32) as:

$$\left[\frac{Y_j P_{1i}}{Y_i P_{1j}}\right]^{\rho} < \frac{w_i}{w_j} < \left[\frac{Y_j}{Y_i}\right]^{\rho} \qquad (35)$$

Table 3 shows the price ratios calculated for the different weights attributed to the welfare of the households.

Using P_{ij} = Cr$ 3.61 and the price ratios calculated from Table 3, we can say that (assuming $0.005 < \alpha < 0.10$):[21]

a) if the government opts to adopt a low value for ρ (let us say, $\rho = 0.1$), then Sanepar's lower rate should be in the interval (Cr$ 2.53 – Cr$ 2.61), instead of Cr$ 1.37;

b) for $\rho = 0.5$, its lowest price should be between Cr$ 0.66 and Cr$ 0.71;

c) for $\rho = 1$, its lowest price should be equal to Cr$ 0.14, regardless of the value assumed for α;

d) for $\rho = 2$, the price P_{1j} should be very small, a value between Cr$ 0.005 and Cr$ 0.01;

If the aversion to inequality is of the Rawlsian type, that is to say, $\rho = \infty$, then the price ratio will be equal to $P_{1i}/P_{1j} = 0.04^{(1/\alpha_i)}$. As the income ratio has a very low value and the exponent is positive, the above expression estimates a price ratio very close to zero for any α_i. In this case, the lowest price to be charged by Sanepar would be zero.

20 The values Cr$ 3.61 and Cr$ 1.37 are, respectively, the higher and lower marginal rates in the Sanepar price schedule. As to the assumption of the household income differential, it seems reasonable when we consider, in its pricing structure, the following information from Sanepar (1987, page 96) on household income and water consumption:

Income, in number of monthly minimum wages	Monthly water consumption, in cubic meters
Up to 1	10.1
1 – 2	11.0
2 – 5	12.3
5 – 10	15.7
10 – 20	22.5
More than 20	32.3

21 Given that we are setting the value of P_{ij} at equal to Cr$ 3.61, any P_{ij} less than Cr$ 1.37, as seen in the data taken from Table 3, would require a higher subsidy from the government.

The data in Table 3, as well as in the example above, allow us to see how higher values assumed for the aversion to inequality parameter produce larger disparities between the highest and lowest rates that should be charged by a public utility. The great sensitivity of the price ratio to distributional objectives defined by the government is made clear.

Table 3
Price ratios for selected values for the aversion to inequality parameter (ρ) and the importance of the good for producing welfare for the household (α_i).

(for Y_i / Y_j equal to 0.04)

α_i	Level of aversion to inequality			
	$\rho = 0.1$	$\rho = 0.5$	$\rho = 1.0$	$\rho = 2.0$
0,005	0,724	0,199	0,04	0,0016
0,01	0,723	0,198	0,04	0,0017
0,02	0,720	0,196	0,04	0,0018
0,03	0,718	0,195	0,04	0,0019
0,04	0,716	0,193	0,04	0,0020
0,05	0,714	0,191	0,04	0,0021
0,06	0,711	0,190	0,04	0,0023
0,07	0,709	0,188	0,04	0,0024
0,08	0,707	0,187	0,04	0,0025
0,09	0,704	0,185	0,04	0,0027
0,10	0,702	0,183	0,04	0,0028

7. Conclusions

In this article, we have attempted to contribute to discussion on the setting of public prices, through examining the way in which price discrimination can be established to make public utility services a more effective instrument of social policy. We have shown that the use of distributional objectives in setting rates to be charged to different consumers broadens the range of considerations to be taken into account by the government, in requiring a prior definition with regard to the way public services should be financed: besides the amount that the government can transfer to a public company, it must be decided how prices should differ and, consequently, the amount of the cross-subsidy between households that the rate structure will produce.

It was clear too that the rules traditionally advocated for setting prices, either in accordance with marginal cost or in accordance with the inverse of consumer demand price elasticity, should be qualified to incorporate other elements that may help in determining the optimal rate to be charged, as well as the price differentials. These elements are not just the welfare weights used, but also the characteristics of the good in terms of its importance in producing welfare for the household, and the shadow-price of the public company's deficit.

One important conclusion to be drawn from this article consists of showing how the demand price elasticities have a dominant role in discriminatory pricing, determining the values that the welfare weights should assume to produce the prescribed price differentials.

It is important to emphasize the relationship between the management of public companies' prices and the process of economic development. This process implies, for example, an improvement in income distribution, which can attenuate the need to subsidize these public companies. Economic development can also bring cost reductions in the production of the public service, allowing lower prices to be charged to consumers. At the same time, it was interesting to show how the present population growth that we are witnessing in the urban centers of developing countries can affect the rate structures adopted by companies providing public services. The expansion of their services may require a larger cross-subsidy, to be paid by the non-poor, and/or an increase in the transfer of funding provided by the government to these companies.

It also showed that current rate structures adopt implicit welfare weights. We have illustrated how these weights may be estimated by the use of price differentials defined by the price lists. When properly done, this estimation allows a comparison between the implicit welfare weights used by similar social programs, so as to check their consistency in distributional terms.

The sensitivity of the optimal rate structure was examined to evaluate how alternative distributional goals affect the determination of discriminatory prices. The exercise we have carried out has shown that small changes in the aversion to inequality parameter produce large price differentials among households.

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CHAPTER 4

HOW ARE FEDERAL GOVERNMENT FUNDS DISTRIBUTED? REGIONAL COMPOSITION AND STATE IMPLEMENTATION OF 1995 FISCAL AND SOCIAL SECURITY BUDGETS

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Abstract

This article analyzes Federal public spending under the Fiscal and Social Security Budgets at the Regional and State levels, focusing on the 1995 financial year.

It concludes that the distribution of expenditures has developed in a positive manner, favoring States in Regions with lower income levels, although, due to its intensity and composition, this does not necessarily constitute an approach compatible with the reduction of inequalities.

Some distortions still persist, including high *per capita* expenditure levels for the less heavily-populated States in Northern Brazil, due to inter-Government transfers, and Rio de Janeiro (the nation's former capital).

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Introduction

Until very recently, monetary stabilization dominated the scenario for economic policy in Brazil, shaping all Federal Government discussions and initiatives. Today, with this problem recently resolved, reflections are turning to an increasing extent towards issues related to a return to development, once again stressing an approach to regional affairs.

The logic of regional development is no longer bound by earlier prescriptions, which makes the discussion of issues still more stimulating and challenging. In these terms, it is necessary to measure and characterize the associated phenomena, rethinking the basic parameters for their analysis, and finally redefining appropriate intervention mechanisms, should we feel that this is still an appropriate field of action for Government policies, beyond the *invisible hand* of the markets.

Attention should also be given to sweeping changes in the standards for Federal expenditures due not only to the new Constitutional situation but also the continuation of a constrictive fiscal environment offering few options. This alteration alone already offers encouragement for the study of the spatial composition of these expenditures through detailed analysis, particularly by those concerned with the prospects of the Federal Government offering vigorous support to States hampered by limited resources and relatively lower levels of development.

It should be stressed that there are few references in recent literature on the issue of the Regional and State composition of Federal expenditures. In addition to the methodological difficulties related to proper data collection and treatment, as well as the poor primary definition of Regionalization in the Federal Government Financial Revenues Integrated System (SIAFI) - *Sistema Integrado de Arrecadação Financeira*, soaring inflation has also constituted a long-established stumbling-block.

The recent fiscal situation is well understood. For instance, it is known that Government investments shrank during the past decade, and that for at least some time to come they will probably continue at levels below those reached during the 1970s. In counterpart, there are clear-cut efforts undertaken recently by the Federal Government sector to meet the Constitutional precepts of universalization of social welfare policies, expanding the scope of benefits granted previously only in a more restricted manner, such as social security. It is also true that, apart from problems related to debt caused by high real interest rates, the relative share of the States and Municipalities in Government funding has improved, particularly for the latter.

With regard to Federal tax revenues as a whole, a portion of revenues brought in by the IPI excise tax and income tax paid by both individuals and corporations has been allocated to the Constitutional Funds set up to underwrite private investment in the less developed Regions:

North, Northeast and Center-West. Additionally, particularly at the regional level, various tax exemptions, incentives and subsidies have been maintained which were in effect prior to Brazil's 1988 Constitution.

However, from the spatial standpoint, the progressive nature of Federal funding and investments remains an important point for the prospects of a gradual reduction in Regional or State inequalities of income. How do Federal expenditures behave, within this context? What portion of outlays should be more carefully distributed among the States? What is the role played by inter-Government transfers, whether Constitutional or not, in this aspect? Seeking replies to these and other similar questions is the core purpose of this article.

1. Regional and state distribution of expenditures

Prior to undertaking an in-depth analysis of the regional structure for the 1995 financial year, the conduct of the regional composition of Federal outlays over the past few decades should be studied. Just what was the progress of its development? A summarized chart is given in Table 1.1., where the following principal trends can be identified:

a) a steep but steady shrinkage in the share held by the Southeast Region, (down from 62.6% in 1970 to 34.7% in 1995), reflecting the loss of a reasonable portion on the Federal funding cake, as well as inter-Government transfers;

b) relative stability for the share held by the South Region, (at around 11% of total revenues); and

c) expansion in the relative share in Federal expenditures of the North Region (up from under 3% in 1980 to 5.7% at the end of series); Northeast (up from around 13% during the 1970s and early 1980s to 18.6% in 1995); and Center-West (up from 9% in 1970 to around 30% in 1995, clearly reflecting the consolidation of Brasilia as the nation's capital); with the first two, (particularly the North Region) absorbing increasing proportions of inter-Government transfers as a whole.

The relative share in Federal expenditures reflected in the consolidated figures for the three levels of Government (except 1995 - see penultimate line of Table 1.1.) rose from 61.6% in 1970 to 79.8% in 1985, showing a clear upward trend for the pre-Constitution period. This then dropped to 65.6% 1992, reflecting the opposite movement – decentralization – in sharing out the tax cake brought in by the Federal Government, as stipulated by Brazil's 1998 Constitution.

Table 1.1
% Share of the Regions in Total Federal Government Expenditures - Central and Decentralized Public Service (Excluding Interest and Amortization of Domestic and Foreign Debt), Selected Years

(%)

Regions	Years					
	1970	1975	1980	1985	1992	1995[1]
North	3,5	3,6	2,9	3,4	5,3	5,7
Northeast	14,5	12,0	13,4	13,2	18,1	18,6
Southeast	62,6	59,1	54,1	47,0	38,5	34,7
South	10,3	9,6	11,4	10,0	12,6	10,9
Center-West	9,0	15,7	18,0	26,3	25,6	30,1
Total Federal Outlays	100,0	100,0	100,0	100,0	100,0	100,0
Totol Federal / Consolidoted [2]	61,6	68,0	74,5	79,8	65,6	...
Federal Transfers/Outlays	10,2	9,5	9,4	11,8	17,2	19,6

Source: FGV/IBRE/CEF •1970 - 1985); IBGE/DPE/DECNA (1992); and COSIS/STN (SIAFI 1995).
Prepared by: CGPOR/DIPRU/IPEA.
Note: [1]In order to make 1995 comparable with the other years, the nationwide and foreign portions of expenditures were included with the Federal District, and are thus integrated with the Center-West Region.
[2]This figure refers to the proportion of Federal Government expenditures (central ond decentrolized civil service) in the consolidoted total outloys of the public sector (Federal, Stote and Municipal Governments, toking the same civil service levels).

The proportion between transfers to the States, the Federal District and Municipalities, and total Federal outlays (see the last line of Table 1.1) hovered around 10% during the first four years analyzed, rising to 17.2% in 1992 and reaching 19.6% in 1995. As a whole, transfers thus doubled their level over the course of these years.[1]

In brief, the development of the regional composition of Federal expenditures was generally favorable to the less-developed Regions, and expressive in this area with regard to the Fiscal and Social Security Budgets. During the final year of this period, what were the basic characteristics and nuances of the Regional and State expenditure profiles, for the principal sectors and categories of budget implementation?

In order to answer this question, the following analysis focuses solely on 1995. The data supplied by the National Treasury Bureau[2] (on nominal settled allocations)[3] were treated so as

1 Further details on the development of the regional distribution of inter-Government transfers may be found in Galvão et alii (1997).

2 Translator's Note: STN - Secretaria do Tesouro Nacional, in the original.

3 Includes a portion of outstanding amounts payoble whose amounts registered in the 1996 General Federal Budget reached R$ 8.4 billion, according to the Notionol Treosury Bureau (STN - Secretorio do Tesouro Nocionol).

to make them free from the usual distortions: intra-Government transfers and the component for interest, charges and amortization of domestic and foreign debt.[4]

The data cover the following spatial categories of analysis: *abroad* - for expenditures outside Brazil; *nationwide + Federal District* - which here covers expenditures that are nationwide rather than regionalized, as well as those in the Federal District,[5] some *regional records not sub-divided by State* (expenditures in the Northeast, North, Southeast, South and Center-West) and finally expenditures in each of the *States* which, added to the *regional* records available, reflect the *Regions*.

As shown in Table 1.2., of the R$ 316.9 billion in expenditures covered by the 1995 Federal Budget, expressed in Law N°. 8,980 dated January 1995, R$ 132.1 billion covered the expenditures that are of greater important for a regional analysis of public expenditures, namely: payroll and related costs, other current expenditures, investments, financial investments and other capital expenditures. Of this amount, R$ 128.6 billion was expended.

Table 1.2
Comparative Table - Federal Budget and Expenditures – 1995

(R$ billion)

Specification	1995 Budget [1]	1995 Implementation [2]
Overall Amounts	316,9	241,3
Interest & Amortization (*)	184,8	112,7
Other expenditures (without interest & amortization)	132,1	128,6

Source: [1] 1995 General Federal Budget.
[2] 1995 General Federal Budget Implementation Account - STN; SIAFI - Settled allocation.
Prepared by: CGPOR/DIPRU/IPEA
Note: (*) Interest and amortization include forecast (1) and actual (2) amounts for the roll-over of domestic and foreign debt. The net balance for these payments totaled R$ 25.8 billion (1995 General Federal Budget Implementation Account).

As a matter of relevance, expenditures on the Constitutional Funds for the North, Northeast and Center-West - FNO (*Fundo Constitucional do Norte*); FNE (*Fundo Constitucional do*

4 This financial portion of the expenditures featured a very low level of regionalization, distorting the analysis from the spatial standpoint. Additionally, the existing records included an accounting aspect associated with the roll-over the debt, which caused a certain illusion with regard to the actual volume of global resources set aside in the budget and paid out during the financial year.

5 The addition of the Federal District to the nationwide category does not represent any appreciable loss in the quality of the analysis. On the one hand, the Federal District is a unique unit within the Federation that to a large extent distorts conclusions on other States. On the other, dissociating Federal District expenditures from those in the nationwide category is always difficult, even when explicit, as in the study of the 1995 Government Budget. See Galvão et alii (1996).

Nordeste); and FCO (*Fundo Constitucional do Centro-Oeste*) were included *a posteriori* in the SIAFI data-base.[6] This means that the settled allocations (shown in Table 1.2) were increased by R$ 1.1 billion through the Constitutional Funds, bringing the total expenditures under analysis up to R$ 129.7 billion.

Different treatment was assigned to the tax incentive funds: Northeast Investment Fund - FINOR (*Fundo de Investimentos do Nordeste*); Amazonia Investment Fund - FINAM (*Fundo de Investimentos da Amazonia*); and the Fund for the Economic Recovery of Espírito Santo State FUNRES (*Fundo para Recuperação Econômica do Estado de Espírito Santo*), which were also not included in the data-base. Despite their importance in regional expenditures, these funds – amounting to R$ 336 million, R$ 355 million and R$ 12 million respectively – are financed by resources from tax waivers, which is why they are not added to the expenditures under analysis here.[7]

1.1 Basic Regional Profile

Table 1.3. gives the regional profile for the implementation of the Fiscal and Social Security Budgets, leaving out interest, charges and amortization.

The amount of R$ 129.7 billion was distributed as follows, in spatial terms: just over one quarter (25.6%) was assigned to items that are nationwide in scope, or within the Federal District; (1.1%) abroad; (5.8%), North Region; (19.0%), Northeast Region; (34.4%), Southeast Region; (10.8%), South Region; and (3.4%), Center-West Region (without the Federal District).[8]

The regional distribution for the fiscal sphere is more progressive, favoring Regions with lower income levels to a greater extent, although the *nationwide + Federal District* portion of the expenditures has tended to be higher (around one third of expenditures within the fiscal sphere were allocated to the *nationwide + Federal District* or *abroad* categories). Social security tended to concentrate more in the Southeast (43.0%) and South (11.9%). The shares of the States in expenditures within the fiscal sphere for these two Regions were invariably lower than those for social security. In the case of São Paulo, its portion for social security was almost three times higher than that noted for the fiscal sphere.

6 The wording accompanying the 1995 Federal Balance Sheet stresses that information on some funds was not available when the final edition was published, and is thus not included in these figures. 1995 General Federal Budget Implementation Account (1996 p. B and 26).

7 In 1995, these figures were still included in the General Federal Budget, and were excluded from the 1997 Budget for the reasons mentioned above.

8 As a point of information, the inclusion of Tax Incentive Funds (FINOR, FINAM and FUNRES) had little effect on the total distribution of the expenditures. The percentage variations in the total expenditures would have been + 0.2% for the North Region; + 0.1% for the Northeast; - 0.2% for the Southeast and - 0.1% for the South and Center-West.

Table 1.3
Federal Government Expenditures by Budget Sphere,
Regions and States – 1995

(R$ Million)

Region/State	Fiscal	(%)	Social Security	(%)	Total	(%)
Nationwide + Federal District	18 033,6	31,0	15 197,4	21,3	33 231,0	25,6
Abroad	1 382,1	2,4	0,0	0,0	1 382,1	1,1
North	5 119,8	8,8	2 372,1	3,3	7 491,9	5,8
Non-State	221,8	0,4	43,0	0,1	264,8	0,2
Acre	404,0	0,7	150,8	0,2	554,8	0,4
Amazonas	786,6	1,4	458,4	0,6	1 245,0	1,0
Amapá	509,4	0,9	99,1	0,1	608,5	0,5
Pará	1 572,9	2,7	1 129,7	1,6	2 702,6	2,1
Rondônia	683,3	1,2	255,4	0,4	938,6	0,7
Roraima	387,4	0,7	56,3	0,1	443,7	0,3
Tocantins	554,4	1,0	179,4	0,3	733,8	0,6
Northeast	11 817,1	20,3	12 822,0	17,9	24 639,1	19,0
Non-State	1 076,7	1,8	127,6	0,2	1 204,3	0,9
Alagoas	719,0	1,2	721,8	1,0	1 440,7	1,1
Bahia	2 219,4	3,8	3 033,6	4,2	5 253,0	4,0
Ceará	1 620,7	2,8	2 104,4	2,9	3 725,1	2,9
Maranhão	1 221,2	2,1	1 160,6	1,6	2 381,9	1,8
Paraíba	1 023,3	1,8	1 173,2	1,6	2 196,5	1,7
Pernambuco	1 775,2	3,0	2 406,5	3,4	4 181,7	3,2
Piauí	739,4	1,3	741,2	1,0	1 480,6	1,1
Rio Grande do Norte	833,2	1,4	887,6	1,2	1 720,8	1,3
Sergipe	589,0	1,0	465,5	0,7	1 054,4	0,8
Southeast	13 922,8	23,9	30 726,5	43,0	44 649,4	34,4
Non-State						
Espírito Santo	555,9	1,0	885,1	1,2	1 441,0	1,1
Minas Gerais	3 058,6	5,3	5 398,6	7,6	8 457,2	6,5
Rio de Janeiro	6 509,4	11,2	11 713,8	16,4	18 223,1	14,0
São Paulo	3 799,0	6,5	12 729,0	17,8	16 528,0	12,7
South	5 483,7	9,4	8 503,2	11,9	13 986,9	10,8
Non-State			3,7	0,0	3,7	0,0
Paraná	1 751,9	3,0	2 592,0	3,6	4 344,0	3,3
Rio Grande do Sul	2 692,4	4,6	4 228,8	5,9	6 921,2	5,3
Santa Catarina	1 039,4	1,8	1 678,7	2,3	2 718,1	2,1
Center-West (without Federal District)	2 487,5	4,3	1 876,7	2,6	4 364,2	3,4
Non-State	225,6	0,4	1,5	0,0	227,1	0,2
Goiás	883,0	1,5	1 012,8	1,4	1 895,8	1,5
Mato Grosso do Sul	540,0	0,9	456,0	0,6	995,9	0,8
Mato Grosso	838,9	1,4	406,4	0,6	1 245,3	1,0
Brazil	58 246,5	100,0	71 497,9	100,0	129 744,4	100,0

Source: COSIS/STN; SIAFI 1995 (including the Constitutional Funds).
Prepared by: CGPOR/DIPRU/IPEA.

For the North and Center-West Regions (without the Federal District) the opposite occurred, with the respective shares being higher in the fiscal sphere. In the Northeast, the three largest

States (Bahia, Pernambuco and Ceará) behaved similarly to States in the Southeast and South, whilst the remainder followed the standard for the North and Center-West Regions.

An explanation for this conduct derives from the tighter correlation of the principal items covered by the social security sphere with States featuring greater levels of organization and formalization of the labor market. Direct expenditures on social welfare, which accounted for the largest portion of these funds, tend to be more highly-concentrated in the more populated States with higher development levels, being less susceptible to a deliberate slant favoring those with lower income levels.

Rio de Janeiro State is a case apart, as its relative share in both the fiscal and social security spheres was very high, putting it well into the running for the State absorbing the largest slice of the total resources (14.0%, topped only by the *nationwide + Federal District* spatial category).

Table 1.4. gives the Regional and State profile of expenditures x inhabitant and the *per capita* Gross Domestic Products.[9] Comparing the total regionalized expenditures (some of the Fiscal and Social Security Budgets) with the respective populations, a trend becomes clear in the variation of the *per capita* expenditures, which range from R$ 511.3 per inhabitant in the Center-West Region (without the Federal District) to R$ 673.60 per inhabitant in the Southeast. The South Region posts an average of R$ 604.80 per inhabitant, and the Northeast Region, R$ 547.80 per inhabitant. The North Region is relatively close to the Southeast, at R$ 671.4 per inhabitant. These two Regions are above the national average for expenditures of the regionalized portion per inhabitant at R$ 617.4, while the remainder drop below this average. However, this regional data blurs an overview of more intensive variations at the State level.

The high average for the Southeast Region is due mainly to the weight of Rio de Janeiro State, which posts the high proportion of R$ 1,370.5 per inhabitant, a figure that is pumped up by the Social Security Budget of R$ 881.00 per inhabitant, reaching 141.1% more than the national *per capita* average in this sphere. In the North Region, the weight of the former territories makes a difference, particularly Amapá with R$ 1,865 per inhabitant; Roraima at R$ 1,692.10; and Acre at R$ 1,218.80; in addition to Rondônia R$ 700.70 and Tocantins R$ 728.70. All are better supported in the fiscal sphere than for social security, which boosts the average for the Region appreciably, to the detriment of less favorable positions for Amazonas and Pará States, which are more heavily populated.

The Northeast, South and Center-West Regions (without the Federal District) whose averages fall below that for the sum of the Regions, show more homogenous State conduct,

9 This analysis requires that the portion of expenditures in the Federal District be ignored, as well as nationwide and abroad, for a total amount of R$ 34.6 billion.

with the exception of Rio Grande do Sul State, which is better endowed with Federal funding, in relative terms.

The States with the smallest portions of the regionalized expenditures were, in this order: Bahia (R$ 415.40 per inhabitant); Goiás (R$ 440.00); Maranhão (R$ 455.30); São Paulo (R$ 490.50) and Pará (R$ 496.00). The less-privileged positions for the three least-benefited States (Bahia, Goiás and Maranhão) are to some extend explained by the following arguments: a) these are relatively heavily-populated States, particularly Bahia; b) in all three States, a limited portion of expenditures is assigned to the social security sphere, when correlated with their respective population fractions (it is noted that the order is inverted, with Bahia better-endowed than Goiás, which in turn benefits more than Maranhão); c) particularly in the case of Bahia, which ranked bottom in terms of the fiscal component, it should also be recalled that this is today the most important State in Northeast Brazil, in economic terms, but still lacks regional Federal agencies with appreciable clout, in contrast to Pernambuco with its Northeast Development Superintendency (SUDENE - *Superintendência de Desenvolvimento do Nordeste*) and Ceará with its National Drought Prevention Works Department (DNOCS - *Departamento Nacional de Obras Contra as Secas*).

Table 1.4
Federal Government Expenditures and *Per Capita* GDP by Region and State (excluding the Federal District - 1995)

Region/State	*Per capita* Expenditure (R$ / Inhab) (A)	*Per capita* GDP (R$ / Inhab) (B)	(C) (A)/ (B) (%)	State/Total Regions (%)
North	671,38	2 443,5	27,48	158,52
Acre	1 218,80	2 920,5	41,73	240,77
Amazonas	536,60	3 102,7	17,29	99,78
Amapá	1 865,40	3 091,9	60,33	348,08
Pará	496,00	2 308,4	21,49	123,96
Rondônia	700,70	2 515,1	27,86	160,73
Roraima	1 692,10	2 579,1	65,61	378,52
Tocantins	728,70	1 098,9	66,31	382,59
Northeast	547,84	1 705,8	32,12	185,29
Alagoas	536,50	1 627,5	32,96	190,18
Bahia	415,40	2 027,6	20,49	118,20
Ceará	554,80	1 546,3	35,88	207,00
Maranhão	455,30	1 163,7	39,13	225,74
Paraíba	657,60	1 276,2	51,53	297,28

(cont...)

(continued)

Region/State	*Per capita* Expenditure (R$ / Inhab) (A)	*Per capita* GDP (R$ / Inhab) (B)	(C) (A)/ (B) (%)	State/Total Regions (%)
Pernambuco	561,70	1 895,8	29,63	170,93
Piauí	543,30	962,0	56,47	325,82
Rio Grande do Norte	666,40	2 032,7	32,78	189,14
Sergipe	656,90	2 484,8	26,44	152,52
Southeast	673,60	4 851,2	13,89	80,11
Espírito Santo	517,10	3 262,3	15,85	91,45
Minas Gerais	512,40	3 177,9	16,12	93,02
Rio de Janeiro	1 370,50	4 436,0	30,89	178,24
São Paulo	490,50	5 966,0	8,22	47,43
South	604,80	4 215,9	14,35	82,77
Paraná	498,60	4 277,3	11,66	67,25
Rio Grande do Sul	722,60	4 303,5	16,79	96,87
Santa Catarina	561,90	3 931,6	14,29	82,46
Center-West (without Federal District)	511,34	3 020,5	16,93	97,67
Goiás	440,00	2 929,2	15,02	86,66
Mato Grosso do Sul	520,70	3 837,7	13,57	78,28
Mato Grosso	538,20	2 514,7	21,40	123,48
Total Regions (without Federal District)	617,40	3 562,0	17,33	100,00
Brazil	832,64	3 605,3	23,09	-

Source: Expenditures - COSIS/STN; SIAFI 1995; GDP - IPEA/DIPES.
Prepared by: CGPOR/DIPRU/IPEA.
Note: Expenditures per inhabitant in the Regions include the portion *not allocated by State*.

The proportion of expenditures in relation to the Gross Domestic Products of each State or Region differs widely. In the North and Northeast, this proportion reaches an average of over 25%. In the North Region, only Amazonas State drops below 20%, while all the States in the Northeast top this figure. In the former territories of Amapá and Roraima, and in Tocantins State, this exceeds 60%, while in Paraíba and Piauí States, it exceeds 50%, clearly indicating the relative weight of Federal Government expenditures in these States.

In counterpart, in the South, Southeast and Center-West (without the Federal District) the average proportions were respectively, 13.89%; 14.35%; and 16.06%. The only State to stand out to any extent from this pattern was Rio de Janeiro at 30.89%, although Mato Grosso is also slightly above the 20% level at 21.4%. São Paulo posted the lowest proportion of *Federal expenditures / GDP* at only 8.22%.

This means that all the States in Northeast and North Brazil (with the exception of Amazonas State), in addition to Rio de Janeiro and Mato Grosso, post proportions that exceed the figure for the set of Regions or States under consideration, as shown in the final column of Table 1.4.

Compared with the Product, Federal expenditures in general seem to reflect a certain standard of progressivity in Regional and State terms, channeling larger volumes of the resources available to States with lower income levels. In general, the *direction* of expenditures seems correct, although their intensity is still open for discussion, as well as the specific positions of certain States.

1.2 Expenditures by Type

Distribution by type of expenditure as shown in Table 1.5. helps shape a more accurate view of the spatial structuring of outlays. Items covering investments, financial investments and other capital expenditures represent a smaller portion of the outlays.

Outstanding in the investments group is the Northeast (23.0%); Southeast (21.9%) and *nationwide + Federal District* (27.8%). Another striking factor in this group is the very limited participation of the South Region (6.7%). The profile by State of the distribution of investments is appreciably different from the others, particularly in terms of the relative weight of expenditures abroad (10.0%) and the portion of expenditures not assigned to the States in the Northeast Region (6.5%). The *national + Federal District* category and Rio de Janeiro State, with relative shares of 27.8% and 10.7% respectively also stand out. São Paulo absorbed 6.2% of investments and Minas Gerais takes up 4.3%. Expenditures under this item are also high in relative terms in the three principal Northeast States: Pernambuco (3.7%), Ceará (3.2%) and Bahia (2.9%).

Financial investments [10] rate low in terms of regionalization, with 74.6% of expenditures being classified under the *nationwide + Federal District* category; other capital expenditures, whose overall value is negligible, are concentrated mainly in the Southeast (50.6%) and South (14.7%).

Expenditures on staff and charges are highest in the Southeast Region at around 36.3%, which even outstrips the *nationwide + Federal District* jointly at 35.3%. This is justified mainly by the high proportion of public servants in Rio de Janeiro State.

These expenditures reached 13.1% in the Northeast, and 5.0% in the North Region, keeping close to their respective share of national income. It should be stressed that the States of Pernambuco (2.6%) and Ceará (2.5%) in the Northeast Region receive larger portions of Federal expenditures on staff and charges than Bahia State (2.3%), which has a larger population. In the South and Center-West (without the Federal District) the relative shares were respectively 7.6% and 2.2%. Finally, expenditures on staff and charges abroad reached 0.6% of the total.

10 Includes the Constitutional Funds.

Table 1.5
Federal Government - Financial Implementation by Type of Expenditure, by Regions and States – 1995

(%)

Region/State	Staff and Charges	Other Current Expenditures	Investments	Financial Investments	Other Capital Expenditures	Total
Nationwide + Federal District	35,3	15,5	27,8	74,6	16,7	25,6
Exterior	0,6	0,9	10,0	0,0	0,4	1,1
Norte	5,0	6,3	7,3	3,6	6,6	5,8
Não-Estadualizado	0,0	0,0	0,2	2,6	0,0	0,2
Acre	0,3	0,5	0,3	0,0	0,2	0,4
Amazonas	0,9	1,0	2,3	0,0	2,1	1,0
Amapá	0,6	0,5	0,2	0,0	1,6	0,5
Pará	1,7	2,5	1,8	0,1	1,0	2,1
Roraima	0,9	0,7	1,5	0,2	1,1	0,7
Rondônia	0,4	0,3	0,4	0,0	0,3	0,3
Tocantins	0,1	0,8	0,5	0,6	0,3	0,6
Nordeste	13,1	22,7	23,0	9,2	3,9	19,0
Não-Estadualizado	0,0	0,3	6,5	7,8	0,0	0,9
Alagoas	0,8	1,4	1,0	0,0	0,0	1,1
Bahia	2,3	5,4	2,9	0,4	0,5	4,0
Ceará	2,5	3,3	3,2	0,3	0,3	2,9
Maranhão	1,0	2,4	1,4	0,2	0,2	1,8
Paraíba	1,6	2,0	1,2	0,1	0,3	1,7
Pernambuco	2,6	3,8	3,7	0,1	2,2	3,2
Piauí	0,6	1,5	1,1	0,1	0,2	1,1
Rio G. do Norte	1,1	1,6	1,0	0,2	0,2	1,3
Sergipe	0,5	1,0	0,8	0,0	0,3	0,8
Sudeste	36,3	37,9	21,9	1,1	50,6	34,4
Espírito Santo	0,9	1,4	0,7	0,1	0,3	1,1
Minas Gerais	4,8	8,2	4,3	0,3	2,5	6,5
Rio de Janeiro	25,0	10,5	10,7	0,3	2,4	14,0
São Paulo	5,6	17,9	6,2	0,4	45,3	12,7
Sul	7,6	13,1	6,7	6,2	14,7	10,8
Não-Estadualizado	0,0	0,0	0,1	0,0	0,0	0,0
Paraná	1,9	4,3	1,6	1,7	0,5	3,3
Rio G. do Sul	4,2	6,1	3,4	4,1	13,9	5,3
Sta. Catarina	1,5	2,6	1,6	0,3	0,3	2,1
Centro-Oeste (s/ DF)	2,2	3,7	3,5	5,3	7,2	3,4
Não-Estadualizado	0,0	0,0	0,0	2,6	0,0	0,2
Goiás	1,0	1,8	1,0	0,7	0,5	1,5
Mato G. do Sul	0,6	0,8	0,8	0,8	3,4	0,8
Mato Grosso	0,6	1,0	1,6	1,2	3,3	1,0
Brasil (%)	100,0	100,0	100,0	100,0	100,0	100,0
Valor(R$ milhões)	37 889,2	78 312,8	4 748,1	8 600,7	193,4	129 744,2

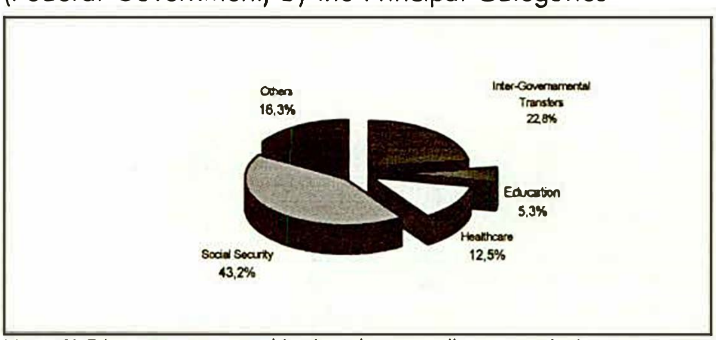
Source: COSIS/STN; SIAFI 1995 (includes Constitutional Funds).
Prepared by: CGPOR/DIPRU/IPEA.

Other current expenditures which account for over half of the total settled allocations (R$ 78.0 billion) feature different regional profiles. Expenditures in the Southeast total almost R$ 30.0 billion,[11] or 37.9% of the outlays under this type of expenditure. The relative share of the Northeast was also appreciable at 22.7% of the total. The South Region received 13.1%, while the North and Center-West Regions (without the Federal District) absorbed 6.3% and 3.7% respectively. Expenditures under the *nationwide + Federal District* and *abroad* categories accounted for 15.5% and 0.9% respectively. This profile can be largely explained by the fact - already outlined - that outlays related to the social security sphere were behind this relatively higher allocation in the more - developed Regions.

However, this approach overestimates Federal Government capacity to allocate funds, as many of these outlays included in this group of expenditures consist of transfers – not necessarily tax-based – to other spheres of Government (inter-Government transfers) or even to families (such as the grant and maintenance of social welfare benefits, or dole for the unemployed).

Graph 1 divides the financial implementation of Other Current Expenditures for 1995 into some of the principal categories identified here: a) Budget Unit 73000 - Transfers to States, Federal District and Municipalities, discounting the quota for the education allowance, which is included under the *Education* function; and b) by function, for the other cases.

Graph 1
Percentage Distribution of Other Current Expenditures (Federal Government) by the Principal Categories



Note: 1) *Education* - increased by the education allowance, which is an inter-Government transfer.
2) *Healthcare* - excludes the Sanitation (076) and Environmental rotection (077) programs.
3) *Social Security* - excludes the Civil Servants Asset Formation Program (084).

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11 Note that these figures include inter-Government transfers.

As may be seen, inter-Government transfers to States, the Federal District and Municipalities represent 22.8% of outlays for this group of expenditures. Added to expenditures under the *Social Security* function (43.2%) which also constitutes a transfer of resources brought in by the Federal Government, a figure of 66% of the total settled allocations is reached for this expenditure group. For the remaining resources of this expenditure group, only two categories *Healthcare* and *Education* - warrant particular attention, at 12.5% and 5.3% respectively.[12]

Table 1.6 gives the amount of the *per capita* outlays in these three categories. For education and healthcare, the levels of expenditure per inhabitant are appreciably higher in the Southeast (R$ 22.30 for education and R$ 64.80 for healthcare) and South (R$ 18.20 for education and R$ 64.30 for healthcare).

In counterpart, the Northeast, North and Center-West Regions (without the Federal District) post lower *per capita* averages of, respectively: R$ 14.50, R$ 14.30 and R$ 13.30 for education; and R$ 43.30, R$ 38.30 and R$ 49.90 for healthcare.

This same scheme is repeated for *per capita* expenditures on social security. The South and Southeast post rates that are higher than those for the Northeast, North and Center-West Regions (without the Federal District). Only the hierarchy of amounts among the Regions seems to be more accentuated here, varying from R$ 271.70 in the Southeast to R$ 100.30 in the North Region. The expenditures in the Northeast at R$ 166.70 per inhabitant are appreciably higher than those for the North and Center-West (without the Federal District), at R$ 115.80 per inhabitant for this latter Region.

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12 It should be noted that, in the case of the healthcare and education segments, expenditures are referred back to the functions as function-program classification categories adopted by the Integrated Budgetary Data System (SIDOR - Sistema Integrado de Dados Orçamentários) and SIAFI, which should not be confused with the expenditures by the respective sectoral ministries. In the case of the Education function, expenditures classified as Transfers to States, Federal District and Municipalities were added (73,000) to the education allowance quota. Expenditures under the Social Security function correspond to the activity Grant and Maintenance of Benefits category.

Table 1.6
Outlays Per Inhabitant with Other Current Expenditures on Education, Healthcare and Social Security, by Region – 1995

Regions	Education		Healthcare		Social Security	
	R$/Inhab	(%)	R$/Inhab	(%)	R$/Inhab	(%)
North	14,3	78,0	38,3	68,9	100,3	46,8
Northeast	14,5	79,0	43,3	77,7	166,7	77,7
Southeast	22,3	121,7	64,8	116,4	271,7	126,7
South	18,2	99,3	64,3	115,6	234,6	109,4
Center-West (without Federal District)	13,3	72,8	49,0	88,0	115,8	54,0
Regions	18,3	100,0	55,6	100,0	214,5	100,0
Brazil	27,0		63,5		219,3	

Source: Expenditures - COSIS/STN; SIAFI 1995.
Prepared by: CGPOR/DIPRU/IPEA.
Note: [1] Both the population of the Federal District as well as the portions of expenditures *nationwide + Federal District* and *abroad* were not taken into consideration.

The data show that for the education and healthcare categories, proportionately less was spent of the funding transferred or invested directly by the Federal District in States with the worst social indices in the corresponding areas. Naturally, the case of Social Security seems a little different. The relatively favorable position of the Northeast, for instance, is clearly explained by rising expenditures on rural social security services.

Some additional comments will help to clarify this data still further, particularly in the case of education, where the relative positions of these States in Federal *per capita* expenditures vary sharply from regional averages. Federal outlays are clearly supplementary to State and Municipal efforts, and tend to be concentrated in areas where the Federal Government shoulders greater responsibilities. Of particular interest is the weight of the Federal universities, reflecting the role of the Federal Government in higher education. Larger portions of the *per capita* outlays by the States on higher education compared to the total *per capita* expenditures in the *education* category are noted in Acre (42.0% of total expenditures with other current expenses for education), Paraíba (40.4%), Rio Grande do Norte (33.9%), Roraima (32.5%) and Pará (31.3%). Some States posted a high proportion of *per capita* expenditures on medical residencies and the maintenance of teaching hospitals: Tocantins (79.0%), Maranhão (61.8%), Piauí (55.6%) and Roraima (51.7%).

São Paulo posted low *per capita* expenditures under Other Current Expenses on higher education (3.4% of its total outlays for this function) as its main universities are State-run. On the other hand, the composition of outlays in Rio de Janeiro for this same category includes specific outlays on items not noted in other States, such as the *TV Educativa* educational television channel, in addition to others of an administrative nature.

Looking at healthcare, it should be recalled that Rio de Janeiro State once again stands out as it clusters a number of institutions which are benchmarks for Brazil as a whole, explaining such high levels of *per capita* expenditures.

2. Transfers of federal funding to the states, municipal districts and municipalities

Inter-Government transfers from the Federal Government totaled R$ 25.5 billion in 1995, representing some 20% of total Federal Government outlays (excluding interest and amortization). This consists largely of fiscal revenues transferred to States and Municipalities in order to reduce Regional inequalities in income and supplement their respective fiscal capacities, as required to comply with the obligations inherent to these spheres of Government.[13]

According to the usual nomenclature, two distinct fields may be analyzed: Constitutional or Tax-Based Transfers (normal sharing-out of Federal tax revenues at the State of Municipal level) and Non-Tax Matters.

The first portion of these transfers - known as Constitutional or Tax-Based - includes the education allowance quota, the States Participation Fund (FPE - *Fundo de Participação dos Estados*) the Municipalities Participation Fund,(FPM - *Fundo de Participação dos Municípios*), the Industrialized Products Export Compensation Fund (FPEX - *Fundo de Compensação pela Exportação de Produtos Industrializados*), the Tax on Financial Operations involving Gold (IOF - *Imposto Sobre Operações Financeiras sobre Ouro*) and the Rural Land Tax (ITR - *Imposto Territorial Rural*). The data for this initial portion of the transfers is given in Table 2.1.

13 Due to the nature of this data, all amounts can be distributed by State, which is why the Federal District appears in all the Tables under this item, and the nationwide portion is not shown.

Table 2.1
Constitutional or Tax-Based Transfers to States, Federal District and Municipalities % Share of Regions and Total Amounts – 1995

(%)

	FPM	FPE	FPEX	Educ Allw	IOF Gold	ITR	Total
North	8,5	25,4	4,5	2,1	57,2	4,4	15,6
Northeast	35,3	52,5	10,1	7,8	9,2	9,7	38,3
Southeast	31,2	8,5	47,4	68,8	6,4	38,5	25,0
South	17,5	6,5	36,6	16,7	0,2	21,9	14,0
Center-West	7,5	7,2	1,3	4,6	26,9	25,6	7,1
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Value (R$ million)	8 170,4	7 803,0	1 385,8	1 221,7	3 35,1	15,6	18 931,6
(%)	43,2	41,2	7,3	6,5	1,8	0,1	100,0

Source: COSIS/STN; SIAFI 1995.
Prepared by: CGPOR/DIPRU/IPEA.

As may be noted, the States Participation Fund (FPE) and the Municipalities Participation Fund (FPM) – which are distributive transfers by definition – account for 84.4% of the total, with 41.2% from the FPE and 43.2% from the FPM. The North and Northeast together absorb some 78% of the FPE; the Northeast takes 52.5%. For the FPM, the Southeast holds a large share (31%), due largely to the population criteria applied to small Municipalities, hot on the heels of the Northeast (35%). For the same reason, the South also doubles it share, comparing the FPM percentage with that for the FPE. The Center-West remains almost unchanged at 7.2% and 7.5% of the FPE and FPM respectively.

For other Constitutional or Tax-Based Transfers, which together represent around 17%, the main items are the Industrialized Products Export Compensation Fund (FPEX) at 7.3%, which is the fund set up by the portion of the IPI excise tax on exported products, as well as the education allowance quota (6.5%).

Analyzing the FPEX, it is noted that, as might be expected, the South and the Southeast hold the largest shares at 47.4% and 36.6% respectively, as the Regions with the most intense economic activity and thriving export sectors. The education allowance charged at 2.5% of company payrolls is designed to finance Government expenditures on primary education: two-thirds are transferred directly to the State where the tax is collected, constituting the quota in the transfers. This is why the Southeast accounts for 68.8%, followed by the South at 16.7%, the Northeast with 7.8%, the Center-West with 4.6% and the North with only 2.1%.

The second portion of inter-Government transfers (Table 2.2) includes the Non-Tax revenues that are regulated by legal provisions (also known as Non-Tax Normal Transfers) such as expenses with the new States and the Federal District, and those known as Non-Regular or Negotiated, which includes agreements, adjustments and other pacts between the Federal Government, and the State and Municipal Governments.

The Constitutional or Tax-Based Transfers account for 74.2% of the total: the Non-Tax Transfers cover the remaining 25.8%, with 16.3% being Negotiated and 9.5% being Regular Non-Tax Transfers.

Analyzing the Negotiated Transfers more specifically, it is noted that, in terms of Regional shares, while the Northeast absorbs the largest portion of Tax-Based Transfers, for the Negotiated Transfers the Southeast is in the lead (34.5%), particularly São Paulo with 18.5%. Of the total R$ 4.2 billion in Negotiated Transfers, 76.5% were transferred to the States and 23.5% to the Municipalities.

For Regular Non-Tax Transfers, the Center-West naturally ranks first, due to the 65.4% share absorbed by the Federal District, followed by the North Region at 23.0% (Amapá 8.8%; Rondônia 6.8%; Roraima 5.4% and Acre 2.0%).

Table 2.2
% Share of States in Tax-Based and Non-Tax Transfers - 1995

(%)

Region/State	Tax-Based or Constitutional	Non-Tax Regions & States: Regular	Non-Tax Regions & States: Negotiated	Total	Overall Total
North	15,6	23,0	9,3	14,3	15,3
Acre	1,6	2,0	0,8	1,2	1,5
Amazonas	1,8	0,0	1,4	0,9	1,6
Amapá	1,7	88	1,2	4,0	2,3
Pará	5,2	0,0	2,6	1,7	4,3
Rondônia	1,6	6,8	1,7	3,6	2,1
Roraima	1,2	5,4	0,9	2,6	1,5
Tocantins	2,5	0,0	0,6	0,4	1,9
Northeast	38,3	0,0	26,1	16,5	32,7
Alagoas	2,8	0,0	1,7	1,1	2,3
Bahia	8,4	0,0	6,6	4,2	7,3
Ceará	5,4	0,0	3,8	2,4	4,6
Maranhão	4,9	0,0	2,6	1,7	4,1
Paraíba	3,4	0,0	1,7	1,1	2,8
Pernambuco	5,3	0,0	4,2	2,6	4,6

(cont...)

(continued)

Region/State	Tax-Based or Constitutional	Non-Tax Regions & States Regular	Negotiated	Total	Overall Total
Piauí	2,9	0,0	2,0	1,3	2,5
Rio Grande do Norte	2,8	0,0	2,1	1,3	2,4
Sergipe	2,4	0,0	1,4	0,9	2,0
Southeast	25,0	6,8	34,5	24,3	24,8
Espírito Santo	1,8	0,0	1,3	0,8	1,5
Minas Gerais	9,3	0,0	8,2	5,2	8,2
Rio de Janeiro	3,3	6,8	6,5	6,6	4,2
São Paulo	10,7	0,0	18,5	11,7	10,9
South	14,0	4,4	11,8	9,1	12,7
Paraná	5,1	3,3	4,3	3,9	4,8
Rio Grande do Sul	5,7	1,1	3,8	2,8	5,0
Santa Catarina	3,2	0,0	3,7	2,3	3,0
Center-West	7,1	65,8	18,4	35,8	14,5
Federal District	0,5	65,4	11,1	31,1	8,4
Goiás	2,9	0,0	3,0	1,9	2,7
Mato Grosso do Sul	1,3	0,0	1,4	0,9	1,2
Mato Grosso	2,3	0,3	2,8	1,9	2,2
Total	100,0	100,0	100,0	100,0	100,0
Value (R$ million)	18 931,6	2 420,2	4 155,9	6 576,1	25 507,6
%	74,2	9,5	16,3	25,8	100,0

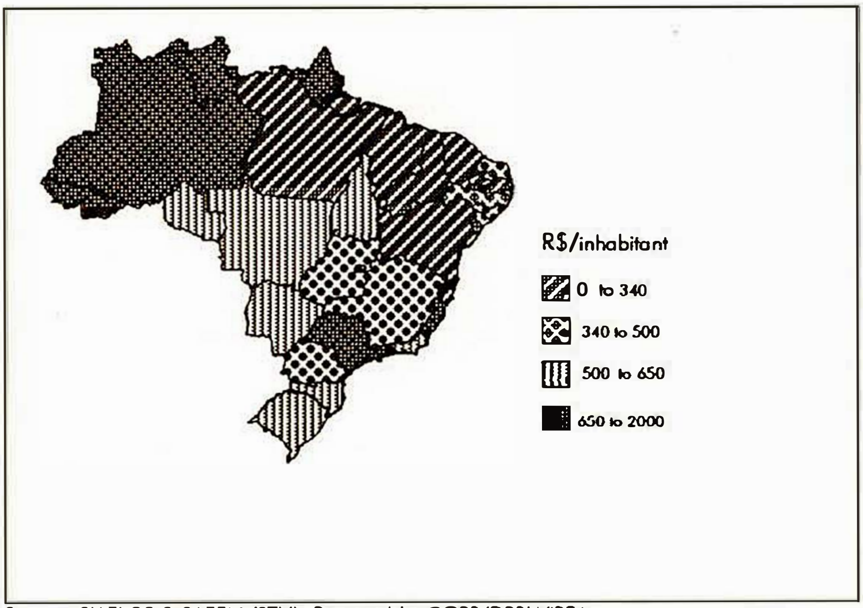
Source: SIAFI and "Negotiated Transfers to States and Municipalities - January/December 1995" - STN - Treasury Ministry.
Prepared by: CGPOR/DIPRU/IPEA.
Note: Includes the amount of R$ 164.7 million in Rondônia. In SIAFI, this amount is classified as direct investment, but it consists of payment to the staff of this former territory.

For an approximate overview of the funds available in each State, the value of the Federal transfers is added to the tax revenues of the States and Municipalities [14] The main tax for the tax revenues of the States is the ICMS, which represented 94.3% of the total in 1995. Of the amounts brought in through the ICMS, 25% is transferred to the Municipalities, ranking second for sources of Municipal funding. Its principal source is the Municipality Participation Fund – a federal transfer that together with the ICMS – represents 75% of total Municipal revenues, according to information from the Municipal Data-Base of the Brazilian Municipal Management Institute (IBAM - *Instituto Brasileiro de Administração Municipal*) [Bremaeker (1995)] for 1992; the tax revenues of the municipalities hold a share of some 10%.

[14] Further details in Galvão et alii (1997).

Map 1 below shows the distribution by State of the available funding of State and Municipal governments in *per capita* terms, clustered into four ranges that divide them into groups with approximately the same number of states.

Map 1
Available Funding of State and Municipal Governments, per inhabitant – 1995



Source: SIAFI 95 & SAFEM (STN). Prepared by CGPR/DPRU/IPEA

The higher range (over R$ 650.00 per inhabitant) includes Amapá, Federal District, Roraíma, Acre, São Paulo, Amazonas and Espírito Santo. Some are in this range due to their own fiscal capacity, such as São Paulo or even Amazonas States, while others reach this level due directly to the volume of Federal Transfers. The next level (R$ 500.00 - R$ 650.00 per inhabitant) includes Tocantins, Mato Grosso, Rondônia, Santa Catarina, Rio Grande do Sul, Rio de Janeiro and Mato Grosso do Sul. It should be stressed that the somewhat unfavorable position of Rio de Janeiro is due its low *per capita* share in Federal Transfers, allied to its limited inherent fiscal capacity. The new States of Rondônia and Tocantins are included in this group due to Federal Transfers. The third level (R$ 340.00 - R$ 500.00 per inhabitant) includes Sergipe, Goiás, Minas Gerais, Paraná, and the Northeastern States of Rio Grande do Norte, Pernambuco and Alagoas. Finally, the lowest level (up to R$ 340.00 per inhabitant) includes Ceará, Bahia, Paraíba, Piauí and Maranhão, all in the Northeast, in addition to Pará State.

Finally, it is noted that all the States in the Northeast Brazil fall below the national average for available funding at the State level, which is R$ 540.60. This is because, although this Region is well-positioned for transfers and is also relatively well-populated, economic activities are generally sparse throughout the Region, resulting in lower revenues per inhabitant.

3. Analysis of main projects/activities

The most important projects and activities outline a common standard when ranked into a hierarchy in terms of the values for settled allocations for the macro-Regions. Table 3.1 lists the principal projects and activities in all Regions, with comments on those that do not appear in the Table as they are important in only one specific Region.

Table 3.1
Fifteen Major Projects/Activities, ranked by importance in Brazil and the Regions (excluding interest, charges and amortizations) – 1995

(%)

Projects/Activities	Brazil	North	North east	South east	South-Center	Center-West
Grant and Maintenance of Benefits	25,40	14,86	30,90	40,03	38,24	23,28
Federal Social Security Charges	7,06	3,47	7,47	13,24	6,62	4,75
Municipal Participation Fund	6,33	9,57	12,03	5,71	10,24	14,13
Unified Health System (SUS) Maintenance and Operations	6,13	5,01	7,53	8,87	9,79	9,33
State/Federal District Participation Fund	6,02	27,23	17,08	1,48	3,64	12,22
Staff Overhead	4,09	5,11	4,90	7,27	3,17	4,67
Coordination and Maintenance - Education	2,94	4,63	4,23	3,17	5,71	5,41
Coordination and Maintenance Admin Services	1,61	3,79	2,28	2,18	1,69	2,71
Admin and Coordination - Court Services	1,47	2,40	2,01	1,78	2,43	2,45
State and Federal District Quota for Exporters - IPI Excise Tax Revenues	1,08	0,86	0,58	1,47	3,63	0,44
Quota of States and Federal District – Education Allowance	0,93	0,36	0,40	1,88	1,46	0,75
School Meals	0,48	0,81	0,92	0,48	0,57	0,96
Benefits for Public Servants	0,46	0,66	0,60	0,69	0,47	0,68
Unified Health System Operations	0,43	0,25	0,29	0,50	1,45	1,06
Inspection Development and Improvement	0,36	0,39	0,28	0,58	0,63	0,66
Total	64,80	79,41	91,49	89,32	89,74	83,48
Overall Total - Expenditures [2]	100,00	100,00	100,00	100,00	100,00	100,00

Source: COSIS/STN; SIAFI 1995.
Prepared by CGPOR/DIPRU/IPEA.
Notes: [1] Center-West excludes Federal District.
[2] Corresponds to the overall total for Federal expenditures in each Region, and the nationwide total, excluding interest, charges, amortizations and Constitutional Funds (FNO, FNE and FCO).

The grant and maintenance of benefits is the main project and activity of the Social Security Service, which has firmed up its position as the leader at the national level with 25.4% of total outlays (without interest, charges and amortization) as well as for the macro-regions, where it fails to lead only in the North. Although still young in terms of firm settlement of its population and economic organization, this Region posts the lowest rates for expenditures on retirees, for both social security (14.8%) as well as Federal social welfare charges, with the lowest regional share (3.4%). In the North, the FPE is the largest item, representing over one quarter of total regional expenditures (27.23%).

For the Northeast, the principal projects and activities were, in order, social security benefits (30.9%), FPE (17.1%) and FPM (12%). Projects and activities for healthcare and education ranked slightly lower.

In the Southeast, social security charges ranked top (40% for the social welfare system and 13.2% for the Government sector). The fourth item is Staff Overhead (7.27%) which, as already noted, is absorbed to an appreciable extent by Rio de Janeiro.

Basically, the distribution of outlays in the South differs little from that in the Southeast. However, its share in the IPI excise tax revenues is noteworthy (3.63%), ranking seventh, the highest in relation to the other macro-Regions. For the Center-West - always recalling that the Federal District is not included - the presence of Government structure (and even retirees) is reduced. Its very small share in the IPI excise tax quota (0.44%) should also be noted, as this is the lowest among the macro-Regions.

Table 3.1. omits the exceptions represented by projects or activities whose relative importance is apparent only in one specific Region. Due to its spatial configuration, the North Region clearly differs most sharply from the pattern established by the projects and activities analyzed above. Here the projects and activities related to Federal Government Transfers for payment of staff on payroll (5.7%) and pensioners (1.9%) of the former States and territories in this Region become more important, in addition to the Transfer of the Tax on Financial Operations for Gold (2.6%). In the Northeast, projects and activities fostering regional development play a leading role, particularly Development of Basic Education for the Northeast (0.9%) and Support for Small Farmers (PAPP Programa de Apoio ao Pequeno Produtor Rural) (0.7%).

In the Southeast, the only exception is the Coordination and Maintenance of Administrative and Support Services for the Navy, which ranks seventh, with 2.4% of the total for the Region.[15] In the South, a contrast analysis highlights only the Acquisition of Projects to Implement the Food Supply Policy (3.6%), ranking eighth. This is also important in the Center-West, absorbing

15 This exception probably reflects the poor regionalization of the SIAFI records.

4.6% of outlays, in addition to Transfers of the Tax on Financial Operations for Gold (2.6%) and the Agri-Environmental Development Program for Mato Grosso State (PRODEAGRO - *Programa de Desenvolvimento Agroambiental de Mato Grosso*) at 1.5%, which is a regional development program.

As a whole, the data on projects and activities generally highlight the difficulties faced by the Federal Government in encouraging new initiatives that provide support for development. The few that have been identified are aligned more with past commitments and visions. In terms of the scope of the actions, the data reflects tremendous efforts to adapt to the new federative framework, as well as the stream of fresh ideas shaping social policies under Brazil's 1988 Constitution.

4. Conclusions

Federal Government expenditures covered under the Fiscal and Social Security Budgets have made positive progress towards a situation where the less-developed Regions receive larger slices of total resources. This means that the North, Northeast and Center-West have expanded their shares of the Federal revenue cake. In parallel, the distribution profile of these resources among the Regions and States in 1995, as analyzed in this article, also seems to reflect a pattern that tends to benefit States with larger populations and lower income levels. Apart from a few specific cases, this pattern can be noted in various parts of the analysis.

However, there is a view that the intensity with which this funding is channeled to the poorer, more heavily populated areas is insufficient to trigger any appreciable improvement in the marked regional inequalities found in Brazil. This is still more striking in a comparison of this profile with that of other areas of Federal Government expenditures (not analyzed in this work) such as the investment budget for State-owned companies or the investment profile for official development financing agencies.

Some of the basic characteristics of the regional and State composition of Federal funding covered by this analysis warrant reflection. The distinction between the individual regional profiles for the fiscal and social security spheres proved relevant for analysis. The former seemed less *regressive* in its regional distribution. In contrast, expenditures on social security stressed the predominant position of the Southeast over the other Regions, reflecting more rigid allocations for this type of outlay, particularly those that are specifically earmarked for social welfare activities.

This may also be noted from other angles, including the type of expenses and the principal projects and activities. The regional profile for Other Current Expenditures is strongly influenced by the component for expenditures in the social security sphere, which proved less favorable from the distributive standpoint at the spatial level than that for investments, although the latter represented a small portion of the outlays.

A more detailed analysis of the Other Current Expenses group, particularly its major components noted in 1995, shows that Federal expenditures on core functions such as education, healthcare and social welfare tend to reach higher levels per inhabitant in the Southeast and South Regions, which already post the best social indicators in their respective areas. Even after relativizing these conclusions through a more detailed analysis of the policies and the corresponding sectoral aspects, the 1995 expenditure ratios nevertheless seem almost indefensible for areas such as education and healthcare that are so sensitive to regional inequalities.

Comparing Federal outlays in the Regions and States with the respective populations and product, the results are open to various interpretations. On the one hand, the very favorable positions held in these comparisons by the former territories in Northern Brazil, meaning high levels of expenditure per inhabitant and a high proportion of outlays compared to the respective fractions of the gross domestic product, lead to the hypothesis that there is a type *fixed cost* involved in maintaining the minimum services offered by the Federal Civil Service in the *new* States. With very small populations, this results in a high level of expenditure per inhabitant. This suggests that establishing new States would tend to represent a potential additional cost for the Federal Government, often adversely affecting the share-out profile of the tax revenue cake and actions in other States.

Still more obvious is the appreciable weight of Rio de Janeiro, a legacy of its position as the former capital of Brazil. The situation of this State is obviously not dissimilar to that of the Federal District, which could not be isolated in the analysis, but which absorbs appreciable amounts of Federal Government funding for maintenance. These expenditures hint that Brazil in fact is endowed with two capitals, due to the specific nature of the composition of Federal expenditures in Rio de Janeiro, as shown in various parts of this work. Alongside the former territories, Rio de Janeiro and the Federal District constitute the most obvious skew-points in the regional expenditures profile. This analysis encourages the idea of the need to organize broad-ranging discussions of the situation of these States and Federal District.

The Constitutional or Tax-Based Transfers which account for the largest portion of the funding (72.4% of the total) tend to favor the Northeast Region in general terms, due largely to its position in the States and Federal District Participation Fund (FPE). Non-Tax Transfers (Regular and Negotiated) weigh in favor of the Federal District, particularly due to its share in the Regular Transfers, while the Southeast benefits from the Negotiated Transfers.

Looking at projects and activities individually, a factor already apparent during the earlier analysis of the budget becomes even more obvious: the limited initiative capacity of the Federal Government in the field of regional policy. On the one hand is the absolute weight of projects and activities that are closer to what might be called the normal, recurring actions of the

Federal Government machine (administration and maintenance; Federal transfers and payment of pensions and social welfare benefits) which generally are not differentiated by Region, as they apply to the entire country.

On the other hand, some larger-scale actions were noted. Certain programs gain a greater relative weight within a specific spatial compartment of Brazil, particularly those linked to the supply policy, such as transfers for payment of staff and retirees in the *new* States, as well as others that are typically regional survivors of past initiatives, such as: Small Farmer Support Program (PAPP - *Programa de Apoio ao Pequeno Produtor Rural*); Basic Education Development Program for the Northeast (*Programa de Desenvolvimento de Educação Básica para o Nordeste*); or the Agri-Environmental Development Program for Mato Grosso State (PRODEAGRO - *Programa de Desenvolvimento Agroambiental de Mato Grosso*).

The lack of a set of innovative projects of appreciable size reflects the limited freedom in allocating funds currently faced by the Federal Government. It also confirms that there is no initiative, either already structured or on the drawing board, to transform the current status and rationale of regional policy. There are few signs of any direct concern with reducing gaps and imbalances, and the exceptions consist of actions whose formulation dates back to past eras. The composition of the Negotiated Transfers, amang other components where the allocative option of the Federal Government prevails, confirms this analysis, and spotlights the need to rethink larger-scale initiatives focused on the issue of gaps and imbalances.

This becomes increasingly urgent as the prospects improve for a return to a fresh investment cycle, probably with marked repercussions on the configuration of the production structure in spatial terms, with a consequent reshuffling of work among the Regions. Although the Federal role will tend to shrink during this current stage, it should be recalled that, without its support – including regulating processes – the chances will be very slim for Brazil to move steadily ahead on the path towards reducing regional (and personal) inequalities of income.

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CHAPTER 5

MICROECONOMIC EFFECTS OF PRIVATIZATION IN BRAZIL

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Abstract

Several authors have compared the efficiency of state-owned enterprises with that of private-sector companies but taken as a whole they have failed to reach a convincing conclusion. An analysis of trends in privatized companies can serve as a basis for overcoming some of the methodological and empirical difficulties encountered in the literature. The paper sets out to contribute to this endeavor by examining the impact of privatization on the performance of Brazilian state-owned enterprises divested in the periods 1981-89 and 1991-94. Statistically significant results show a clear improvement in performance after privatization. The improvement was especially significant, in both economic and statistical terms, for firms in which a controlling share was sold and for firms privatized in the period 1991-94.

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1. Introduction

The many privatization programs implemented around the world in recent years have been motivated by two key objectives: to increase the efficiency of the economy and to contribute to fiscal adjustment. Generally speaking, experience shows that the fiscal motivation has prevailed in practice, and privatization has usually been adopted by governments with the aim of reducing the public-sector deficit. From the theoretical standpoint, however, it is the pursuit of efficiency that effectively justifies the implementation of privatization programs, for while the fiscal benefits are mostly transient, an increase in efficiency generates a lasting increase in incomes.

Moreover, as Pinheiro & Schneider (1995, p. 770) point out, even though in the short term there may be a trade-off between the two objectives, in the long term they are convergent: an increase in efficiency guarantees growth in profits, incomes and tax receipts. This perception led the World Bank to the conclusion that "the economic benefits of privatization ore maximized when governments make increased efficiency their number one objective" (Kikeri, Nellis & Shirley, 1992, p. 6).

It is worth noting, nevertheless, that the empirical evidence of performance differences between state-owned enterprises (SOEs) and firms in the private sector — evidence which underlies recommendations such as the World Bank's — is plentiful but not entirely conclusive. Vickers & Yorrow (1991, p. 117), for example, comment that in competitive markets private-sector firms are generally (but not always) more efficient than SOEs and that in oligopolistic markets there seem to be no differences. Boardman & Vining (1989, p. 1) note thot olthough "the property rights theory of the firm suggests that public enterprises should perform less efficiently and less profitably than private enterprises,... the existing empirical evidence actually provides weak support for this hypothesis".

Thus, as pointed out by Meggison, Nash & Randenborgh (1994, p. 404), it is interesting that so many major privatization programs, which brought about a virtual revolution in the functioning of entire economies, were based on such fragile theoretical suppositions and empirical evidence:

What we find most surprising about the privatization programs of the 1980s, however, is not their size or scope but the fact that they were adopted largely on faith. The academic literature available at the time these decisions were made offered precious little guidance as to the best method of divesting state-owned assets and only limited theoretical analysis of the predictable costs and benefits of privatization. Furthermore, while the extant literature on the performance of SOEs was voluminous, the few empirical analyses of privatization itself that had been published were far from conclusive. While authors such as Bailey (1986), Bishop & Kay (1989), and Pryke (1982) present arguments or evidence favoring privatization's role in promoting economic efficiency, the exact opposite view is put forward by Kay & Thompson (1986) and Wortzel & Wortzel (1989).

This impression is shared by several authors. In answer to the question whether privatization is a driver of economic development, Yoder, Borkholder & Friesèn (1991, p. 426) state that "although the question is ultimately an empirical one open to investigation, it is somewhat ironic that the promise of privatization has been put to empirical test so infrequently".

This paper sets out to contribute to efforts to fill the gap. In this sense it is one of an increasing number of empirical studies of the impact on SOEs of their transfer to private ownership. It analyzes the extent to which the performance of Brazilian SOEs privatized in the 1980s and in the period 1991-94 improved following divestiture. The next section describes other studies produced with the same aim, summarizing the empirical evidence available from the literature, especially on the Brazilian experience. The methodology adopted for the analysis is outlined in the third section, which also presents the data utilized. The fourth section discusses the results obtained, and a final section presents conclusions.

2. Empirical evidence

Most of the reasons for which the efficiency of an economy tends to improve with privatization have to do with a change in the incentives offered to managers and employees. In particular, privatization is expected to raise the efficiency of a firm because it leads to clearer goals, attenuates problems of agency (managers are better supervised and in turn manage their own subordinates better, so that there is less room for the pursuit of personal agendas), and introduces the discipline of the market by removing flexible budgets and exit barriers.[1]

State-owned enterprises (SOEs) have a private face and a public face: on one hand, they have commercial goals that relate to the production and marketing of a good or service; on the other, they have public-policy goals, such as the development of sectors situated "downstream" or "upstream" in the production chain, integration of the national territory, meeting the needs of disadvantaged sections of the community, creating jobs, controlling inflation, and so on. This Janus-like duality has a negative impact on economic efficiency since (a) managers of SOEs are not always clear about the goals of the public sector which, as the controlling shareholder, often pursues conflicting interests, thus hindering decision making and resource allocation;[2] and (b) social goals are usually achieved to the detriment of commercial goals and at considerable cost to profitability. The private sector is characterized by greater clarity about goals, which are directly focused on commercial results. Privatization basically

1 Some of the points in what follows are discussed in Pinheiro & Giambiagi (1992).

2 On this point, a World Bank paper has the following to say: "Bureaucrats typically perform poorly in business, not because they are incompetent (they aren't), but because they face contradictory goals and perverse incentives that can distract and discourage even very able and dedicated public servants" (World Bank, 1995, p.3).

entails relinquishing non-commercial goals and thus allows for more efficient resource allocation.

SOEs belong to society as a whole but little benefit accrues to each individual citizen from sound administration of a particular SOE. An important consequence of this diffuse ownership structure is that it is not rational for an individual to expend effort on overseeing the management of SOEs. As a reflection of this situation, executives of SOEs are often appointed on political grounds, and there is only a marginal incentive for taking the interests of "shareholders" into account. This in turn gives the senior management of an SOE leeway to pursue their own personal goals or those of the people who appointed them.[3]

The problem is put in the following way by Boycko, Shleifer & Vishny (1996, p. 309):

Public enterprises around the world have proved to be highly inefficient, primarily because they pursue strategies, such as excess employment, that satisfy the political objectives of politicians, who control them. *Privatization of public enterprises can raise the cost to politicians of influencing them, since subsidies to private firms necessary to force them to remain inefficient are politically harder to sustain than wasted profits of the state firms.* (emphasis added)

In the private sector, corporate management is more closely monitored and problems of agency are less serious and less frequent. Indeed, this is why it is believed that the goal of promoting efficiency is better served when an SOE is not floated on the stock exchange or divested in such a way as to enable employees, managers and/or investors subject to political pressure to acquire a significant proportion of its equity (Boycko, Shleifer & Vishny, 1996, pp. 317-318).

The third key difference between state-owned and private-sector enterprises is the degree of access to Treasury funds enjoyed by the former, which enables them to survive despite major systematic losses. SOEs very rarely go bankrupt. Because they are well awore of this fact, managers and employees of SOEs feel under no pressure to ensure that their enterprises are profitable and operate efficiently. This problem proved especially acute in East Europe, popularizing the concept of "soft-budget constraints" created by Kornai (1979).

Another way in which privatization can contribute to an increase in efficiency is by intensifying competition among firms, frequently in situations where there was previously no such competition. No doubt the most conspicuous examples of such situations can be found in the former communist countries, but they are also highly relevant in countries like Brazil. For a considerable period the Brazilian state had a monopoly in several key industries, such as flat steel and petrochemical feedstocks, for example. Since privatization, firms in these industries

3 The issue is analyzed in detail by Shapiro & Willig (1990).

have been forced to compete among themselves. The extent to which this effect occurs evidently depends not only on the structure of the market in which the SOE operates but also on the privatization format selected by the government.

As already mentioned, although the theoretical arguments are strong the empirical evidence relating to the effect of ownership structure on the efficiency of a firm is not conclusive. Cavalcanti (1991), for example, uses data for 88 water and sewerage enterprises (66 public and 22 private) in Great Britain at the end of the 19th century to estimate cost functions, concluding that ownership structure did not significantly impact their efficiency. Plane (1992, p. 841), using a model with data from 45 developing countries, concludes that "the regressions for the periods 1970-81 and 1970-85 do not reject the hypothesis that, on average, marginal factor productivity is significantly lower in the parastatal sector". Yoder, Borkholder & Friesèn (1991), who also use data from 45 developing countries, conclude that there was no evidence of a significant increase in efficiency due to privatization. In a study with production frontiers for Brazilian firms, Tyler (1978) does not obtain significant differences in technical efficiency between SOEs and private-sector firms.[4]

Table A.1 in the Appendix summarizes the findings of a series of studies on the relative performance of firms in the public and private sectors, suggesting a moderate advantage for the latter although the results vary considerably from one industry to another and are subject to doubt regarding the methodology used.[5] The main difficulty with empirical studies of this kind is in isolating the effect of capital ownership from the effects of other equally relevant variables. As Boardman & Vining (1989, p. 1) point out in their review of the literature, "with the exception of two studies that examine Indonesia and Tanzania, no study has explicitly compared the effect of ownership while controlling for relevant factors". Studies such as those by Plane (1992) and by Yoder, Borkholder & Friesèn (1991) are criticized either because the SOEs operate in different sectors from the private firms studied (often as monopolists) or because they operate under different conditions (in terms of flexibility in procuring goods and services, for example). A comparison with private firms operating in the same sectors but in different countries is also problematical because it is not obvious how to separate differences due to local conditions in each country (e.g. macroeconomic situations) from differences due to ownership (Galal et al., 1994).

4 Boardman & Vining (1989), Yoder, Borkholder & Friesèn (1991) and Vickers & Yarrow (1991) list several other studies with similar findings.

5 Boardman & Vining (1989, p. 5) have the following comments on these findings: "In sectors where there is some evidence of superior public efficiency (electricity and water), there is limited competition or the private firms are highly regulated. Evidence of the greater efficiency of PCs [private corporations] appears to be in the delivery of services where governments subcontract to the private sector and their monitoring costs — for example, for refuse collection, fire protection, and nonrail transit — are relatively low. The health-related literature also suggests greater efficiency for the private sector, but because few of the studies control for service quality differences — which is obviously important given the heterogeneous nature of these services — they are not wholly convincing."

Boardman & Vining (1989) seek to circumvent this problem by performing a set of regressions with data for 409 private-sector firms, 57 SOEs and 23 firms of mixed ownership taken from the *Fortune* list of the 500 largest non-American industrial firms. The typical regression has a performance variable (return on equity, sales per employee etc.) as dependent variable, explanatory variables that reflect size, nationality and sector (including concentration), and several dummy variables to capture the effect of ownership on performance. The authors conclude that SOEs and firms of mixed ownership perform significantly worse than comparable private firms when controlling for the effects of other factors.

More recently, accumulating experience with privatization in several parts of the world has allowed appraisal of the relative performances of firms in the public and private sectors to be replaced with empirical analysis of the effect of privatization on specific enterprises (e.g. Meggison, Nash & Randenborgh 1994, Galal et al. 1994, Costa 1994). The advantage of this type of exercise is that the firm functions as its own control, thus avoiding the influence of differences due to the specific country or sector involved.

The study by Galal et al. (1994) on 12 privatization experiences in the United Kingdom, Chile, Malaysia and Mexico is without doubt the most comprehensive investigation to date on the impact of privatization on the well-being of the community as a whole and that of stakeholders individually (be they investors, government, customers, employees or competitors). For each of these 12 transactions, the authors constructed a counterfactual scenario designed to suggest what might have happened if the firms had not been privatized. This scenario is used for control. The impact of privatization is measured as the difference between the social value of the firm under private ownership (i.e. after privatization) and its value under public ownership as represented in the counterfactual scenario. The authors conclude that in 11 out of the 12 cases studied, privatization led to an increase in global well-being. The single exception was the divestment of Mexicana Aviación.[6]

The main problem with the methodology used in Galal et al. (1994) is of course its high application cost. While Gerchunoff (1992), for example, defends this methodology from the conceptual standpoint, he does not use it in his analysis of privatization in Argentina. The methodology is highly detailed for each case yet does not generate more than a small number of observations, and it is therefore impossible to test for the statistical significance of the changes observed. As noted by Meggison, Nash & Randenborgh (1994, p. 404), other studies — such as Yarrow (1986) and Caves (1990) — suffer from the same shortcoming.

Eckel, Eckel & Singal (1993) seek to overcome this problem by analyzing the behavior of stock prices. If transfer of ownership to the private sector raises the efficiency of a firm, this

6 The authors concluded that none of the 12 cases was prejudicial even to employees, who are often believed to lose out as a result of privatization, and indeed that ten cases were beneficial to them.

should be reflected in a reduction in the prices at which the stocks issued by its direct competitors trade in the equity market. The study uses this approach to investigate whether privatization can be said to have enhanced the efficiency of British Airways and Air Canada. The authors conclude that privatization of the latter had a significant adverse impact on airlines in North America. In the case of British Airways, however, the results "are ambiguous, mainly positive but not significant... The impact of privatization on competitors depends on the regulatory and competition environments" (Eckel, Eckel & Singal, 1993, p. 17).

Another group of studies sets out to derive conclusions that can be generalized for a large number of firms, albeit with a lower level of detail in the analysis of each individual operation. Studies of this kind also typically consider only the effects on some of the various types of agent affected by privatization, usually by employing variables indicative of the privatized firm's performance.

Hachette & Lüders (1993, pp. 125-132) seek to evaluate the impact of privatization on investment, indebtedness and efficiency in former SOEs in Chile by analyzing a vector of variables taken from their financial statements. They utilize two procedures: (a) identification of differences in performance between private, privatized and public enterprises based on a factor analysis using variables taken from financial statements; (b) a direct comparison of the evolution of these variables for each group of enterprises in the period 1965-85. The authors observe no "significant differences of behavior between public, private and privatized firms when subject to the same set of rules and regulations. This result was obtained even when criteria as different as those relating to efficiency, investment, debt and relationships with other firms were considered jointly. (...) For all practical purposes, the results obtained do not demonstrate any important differences between public and private firms when subject to the same rules".

In another study of the same kind but methodologically more elaborate, Meggison, Nash & Randenborgh (1994) compare the operating and financial performance, before and after privatization, of 61 firms in 18 countries and 32 different sectors. All were privatized by flotation (public offering on the stock exchange) during the period 1961-90. The authors evaluate the impact of privatization on the performance of these firms by comparing the mean values of a series of variables (mostly taken from financial statements) in the three years prior to privatization and the three years afterwards, using the sign test and the Wilcoxon Signed Rank Test for this purpose. Here is the authors' summary of their conclusions:

> Our results document strong performance improvements, achieved surprisingly without sacrificing employment security. Specifically, after being privatized, firms increase their real sales, become more profitable, increase their capital investment spending, improve their operating efficiency, and increase their work forces. Furthermore, these companies significantly lower their debt levels and

> increase dividend payout. Finally, we document significant changes in the size and composition of corporate boards of directors after privatization. (...) Our results are also quite robust to various partitions of the data into smaller subsamples, such as full-versus-partial privatizations, industrialized-versus-developing country divestitures, and competitive-versus-regulated industry sales (Meggison, Nash & Randenborgh, 1994, pp. 403-406).

The methodology used by Meggison, Nash & Randenborgh (1994) is also used by Costa (1994) to evaluate the extent to which Brazilian state enterprises privatized during the 1980s improved their performance after transfer to private ownership. Costa points out that her study is severely impaired by scarcity of data, acknowledging that "although the results obtained suggest an improvement in the performance of these firms, in most cases they were not statistically significant" (Costa, 1994, p. 33).

Other empirical studies dealing with the impact of privatization on Brazilian enterprises confine themselves to an analysis of the evolution of indicators, without evaluating the statistical significance of the changes observed. Gandara & Kaufman (1994, p. 11), for example, note significant cost savings per ton produced in 1992-93 by privatized steel mills, varying from 2% in the case of Usiminas to 27% in that of Piratini. Paula (1995) also discusses the effects of privatization on the Brazilian steel industry, focusing on the degree of concentration and the financial, technological and corporate strategies adopted, and concluding that the impact in these areas was significant but differed from one firm to another:

> With regard to financial strategies, the most conspicuous change was observed in the case of Acesita, which substantially altered its debt structure by issuing convertible debentures and securitizing exports. Two clearly different strategies were found to exist with regard to payment of dividends: an aggressive one (Usiminas, Acesita and Açominas) and a conservative one (CSN and CST). Regarding technological strategy, the highlight was CST, which changed its investment priorities by deciding to install a continuous casting line before revamping its blast furnace. In research and development, Usiminas restructured the activity in order to achieve faster results and Cosipa reinforced its effort in this area. As for competitive strategies, Usiminas and Acesita not only acquired other steel mills, but also extended their operations into steel distribution, while CSN began generating its own power" (Paula, 1995, p. 23).

BNDES (1995) presents a well-documented empirical analysis of the impact of privatization on the performance of privatized firms. The study analyzes the three industries in which most privatization had then taken place in Brazil — steel, chemicals/petrochemicals, and fertilizer, accounting for 95.7% of total privatization proceeds up until December 1994. It finds that production, sales, investment, profits and productivity all increased and workforces were reduced by these firms after privatization (and in many cases starting before privatization). Like Gandara & Kaufman (1994) and Paula (1995), the authors of this study also draw attention to the significant impact of privatization on the Brazilian steel industry:

> Commercial strategies also became more aggressive, including the provision of services in partnership with customers, acquisition of steel distributors, promotional campaigns in the media, and creation of overseas distribution channels. Cost savings derived from the introduction of modernization and productivity programs and from managerial autonomy in the area of procurement, enabling firms to decentralize purchasing, enter into partnership with suppliers, buy on consignment and reduce inventory. (...) The product mix was enhanced by increasing the share of high value-added items, and new markets were pursued, especially in Asia and the Americas. (...) The positive effects of the new business vision adopted by the steel industry under private ownership can already be clearly seen from the improvement in the companies' efficiency. However, it must be stressed that other factors have benefited the industry besides the positive impact of privatization, such as price liberalization and adjustments introduced prior to privatization.

The authors are less enthusiastic about the impact of privatization on the petrochemical industry, concluding that it served only to reinforce "modernization and quality programs by intensifying the rationalization process that had already begun beforehand, thus strengthening the competitiveness of the companies in question. (...) However, the industry continues to face the same internal structural deficiencies, i.e. small scale, an excessive number of firms, fragmented ownership, and inadequate technological capabilities". In the fertilizer industry, they argue, privatization enabled operations to be concentrated and vertically integrated but had a far less significant impact than overall liberalization and deregulation of the economy.

The BNDES study (1995) also underscores and documents the fact that privatized firms have invested heavily in environmental protection and control, contradicting the expectations of some authors (e.g. Galal et al., 1994) that privatization would be damaging to the environment. Cosipa, for example, plans to increase average annual investment from some US$20 million in 1990-94 to US$584 million in 1995-98, allocating US$121 million to pollution control. Álcalis, another firm with problems in this area prior to privatization, has since invested massively in pollution control and won an operating license from FEEMA for the first time in October 1994.

3. Methodology and data

The methodology used in this paper to test for changes in the performance of privatized firms is the Wilcoxon Signed Rank Test and the sign test, essentially the same methodology used by Meggison, Nash & Randenborgh (1994) and by Costa (1994). The sign test measures the proportion of firms that changed in the expected direction. The Wilcoxon Signed Rank Test adjusts this measure for the magnitude of the change. The tests were applied to a set of variables designed to evaluate the economic and operating performance of the firms in question. In both cases, the basis for testing whether performance changed was a comparison between the arithmetic means of the variables before and after privatization. As far as possible, an effort was made to compare the mean for the four years prior to divestiture (years -4 through -1) with the mean for the four years following privatization (years 1 through 4). Nevertheless, the study covers all firms for which information was available with regard to at least one year before and one year after privatization. The year of privatization itself (year 0) was left out because it included some months during which a firm was state-owned and some months when it was under private ownership.

The Wilcoxon Signed Rank Test and the sign test are non-parametric tests which test the hypothesis that a particular "treatment" has no effect by using matched pairs of variables.[7] Formally, suppose n independent pairs of variables are observed (X_i, Y_i), $i = 1, ..., n$. In this case X_i represents the response of the control group and Y_i the response of the group subjected to treatment, in this case privatization. The effect of the treatment can be measured by $Z_i = Y_i - X_i$. Thus the hypothesis that the treatment has no effect, i.e. that privatization does not affect a firm's performance, corresponds to the hypothesis that all the Z_is are symmetrically distributed in relation to zero (i.e. that $X_i - Y_i$ and $Y_i - X_i$ have the same distribution).[8]

The Wilcoxon Signed Rank Test rejects the null hypothesis that privatization has no effect for the alternative that privatization enhances a firm's performance for high values of the statistic W defined as:[9]

7 A detailed description of the Wilcoxon Signed Rank Test and similar non-parametric tests is given in Bickel & Doksum (1977, pp. 344-378). This test is also known as the Wilcoxon-Mann-Whitney test. The following paragraphs summarize the discussion in Bickel & Doksum.

8 The Wilcoxon Signed Rank Test and the sign test can also be interpreted as testing that the median of the distribution of Z_is is zero.

9 Note that in this case a unilateral test is used in which higher values of Y than of X are interpreted as reflecting an improvement in performance, i.e. higher profit. This means that the alternative hypothesis is that Z_i is stochastically greater than $-Z_i$. For some indicators, however, an improvement in performance will occur when the opposite is true (for example, less debt after privatization). In this case, the null hypothesis is rejected for values of W below a critical value.

$$W = 1/2 \sum_{i=1}^{n} R_i + n(n+1)/4 = \sum_{i=1}^{s} T_i \qquad (1)$$

where R_i is the signed rank of Z_i, i.e. the rank of $|Z_i|$ multiplied by the sign of Z_i. $T_1 < \ldots\ldots < T_s$ are ranked positive values of R_i and s is the number of positive Z_is. For $n \leq 16$, the critical values for the test are given in Bickel & Doksum (1977, pp. 479-481). For $n > 16$, a normal approximation can be used in light of the fact that when the null hypothesis is valid:

$$E(W) = n(n+1)/4 \qquad (2)$$

and:

$$Var(W) = n(n+1)(2n+1)/24 \qquad (3)$$

A second test used here, albeit less sensitive than the Wilcoxon Signed Rank Test, is the sign test, which takes only the signs of Z_i into account. The sign test rejects the null hypothesis that the treatment has no effect if the S statistic, equal to the number of positive Z_is, exceeds (or, depending on the alternative hypothesis, falls short of) a suitably chosen critical value. If the null hypothesis is true, S has binomial distribution with parameters n and ½. For $n>10$, the critical values for a test of significance level α can be approximated by $½ + n/2 + \sqrt{n}\, z(1-\alpha)/2$, where $z(1-\alpha)$ is the $(1-\alpha)$ percentile of the standard normal distribution.[10] For $n \leq 10$, the critical values are given in Bickel & Doksum (1977, p. 478).

Eight variables were selected initially for analysis: net sales, net income, net worth, investment, net fixed assets, number of employees, debt-to-equity ratio, and current liquidity ratio. From these were derived six more variables, designed to measure a firm's efficiency (sales per employee and profit per employee),[11] profitability (return on sales and return on equity), and propensity to invest (investment/sales, and investment/net fixed assets). These last four variables, stated as a ratio between two flows, offer the advantage of not being sensitive to the deflator used. Moreover, for some of the firms privatized in 1991-94, it was possible to derive labor productivity from data for production before and after privatization.

The data were collected from a large number of sources. A significant proportion of the data came from financial statements published in *Visão*, *Balanço Anual* and *Maiores e*

10 The term ½ is the well-known continuity correction for the unilateral test in which the alternative hypothesis is that Z_i is stochastically greater than $-Z_i$. For the case in which the alternative hypothesis involves a fall in the value of the indicator, the continuity correction is given by -½. For bilateral tests (privatization has some effect, but an unspecified one), the correction is not used.

11 It should be noted that the efficiency measures used here reflect partial indicators of productivity and are therefore subject to the well-known problem that they reflect both changes in total factor productivity and factor substitution. See Espinal & Pinheiro (1992) on this point.

Melhores yearbooks, and a supplement to *Conjuntura Econômica* called *500 Maiores*, as well as from less usual sources such as a database created by *Economática*. It was especially difficult to obtain data on firms privatized in the 1980s because of their small size, which in most cases excluded them from the publications mentioned. Moreover, some firms have since disappeared or changed their names.[12] In the case of 1980s privatizations, it was therefore decided to write to the firms in question to ask for the requisite data. When a reply was received, priority was given to the data supplied directly by the firm.

A key complication in the empirical analysis was the high inflation prevailing throughout the period studied. This required a method for distinguishing real variation from merely monetary variation. The solution adopted was to use the industrial price index (wholesale) as a deflator for all data, and to define as real changes any changes in product prices relative to the index or relative to input prices. However, the effect of these relative price changes is substantially attenuated by the use of averages for up to four years before and after privatization.

Another key procedure was the standardization of variables to ensure that the behavior of the larger firms did not outweigh that of the smaller firms, thus distorting the results. In other words, because the data used came from firms of different sizes, the variables had to be standardized so as to isolate the effect of privatization. All variables were therefore standardized by dividing the means for before and after privatization by the value of the variable in year zero, i.e. the year of privatization. In the case of net income and net worth, which for some firms were negative in the year of privatization, and the variables derived from these, the means for before and after privatization were divided by the absolute value of the variable in year zero.

The number of firms covered in both decades was satisfactory despite the difficulties mentioned. For the sample as a whole, between 29 and 46 observations were obtained, depending on the variable. For the 1980s, the number of observations ranged from 14 to 19. For the period 1991-94 it ranged from 11 to 27.[13] With this number of firms, it was also possible to partition the sample into firms in which a minority share of equity was sold and firms

[12] Companhia de Celulose da Bahia was shut down between 1985 and 1989, when it was acquired by the Klabin group and became a division of a group company. Companhia Guatupara de Celulose/Papel (Celpag, later Celpav), remained at a pre-startup stage until December 1991, and most of the data on this firm could therefore not be used. It proved impossible to obtain sufficient data on the following SOEs privatized in the 1980s: Companhia Siderúrgica Mogi das Cruzes, Estrada de Ferro Perus-Pirapora, Encine Audiovisual, and Fiação e Tecelagem Luftala (wound up) — correspondence mailed to all these was returned; Indústria Brasileira de Papel, Federal Seguros, Força e Luz Criciúma, Didacta Sistemas Educacionais, Melhoramentos Blumental, Engenharia Hidráulica e Instrumentação (Engematic), Fermag Ferritas Magnéticas, Cimetal Siderúrgica, and Mineração Carmec. All were excluded from the empirical analysis. It also proved impossible to obtain sufficient data on any of the variables for the following SOEs privatized in the 1990s: Mineração Caraíba, and Sociedade de Navegação da Bacia do Prata. Data for Cosinor, which was wound up shortly after privatization, were not used.

[13] Table A.7 in the Appendix lists the firms covered by the empirical analysis and the year in which each one was privatized.

in which a controlling share was sold: the number of observations ranged from seven to 14 for the former and from 22 to 32 of the latter. As for the data themselves, the quality of the data obtained on firms privatized in the 1990s seems better in the sense that the sources were more homogeneous and the firms were much larger. In the case of those privatized in the 1980s, the contribution made by the firms themselves by supplying information was fundamental in terms of the number of observations and the quality of the data.

For the purposes of analysis, the variables were grouped into six categories: production volume, efficiency, employment, profitability, financial situation, and propensity to invest. Production volume was measured in terms of real sales and, for a group of firms privatized in the 1990s, physical production itself. Efficiency was measured by sales per employee, profit per employee, and labor productivity. Employment was measured by the number of employees, i.e. headcount. Profitability was measured by net income, return on sales, and return on equity. Financial situation was measured by the real value of net worth, the debt-to-equity ratio, and current liquidity ratio. Propensity to invest was measured by the deflated value of net fixed assets, real investment, investment divided by sales, and investment divided by net worth.

How should these variables be expected to behave as a result of privatization? According to the model used by Boycko, Shleifer & Vishny (1996), privatization should lead to a reduction in excess manpower and also, at least in the Brazilian case, to a reduction in payroll and input costs, as well as an increase in the prices charged to customers, all of which are adversely influenced by political factors when firms are state-owned. These changes in turn shift the marginal cost curve downward and the marginal revenue curve upward, thus tending to lead to a rise in production. This latter factor will have a positive impact on the demand for labor, but the net effect of privatization on employment will depend on the firm's initial situation while still under public ownership.[14]

The increase in production and profitability in turn attract more investment, so it is reasonable to expect net worth to expand.[15] Lastly, privatization is expected to lead to better management of finances by firms, with a reduction in debt and an improvement in current liquidity ratio. In the Brazilian case, in particular, the preparation for privatization itself included

[14] Meggison, Nash & Randenborgh (1994), for example, note that privatization generated an increase in the average headcount of the privatized firms in their sample.

[15] Because government controls imposed on SOEs in recent years have forced them to reduce investment disproportionately, several profitable investment opportunities must have been missed. Firms would be expected to take advantage of privatization and the end of these controls to catch up on the missed investment opportunities. To some extent, this is indeed the situation outlined in BNDES (1995).

a number of adjustments designed to improve the debt structure of the SOEs in question, often involving Treasury assumption of some debt.[16]

In principle, therefore, privatization is expected to lead to a rise in sales, profit, investment, fixed capital and current liquidity ratio, and to a fall in headcount and debt. This in turn should result in a rise in sales per employee, profit per employee, return on sales, return on equity, and propensity to invest (investment/sales, and investment/net fixed assets). In the case of the last four variables, however, the increase would be expected mostly in the medium term and the sign of the short-term variation is unpredictable.

Two issues must be mentioned before moving on to an analysis of the empirical findings. The first relates to the care that must be taken when analyzing any data for the effects of privatization on the efficiency of a firm. As exhaustively discussed by Galal et al. (1994), no study of the effects of privatization on corporate efficiency will ever be complete because it is impossible to be sure that any changes observed are due to privatization, rather than, say, liberalization and deregulation of the economy, or that the changes would not have occurred anyway if the SOE had not been privatized (for example, performance might have improved because of an improvement in the macroeconomic situation). However, this caveat carries more weight when the effects of privatization on only a few firms are studied. In an empirical analysis such as that discussed in the next section, which covers a large number of firms in different sectors and privatized during a period lasting one and a half decades, while corporate performance must have been affected by other variables these effects are unlikely to distort the findings.

The second issue relates to the social goals of SOEs. More specifically, how one factors in, for each privatization, what Galal et al. (1994, p. 23) call the fundamental trade-off of privatization, i.e. the fact that while management under private ownership tends to increase static and dynamic efficiency, on the other hand private motivation may lead to an increase in exploitation of customers, employees and the environment. In other words, "there is a trade-off between the possibility that private objectives are less desirable socially, and the possibility that the private sector will pursue these objectives more efficiently".

If social goals are external to the firm, a comparison between the performance of SOEs and private firms is a virtually impossible task, since it is practically impossible to measure the results of activities with non-commercial goals. As noted by Boardman & Vining (1989, p. 9), however, in practice it can be seen that the non-commercial goals of SOEs tend to be internal rather than external: "A common version of this... argument is that benefits are *internal* to the

[16] Total debt ought also to diminish, since the Treasury no longer guarantees a firm's debt after privatization. Under normal circumstances this should make borrowing more costly and the firm would be expected to reformulate its capital structure so as to reduce leverage.

SOE in the form of higher wage levels and perquisites or higher aggregate SOE employment. If internal benefits do accrue they are likely to be achieved only at a net deadweight loss" (original italics). Thus a relinquishment of these goals would lead to an increase in the total surplus generated by the firm and, aside from possible distributive problems, would tend to benefit society as a whole. To put it another way, relinquishment of non-commercial goals reinforces rather than jeopardizes the benefits of the increased efficiency that results from privatization.

4. Results

Table A.2 presents a summary of the results obtained for the sample as a whole. Tables A.3 and A.4 repeat the analysis but subdivide firms according to whether they were privatized in the 1980s or 1990s. Tables A.5 and A.6 subdivide the results according to whether a controlling stake in equity or only a minority share was sold[17] (Tables A.2 through A.6 are in the Appendix at the end of the paper). In each case, the values shown are the means (medians) of the variables before and after privatization (after normalization of the values for each firm so that the variable for year zero, the year of privatization, has the value 1), the difference between the means (medians), and the proportion of firms for which the variable increased. In addition, the tables present the values of the *Z* statistic to test the null hypothesis that the median of the differences is equal to zero. The first statistic corresponds to the Wilcoxon test and the second to the sign test.

The null hypothesis that privatization does not affect corporate performance was tested in every case against the alternative that performance does improve after privatization. An improvement in performance is taken to mean an increase in production (real sales), efficiency, propensity to invest, profitability, liquidity and net worth, and a reduction in employment and debt. The critical values for the unilateral test were selected accordingly. Each table presents the significance levels for bilateral tests, contrasting the null hypothesis that nothing changes with privatization with the alternative that something does happen, but this is not discussed in what follows.

Generally speaking, the results obtained confirm that privatization leads to a significant improvement, in statistical and economic terms, in the firm's performance. Thus the null hypothesis that transfer of ownership does not alter the firm's performance is rejected for most of the variables, in favor of the alternative that privatization leads to an increase in production, efficiency, profitability and propensity to invest, a reduction in the need for manpower, and an improvement in the firm's financial indicators. However, the findings show some relevant differences depending on the way in which the sample is subdivided.

[17] In the 1980s, privatization involved the sale of a controlling share of 17 out of the 21 firms for which data were obtained. For 1991-94, the proportion was 17 out of the 29 firms in the sample.

Real sales increased substantially for the sample as a whole and for all subsamples considered, with both the Wilcoxon test and the sign test rejecting the hypothesis that nothing changes with privatization at a significance level of 1% or 5% in almost all cases. For the total sample, the mean (median) of real sales increased 18% (27%) between the period before and the period after privatization, with a statistically significant increase at the 1% level. It is worth noting that for cases in which a controlling share was sold, sales fell during the period in which the firm was preparing for privatization and then rose again after privatization, whereas for cases in which a minority share was sold, real sales increased continuously. For the SOEs privatized in the 1990s, it can be seen that production increased in 90.5% of the cases studied, from a mean (median) of 97% (94%) of their value in the year of privatization to 116% (105%) in the subsequent period.

Efficiency was found to increase very significantly after privatization both for the sample as a whole and for every case in all subsamples. Except for the subsample of privatizations involving a minority share, this increase was statistically significant at the 1% level. Real sales per employee increased on avearage (median) 60% (83%) for the total sample, and 98% (92%) for firms privatized in the 1990s. Moreover, as expected, the values were substantially higher when a controlling hare as sold than when a minority share was sold. Production per employee increased after privatization for all firms for which data was obtained (Table A.4). Profit per employee increased overall, but the increase was sharpest and statistically significant in the cases where a controlling share was privatized.[18] For the total sample, 88.1% of the privatized firms showed an increase in sales per employee, while 75% showed an increase in profit per employee. For the subsample of minority-share sales, the proportions were 89.7% and 82.1% respectively.

Another variable that behaves uniformly for the entire sample as well as its various subdivisions is headcount, which fell in all cases, mostly to an economically and statistically significant extent. For the total sample, headcount decreased on average (median) 49% (31%) between the period before and after privatization. Moreover, the mean (median) fall in headcount for all SOEs privatized in the period 1991-94 and for which data were obtained was nearly half (37%). Headcount fell between 30% and 40% for the vast majority of these firms. Nonetheless, it is interesting to note that around three-fourths of the reduction in employment levels took place during the period in which the firms were preparing for privatization, while only one-fourth occurred after privatization. In the specific case of firms privatized in the 1980s, the reduction in headcount occurred entirely before privatization, and

[18] The variables "profit" and "investment" and the variables derived from them showed higher coefficients of variation (standard deviation/mean) and kurtosis (long tails, with a higher probability of outliers) than the rest. This difference is reflected in more significant differences between the mean and the median. In such cases, the median seems to be a more appropriate measure since it is not very sensitive to extreme observations, unlike the mean, which can be acutely distorted by outliers.

mean headcount increased in the subsequent period. A similar trend can be observed in the case of firms in which a controlling share was sold. These findings suggest that the reduction in headcount was due mainly to the existence of surplus manpower, which tends to be characteristic of a large number of SOEs, and is for the most part easily identified and eliminated even before privatization. Data for the 1990s also show that although the number of workers employed in production fell, it increased as a percentage of the total workforce as a result of privatization.

As expected, privatization led to an increase in profitability. Both the Wilcoxon test and the sign test showed a statistically significant increase in net income as a result of privatization, except for cases in which a minority share of equity was sold. The same was true of return on equity. There was a statistically significant increase in return on sales for the entire sample, for privatizations in the period 1991-94 and for sales of a controlling share. In these cases, profitability rose from a negative mean/median to a positive value after privatization.

Financial indicators also improved as a result of privatization, although the findings for this group of variables proved less significant than initially expected. The most striking result was for net worth, which increased to a particularly significant extent, in both statistical and economic terms, for privatizations of a controlling share and for SOEs privatized in the 1990s. Debt decreased for the total sample, for firms sold in 1991-94 and for privatizations of a controlling share; the decrease was statistically significant at a level of at least 10%. A similar trend was observed in the case of current liquidity ratio, which increased to a statistically significant extent only for privatizations occurring in the 1990s and sales of a controlling share.

Another clearly positive result was the tendency for investment to increase after privatization. For the total sample and for all subsamples, there was a significant increase in investment at a 1% level in all cases. For the total sample, the median increased from a level before privatization equivalent to 55% of the value observed in the year of privatization to more than twice that value in the subsequent period, and the mean increased still more. Additionally, 83.3% of the firms for which data were obtained increased the level of investment in the post-privatization period compared with the period prior to privatization. A similar trend was observed in fixed assets (net fixed assets), with a statistically significant increase in all cases except for the subsample of minority-share sales. The ratio of investment to sales also increased significantly at a 1% level in all cases except for the subsample of minority-share sales (significant at 5%). The ratio of investment to net fixed assets increased to a statistically significant extent for the entire sample, for privatizations in 1991-94 and for controlling-share sales. In all cases except the ratio of investment to net fixed assets for minority-share sales, the increase in investment and propensity to invest was very substantial in economic terms.

Generally speaking, the results obtained substantiate the theoretical arguments presented at the start of Section 2 in at least three ways. First, firms become more efficient and profitable as a result of privatization. Second, the improvement in performance is more significant in statistical and economic terms in cases where a controlling share is privatized than in those where a minority share is sold. This is consistent with the idea that transfer to the private sector enhances the incentives to employees and management. Third, the changes were more significant for privatizations that occurred in the 1990s than in the 1980s, confirming the principle that the effects of privatization on the efficiency of firms are greater when privatization is combined with other measures involving liberalization and austerity (positive real interest rates, tighter constraints on access to Treasury funds etc).[19]

5. Conclusions

Privatization in Latin America is the most evident facet of a program of reforms designed to replace the old development model that gave pride of place to capital accumulation under a semi-autarkic regime and strong state intervention, with a new model that prioritizes increased efficiency and the role of private enterprise in determining decisions about production and resource allocation. This process is implicitly based on the assumption that private-sector firms are more efficient than state-owned ones. Although there are several reasons for accepting this assumption, the many studies that have set out to evaluate empirically the comparative performance of SOEs and private enterprise have reached differing conclusions, some of which favor the former, some the latter, while yet others fail to find any statistically significant differences between the two groups in terms of efficiency. Generally speaking, although private enterprise has been found to enjoy a moderate advantage, this does not seem sufficient to justify the popularity of the privatization programs implemented around the world or the expectations these programs have aroused regarding an increase in the efficiency of the privatized firms.

The study outlined in this paper was designed to evaluate the extent to which the promise of increased efficiency due to privatization has in fact materialized in Brazil. The performances of state-owned enterprises (SOEs) privatized in the periods 1981-89 and 1991-94 were compared before and after privatization case by case. The statistical significance of the changes was measured using the Wilcoxon Signed Rank Test and the sign test, applied to a set of variables designed to measure production (real sales), efficiency, profitability, employment, propensity to invest and key financial ratios.

In most cases, the study found economically and statistically significant evidence that privatization led to a substantial improvement in the performance of former state-owned

[19] It is also possible that the lower significance of the results for the 1980s is due in part to greater variance in measurement errors for the data relating to this period than for the data relating to 1991-94, as suggested by the greater differences between means and medians. Similarly, part of the improvement in performance for firms privatized in 1991-94 compared with observations for the 1980s may be due to the Brazilian economy's better performance in 1993-94 than in 1988-92. A contrast as sharp as this did not occur in the 1980s.

enterprises. For the sample as a whole, the Wilcoxon test showed a significant increase at a 1% level in real sales, sales per employee, net income, net worth, investment, net fixed assets and the ratio of investment to sales, and a significant reduction, also at 1%, in headcount.

The significance of the performance improvement persisted when the sample was subdivided into firms privatized in the 1980s and in 1991-94. For the former subsample, the results obtained were generally speaking as expected, showing significant growth in sales, sales per employee, profit, return on equity, investment, the ratio of investment to sales and net fixed assets, and a reduction in headcount. For firms privatized in the 1980s, however, the Wilcoxon test and the sign test did not show significant changes in profit per employee, return on sales, debt, current liquidity ratio, or the ratio of investment to net fixed assets (thus not rejecting the null hypothesis that privatization did not lead to changes in these variables).

For firms privatized in the period 1991-94, the results showed economically and statistically significant changes for *all* variables in the expected direction. The efficiency of the firms concerned practically doubled in terms of sales per employee, and increased 83% in terms of labor productivity. Profitability changed from negative to positive, net worth almost quintupled, debt fell and liquidity rose. Median investment more than quintupled, expanding more than fourfold as a proportion of sales and more than twofold as a proportion of net fixed assets. Ninety per cent of the firms in the subsample increased sales per employee, and 100% boosted labor productivity; net income rose for 78% of the firms, and investment for 93%.

When the overall sample was subdivided according to whether a controlling or minority share of equity was privatized, performance was also found to have improved for each subset of firms analyzed separately. For minority-share privatizations, the tests showed statistically significant changes in sales, efficiency (sales per employee), headcount and investment (in real value and as a proportion of sales), and the changes were in the expected direction in every case. Far more significant results (in terms of both economic and statistical significance) were obtained for controlling-share privatizations. In this case, *all* variables showed a performance improvement and always with statistical significance.

In sum, the findings obtained in this study clearly point to a statistically significant improvement in the performance of firms as a result of privatization. More specifically, they show that privatization:

(a) led to an increase in production volume;

(b) promoted efficiency;

(d) led to an improvement in financial ratios, especially in the case of controlling-share privatizations and privatizations in the period 1991-94, with an increase in current liquidity ratio, capital restructuring, expansion in net worth and reduction in debt;

(e) led to an increase in investment and in propensity to invest;

(f) led to a reduction in employment levels compared with the period prior to privatization, although most of the reduction occurred during the preparation for privatization and, in the case of firms privatized in the 1980s, employment increased again after privatization compared with the year in which the sale took place. The number of people directly employed in production increased as a proportion of the total workforce.

Additionally, the results corroborate the theoretical arguments presented in the paper in at least four respects. First, the firms became more efficient and profitable as a result of privatization. For the sample as a whole and also for the various subsamples, sales per employee and net income increased significantly after privatization. Second, the fact that the improvement in performance was more significant, in both economic and statistical terms, for cases in which a controlling share was privatized than for minority-share sales is consistent with the idea that transfer of ownership changed incentives to employees and management. Third, the fact that changes were more significant for firms privatized in the 1990s than for those sold in the 1980s confirms the principle that the impact of privatization on efficiency is greater when it is combined with other measures involving liberalization and austerity. Fourth, the results obtained are conclusive with regard to the reduction in employment due to privatization: both mean and median headcount decreased, empirically evincing the conceptual implications of the model of Boycko, Shleifer & Vishny (1996). Nevertheless, between two-thirds and three-fourths of the reduction in employment occurred during preparation for privatization, and only one-fourth to one-third after privatization. In the case of firms privatized in the 1980s, in particular, the entire reduction occurred before privatization, and mean headcount rose again in the subsequent period. A similar trend was observed for controlling-share sales.

The results are obviously important not only because they show that the promise of privatization has been kept, but also in view of the optimism they support as to the benefits a country can derive by transferring to private ownership sectors responsible for significant portions of economic activity, such as electricity, water and sewerage, telecommunications, petroleum, railroads etc. However, despite the economic and statistical significance of the changes in performance achieved by privatized firms, it is necessary to understand the limits of the results that can be obtained merely by transferring ownership to the private sector. As already mentioned, the problem is not lack of competence in the state sector. Employees of SOEs are recruited among the graduates of leading universities and have acknowledged competence on average. Indeed, the same professionals are usually kept on after privatization and are responsible for making the firms more efficient than they were before privatization. In many cases, even senior management has been kept on.

The problem does not reside in professional qualifications or skills, but in the incentives offered to employees and managers. In SOEs, it resides in lack of competition; easy access to Treasury funds; severe asymmetry of information between management and government, which prevents effective monitoring, supervision and punishment of inefficiency; and the establishment of goals that are often contradictory and inefficient, encouraging the pursuit of personal or purely corporatist agendas and leading to a performance that falls far short of the possible and desirable from the standpoint of society as a whole.

Thus in order to extract maximum benefits from privatization it is necessary to grasp the fact that transfer of ownership is not the be-all and end-all of the process. The right incentives must be offered to promote efficient operation by firms after they are privatized. It is important to bear in mind that the probable reason why many studies have not observed significant differences between public and private enterprises is that in practice the incentives offered to employees and managers may often be less different than is suggested by the theory (Boardman & Vining, 1989, pp. 3-4). Problems of agency are indeed found in private-sector companies with a large number of minority shareholders. Moreover, incentives to the pursuit of efficiency may be lacking in poorly regulated monopolies, or distorted by protectionism in the form of import barriers or measures that hinder competition among agents and foster rent-seeking activities. Experience to date both in Brazil and worldwide has also shown that access to the Treasury is not the sole privilege of public-sector enterprises and that the state also sometimes raises exit barriers for inefficient firms in the private sector.

In principle, the mere sale of SOEs is not a necessary or sufficient condition for obtaining the correct set of incentives in the economy. Some countries have succeeded in making some of their SOEs efficient, but these are rare cases and have proved short-lived because they failed to survive a change of government or an attenuation in the macroeconomic difficulties that originally motivated the performance improvement (Kikeri et al., 1992). In this regard it is undoubtedly true that the sale of SOEs is a crucial step toward increasing the efficiency of these firms, since privatization makes it more difficult for politicians to distort incentives. This point is stressed by Boycko, Shleifer & Vishny (1996, p. 309): "Privatization of public enterprises can raise the cost to politicians of influencing them, since subsidies to private firms necessary to force them to remain inefficient are politically harder to sustain than wasted profits of the state firms". Furthermore, privatization ties the hands of the government and enhances the credibility of public policy.

If the effects of privatization are to be maximized, however, mere sale of SOEs must be combined with trade liberalization, measures to foster competition, and a guarantee that inefficiently managed firms will not be given access to Treasury funds. Where competition is possible, it should be stimulated. Where its role is limited for technological reasons or because of market size, efficient regulatory mechanisms must be implemented. Particularly in the case of public utilities, it is vital to prevent the operation of private monopolies from recreating the distortions that were commonplace when the state held a monopoly, such as ignoring the need to raise productivity in the certainty that rates can always be increased to cover costs, and that the strategic positioning enjoyed by firms guarantees access to Treasury funds at the municipal, state or Federal level when difficulties are encountered owing to inefficient management.

Appendix

Table A.1
Empirical findings on the relative efficiency of state-owned and private enterprises

Sector	SOEs more efficient	Result ambiguous or no difference in efficiency	Private sector more efficient
Electricity	Meyer (1975)	Mann (1970)	Shepherd (1966)
	Neuberg (1977)	Junker (1975)	Moore (1970)
	Pescatrice &	Spann (1977)	Peltzman (1971)
	Trapani (1980)	Färe et al. (1985)	Tilton (1973)
		Atkinson & Halvorsen (1986)	De Alessi (1974)
			De Alessi (1977)
Refuse collection	Pier et al. (1974)	Hirsch (1965)	Kitchen (1976)
		Kemper & Quigley (1976)	Savas (1977)
		Collins & Downes (1977)	Pommerehne & Frey (1977)
			Stevens (1978)
			Edwards & Stevens (1978)
Water	Mann & Mikesell (1971)	Feigenbaum & Teeples (1983)	Hausman (1976)
	Bruggink (1982)		Morgan (1977)
			Crain & Kardkoahi (1978, 1980)
Health care		Becker & Sloan (1985)	Clarkson (1972)
			Rushing (1974)
			Lindsay (1976)
			Frech (1976)
			Bays (1979)
			Frech (1980)
			Bishop (1980)*
Health care (continued)			Frech & Ginsburg (1981)
			Finsinger (1982)
			Wilson & Jadlow (1982)
			Schlesinger & Dorwart (1984)**
Airlines		Forsyth & Hocking (1980)	Davies (1971)
		Morrison (1981)	Davies (1977)
		Jordan (1982)	
Railroads		Caves & Christensen (1980)	
		Caves et al. (1982)	
Financial institutions		Lewin (1982)	Davies (1981)
Fire protection			Ahlbrecht (1973)
Non-rail transit			Pashigian (1976)
			Palmer et al. (1983)
			McGuire & Van Cott (1984)

Source: Boardman & Vining (1989)
*Review of ten other studies
** Excludes nonprofit public firms.

Table A.2
Summary of findings for entire sample of privatized firms

Variable	Number of firms	Mean before privatization (median)	Mean after privatization (median)	Difference between means (medians)	Z statistic for median of differences*	Proportion of firms with increase in variable (%)	Z statistic for proportion of changes **
Sales	46	1,01 (1,00)	1,19 (1,27)	0,18 (0,27)	3,39 [a,d]	67,3	2,80 [a,d]
Sales per employee	42	0,99 (0,81)	1,59 (1,48)	0,60 (0,67)	4,97 [a,d]	88,1	4,78 [a,d]
Profit per employee	40	0,83 (-0,09)	1,15 (0,44)	0,32 (0,53)	2,23 [b,f]	75,0	3,00 [a,d]
Headcount	44	1,63 (1,30)	0,83 (0,90)	-0,80 (-0,40)	-4,66 [a,d]	9,1	-5,28 [a,d]
Net income	44	2,51 (-0,10)	0,68 (0,42)	-1,83 (0,52)	2,42 [a,e]	77,3	3,47 [a,d]
Return on sales	42	-50 (-0,22)	0,60 (0,26)	1,10 (0,48)	1,79 [b,f]	61,9	1,39 [c]
Return on equity	44	-0,77 (-0,58)	30,8 (0,27)	3,85 (0,85)	2,18 [b,e]	70,5	2,56 [a,d]
Net worth	45	0,70 (0,60)	1,74 (1,78)	1,04 (1,18)	4,34 [a,d]	88,9	5,07 [a,d]
Debt to equity	39	1,42 (1,19)	1,05 (1,00)	-0,37 (-0,19)	-1,30 [c]	38,5	-1,28 [c]
Current liquidity ratio	43	1,34 (0,94)	1,343 (1,25)	0,09 (0,31)	1,22	62,7	1,52 [c,f]
Investment	30	0,66 (0,55)	5,32 (2,10)	4,66 (1,55)	4,02 [a,d]	83,3	3,47 [a,d]
Net fixed assets	31	0,89 (0,81)	1,22 (1,27)	0,33 (0,46)	3,64 [a,d]	87,1	3,95 [a,d]
Investment/sales	29	0,75 (0,59)	11,43 (2,16)	10,68 (1,57)	3,64 [a,d]	79,3	2,97 [a,d]
Investment/net fixed assets	29	1,17 (0,79)	10,26 (1,31)	9,09 (0,52)	2,04 [b,e]	58,6	0,74

Source: Balanço Anual, Visão, Sest, Economática, archives of Fundação Getúlio Vargas, data supplied by firms.
Note: In all cases, variables were standardized so as to have a value equal to 1 in the year of privatization. For net income and net worth, which in many cases were negative in the year of privatization, variables were standardized so that their *absolute value* in the year of privatization was equal to 1. This explains why the means before and after privatization are less than 1 in some cases.

[a] 1% significance level for the unilateral test
[b] 5% significance level for the unilateral test
[c] 10% significance level for the unilateral test
[d] 1% significance level for the bilateral test
[e] 5% significance level for the bilateral test
[f] 10% significance level for the bilateral test

*For a number of observations ≤ 16, critical values derived from Table VII in Bickel & Doksum (1977).

**Statistic for the unilateral test, using continuity correction. The bilateral test statistic, not reported, does not use continuity correction. For a number of observations ≤ 10, critical values derived from Table VI in Bickel & Doksum (1977).

Table A.3
Summary of findings for subsample of firms privatized in 1980s

Variable	Number of firms	Mean before privatization (median)	Mean after privatization (median)	Difference between means (medians)	Z statistic for median of differences*	Proportion of firms with increase in variable (%)	Z statistic for proportion of changes **
Sales	19	1,04 (0,85)	1,51 (1,29)	0,47 (0,44)	2,54[a,e]	68,4	1,38[c]
Sales per employee	16	1,20 (0,92)	1,40 (1,39)	0,20 (0,47)	2,38[a,e]	75,0	1,75[b,e]
Profit per employee	14	1,79 (0,10)	0,89 (0,21)	-0,90 (0,11)	0,72	71,4	1,34[c]
Headcount	16	1,64 (1,06)	1,21 (0,99)	0,43 (0,07)	-1,40[c]	25,0	-1,75[b,e]
Net income	17	0,65 (-0,03)	1,71 (0,32)	1,06 (0,35)	1,54[c]	76,5	1,94[b,e]
Return on sales	16	0,52 (0,06)	0,52 (0,018)	0,00 (0,13)	0,36	50,0	-0,25
Return on equity	17	0,83 (0,01)	7,65 (0,25)	6,82 (0,25)	1,44[c]	64,7	0,97
Net worth	19	1,56 (0,68)	6,28 (1,60)	4,72 (0,92)	1,53[c]	73,7	1,83[b,e]
Debt to equity	17	1,99 (0.96)	3,11 (0.95)	1,12 (-0.01)	-0,12	41,2	-0,49
Current liquidity ratio	19	1,28 (0,97)	1,15 (1,07)	-0,13 (0,10)	-0,70	52,6	0,00
Investment	16	0,77 (0,55)	4,93 (2,10)	4,16 (1,55)	2,69[a,d]	75,0	1,75[b,e]
Net fixed assets	16	0,80 (0,77)	2,02 (1,19)	1,22 (0,42)	2,48[a,e]	81,3	2,25[b,e]
Investment/sales	15	0,93 (0,59)	3,37 (2,16)	2,44 (1,57)	2,33[a,e]	73,3	1,55[c,f]
Investment/net fixed assets	15	1,54 (0,86)	1,71 (1,21)	0,17 (0,35)	0,80	60,0	0,52

Source: Balanço Anual, Visão, Sest, Economática, archives of Fundação Getúlio Vargas, data supplied by firms.
Note: In all cases, variables were standardized so as to have a value equal to 1 in the year of privatization. For net income and net worth, which in many cases were negative in the year of privatization, variables were standardized so that their *absolute value* in the year of privatization was equal to 1. This explains why the means before and after privatization are less than 1 in some cases.

[a] 1% significance level for the unilateral test
[b] 5% significance level for the unilateral test
[c] 10% significance level for the unilateral test
[d] 1% significance level for the bilateral test
[e] 5% significance level for the bilateral test
[f] 10% significance level for the bilateral test

*For a number of observations ≤ 16, critical values derived from Table VII in Bickel & Doksum (1977).
**Statistic for the unilateral test, using continuity correction. The bilateral test statistic, not reported, does not use continuity correction. For a number of observations ≤ 10, critical values derived from Table VI in Bickel & Doksum (1977).

Table A.4
Summary of findings for subsample of firms privatized in 1990s

Variable	Number of firms	Mean before privatization (median)	Mean after privatization (median)	Difference between means (medians)	Z statistic for median of differences*	Proportion of firms with increase in variable (%)	Z statistic for proportion of changes **
Sales	27	1,25	1,40	0,15	2,55[a,e]	74,1	2,31[b,e]
		(1,13)	(1,25)	(0,12)			
Production	21	0,97	1,16	0,19	3,63[a,d]	90,5	3,49[a,d]
		(0,94)	(1,05)	(0,11)			
Sales per employee	26	0,86	1,70	0,84	4,43[a,d]	92,3	4,12[a,d]
		(0,77)	(1,48)	(0,71)			
Profit per employee	26	0,32	1,29	0,97	2,25[b,f]	73,1	2,16[b,e]
		(-0,39)	(0,53)	(0,92)			
Production per employee	19	0,76	1,39	0,63	3,82[a,d]	100,0	4,13[a,d]
		(0,73)	(1,24)	(0,51)			
Headcount	28	1,65	0,85	-0,80	-4,62[a,d]	0,0	-5,10[a,d]
		(1,33)	(0,84)	(-0,49)			
No. of employees in production	21	1,25	0,91	-0,34	-3,42[a,d]	4,8	-3,93[a,d]
		(1,22)	(0,87)	(-0,35)			
Proportion of employees in production	20	0,97	1,04	0,07	2,09[b,f]	70,0	1,56[c,f]
		(0,95)	(1,01)	(0,06)			
Net income	27	1,72	0,96	-0,74	1,75[b,f]	77,8	2,70[a,d]
		(-0,37)	(0,51)	(0,88)			
Return on sales	26	-1,10	0,65	1,75	1,74[b,f]	69,2	1,77[b,e]
		(-0,32)	(0,36)	(0,68)			
Return on equity	27	-1,77	0,20	1,97	1,49[c]	74,1	2,31[b,e]
		(-1,20)	(0,28)	(1,49)			
Net worth	26	0,72	3,39	2,67	4,46[a,d]	100,0	4,91[a,d]
		(0,60)	(1,85)	(1,25)			
Debt to equity	22	1,48	1,12	-0,36	-1,67[b,f]	36,4	-1,07
		(1,34)	(1,00)	(-0,34)			
Current liquidity ratio	24	1,38	1,67	0,29	2,00[b,e]	70,8	1,84[b,e]
		(0,90)	(1,35)	(0,45)			
Investment	14	0,57	25,40	24,83	3,17[a,d]	92,9	2,94[a,d]
		(0,60)	(3,19)	2,59			
Net fixed assets	15	0,94	1,36	0,42	2,56[a,d]	93,3	3,09[a,d]
		(0,81)	(1,33)	(0,52)			
Investment/sales	14	0,56	20,06	19,50	2,98[a,d]	85,7	2,41[a,d]
		(0,60)	(2,46)	(1,85)			
Investment/net fixed assets	14	0,79	19,42	18,63	1,66[c]	57,1	0,27
		(0,78)	(1,86)	(1,08)			

Source: Balanço Anual, Visão, Sest, Economótica, archives of Fundação Getúlio Vargas, data supplied by firms.

Note: In all cases, variables were standardized so as to have a value equal to 1 in the year of privatization. For net income and net worth, which in many cases were negative in the year of privatization, variables were standardized so that their absolute value in the year of privatization was equal to 1. This explains why the means before and after privatization are less than 1 in some cases.

[a] 1% significance level for the unilateral test
[b] 5% significance level for the unilateral test
[c] 10% significance level for the unilateral test
[d] 1% significance level for the bilateral test
[e] 5% significance level for the bilateral test
[f] 10% significance level for the bilateral test

*For a number of observations ≤ 16, critical values derived from Table VII in Bickel & Doksum (1977).

**Statistic for the unilateral test, using continuity correction. The bilateral test statistic, not reported, does not use continuity correction. For a number of observations ≤ 10, critical values derived from Table VI in Bickel & Doksum (1977).

Table A.5
Summary of findings for subsample of firms in which a controlling share of equity was privatized

Variable	Number of firms	Mean before privatization (median)	Mean after privatization (median)	Difference between means (medians)	Z statistic for median of differences*	Proportion of firms with increase in variable (%)	Z statistic for proportion of changes **
Sales	32	1,31 (1,18)	1,56 (1,32)	0,25 (0,14)	2,24[b,e]	68,8	1,94[ab,e]
Production	12	1,03 (0,96)	1,21 (1,05)	0,18 (0,09)	2,90[a,d]	91,7	2,60[a,e]
Sales per employee	29	0,93 (0,84)	1,64 (1,50)	0,71 (0,66)	4,55[a,d]	89,7	4,09[a,d]
Profit per employee	28	0,95 (-0,39)	1,02 (0,42)	0,07 (0,81)	2,76[a,d]	82,1	3,21[a,d]
Production per employee	12	0,81 (0,76)	1,49 (1,30)	0,68 (0,54)	3,06[a,d]	100	3,18[a,d]
Headcount	29	1,83 (1,30)	0,98 (0,89)	-0,85 (-0,41)	-4,12[a,d]	3,4	-4,83[a,d]
Net income	31	2,22 (-0,16)	1,25 (0,36)	-0,97 (0,52)	2,29[b,e]	80,6	3,23[a,d]
Return on sales	29	0,16 (-0,33)	0,43 (0,18)	0,27 (0,51)	1,68[b,f]	69,0	1,86[b,e]
Return on equity	31	-0,21 (-0,75)	4,20 (0,24)	4,41 (0,99)	2,02[b,e]	77,4	2,87[a,d]
Net worth	31	1,12 (0,60)	5,67 (1,78)	4,55 (1,18)	3,63[a,d]	87,1	3,95[a,d]
Debt to equity	29	1,96 (1,39)	2,29 (0,99)	0,33 (-0,40)	-1,63[c]	31,0	-1,86[b,e]
Current liquidity ratio	32	1,24 (0,93)	1,39 (1,20)	0,15 (0,27)	1,38[c]	65,6	1,59[c,f]
Investment	23	0,74 (0,65)	17,71 (2,26)	16,97 (1,61)	3,28[a,d]	78,3	2,50[a,d]
Net fixed assets	24	0,84 (0,81)	1,83 (1,32)	0,99 (0,51)	3,54[a,d]	87,5	3,47[a,d]
Investment/sales	22	0,78 (0,57)	13,93 (2,68)	13,15 (2,11)	3,10[a,d]	77,3	2,35[a,d]
Investment/net fixed assets	22	1,26 (0,78)	8,60 (1,32)	7,34 (0,54)	1,90[b,f]	63,6	1,07

Source: Balanço Anual, Visão, Sest, Economática, archives of Fundação Getúlio Vargas, data supplied by firms.
Note: In all cases, variables were standardized so as to have a value equal to 1 in the year of privatization.
For net income and net worth, which in many cases were negative in the year of privatization, variables were standardized so that their *absolute value* in the year of privatization was equal to 1. This explains why the means before and after privatization are less than 1 in some cases.

[a] 1% significance level for the unilateral test
[b] 5% significance level for the unilateral test
[c] 10% significance level for the unilateral test
[d] 1% significance level for the bilateral test
[e] 5% significance level for the bilateral test
[f] 10% significance level for the bilateral test

*For a number of observations ≤ 16, critical values derived from Table VII in Bickel & Doksum (1977).
** Statistic for the unilateral test, using continuity correction. The bilateral test statistic, not reported, does not use continuity correction. For a number of observations ≤ 10, critical values derived from Table VI in Bickel & Doksum (1977).

Table A.6
Summary of findings for subsample of firms in which a minority share of equity was privatized

Variable	Number of firms	Mean before privatization (median)	Mean after privatization (median)	Difference between means (medians)	Z statistic for median of differences*	Proportion of firms with increase in variable (%)	Z statistic for proportion of changes **
Sales	14	0,82 (0,71)	1,20 (1,15)	0,38 (0,44)	2,61[a,d]	78,6	1,87[b,e]
Production	9	0,88 (0,94)	1,09 (1,09)	0,21 (0,15)	2,31[a,e]	88,9	2,00[b,e]
Sales per employee	13	1,11 (0,69)	1,47 (1,35)	0,36 (0,66)	2,20[a,d]	84,6	2,22[a,d]
Profit per employee	12	0,54 (0,52)	1,45 (0,58)	0,91 (0,06)	-0,63	58,3	0,29
Production per employee	7	0,68 (0,67)	1,21 (1,12)	0,53 (0,45)	2,37[a,e]	100,0	2,27 [a,e]
Headcount	15	1,24 (1,31)	0,95 (0,90)	-0,29 (-0,41)	-2,22[b,e]	20,0	-2,07[b,e]
Net income	13	-0,88 (0,49)	1,23 (0,72)	2,11 (0,23)	1,01	69,2	1,11
Return on sales	13	-2,03 (0,48)	0,99 (0,52)	3,04 (0,04)	0,45	46,2	-0,55
Return on equity	13	-2,11 (-0,22)	0,41 (0,35)	2,52 (0,57)	0,87	53,8	0,00
Net worth	14	1,59 (0,74)	2,03 (1,71)	0,44 (0,97)	2,42[a,e]	92,9	2,94[a,d]
Debt to equity	10	0,94 (0,94)	1,12 (1,00)	0,18 (0,06)	0,36	60,0	0,95
Current liquidity ratio	10	1,62 (0,97)	1,55 (1,37)	-0,07 (0,40)	-0,31	60,0	0,32
Investment	7	0,49 (0,53)	3,88 (1,68)	3,39 (1,15)	2,37[a,e]	100,0	2,27[a,e]
Net fixed assets	7	0,97 (0,56)	1,24 (1,20)	0,27 (0,64)	1,18	85,7	1,51[b]
Investment/sales	7	0,65 (0,59)	3,57 (1,91)	2,92 (1,32)	2,03[b,e]	85,7	1,51[b]
Investment/net fixed assets	7	0,90 (0,97)	15,47 (0,86)	14,57 (-0,11)	0,51	42,9	-0,76

Source: Balanço Anual, Visão, Sest, Economática, archives of Fundação Getúlio Vargas, data supplied by firms.
Note: In all cases, variables were standardized so as to have a value equal to 1 in the year of privatization. For net income and net worth, which in many cases were negative in the year of privatization, variables were standardized so that their *absolute value* in the year of privatization was equal to 1. This explains why the means before and after privatization are less than 1 in some cases.

[a] 1% significance level for the unilateral test
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[c] 10% significance level for the unilateral test
[d] 1% significance level for the bilateral test
[e] 5% significance level for the bilateral test
[f] 10% significance level for the bilateral test

*For a number of observations ≤ 16, critical values derived from Table VII in Bickel & Doksum (1977).
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Table A.7
Enterprises included in the empirical analysis

Enterprise	Year of sale	Enterprise	Year of sale
América Fabril	1981	Copesul	1992
CQR	1981	Goiasfértil	1992
Riocell Adm.	1982	Fosfértil	1992
Rio Grande Celulose	1982	Ultrafértil	1993
Floresta Riocell	1982	Celma	1991
Tecidos Dona Isabel	1982	Petroflex	1992
Método Adm.	1982	Álcalis	1992
Coperbo	1982	Acesita	1992
Opalma	1983	PQU	1994
Nitriflex	1983	Embraer	1994
Cimento Portland Perus	1980	CSN	1993
Livraria José Olympio	1984	Cosipa	1993
Tecidos Nova América	1987	Açominas	1993
Máquinas Piratininga do Nordeste	1987	Polisul	1992
Sibra	1988	PPH	1992
Aracruz	1988	Acrinor	1994
Celpag	1988	Ciquine	1994
Caraíba Metais	1988	Polialden	1994
CBC	1989	Politeno	1994
Cofavi	1989	Arafértil	1994
Usiba	1989	Lindag	1992
Piratini	1992	Nitriflex	1992
CST	1992	CBE	1992
Usiminas	1991	Oxiteno	1993
Mafersa	1991	Poliolefinas	1993

Source: National Privatization Council (Conselho Nacional de Desestatização): 1985-89, Brasilia, 1990; BNDES, Programa Nacional de Desestatização: Sistema de Informações, December 1995.

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CHAPTER 6

INVESTMENT IN INFRASTRUCTURE IN BRAZIL: CHARACTERISTIC FACTS AND LONG TERM RATIOS*

Pedro Cavalcanti Ferreira**

Abstract

This paper shows that not only the long term trend (from 1970 to 1993) in public investment in infrastructure as a proportion to output is declining, but also that this decline has recently accelerated in all sectors. Moreover, using cointegration techniques, long term elasticity between GDP and alternative measures of the stock infrastructure is estimated. Results suggest there is significant elasticity of about 0.70. Hence, the continuous decline in infrastructure investment has had an unfavorable impact on output and, if not reversed decisively in the years to come either through direct public investment, partnerships, sales and/or concessions to the private sector, output and the rate of productivity growth in the Brazilian economy may come up against unyielding constraints in the near future

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1. Introduction

The connection between infrastructure and economic growth is already well established in economic literature, both at the empirical and the theoretical levels. Capital employed in infrastructure affects the return on private inputs and, thus, stimulates investment and employment. The transmission mechanism is simple. For a given number of infrastructure factors - better roads, cheap and abundant power and communications - final output is raised and, consequently, leads to greater productivity in private factors and reduces the unit cost of inputs. Greater productivity, in turn, translates into a higher factors return, thus encouraging investment and employment. Infrastructure may also trigger *crowding in*, in that it provides the conditions for private investment to be made.

Based on articles by Aschauer (1989) and Barro (1990), rich empirical literature has been developed that seeks to estimate the impact of infrastructure investment on the level and rate of productivity and growth in output. The results vary according to the data type and the techniques used; however, in the greater majority of these studies, the estimates are generally significant and of extensive import. For example, using data in respect of the United States, Cavalcanti Ferreira (1993) estimates that a 10% increase in infrastructure investment would, in the long run, add growth of 1% to total factor productivity. Using a cross section of 63 countries, he estimates that the elasticity of the growth rate in relation to public capital is about 0.2, higher than the estimates for time series. Munnel arrives at an estimate (1990) of 0.3 for American states.

More disaggregated studies point in the same direction. Easterly and Rebelo (1993) show that investment in transport and communication seems to be consistently correlated with growth and has high coefficients, between 0.59 and 0.66. They also show that there is no evidence that public investment crowds out private investment in infrastructure. Ingram (1994) estimates the correlation and elasticity between physical measures of infrastructure stock for the various sectors (e.g., kilowatt capacity, kilometers of paved roads) and the level of economic activity in developing countries. His results show that the greatest impact would lie in telecommunications, power, and roads (in decreasing order). Ingram suggests that the impact of infrastructure on output is neither immediate nor contemporary but rather extends over several years, while firms and other economic agents adjust to the new services.

These studies therefore show that the effect of infrastructure on production is substantial. They motivate the chief topic of this article, namely recent public investment performance in Brazil and the long-term trend of the ratio of infrastructure to output. Public investment has fallen continually in recent years, particularly in companies owned by the federal government. For example, average spending on gross capital formation for the state-owned Eletrobrás system between 1990 and 1993 is less than 1/3 of the average for the years 1980 - 1984.

Similar patterns are to be found in other sectors such as railroads and ports. For federally owned companies as a whole, investment in 1993 was less than 1/3 of the amount spent in 1980.

At the same time, an examination of government investment[1] shows a slight upward trend in the long term, although the volatility of this investment is high. Nonetheless, when measured as a proportion of GDP, this spending began to fall at the beginning of the 70s and only recovered in the 90s. There is also a problem in their composition, since federal government investment hos been falling since 1988, while municipal investment has risen. This simple observation (and data given later on show this) shows that most of the capital stock in government infrastructure and services supplied has deteriorated sharply in recent years, the most glaring example being that of the railroad system.

The sharp drop in public spending on productive infrostructure may hamper the future growth of the Brazilian economy. The country's production is transported and shipped at high cost when compared to developed countries; and the waste in transporting agricultural crops is enormous. The shortage of telephones in large cities often forces the price of a telephone line up to over US$ 5,000, while the service is well below international standards: in Brazil, an international call costs four times more than a similar connection in Chile. Investment in railroads is virtually at a standstill and work on 16 hydroelectric power plants is on hold or behind schedule. The challenge for Brazilians is not only that of recovering some of the deterioration in infrastructure but also of expanding it so as to be able to handle the current and future needs of the economy. Given that our estimates show high long-term elasticity between infrastructure stock and GDP, the suspension of these investments may not only hamper the competitiveness of our output but also the pace of growth in output and productivity and the well-being of the population.

This article is organized into six sections, including this introduction. The following section examines the overall picture and the long-term trend for government investment. The three following sections examine the energy, transport and communication sectors, respectively. In the sixth section, estimates for long-term elasticity between alternative infrastructure measures and real GDP are presented. In the last section, we will make our final comments.

2. Long-term trends and the recent global background

The charts that follow show the long-term trend of government and federally owned company investment between 1970 and 1993. The trends were derived by using the Hodrick-

[1] We understand *administration investment* as being federal, state and municipal government investment, either by the direct administration [government] or by government entities.

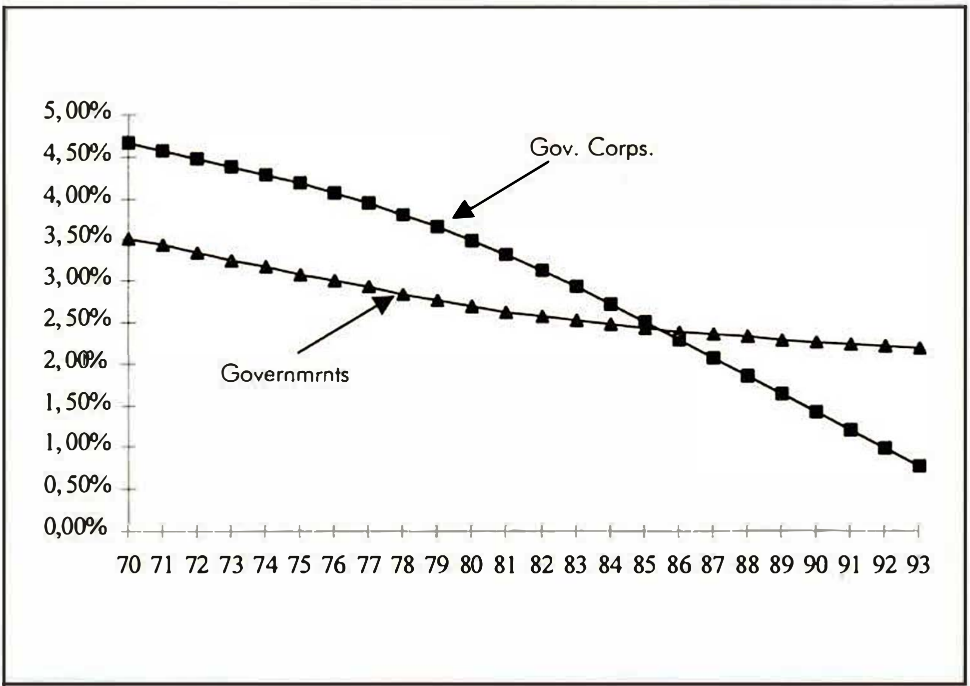
Prescott filter, widely utilized in Real Business Cycle literature[2]. Basically, the $\{s_t\}_{t=1}^{T}$ trend is chosen so as to solve the following equation:

$$\min_{\{s_t\}}\left\{\left(\frac{1}{T}\right)\sum_{t=1}^{T}(x_t - s_t)^2 + \left(\lambda/T\right)\sum_{t=2}^{T-1}(s_{t+1} - s_t) - (s_t - s_{t-1})^2\right\}$$

where $\{x_t\}_{t=1}^{T}$ is the series in question and $\lambda>0$ is detrimental to fluctuations: if λ is equal to zero the trend is identical to the series observed; if it is infinite, the trend is a straight line. Chart 1 shows the investment trend as a proportion of the GDP.

The trend for both federal companies and direct government spending is clearly negative. For state companies, however, it is not just negative, but the decline accelerates in the 80s. The opposite occurs with government investment: the trend of their ratio to GDP has a negative but decreasing slope in absolute values.

Chart 1
Trend in Government Relative to GDP – 1970/93



Source: Primory dato processed by Ceeg/Ibre/FGV-RJ and IBGE.

2 Basically, the filter amplifies growth cycles in the business cycle frequency and smoothes out long-and short-term fluctuations. See Prescott (1986, pp. 10-11), for a presentation of his methodology.

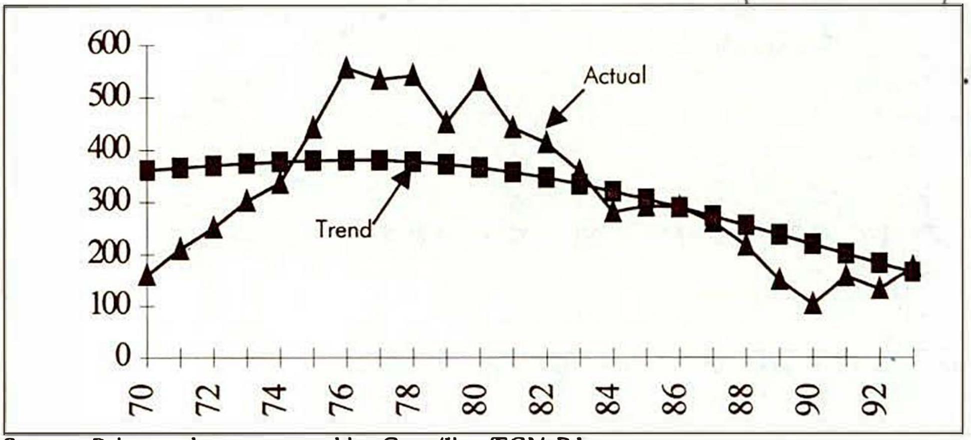
These two trends reflect a phenomenon that has been occurring since the end of the 70s – the reduction of the relative importance of government investment. Investment by federal government-owned companies reached 5.8% in 1976, the peak year, but is now no more than 1.3% of GDP. Chart 2 shows, at 1980 prices, the observed pattern of investment by government-owned companies as well as its trend, which may be described as a parabola with its peak occurring in 1976.

We should note that spending by government-owned companies on gross capital asset formation grows continuously until 1976 and stays at this higher level for four years – only then to plummet abruptly and continuously. At the same time, the GDP trend remains positive for the entire time, although it slowed during the 1980s. These two movements explain the continuous fall in the ratio of capital spending by government-owned companies and GDP. Note, however, that this pattern is uneven as shown in Table 1, which shows the evolution of expenditure in gross capital formation by federal government-owned companies in the infrastructure sector.

Note that total investment in the three sectors in 1993 was only 43% of that in 1980. This decline was asymmetrical. On the one hand, in the transport sector (ports, railroad and sea transport), expenditure in gross capital assets fell to less than 10%, on average, of that in 1980 and certainly, at present, does not replace the depreciation of installed capital. Power sector investment has also fallen sharply. On the other hand, investment in telecommunications stays relatively high in the 80s and rises to a higher level in 1991. This pattern will be examined in greater detail in the following sections. Government expenditure, shown in Chart 3, shows a different pattern.

Chart 2
Government-Owned Company Investments: trends and actual – 1970/93

(Cr$ trillion in 1980)



Source: Primary data processed by Ceeg/Ibre/FGV-RJ

Table 1
Federal Corporation Infrastructure Investment– 1980/93

(In US$ billions)

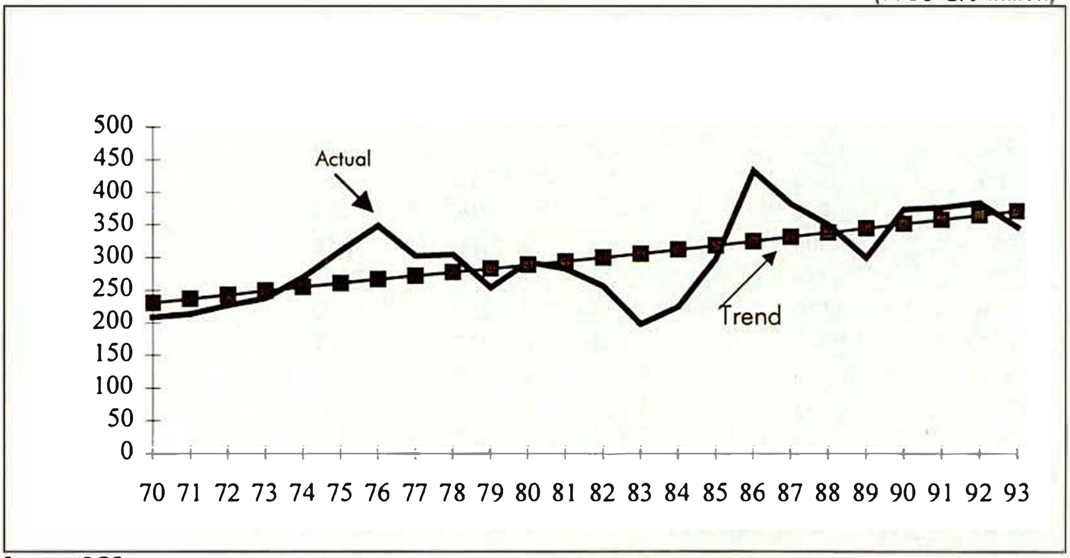
Year	Telecommunications	Power	Transport	Total
1980	1,966	4,563	2,538	9,067
1981	1,825	3,270	2,515	7,610
1982	1,951	4,566	1,780	8,297
1983	1,672	4,771	1,818	8,261
1984	1,604	3,222	1,818	6,644
1985	1,705	2,134	1,523	6,162
1986	1,927	3,487	1,265	6,679
1987	1,790	4,148	1,190	7,128
1988	1,776	2,870	2,410	7,056
1989	2,310	2,269	653	5,232
1990	1,647	1,258	327	3,232
1991	2,999	1,749	172	4,919
1992	2,783	1,533	244	4,561
1993	2,600	1,101	267	3,967

Source: Ceeg/ Ibre/ FGV
*Transport includes ports, railroad, and the maritime sector.
The trend in this case is positive, although for 1970 through 1983 the investments analyzed fall after 1976, slipping to a lower level than their 1970 figures. After 1983, the trend is clearly positive although still very volatile. The fact that the trend of government investment/GDP ratio for the entire period is negative (Chart 1) stems from two factors: a) GDP grew more rapidly in the seventies and b) the aforementioned sharp drop in government investment up to 1983. Indeed, the share of this expenditure in GDP falls from 3.87% in 1970 to 3.55% in 1976 and to a low of 1.69% in 1983. Beginning in 1983, this share grows, although not consistently. In 1992 it was 2.64% and in 1993 it falls slightly.

The recent resumption of government investment merits an aside - the apparent paradox of this growth in investment being accompanied by a deterioration of the service quality. Two reasons can be pointed out to explain this fact. The first, of lesser importance in our opinion, is linked to waste, price padding, delays (that force contractors to hike the cost of works to be able to cover financial costs) and other improprieties. More important, however, is the relative increase in investment costs, which rise faster than the general price index throughout the eighties [Bonelli and Pinheiro (1994)]. Indeed, as shown in Chart 4, the FBKF deflator/GDP deflator ratio, which is greater than 1 but is relatively stable up to 1986, leaps as of that year. Between 1980 and 1993, the FBKF deflator grows about 41% faster than that of GDP.

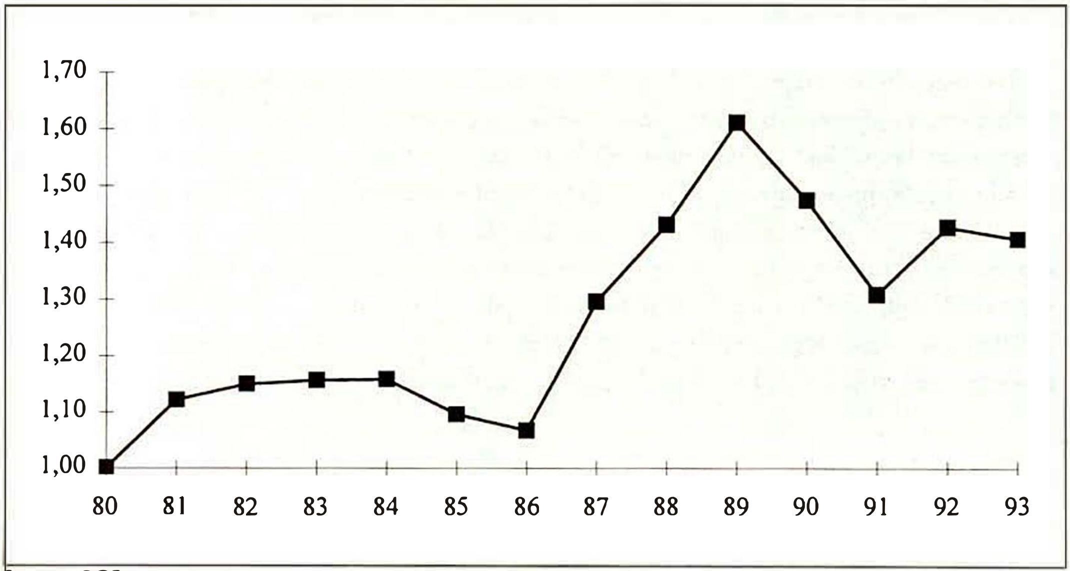
Chart 3
Government Investment: trend and actual – 1970/93

(1980 Cr$ trillion)



Source: IBGE.

Chart 4
FBKF Deflator / GDP Deflator – 1980/93



Source: IBGE.

The second observation is linked to the distribution of investment among the different levels of government spending. The overall increase in government investment was accompanied by a shrinking of investment at the federal level, in both absolute and relative terms. Its share of the total falls from 33.2% between 1986 and 1988 to 16.9% between 1991 and 1993, while in real terms the average from 1991 to 1993 is only 53% of that observed between 1986 and 1988: it falls from US$ 5.129 billion to US$ 2.699 billion. The pattern of investment by municipalities is the exact opposite; it was only 26.2% of the total between 1986 and 1988 but soared to 40% in the first three years of the 90s, which means that municipalities are currently investing an average of 60% more in real terms than they did in the 80s – a leap from US$ 3.453 billion in 1986 to US$ 6.217 billion 1993. State government investment also rises although by less than that of the municipalities: it goes up from 40.6% to 43.3% of the total and grows 18% in real value.

The pattern set out in Table 2 reflects changes introduced by the Constitution of 1988, which transferred revenue to the states and towns without requiring any compensating transfer of responsibility and expenditure of the same size.[3] This provided states and cities with immense funds free for them to invest. At the same time, it left the federal government short of funds, which may explain the catastrophic situation of the federal railroad system: Federal government investment, in every year in the 90s, was less than half the level of 1987, whereas total expenditure at all levels of government was higher in every year. Chart 5 shows the trend of the FBKF ratio of government-owned companies and government spending to the total for the country.

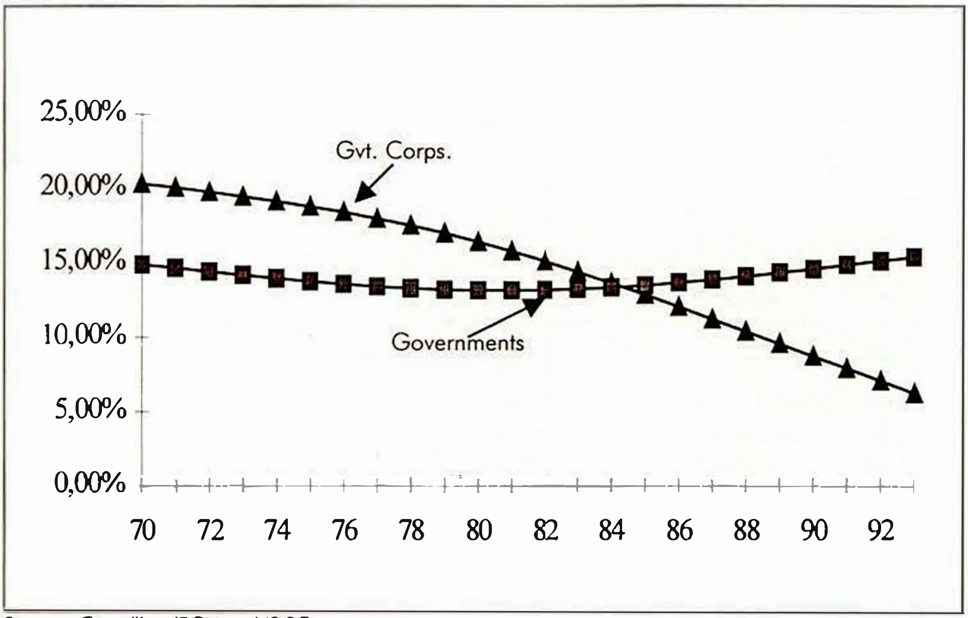
Table 2
State, Municipal and Federal Share
in Total Government Investment – 1986/93

	Federal	State	Municipal
1986	27,66%	48,57%	23,76%
1987	39,03%	37,26%	23,72%
1988	33,53%	35,91%	30,56%
1989	29,16%	47,96%	22,88%
1990	15,14%	60,63%	24,24%
1991	18,31%	45,53%	36,16%
1992	14,18%	43,91%	41,91%
1993	18,36%	41,11%	40,53%

Source: IBGE

The share of investment by government-owned companies falls continuously, whereas the share of direct government[3] spending begins to recover in 1983. Indeed, public companies investment, which accounts for 25% of the total investment in 1976, falls to less than 8% in 1993. Even considering privatization, the drop is still very sharp since the privatized companies have never invested more than 20% of the total for state companies. This would make government-owned company investment minus that of the privatized companies plummet from about 20% in 1976 to 8% in 1993. The share of government investment falls from 19% in 1970 and 16% in 1976 to 9.8% in 1983. Since then it has been recovering and currently it stands at about 19% of the total. Contributing to this was not only the increase in government expenditure but also the drop in the country's total investment, which, in 1992, was an all-time low as a percentage of GDP– less than 15% in constant prices. In real terms, the amount of total gross capital formation falls. At any rate, as we have stressed, this recovery in government investment is asymmetrical, as federal government investment has been falling continuously since 1989.

Chart 5
Trend of Gvt. Invest. as a Proportion of the Country's Invest. – 1970/93



Source: Ceeg/Ibre/FGV and IBGE

3 In fact, in many cases the Federal Government decided not to transfer expenses, since they represent a strong bargaining lever against states and municipalities.

3. The power sector

Investment in the Eletrobrás system in the 90s has been less than 1/3 of that in the first three years of the 80s. Table 3 shows the amount of the Electrobrás system's investment between 1982 and 1993.

While an average of about US$ 4 billion was invested between 1980 and 1984, only US$ 1.45 billion was spent, on average, between 1991 and 1993. The average for 1985/90 was the double. The cuts that have affected the entire public sector in recent years were particularly severe in the federal power sector.[4] For example, investments made in 1993 were only 60% of the amount approved in the budget. Investment was also affected by the historic decline in tariffs. Despite the recent recovery since the second half of 1991, in 1992 they were still only 75% of the 1970 average. Since more than 60% of the sector's investments are financed out of its own cash flow, the drop in tariffs together with the cuts determined by the federal government, its high debt burden and the general lack of financial organization of the federal government are the main reasons for the drastic reduction in investment in the power sector. Another aggravating factor is the concentration of these investments in the Xingó Power Plant, which represents 44% of the funds invested in 1993. Chart 6 shows growth of total gross investment against the growth of electric power consumption.

Table 3
Federally-Owned Companies' Investment in the Power Sector – 1982/93

(In US$ billions)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
ELETRONORTE	1,527	1,734	1,096	972	737	986	571	350	113	55	86	45
ELETROSUL	174	375	251	334	339	385	317	186	77	49	46	79
CHESF	402	711	665	661	505	1,318	772	670	426	806	867	580
FURNAS	1,451	1,208	733	362	1,161	810	693	622	297	514	362	297
ITAIPU	621	397	250	320	446	356	246	240	225	163	30	0
LIGHT	115	109	93	152	126	139	145	111	73	107	115	78
Others	238	178	85	81	106	73	79	50	25	35	17	22
Total	4,528	4,713	3,175	2,882	3,420	4,067	2,821	2,228	1,235	1,729	1,524	1,101

Source: Ceeg/Ibre/FGV

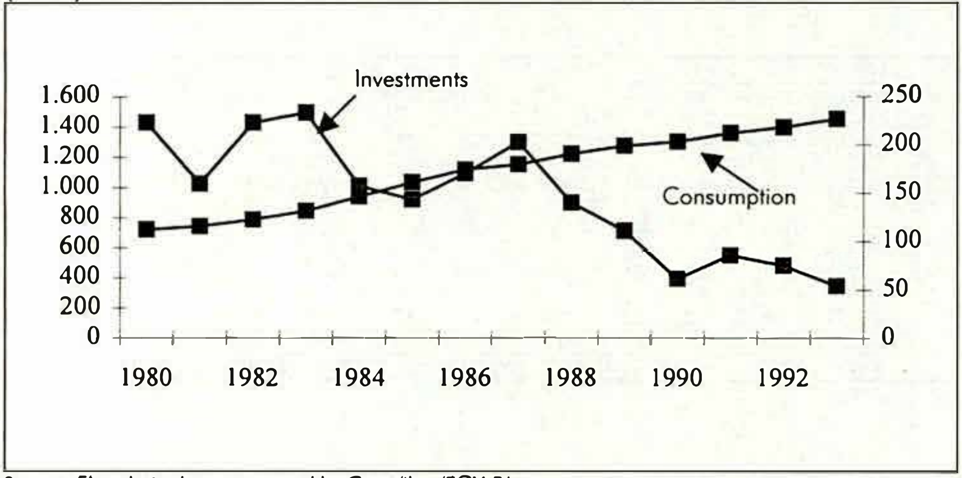
As the chart makes clear, these movements take exactly opposite directions. After 1983, investment falls continuously, while consumption for the whole period grows at a rate of 5.5% p.a., although this rate falls to 3.5% between 1988 and 1993. Although the system's

4 Due to lack of data, we have not included investment in electricity generating companies owned by the states.

generating capacity did not cease to grow during that time, as the gap between investment and consumption was mitigated by the coming on stream of the large power plant projects of the 70s and by the country's recession in the 80s, which partially contained the expansion of industrial and commercial demand for electric power. Nonetheless, there are specific problems in the electric power supply, especially in the North, where certain areas have had power rationing for quite some time. In fact, between 1980 and 1993, there were only two years in which annual growth in electric power consumption in the North did not exceed the national average. Another potential problem is the Center-West region, where agriculture is expanding rapidly.

The sector's poor prospects are further aggravated by the suspension of and/or delay in the work schedules of the power plants under construction (three in the South, 10 in the Southeast and one in each of the remaining regions), a situation that has been worsening in recent years. Thirteen of these projects still need financial rescheduling, that is, they do not even have budgets or calculations of funding sources. These standstills become more troubling when the prospects for the Brazilian economy in the near future are of growth that may not be rapid but should be at least above 4% p.a.

Chart 6
Investment (1980 Cr$ — billions) and Electric Power Consumption (MHZ) for 1980/93



Source: Eletrobrás data, processed by Ceeg/Ibre/FGV-RJ.

4. The transport sector

The sector that has perhaps suffered most from the decline in government investment has been the transport sector. Table 4 shows expenditure on the development of gross capital assets of government-owned companies in this industry.

It is immediately apparent that the total 1993 investment barely exceeds 10% of the 1980 investment figure. The drop is general in all the subsectors, especially in the railroad sector which is made up essentially of two companies: the Rede Ferroviária Federal S.A. (RFFSA) and the Companhia Brasileira de Trens Urbanos (CBTU – the urban train system), which was hived off from the RFFSA in 1984. Investment in railroads was 11% of the total investment by government-owned companies in 1980 – which itself plunged in the period – and ended at 3.8% in 1993. Currently, in real terms it stands at only 11% of its 1980 level.

Although the drop in investment was almost continuous between 1980 and 1993 (in 1985 it was only 67% of 1980 investment), the decline accelerated in 1989, when only half of the 1987 total was invested. In 1993, the Federal Railway System, for example, invested approximately US$ 52 million, 15% less than the 1990 investment level.

The drop in investment was accompanied by a progressive reduction in the volume of cargo transported between 1986 and 1990, which may be partially explained by the recession the country was going through. Net tonnage transported falls from 85 million, the historic peak, to 75 million. However, since 1991, cargo transported has been growing. It is expected that the demand for transport will increase, spurred by the expansion of agricultural production and by the economic growth projected for the near future. In this case, the virtual suspension of investment in the sector presages a worrying scenario for the transport of agricultural production. All the more so because farms are moving further into the interior and the agricultural frontier is expanding in the Center-West and has not been accompanied by an adequate expansion of the railroad system. Moreover, because of lower investment, the railroad network finds itself in precarious circumstances. Rolling stock is becoming outdated or has been "cannibalized," that is, some vehicles are disassembled so that their parts can be used in other machines.

Table 4
Investment in Transport Sector by Government-Owned Companies – 1980/93

(In US$ billions)

Year	Rail	Sea	Ports	Others	Total
1980	1.959	210	361	8	2.538
1981	1.875	291	332	18	2.515
1982	1.310	85	383	2	1.780
1983	1.345	76	395	1	1.818
1984	1.440	141	236	0	1.818
1985	1.310	40	172	1	1.523
1986	832	274	156	3	1.265
1987	984	102	102	2	1.190
1988	2.189	28	186	7	2.410
1989	468	4	172	9	653
1990	293	6	21	8	327
1991	85	8	74	5	172
1992	165	1	73	6	244
1993	214	0	48	5	267

Source: Ceeg/Ibre/FGV

CBTU (Brazilian Urban Transport Company) investments were more erratic. For example, the jump in railway sector investment (240%) between 1987 and 1988 is almost entirely due to this company, since RFFSA investments grew little. By way of comparison, the relative volatility of this expenditure, the standard deviation for CBTU investments between 1986 and 1993 is more than twice that of the RFFSA. In any case, the company invested an average of US$ 510 million per year between 1985 and 1989 and only US$ 89 million, on average, during the Collor and Itamar Franco administrations. It is estimated that this investment is lower than depreciation, which means that total installed capacity may have fallen in recent years. In other words, while the Brazilian urban population grows at a rate of about 2% p.a., urban train services have deteriorated steadily (Chart 7).

Of the total investment by federally owned companies' in 1993, 77% was self-financed. In the case of the CBTU and the RFFSA, the drying up of federal subsidies, tariff control, recurrent operating deficits (the last year the federal transport sector had a surplus was in 1986!) and the cuts directly determined by the federal government as part of its deficit control policy all explain this pattern of shrinkage in investment. The small or null capacity to raise funds abroad has prevented the railway sector from tapping an alternative source of finance widely utilized by other government sectors.

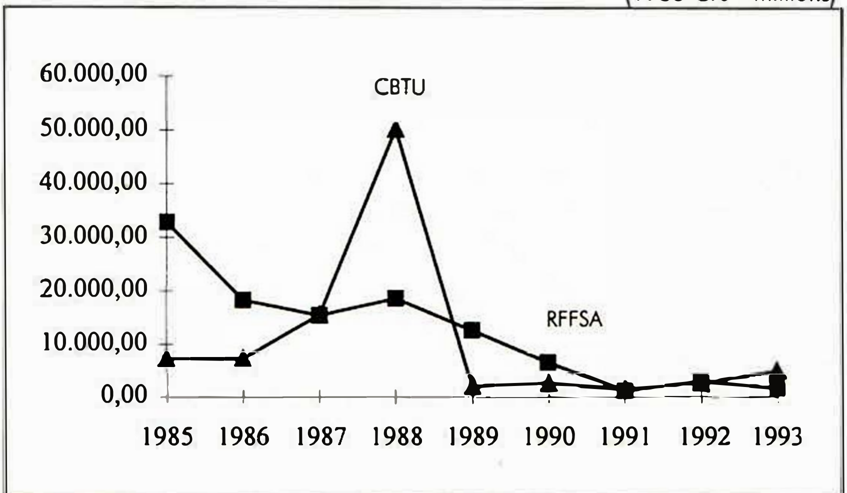
The situation of the highway system is perhaps more delicate than that of the railways, especially considering the fact that approximately 56% of freight transport in the country (against 30% in Europe and the United States) is by road transport. According to World Bank data, Brazil has only 704 km of paved roads per million inhabitants, while the average for the 20 top developing countries (1960-95) is 2,860 [World Bank (1994)]. Of greater concern is the fact that the figure for Brazil is below the average of those 20 countries whose growth is slowest, which is 1,050 km of paved roads for every million inhabitants.

Some other figures give a good idea of the sector's deterioration. It is calculated that the poor conservation of roads and highways increases freight costs by 38% and fuel consumption by 35%. Time wasted on the road may double and a substantial part of the agricultural harvest (between 10 and 20 percent) is lost on the road. Economic costs are, therefore, immense, without mentioning the enormous cost to human life, which amounts to 6,000 deaths a year in accidents on Brazilian roads. Also to be considered is that only 10% of the total extension of Brazilian roads is paved.

Deterioration of the road system accelerated following the 1988 Constitution, which determined the end of budget ties to the National Road System Fund. At the same time, the Constitution increased transfers to the states and municipalities. Investments in the sector by states, however, did not increase. IBGE-based estimates show that the average expenditure in works and installations in 1991, 1992, and 1993 was 20% less than the average for 1986 through 1988. On the other hand, according to the State and Capital City Budget Implementation Report, published by the Ministry of Finance, total expenditure in transport in 1991 and 1992 (Cr$ 87 million in December 1992) was only 72% of the total expenditure in 1987 and 1988 (Cr$ 121 million). Although these totals include other expenses, not just capital investment, they clearly show that capital expenditure cannot be greatly increased given the lack of flexibility in current expenses and costs. This problem is further aggravated by the concentration of expenditure in few states: 51.6% of expenditures in works and installations in 1991 took place in Minas Gerais, Rio de Janeiro and São Paulo, while 48.4% of expenditure on equipment and permanent installations concentrated in São Paulo.

Chart 7
CBTU and RFFSA Investment – 1985/93

(1980 Cr$ - millions)



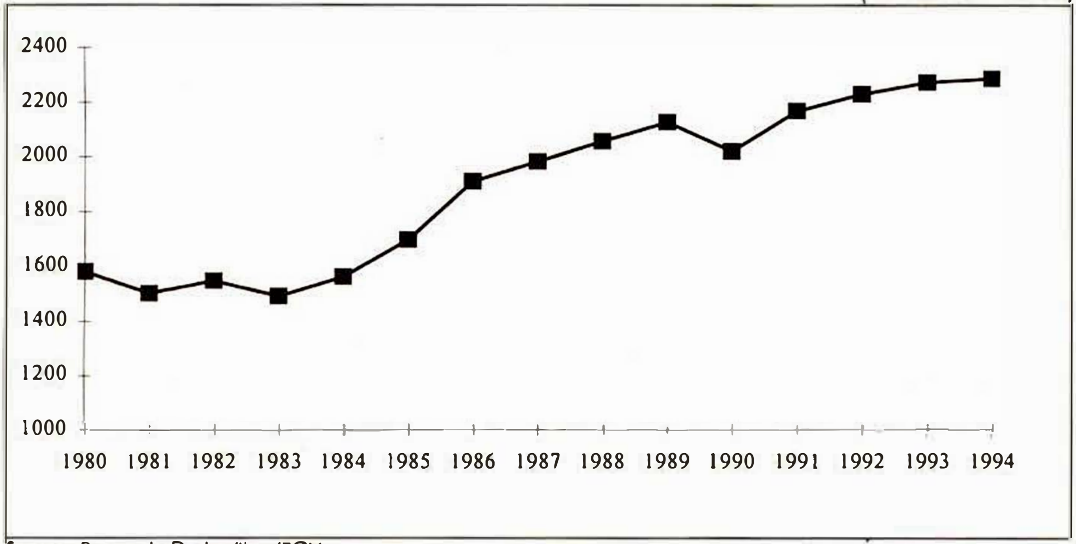
Source: Primary data processed by Ceeg/Ibre/FGV

At the same time that roads were deteriorating, vehicle traffic increased. Chart 8 shows the growth of average monthly diesel consumption between 1980 and 1994. Average consumption in 1994 was 44.6% above that of 1980 and 13.2% above the level in the 90s. Average growth between 1985 and 1993 was 4.26%. The situation, therefore, is worrying. On the one hand, we have a rapid increase in the number of vehicles, as shown by diesel consumption. On the other hand, there is a decline in investment and the road system is deteriorating. In this respect, according to data published in the *Gazeta Mercantil* (Oct. 26/94), only 49% of the federal highways are in good condition; 32%, are in poor condition; and 19%, fair. The World Bank figures are worse: only 30% of our paved roads are in good condition.

It is not by chance that of the 45 proposals for investment in roads in Fernando Henrique Cardoso administration, 35 were in respect of recuperation projects, that is, more than 2/3. Of the other ten, only two (in the North) were for construction and the remaining eight were for duplication of the number of lanes. Indeed, the priority for the specific area in the program is "to recuperate the road and railway network in cooperation with state governments and in partnership with the private sector." The total of the finance proposed for the sector during the four years of the administration is R$5.580 million. Taking this figure into account, a simple calculation allows us to estimate the losses incurred by poor maintenance of the road network. The World Bank calculates that each dollar not spent on infrastructure maintenance will, in the future, mean US$ 5 to US$ 8 in reconstruction expenses, depending on the subsector. Even if we take an optimistic scenario and assume that for road transport the ratio will be one to five and that only half of the R$ 5,580 million allocation will be used on repairs, we can conclude that these R$ 2,79 billion would have been saved if, over the years, R$ 558 million had been used in road repairs – which would have amounted to savings of more than US$2 billion.

Chart 8
Average Diesel Consumption – 1980/94

(1980 CR$ - billions)

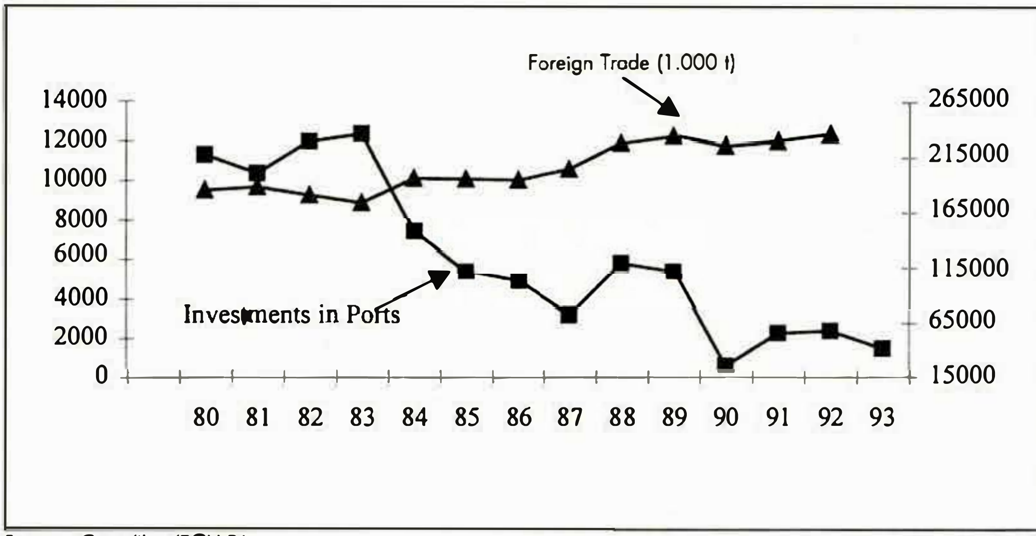


Source: Banco de Dados/Ibre/FGV.

Federally-owned company investments in the port sector (namely, Companhia Docas do Pará, Ceará, Rio Grande do Norte, Bahia, Espírito Santo, Rio de Janeiro, São Paulo and Portobrás until 1990) are also following the decline seen so far in the road and railway transport sectors. While average investment outlay for 1980-84 came to US$ 341 million, for 1991-93 it was only US$ 66 million, less than 20%. Chart 9 shows the pattern of this expenditure against the country's foreign trade (exports and imports) between 1980 and 1992.

While investment falls continuously after a small increase between 1980 and 1983, total foreign trade grows steadily from 1983 on. If investment in ports is currently only 20% of what it was at the beginning of the 80s, the volume of foreign trade, in great part by ship, is currently about 25% higher than it was, on average, in the early 80s. Moreover, the total movement of cargo transported (long haul, coastal shipping, and others) in 1991 – 350 million net tons – is about 39% higher than that of 1980 (242 million) and coastal shipping rose 65%.

Chart 9
Investment in Ports (1980 Cr$ - millions) Versus Foreign Trade (1,000#) – 1980/93



Source: Ceeg/Ibre/FGV-RJ.

This investment pattern, in view of increased shipping volume, has been detrimental to foreign trade not only because of the ports' slow expansion of operating capacity but also because of obsolete or, in may cases, scrapped equipment, little diversification and low efficiency. Add to this picture, archaic labor relations protected by legislation dating from the time of the Empire and the result is the high cost and low efficiency of Brazilian ports, when compared with international standards.

5. The telecommunications sector

Telecommunications has been the only sector in which federal investment has increased in recent years. While the investment average between 1980 and 1984 was US$ 1.8 billion, from 1991 and 1993 this average leaped to US$ 2.8 billion, an increase of 56%. This is reflected, for example, in an annual expansion of the telephone network of approximately 11% and an average increase of 12.7% in investment in the sector between 1980 and 1984 rising to 33.5% between 1991 and 1993.

In 1994 the country's telephone system ranked eleventh in the world with 12.8 million telephones lines; in 1993 alone, 995,000 lines were installed. There are 300,000 public pay phones installed in a total of 16,000 localities. The cellular telephone network is expanding rapidly and in 1994, the total number of these phones exceeded 310,000 units. Finally, the share of telephone services in GDP is currently about 4.5% against 1.97% in 1985.

The growth in the sector's investment may be explained in part by the recovery in its tariffs, begun in 1991. With 85% of concessionaires' revenues coming from the operation of the system and 2/3 of the investments being financed out of the companies' own funds, the price of their services is essential in determining the pattern of investments. In fact, among prices controlled by the federal government (telecommunications, power and petroleum byproducts) telecommunicotion sector tariffs enjoyed the greatest recovery, where the real average for 1993 was 9.9% over that of 1991; and tariffs at the end of 1993 were 28% higher, in real terms, thon in October 199, (the lowest for that year).

A second, less optimistic, explanation would be the fact the sector's situation is so precorious that the economy could not withstand less investment. When expenditure on the development of gross fixed capital for the Telebrás System is measured os a proportion of GDP (Toble 5), a folling trend can be seen, which lasts throughout the 80s; only in 1989 (picking up poce in 1991) is this trend reversed. The average for the second half of the eighties (0.41%) is lower than for the first half (0.46%). For 1991-93, it jumps to 0.59%. Therefore, although it grew in real terms, investment in the Telebrás System borely kept up with GDP growth.

There are many signs of the telephone system's precarious state. Some evidence lies in the fact that the number of lines grew by much less, between 1980 and 1992, than the number of calls. The former increased 2.3 fold, while calls increased 3.34 times; that is, the relative shortage of lines forces each to be used much more today. The truth of the matter is that Brazil hos only eight lines per 100 people, a ratio lower than that of Argentina and Venezuela, for example, and far below that of developed countries: the ratio in the United States is 80 to 100. In vorious parts of the country, the ratio is even worse; in the Northeost, for instance, there are no more than three lines per 100 inhabitants. On average, the 20 countries that grew most between 1960 and 1990 have 30 lines per 100 inhabitants.

Amongst other evidence of precariousness is thot there are currently about one million people in São Paulo on the telephone expansion plan waiting list. Shortage of lines gove rise to a thriving black market for purchasing, selling and renting them. In a city like Rio de Janeiro, a line can sell for as much as R$ 6,500 in some districts; the majority sell for between R$ 2,800 and R$5,000. This situation is worsening: in downtown Rio de Janeiro between December 1993 and October 1994, the price of a line went up from R$2,000 to R$3,200.

It has already been mentioned that the services offered in the country are few and expensive. A coll from Brazil to the United Stotes costs four times more thot one from the United States to Brazil. There is no factor of scale, much less any technologicol factor to prevent any number of componies or agents from operoting internationol and national long-distance services. This is olready done in various countries, and already here in Brazil there is an enormous number of people using long-distance services by meons of cards from private international companies. Fueling competition may not only entail a reduction in the price of calls but also better quality of service. Take the case of Chile, for example. It recently installed o multicarrier system for long-distance calls (the user chooses on the spot the company he/she wishes to use, by means of o specific code) and rotes fell by 70% for internotionol colls ond 80% for domestic calls. The lowest cost of a one-minute call to the United States is US$0.47. In Brozil, the some coll, despite recent tariff ond tox reductions, still costs about US$2.26, five times more.

Table 5
Investment in Telecommunications – 1980/93

Year	GDP %	FBKF %	Govt. Corp. Investments %
80	0,492%	1,16%	11,57%
81	0,477%	1,15%	11,49%
82	0,506%	1,27%	12,75%
83	0,447%	1,25%	12,48%
84	0,407%	1,52%	15,20%
85	0,401%	1,64%	16,40%
86	0,421%	1,91%	19,12%
87	0,378%	1,62%	16,22%
88	0,375%	1,76%	17,63%
89	0,473%	2,90%	29,33%
90	0,353%	3,20%	33,18%
91	0,641%	3,60%	45,12%
92	0,600%	3,28%	45,71%
93	0,538%	3,16%	46,53%

Source: Primary data processed by Ceeg/Ibre/FGV-RJ

With regard to the local cable network, where there is a natural monopoly, whot we have to keep in mind is thot in the odvonced economies, information technology is currently going through a period of extreme dynamism and rapid innovotion, with huge investment in research and development ond new services constantly being introduced. The question we should oddress is: if the state monopoly is maintained, will the government hove the financial resources, while it is investing in the urgent expansion of the telephone network, interconnecting Brazil with an optical fiber network, expanding the number of lines and the public pay phone system and replacing electro-mechanical exchanges (four goals of the current President's program), also to finance a growing volume of research, development, purchases, and the introduction of new technology?

The new administration proposed R$16 billion in investments in the sector, an onnuol average 43% higher than investment in 1993. Added to the other infrastructure sectors – power (except petroleum) and transport – investment in the amount of US $70 billion or about US$ 17.5 billion o year is proposed. This is approximotely 16% of projected total public spending. Undoubtedly, this is an excessively optimistic proposal and will be difficult to achieve financially.

What now seems clear is that the State will not have the ability to attain these goals while still investing in technology and reducing the price of services and telephone lines. Privatization, together with government regulation of carriers and of local telephone services, more than "flexibilization" of the monopoly, seems to us to be the more appropriate solution for the pressing need for investmen in and modernization of the sector. The alternative would be under-investment and a gargantuan bottleneck in economic growth. In this context, the breaking up of the telecommunications monopoly, approved by Congress in the first half of 1995, is an enormous step in this direction. The alteration of the wording "concession to the company under government-shareholding control" from article 21, paragraph XI, of the Constitution to replace it with simply "concession", opens the running of telecommunication services to private enterprise, domestic or foreign, thus making the prospects of investment in the sector more optimistic.

6. Long term ratio between infrastructure and output[5]

This section examines the long-term ratio of infrastructure stock to real GDP. To this end, we built alternative series of installed capital based on some of the investment series discussed earlier and used different depreciation rates. Then, we tested whether there were unitary roots and estimated cointegration ratios.

Two investment series were used – investment by government-owned companies in infrastructure (kinfra) and the total investment by government-owned companies and by the government directly (ktotal) – and three alternative depreciation rates, 6, 8 and 10% were used. The two series are, respectively, the most restrictive and the most comprehensive, in respect of public sector investment. We chose to use different depreciation rates because of the lack of reliable estimates for Brazil. The method used to build the series was that of perpetual inventory and the amount of initial capital was established according to Young (1994).

The existence of unitary roots was tested in the standard manner using the expanded Dickey-Fuller test. Lags were chosen by the Schwartz criterion. For all six capital series, the assumption of a unitary root at a 5% significance level is accepted and for the GDP series one at 10% is accepted. The table below shows the results of the cointegration tests[6], in which the Johanson criterion was utilized.

5 This section was included at the suggestion of an anonymous referee, to whom the author is grateful.

6 Models chosen according to Schwartz criteria.

Table 6
Infrastructure and Public Capital Long-Term Income-Elasticity

Variables	Elasticity	Post	Deterministic model in the co-integration vector		Trace Est.
			Trend	Constant	
lkinfra6	0,64	1	0.012	7.90	22,14
	(0,032)				3,35
lkinfra8	1,12	1	-	-	10,92*
	(0,002)				1,30
lkinfra10	0,34	1	-	12.22	20,38
	(0,177)				7,79
lktotal6	0,71	1	-	5.33	24,16
	(0,127)				7,98
lktotal8	1,04	1	-	-	14,5
	(0,0006)				0,12
lktotal10	1,05	1	-	-	15,55
	(0,0006)				0,12

Note: Number of lags in the VAR equals 2 for all estimates. The values in parentheses are standard deviations.
*Significant at 10%.

The test results confirm the infrastructure stock/output cointegration hypothesis. A cointegration vector exists between all government capital measures and GDP, a hypothesis that accepts a significance of 5% with a single exception (ikinfra8), which is accepted only at 10%. For the measurements based on the series of investments by government-owned companies in the infrastructure sectors (kinfra6, 8 and 10), the elasticity estimates vary between 0.34 and 1.12. In general, they exceed previous estimates for American data obtained by means of other methodologies, which place them between 0.1 (Cavalcanti Ferreira, 1993) and 0.45 (Aschauer, 1988). The more extensive series for government capital (ktotal6, 8 and 10) are, on average, even higher, between 0.71 and 1.05 and, for the last two the possibility that elasticity is equal to one cannot be ruled out.

These results show that, in Brazil, there is also a strong relation between infrastructure and output in the long term. Between 1976 and 1993, real investment in this sector plunged by more than 60%. If it had been sustained at, at least 90% of the 1976 peak, when the fall begins to accelerate, capital stock (kinfra6) would currently be about 35% higher than the actual capital. According to our estimates of elasticity (0.68, in this case), this would imply that 1993 output would be about 24% higher than the GDP of that year. In other words, the estimates in Table 6 confirm our conjecture that the fall observed in infrastructure investment entailed considerable loss of output and remains a serious obstacle to growth.

7. Final remarks

Modern literature on growth as much as old theories on development consider fiscal policy one of the most important instruments for economic growth. On the one hand, tax on income and on investment, because they reduce the net return on investment, would make these activities less attractive and would lower the growth rate. On the other hand, expenditure on infrastructure and on some other types of public investment, since they affect the economy's productivity and, therefore, the return on private investment and on labor would have a beneficial effect on the future growth of output. In this sense, the severe drop in infrastructure investment and the poor quality of services we have seen in this article (which only addressed public sector expenditure) reveal a powerful factor limiting the prospects of growth for the Brazilian economy, principally in the light of the high elasticity-return on infrastructure estimated in Section 6.

The long-term trend (from 1970 to 1993) in public investment as a proportion of output is declining. We found that investment in the power sector has declined by 2/3 over the past ten years and that it has been concentrated almost entirely in two power plants. We also found that investment in ports and railways are at levels that probably do not replace the depreciation of capital (investment in the railway system is presently 10% of what it was in 1980). We likewise noted that less than half of the federal roads are in good condition and that all evidence points to this situation being common to the rest of the road system. The situation in the telecommunications sector, in which, in absolute terms, investment has increased in recent years, is also precarious, which is evinced by the shortage of lines, the high price of services and technological backwardness. The conclusion is immediate and also dire: if this trend is not decisively reversed in the near future, either through direct government investment, partnerships and/or selling off state-owned companies to private enterprise, the rate of growth in output and productivity in the Brazilian economy is very likely to come up against rigid restraints in the very near future. An optimistic point in this context is the so-called Law of Concessions, passed in February 1995, which opens the operation of public utilities to private enterprise; prior to this, public utilities, under the Constitution, could only be government operated. The law redesigns the regulatory framework governing the power, transport, and telecommunications sectors, among others. Although all of its implications for the long term are not yet clear, there is no doubt that it will open up enormous potential for investment in these sectors.

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CHAPTER 7

DEMAND FOR MONEY IN PROCESSES OF HIGH INFLATION*

Octávio A. F. Tourinho**

Abstract

The paper puts forward and tests an equation for money demand in high-inflation processes that extends and generalizes Cagan's celebrated model for hyperinflation. The equation is derived from a theoretical stochastic dynamic programming model of portfolio choices. Its solution suggests the adoption of an inverse relation between money balances and expected inflation. It is argued tha the inflation-rate variance should be introduced as one of the explanatory variables in addition to the real interest rate of a variable to capture the effects of technical progress, and of a seasonal factor. To complete the specification, expectations about inflation rate, inflation variance and income are assumed to be adaptive. The model is tested by applying it to the German hyperinflation and to inflationary experience in Brazil in the last two decades, using the Box-Cox flexible functional form, and is found to be generally valid. Cagan's semi-logarithmic functional form is found to be inappropriate for the analysis of money demand in Brazil in the period 1974-92. It is concluded that the expected level and variance of inflation are indeed significant explanatory variables and that it is impossible to reject the hypothesis that their coefficients are equal in absolute value, as predicted by the theory.

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1. Introduction

The behavior of monetary variables in situations of extreme inflation is still a topic of interest and the subject of intense research in economics. Recent examples are the analysis of high-inflation episodes in several countries in Dornbusch & Fischer (1986), Bruno et al. (1988), and Dornbusch, Sturzenegger & Wolf (1990), besides the interest shown by various other researchers in the study of hyperinflation. The main reason for this interest, as pointed out by Cagan (1956) in his seminal and now classic study of hyperinflation, is that these processes provide a unique opportunity to study monetary phenomena.

Under hyperinflation, astronomic rises in prices and money greatly exceed changes in real income and other factors, enabling the relations among monetary variables to be studied in almost complete isolation from the rest of the economy. In high-inflation processes a similar situation occurs when the high rates of change in nominal variables emphasize the relations between money and prices.

At this point it is useful to be more specific about the meaning of the expression "high inflation". It is worth recalling that Cagan (1956, p. 25) defines hyperinflation as a process which generates price rises of more than 50% per month, computed with continuous capitalization,[1] while Dornbusch, Sturzenegger & Wolf (1990, p. 2) define extreme inflation as a process in which prices rise more than 15%-20% per month. Dornbusch (1992, p. 17) regards high inflation as an intermediate stage in a process that is moving toward extreme inflation, and demonstrates that countries which experience inflation rates of 10%-15% per month[2] for some time are on course for hyperinflation.[3] Conceptually speaking, high inflation is a process which, once it has started, tends to produce hyperinflation unless it is aborted by stabilization. It also produces changes in agents' responses to inflation and leads to the creation of mechanisms designed to compensate for the effects of inflation, e.g. indexation.

The study of monetary phenomena through the analysis of high-inflation processes offers a number of advantages in comparison with the analysis of hyperinflationary dynamics. High-inflation processes provide an opportunity for studying the effects on the demand for money of factors that are not relevant under hyperinflation but are nonetheless interesting and important, such as the impact of real variables on the monetary sector and some of the more subtle details of the interactions among monetary variables. Moreover, high-inflation episodes

1 To be precise, Cagan (1956) defines hyperinflation processes as starting in a month in which prices rise more than 50% and ending in the month before the month in which the rate of price rises falls below 50% and remains at that level for at least a year.

2 All inflation rates in this paper are computed as monthly rates with continuous capitalization.

3 The definition of high inflation is arbitrary, but it may be reasonable to establish about 3% per month as the lower limit. A precise definition is not critical for the purposes of this paper.

provide a larger, more comprehensive data base on which to base empirical studies, since they occur more frequently than hyperinflation, which is a rare phenomenon. The main difficulty in modeling demand for money in high-inflation episodes is that this task must be performed in a more complex and noisy environment than is the case of hyperinflation, since high inflation is less similar to a controlled experiment. When estimating the model, it is necessary to control statistically for the other variables that affect the demand for money, as well as treating a larger, less well-behaved residue. Lastly, when compared with studies of demand for money under low inflation, the analysis of demand for money under high inflation benefits from the sharper variance presented by the explanatory variables, enabling the relevant economic factors in monetary dynamics to be identified more clearly.

This paper is concerned with the specification and estimation of the demand for money in episodes of high inflation. It puts forward a model that in some respects can be considered an extension of the model developed in Cagan (1956) for the monetary dynamics of hyperinflation. Cagan's main contribution was to emphasize real cash balances as the key dependent variable and to use expected inflation as the main explanatory variable for money demand. These developments have since become part of the standard formulation of money demand (see Goldfeld & Sichel, 1990). Cagan's model is a suitable starting-point from which to study high-inflation processes because it behaves robustly when applied to the type of process he analyzes. Although the literature contains a number of studies that question various aspects of Cagan's model for hyperinflation such as the identification of equation parameters, his hypotheses about expectations formation, the functional form of demand for money, the role of the exchange rate, and his estimation procedure, few of the studies published to date have succeeded in refuting Cagan's original model altogether (see respectively Barro, 1970; Sargent & Wallace, 1973; Frankel, 1975; Sargent, 1977; Frankel, 1977; Friedman, 1978; Frankel, 1979; Salemi, 1979; Abel et al., 1979; Hansen & Sargent, 1983). Only in very few cases have such studies obtained confidence intervals for the key parameter — the semi-elasticity of the demand for money with respect to inflation — that exclude Cagan's original estimate. In general, the model has been corroborated by recent studies that have taken advantage of the development of co-integration tests to estimate demand for money in the classic episodes of hyperinflation with less strict requirements for the formation of expectations (see Casella, 1989; Taylor, 1991; Engsted, 1993).

Despite all the work that has been done on Cagan's model, however, some of its possible extensions have not yet been fully explored in the literature. Some directions are indicated in his original article, such as the possibility that the functional form used there may be excessively limited and the suggestion that under certain circumstances the equation should include variables for the real sector of the economy, such as income and interest rates. Others, such as the use of a variable to reflect inflationary risk, are the product of more recent economic thinking. These extensions are elaborated here for a high-inflation context. It is also hoped that the application of the extended model to hyperinflations may help test these enhancements.

Although this paper is confined to the results of estimating of the model for the data of the German hyperinflation episode and for the high and extreme inflation episode observed in Brazil over the last two decades, it seems reasonable to assume that the model proposed has far wider applicability, since the characteristics of the demand equation described here were not obtained in an *ad hoc* manner to fit the data in question but derive from theoretical and empirical considerations of a general nature regarding demand for money under high inflation, as will be seen below.

Application of the model to the Brazilian experience is of interest in its own right, since empirical analyses of demand for money in high-inflation processes are not frequently found in the literature. Montiel (1989) uses the conventional specification for money demand but substitutes observed inflation for expected inflation and obtains somewhat unsatisfactory equations. The co-integration analysis of money and prices has also been extended to high-inflation processes (see, for example, Engsted, 1991; Phylaktis & Taylor, 1992; Rossi, 1994), but usually without including additional explanatory variables in the equation.

The rest of the paper is divided into five sections. The next derives and presents a money demand model that emphasizes the discussion of the functional form of the equation and the role of uncertainty. The third section discusses the empirical specification of the model, with special reference to the formation of expectations. Section 4 presents an estimation of the model for the German hyperinflation, and Section 5 presents an estimation for the Brazilian data in the last two decades. Section 6 summarizes the key findings of the model. Estimation procedures and a description of the data are presented in the appendix.

2. Demand for real cash balances

When analyzing demand for money in high-inflation processes, it is necessary to consider both the effects of changes in the expected inflation rate and the effects of changes in the variability of inflation. The level of inflation is important because when economic agents take decisions about the desired level of money balances, they take into account the fact that money generates a negative real return. Thus they tend to reduce their demand for money in response to an increase in the expected inflation rate in order to minimize the expected loss in the real value of their cash holdings. However, the possibility of reducing the money balances has limits because there is some level of real cash balances above which the benefits of using money as a means of exchange may exceed the inflationary cost and induce agents to hold money in situations where the inflation rate is so high that a casual analysis would suggest total flight from money, as is the case of hyperinflation.

The variability of inflation is also important because even if the expected rate of inflation remains constant, agents will adjust their money balances to offset the effects of changes in inflationary risk, since there will be a component of demand for money that derives from the obligation to make decisions in an environment in which the inflation rate is stochastic. This can be justified by discussing two kinds of effects that an increase in inflationary risk may generate in money demand models.

In a model based on inventory theory, in which there is a penalty if real cash holdings fall short of a given level, or in which there is a convenience return on the holding of money, economic agents will hold larger money balances than in a non-stochastic situation with the same expected inflation rate. By behaving in this way, a typical agent hedges against the possibility of finding himself in a situation where his real cash holdings are insufficient for his transactions, owing to uncertainty about the inflation rate. The greater the probability of a given mismatch between the actual inflation rate and the expected rate, the more demand for money there will be, at the cost of a reduction in consumption. Thus real cash holdings tend to expand in line with inflation variance, as noted by Barro (1970), who develops a model similar to the precautional money demand model in Miller & Orr (1966).[4]

On the other hand, in a portfolio choice model with risk-averse investors there is a speculative motive for holding money which at the margin leads agents to reduce their demand for real balances in response to an increase in uncertainty about inflation, as they attempt to reduce their holdings of an asset which has become riskier. Thus the effect of inflationary risk on speculative demand for real money balances has the same effect as expected inflation, i.e. it runs counter to the effect of precautional demand.

If it is admitted that both effects are in operation, the sign of the inflation variance coefficient in demand for money is ambivalent. This is the case in Liviatan & Levhari (1976, 1977), who put forward a money demand model with two periods, a utility function that depends on the flow of consumption and real money balances, a utility function for terminal wealth, and a space of choices that includes one consumer good and three financial assets: money, index-linked securities, and nominal securities. The sign of the coefficient of the risk variable is also ambiguous in Fischer (1975), who assumes that prices of goods and the return on index-linked securities, nominal securities and equities are governed by Wiener's stochastic process and solves the stochastic dynamic programming problem, in computing the demand for assets. The argument presented in the following sub-section is that in situations of high inflation this ambivalence can be solved because one of these effects will probably predominate.

4 This effect can be obtained by including in their model a component representing the demand for money that cannot be explained by other factors besides uncertainty about cash flow, and by assuming that the stochastic component of real cash flow is due to inflation variability.

2.1 Demand for money in a continuous-time portfolio choice model

The issues discussed above can be treated in a more precise manner using a money demand model designed to show how uncertainty about the inflation rate can affect the portfolio choices of a representative consumer in a situation of high inflation. The structure of the model is similar to that of models originating with the consumption and portfolio choice model presented by Merton (1969) and extended to inflationary economies by Fischer (1975). However, none of these dec ls with demand for money.

The model presented here attributes a convenience return to money and considers money as one of the assets in the economy. In addition, it captures the fact that in high-inflation processes the main alternative to holding money is holding substitute assets that offer indexation as a hedge against inflation, which justifies and requires their inclusion in a portfolio. In many cases these assets will include a foreign currency, while in others the private sector may create such an alternative asset by indexing securities to the prices of certain goods: examples include *Notgeld* in Germany during the hyperinflation episode there. There have also been cases where the Government itself has created such substitute assets to protect its tax receipts against inflation — a classic example is Hungary's "fiscal *pengö*" after World War II — or to increase or freeze its debt (e.g. index-linked public securities in Brazil, Argentina and Israel). In some cases these assets are termed "indexed money", especially if they acquire high liquidity as their use becomes generalized throughout the economy.[5]

Suppose prices of the only consumer good behave in accordance with Ito's stochastic diffusion process, given by equation (1) in which dz is the increment in Wiener's stochastic process[6] z and the parameters π and σ are known to the agent and are fixed:

$$\frac{dP}{P} = \pi\, dt + \sigma\, dz \tag{1}$$

The model is specified in terms of real variables, which are equal to the corresponding nominal variable divided by the price level at each point in time. An agent initially has real wealth $w(0) = w_o$, and at each point in time he decides about his real consumption flow (c) and distributes his real wealth (w) between money and index-linked securities in the proportions η and $(1-\eta)$ respectively. For the sake of simplicity, suppose there is no income from labor.

5 Tight control of the money supply may become very difficult when index-linked assets with high liquidity exist, since transfers of wealth to and from these assets may produce significant variations in monetary balances. Under such circumstances, the monetary authorities may be able to control the broader aggregate in isolation, i.e. the monetary base plus indexed money. The paper does not analyze such situations.

6 See for example Merton (1971) or Fischer (1975) for an introduction to the use of dynamic programming methods with Ito processes in portfolio choice problems.

Index-linked securities, which bear no risk in the real economy, are the only assets besides money[7] and have a non-stochastic return of $r\,dt$, with a nominal return equal to the real return plus the inflation rate. Equation (2) presents the stochastic process followed by Q_b, the nominal value of these securities:

$$\frac{dQ_b}{Q_b} = r\,dt + \frac{dP}{P} = (r + \pi)\,dt + \sigma\,dz \tag{2}$$

The nominal return on money is null because its price is equal to unity. The real return when money is retained ($q_m = 1/P$) is stochastic, since devaluation of real balances depends on price change and can be calculated by Ito's lemma, producing equation (3):

$$\frac{dq_m}{q_m} = (-\pi + \sigma^2)\,dt - \sigma\,dz \tag{3}$$

However, suppose also that there is a convenience yield on money because it enables an agent to economize on the cost of transactions required to carry out his plans for optimal consumption and portfolio management. There is no attempt here to derive this property of money from more basic considerations, but it is clear that if this return did not exist, money would be a dominated financial asset in this economy rather and would not be held in positive amounts in the agent's portfolio.[8] The utility of money is modeled here by introducing into the equation for the representative agent's equilibrium budget an expense that reflects the opportunity cost in real funds of holding part of his wealth in the form of index-linked securities. When this cost is multiplied by the marginal utility of wealth, it can be construed as the convenience return on money renounced by the agent by holding this volume of funds in the form of index-linked securities.

Suppose that this cost per unit of time (δ) is a decreasing function of the proportion of the agent's wealth held in the form of money (η), that it is null when all his wealth is completely liquid ($\eta = 1$), and that it is infinitely large when the real cash balance as a proportion of the portfolio approaches zero ($\eta \rightarrow 0$). Let it be adequately approximated by a negative logarithmic function in the interval $0 < \eta < 1$, as shown in equation (4) where $\kappa > 0$ is the parameter whose

7 This does not entail any loss of generality, since Fischer (1975, p. 520) shows, in a similar model that allows for the existence of nominal securities, that the price of these securities will be precisely that which guarantees that none of them exists in equilibrium provided expectations are homogeneous.

8 An example of a model in which demand for money depends on the expected cost per unit of time of performing the required transactions, which in turn is a function of the variability of the inflation rate, can be found in Barro (1970, equation 54).

unit is that of the real consumer good. Higher values of κ are associated with the greater utility of money, relative to index-linked securities, in facilitating transactions and hence with a higher convenience yield. As κ increases, so does the cost associated with holding a certain proportion of wealth in the form of index-linked securities, and this effect corresponds to a decrease in their liquidity:

$$\delta = -\kappa \log(\eta) \qquad \kappa > 0 \tag{4}$$

Suppose utility (U) depends solely on the flow of consumption and that money stocks held affect utility because of their effect on wealth, which occurs through the cost component (δ). The problem of optimal control to be resolved by a representative agent is to maximize the expected value of the discounted utility (at a continuous rate ρ) of the flow of consumption, equation (5), subject to a budget restriction (flow), equation (6). There is an initial condition regarding wealth, and if the problem is to be well defined the solution must satisfy the transversality condition shown in equation (7), where $V(w)$ represents the indirect utility function of wealth. The state variable is wealth (w) and the controls are consumption and the relative quantity of money held (c and η):

$$\max_{c,\eta} \; E_0 \int_0^\infty e^{-\rho t}\, U(c(t))\, dt \tag{5}$$

subject to:

$$dw = (1-\eta)\, w\, r\, dt + \eta\, w[(-\pi + \sigma^2)dt - \sigma\, dz] + \kappa \log(\eta)dt - c\, dt \tag{6}$$

$$w(0) = w \qquad e \qquad \lim_{t \to \infty} E\,[e^{-\rho t}\, V(w(t))] = 0 \tag{7}$$

The basic equation for the of optimal stochastic control problem stated above, derived from the principle of stochastic dynamic programming, is given in equation (8):

$$\rho V(w) = \max_{c,\eta} \left\{ U(c) + [(1-\eta) r w + \eta(-\pi+\sigma^2) w + \right.$$

$$\left. + \kappa \log(\eta) - c] V'(w) + (1/2) \eta^2 \sigma^2 w^2 V''(w) \right\} \quad (8)$$

Equations (9) and (10) can be derived from the first-order conditions for the maximization problem inside the square brackets in (8):

$$U'(c) = -V'(w) \quad (9)$$

$$\kappa + (-\pi + \sigma^2 - r) w \eta + w^2 \sigma^2 \frac{V''(w)}{V'(w)} \eta^2 = 0 \quad (10)$$

Equation (10) is quadratic in η and can be rewritten as $\kappa + b\,\eta + a\,\eta^2 = 0$, if a and b are defined to represent the corresponding terms in (10). The general solution for this equation is but if $4\,a\,\kappa << b^2$, a Taylor expansion of

the square root in the neighborhood of b^2 followed by the appropriate simplifications will produce the roots $\eta_1 = -\kappa / b$ and $\eta_2 = -b / a + \kappa / b$. Since in our case $a<0$ and $b<0$, the positive root is η_1. Using the expression for b, this solution for equation (10) is shown in equation (11):

$$\eta = \frac{\kappa}{w(\pi - \sigma^2 + r)} \quad (11)$$

When analyzing the demand for money in high-inflation processes, the use of the above-mentioned approximation is justified, since in these cases the condition for it to be valid is probably satisfied, i.e. $(-\pi+\sigma^2-r)^2 >> 4\,\kappa\,\sigma^2\,(V''/V')$. This is shown first by using (11) to approximate κ as $\eta\,w(\pi-\sigma^2+r)$ and denoting the risk-aversion coefficient by $A = w\,V''(w) / V'(w)$, so that (12) is equivalent to this latter condition. As argued below, (12) is probably satisfied in high-inflation processes, since for reasonable values of the parameters involved the order of magnitude of the left-hand side will be greater than that of the right-hand side of the inequality:

$$(\pi - \sigma^2 + r) >> 4\eta\sigma^2 A \tag{12}$$

Let $\vartheta(X)$, the order of magnitude of any variable X, be defined as the integer n such that $10^{n-1} < E(X) < 10^n$. Recall that in high-inflation processes $\pi > 0.1$ (on a monthly basis), so that $\vartheta(\pi) \geq 0$, and note that for price processes that are not excessively erratic, it is probable that $\vartheta(\sigma^2) \leq -1$. If real interest rates are not absurd, $\vartheta(r) \leq -1$. Hence $\vartheta(\pi - \sigma^2 + r) \geq 0$. Now note that κ cannot be so great (relative to total wealth) that holding money is desirable enough to make η significantly distant from zero,[9] since one of the characteristics of high-inflation processes is precisely this flight from money, which corresponds to a small proportion of money in the agent's portfolio, entailing $\vartheta(\eta) = -1$. In order to set limits to the risk-aversion coefficient, it is possible to use the results in Chechetti, Lam & Mark (1994), who estimate the following values of A: approximately 6 using annual data for returns on stocks and bonds in the United States during the last decade, approximately 2 for monthly data on prices of stocks and U.S. Treasury bonds, 20 for monthly data on the forward structure of U.S. Treasuries, and 15 for data on the return on investments in five foreign currencies. Thus if agents are not excessively risk-averse, it is probably reasonable to assume $\vartheta(A) = 1$. Hence $\vartheta(4\sigma^2 A) = -1$. In sum, a comparison between the orders of magnitude of the left-hand and right-hand sides of (12) shows that the approximation from which (11) is derived can be utilized provided the variance of the stochastic price process is not very large, money is not so indispensable that it accounts for a large proportion of the agent's portfolio, and agents are not excessively risk-averse.

This latter observation is important because it shows from the economic standpoint how the approximate solution to the stochastic programming problem in (5)-(7) responds to an increase in inflationary risk. As the variance of the inflation rate increases, the demand for real cash balances *increases* to protect agents against the possibility of having to conduct business with an insufficient stock of money and having to relinquish the high convenience return on money. This is the effect captured by equation (11). There may also be another effect, which would tend to *reduce* demand for money: rising variance in the inflation rate might increase the risk of variations in wealth due to retention of stocks of money, leading risk-averse agents to reduce their stocks of money in order to reduce total portfolio risk. This effect is not present in the money demand equation discussed here because it is important only if the degree of risk aversion is high enough to produce significant adjustments in the amount of money held by an agent. Thus it is important only if the benefits of avoiding additional risk are great enough to

9 Note that the solution for η shown in equation (11) is also the solution for a modified equation (10) in which the quadratic term is unknown. This simplification would be reasonable if $\eta \approx 0$.

justify incurring the higher cost of conducting business with significantly smaller stocks of money. This motive for holding money, in conjunction with the asset portfolio recomposition effect, is implicitly considered one order of magnitude smaller than the transactional motive. Hence the need for the risk aversion coefficient not to be very high for the approximation to be valid.

Because we are basically interested in the demand for real money balances, which is equal to η w and is already specified in terms of the parameters in (11), it is not necessary to proceed with the solution to the optimal control problem, insofar as such a solution can be said to exist. The solution process cannot normally be halted so early on, since the first-order conditions normally involve the indirect utility of wealth function V, which must be found by solving (8).

The analysis of the equation for real money demand obtained above shows that it has the expected signs for partial derivatives: positive for the variance of the inflation rate and for the convenience return on money, negative for the expected inflation rate and for the real interest rate. It is also worth noting that if the parameter for the function that enables the convenience return on money (κ) to be calculated is reduced, for example through the creation of new index-linked assets or through a decrease in the liquidity of existing assets, then demand for money is reduced in the same proportion.

The functional form of (11) is equivalent to the log-log specification usually utilized in the empirical analysis of demand for money and is substantially different, especially in terms of its implications, from the log-linear functional form utilized by Cagan.[10] The question of which is the right functional form to use for the money demand function is discussed in the following section in a context that enables these two functional forms to be discussed simultaneously.

2.2 The functional form of the money demand function

Cagan (1956) specified his model in a log-linear form but considered the possibility that other functional forms might be more appropriate by exploring the reasons for which his regressions did not show a good fit to observations for the period near the end of the hyperinflation episodes. At these points effective demand was higher than that explained by his equation. According to the author, his regression would fit the data more adequately if the curve rose to the left of the graph (for small real balances and high inflation). This led him to disregard data for the last few months of various hyperinflations and to offer two possible explanations: either that expectations of monetary reform could justify retention of these larger holdings, or that demand for real money balances did not behave according to his equation.

[10] The functional form derived in the text also differs from the exponential form obtained by Barro (1970).

The first explanation has already been explored by Flood & Garber (1980), whose findings do not appear conclusive, as can be seen from the nature of the statement that summarizes the results of incorporating the probability of reform into Cagan's equation: "it *would* seem that the instability of the money demand function at the end of hyperinflation is some*what reduced* if the probability of reform is considered" (Flood & Garber, 1980, appendix F, version, emphasis added). The second explanation, which relates to the use of alternative functional forms for demand for real balances under hyperinflation, seems to be eliminated by Cagan on the basis of heuristic reasoning and has only rarely been explored in the literature. Frankel (1977) tests an equation for the German hyperinflation in which the *independent* variable is transformed by the Box-Cox procedure, with unsatisfactory results. However, the transformation of the *dependent* variable seems to be more in line with what Cagan calls alternative functional forms.

It might be argued here that in order to model demand for money under high inflation it is preferable to utilize as the dependent variable the Box-Cox transform[11] of normalized real balances (see Box & Cox, 1964), while at the same time maintaining the linear specification for the independent variables. Use of the Box-Cox transform of money balances *and* of all the explanatory variables when estimating money demand functions is proposed by Zarembka (1968) and applied to the estimation of demand for money in the United States between 1870 and 1963. White (1972) and Spitzer (1976) also use this generalized functional form to estimate demand for money. The approach put forward by Zarembka is also used by Prado (1978) to estimate demand for money in Brazil before 1970, a period when inflation rates were low, but his study obtains what seems to be a very weak discrimination between the different functional forms. The proposition presented here is that only the dependent variable be transformed, for the reasons explained below.

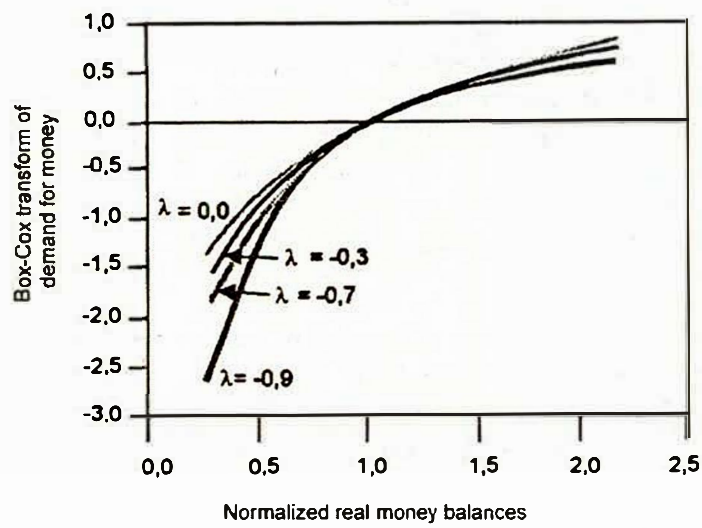
Let z represent the transformed dependent variable, calculated by dividing the observed values of *M/P* by their geometric mean in the sample period.[12] This transformation is shown in equation (13) and illustrated in Figure 1:

$$\Phi(z,\lambda) = \begin{cases} \dfrac{z^{\lambda}-1}{\lambda} & \lambda \neq 0 \\ \log(z) & \lambda = 0 \end{cases} \quad \text{e} \quad \lim_{\lambda \to 0} \Phi(z,\lambda) = \log(z) \qquad (13)$$

[11] The advantage of this transformation over the power transformation z^{λ} is that it is continuous in $\lambda=0$.

[12] This normalization is convenient in what follows and for estimating λ, as we shall see in the next section.

Figure 1
Box-Cox transform of demand for money



Now suppose that the Box-Cox transform of the dependent variable is written as a linear function of the inflation rate, as in equation (15). It can easily be seen that this flexible functional form is capable of representing both of the key formulations that interest us here: the inverse functional form obtained in the previous section and the log-linear specification employed by Cagan. To demonstrate the first statement, recall that the parameter of the convenience return function (κ) is positive and note that in equation (14), obtained by applying the Box-Cox transform with $\lambda = -1$ to both sides of the demand function $m = \eta\, w$ derived from (11), the dependent variable becomes a linear function of the explanatory variables. The signs of the partial derivatives discussed in the previous section are preserved, since the transformation has a positive slope. It is also possible to test whether the inverse functional form of equation (11) fits the data by verifying whether -1 falls within the confidence interval for λ. If all the other hypotheses of the model are assumed correct, this in fact becomes a test of the hypotheses utilized to justify the approximation employed to derive our demand equation:

$$\Phi(z,-1) = 1 - z^{-1} = 1 - (\pi - \sigma^2 + r)\kappa^{-1} \tag{14}$$

The second statement is demonstrated directly, since the natural logarithm is the special case of (13) when the form parameter is null. This means it is possible to verify whether

Cagan's hypotheses adequately match the functional form of real demand for money by testing for $\lambda=0$ in the linear demand equation estimated using the generalized Box-Cox functional form.

The argument just stated regarding the test for the functional form of the demand equation based on the value of λ is valid as long as κ is constant, as assumed in the above derivation. If equation (11) is estimated for a period in which inflation is accelerating, and if the parameter of the function for the convenience return on money declines during the period, for example as index-linked securities become more liquid, then the compound effect of a rise in π and a decline in κ in the money demand equation will distort the inverse ratio of real money balances to inflation, even if equation (11) is valid.[13] This observation will have important consequences for the interpretation of the findings discussed in the empirical sections of this paper and for the study of high-inflation processes in general, since the acceleration of the inflation rate tends to lead to the appearance of more liquid index-linked assets.[14]

Even if the development in the previous section is not used to derive the demand for money, and thus to furnish an indication for the functional form of the equation to be estimated, it is nevertheless desirable to use the Box-Cox transform of normalized money balances as the dependent variable in estimating the money demand equation. This is argued in the analysis below, which shows that this functional form preserves the desirable properties of the money demand function if the dependent variable is defined as a linear function of the rate of price rises and if some restrictions are imposed on λ. This behavioral function is indicated in equation (15), which is obtained when all the other variables that affect demand for real balance are kept constant, and its overall effect is represented by γ. Because the Box-Cox transform has a positive slope, economic theory requires that α be negative, as will be shown later on:

$$\Phi(z,\lambda) = \gamma + \alpha\pi \tag{15}$$

The implications of this specification for the properties of the money demand equation can be explored in further detail by examining equation (16), obtained by using (15) in (13) and solving for the value of money balances (z) and different values of the inflation rate (π):

[13] It is difficult to judge whether the parameter of the functional form changes solely owing to variations in κ because the convenience return on money is not directly observable.

[14] This issue is further discussed in connection with the calculation of elasticity in equation (19).

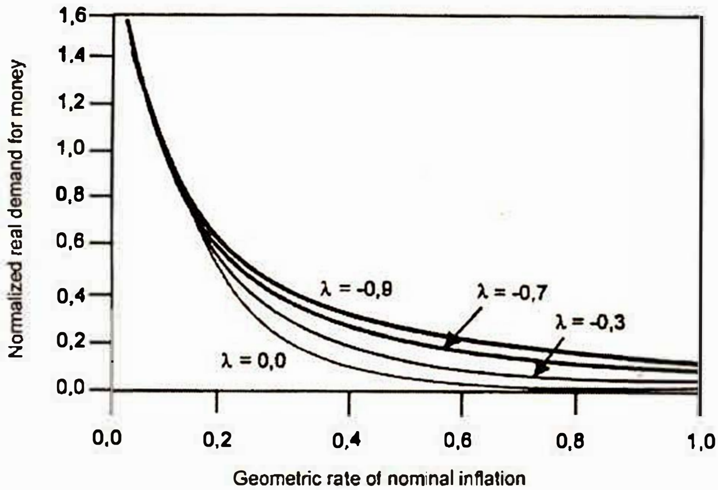
$$z = \begin{cases} [(1 + \lambda\gamma) + \alpha\lambda\pi]^{1/\lambda} & \lambda \neq 0 \\ \exp(\alpha\pi + \gamma) & \lambda = 0 \end{cases} \qquad (16)$$

It is necessary to place some restrictions on the parameter values in equation (16) so as to force it to satisfy the overall properties required of a satisfactory demand function. This concem with the characteristics of the function throughout its domain is justified by the need that the equation behave as expected when inflation rates are both high and low, so that the process of inflation acceleration can be adequately portrayed.

The normalized value of real money balances must be well defined for any inflation rate, and this shows that the term between square brackets in (16) must be positive. By using this condition and requiring that the slope of money demand be negative, it is easy to show that $\alpha < 0$. The condition that $\lambda \leq 0$ can then be derived by requiring that at the limit, when inflation increases, the demand for money balances given by equation (16) approaches the horizontal axis from above. By focusing on the case $\lambda<0$, requiring that the term in round brackets in (16) be positive for any π (and in particular for $\pi=0$) and using the fact that α and λ are both negative, it can be shown that $\gamma < (-1 / \lambda)$. Additionally, when inflation is null, z must be greater than unity, since the money demand function decreases and the geometric mean of z is 1. Thus an examination of (16) for $\pi=0$ shows the necessity of requiring that $(1 + \lambda\gamma)^{1/\lambda} > 1$, which implies $\lambda\gamma < 0$, since $\lambda<0$. This in turn implies $\gamma>0$. The case where $\lambda=0$ only requires $\gamma>0$. The inequations in (17) summarize the preceding discussion and specity the conditions required for the Box-Cox linear functional of inflation to be a reasonable equation for demand for real money balances in high-inflation processes:

$$\alpha < 0, \ \lambda \leq 0 \quad e \quad 0 < \gamma < -1/\lambda \qquad (17)$$

Figure 2
Inflation and Box-Cox real demand for money



As shown in Figure 2, if α and γ are kept constant while λ varies, the money balances calculated using the equation with the Box-Cox transform and $\lambda<0$ will be larger than those calculated using the equation with the logarithmic transform ($\lambda=0$). The largest balances of all are obtained for the inverse function ($\lambda = -1$). To see this, note first that the various functions in this family converge for the rate $\pi = -\gamma/\alpha$, since substitution of this value in (16) produces $z=1$. This means these curves are in fact comparable, since they all produce the same value for the inflation rate associated with the average money stock. For inflation rates that differ from the rate that characterizes intersection of the curves, higher values of λ correspond to greater money balances. This can be shown by noting first that the slope of these curves at their intersection is equal to α and is thus independent of λ. These demand functions have the "high contact" property at that point:[15]

[15] When comparing the performances of the functions in (16) in estimating the demand function for a given set of data, it might be preferable for changes in the parameters λ and γ to be restricted so that all functions were forced to produce the same value of demand for real money balances when there is no inflation. If $z(0) = z_0$, this would imply $\gamma = (z_0 - 1)/\lambda$. In this case, (16) becomes $z = (z_0 + \alpha\lambda\pi)^{1/\lambda}$, which intersect for $\pi_1 = (z_0 - 1)/\alpha\lambda$. Differently from the case in which only λ varies, these curves do not have the same slope at their intersection, and for $\pi < \pi_1$, larger $|\lambda|$ produce *smaller* real money balances, whereas for $\pi > \pi_1$, larger $|\lambda|$ produce larger real money balances. Using this alternative structure, it is possible to derive results analogous to those in the text, relating to convexity, the behavior of elasticity and maximization of inflationary revenue.

$$\frac{d^2 z}{d\pi^2} = \alpha^2 (1 - \lambda)[1 + \lambda\gamma + \alpha\lambda\pi]^{(1/\lambda)-2} \qquad (18)$$

Because the second derivative of (16) is given by (18) and is positive for every π, it can be concluded that all functions in this family are convex. The curvature of these demand curves for $\pi = -\gamma/\alpha$ is a decreasing function of λ, since in this case the expression on the right-hand side of (18) is reduced to the term outside the round brackets, in which the coefficier t of λ is negative. The rate of change in the slope of z is therefore an increasing function of $|\lambda|$, which means that the demand curves corresponding to greater absolute values of the Box-Cox parameter are less (more) inclined immediately to the right (left) of $\pi = -\gamma/\alpha$. This difference in inclination produces the rank order described previously with regard to money balances in the neighborhood of $z = 1$. This rank order with regard to λ in the values of real demand for money extends to all other points in the function domain because they comprise a continuous family of functions and meet only for $z = 1$, as can be seen from (16). This completes the demonstration of the statements regarding the rank order of the effect of λ on the shape and position of the demand curves.

When the inflation elasticity of money balances (denoted here by φ) is analyzed for high rates of inflation, there arises a crucial difference between the two possibilities for equation (16). To see this, it suffices to analyze the properties of the elasticity function, which is given by equation (19):

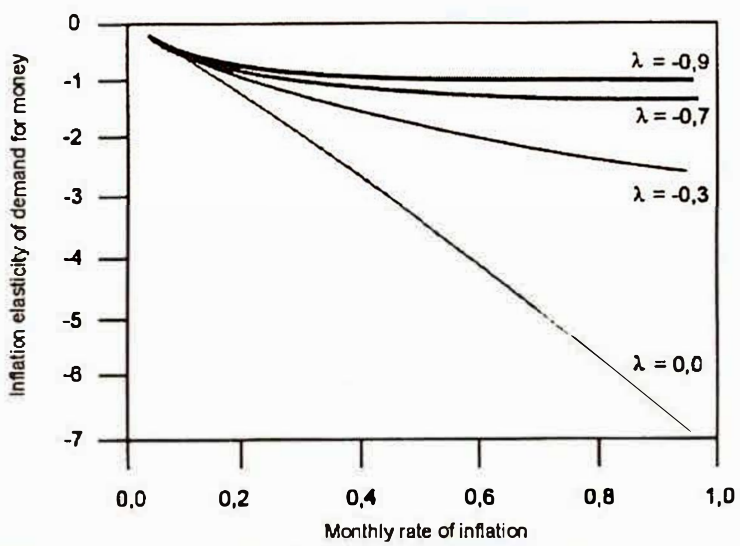
$$\varphi = \frac{\alpha\pi}{1 + \lambda\gamma + \lambda\alpha\pi} \qquad (19)$$

It can be seen at once that when $\lambda=0$ and Φ is the logarithmic transform, equation (19) is reduced to $\dot{\varphi} = \alpha\pi$, which is the expression for this elasticity derived by Cagan (1956). This function, however, increases in absolute value without an upper limit when inflation increases, forcing estimated money balances to approach zero very quickly when inflation rises, and forcing real demand for money to approach zero very quickly as hyperinflation develops, since for any α the proportional reduction in this demand due to an increase in inflation is very large and gets steadily greater.

Alternatively, if $\lambda<0$, the denominator of equation (19) limits the increase in the elasticity when π increases, thus attenuating the collapse of money balances, as illustrated in Figure 3. More importantly, the inflation elasticity of real money demand converges toward the inverse of parameter λ of the Box-Cox transform when hyperinflation sets in, as can be seen in (20), which is obtained by applying the L'Hôpital rule to (19):

$$\lim_{\pi \to \infty} \varphi = \frac{1}{\lambda} \tag{20}$$

Figure 3
Elasticity of Box-Cox demand for money



Equation (20) shows that when the inflation rate increases indefinitely, the limiting elasticity in the case of the Box-Cox transform with $\lambda<0$ is finite, contrary to the infinite value obtained for the case $\lambda=0$. This is consistent with the view that in the former case the velocity with which agents reduce their money holdings under hyperinflation is limited at the margin, so that real balances decline more slowly in this case. This is why the approach proposed here might be useful as a partial remedy for Cagan's difficulty in explaining real demand for money near the end of hyperinflation with the log-linear model.

In the other extreme case, when demand for money has the inverse functional form, as in equation (11), i.e. when $\lambda = -1$, the limiting elasticity is equal to -1. This is true as long as the parameter for the function that characterizes the convenience return on money (κ) is constant. Now consider the possibility that κ is a function of the inflation rate with a negative slope ($\kappa' < 0$). The limiting elasticity of demand for real balances in (11) can easily be calculated as $-1 + \zeta$, where $\zeta = \lim (\pi \kappa'/\kappa)$ is the limiting elasticity of the parameter κ when inflation increases indefinitely.[16] If this expression is compared with limiting elasticity in (20), it can be seen that it is possible to produce in the generalized formulation of the Box-Cox model for equation (16) the limiting elasticity of the model in equation (11), generalized for variable κ, by choosing the parameter λ as indicated in equation (21):

$$\lambda = 1/(\zeta - 1) \tag{21}$$

If the empirical estimate for λ in the Box-Cox model responds principally to he value of the limiting elasticity of demand for money at high inflation rates — as will be the case if it is useful to capture higher observed money balances than those expected on the basis of Cagan's formulation for hyperinflation — then it is possible that its value genuinely reflects the behavior of the scale parameter for the function that characterizes the convenience return on money. Reductions in the absolute value of the form parameter in the Box-Cox formulation, such as may occur when the equation is estimated for the various stages of a hyperinflationary process, can be due to increases in the absolute value of κ that result from the appearance of money substitutes. In this case, however, it may be difficult to distinguish between two possibilities for the nature of the parameters in the model:[17] flexible λ and fixed κ — equation (16) — or fixed λ and flexible κ — extended equation (11).

The Box-Cox functional form can also be instrumental in resolving an issue raised in Cagan's paper: the economies he analyzes seem to inflate at higher rates than economies in which inflation tax is maximized. As discussed earlier, for a given inflation rate the Box-Cox transform with $\lambda<0$ will produce demand for money balances larger than the logarithmic transform ($\lambda=0$) and will also produce higher optimal inflation rates for maximization of the inflation tax, as shown in Figure 4. To prove this, note first that if the demand for real money balances is given by equation (16), the constant inflation rate that maximizes revenue from the inflation tax, which is equal to $\Pi = z\,\pi$, is given by π^* in equation (22):

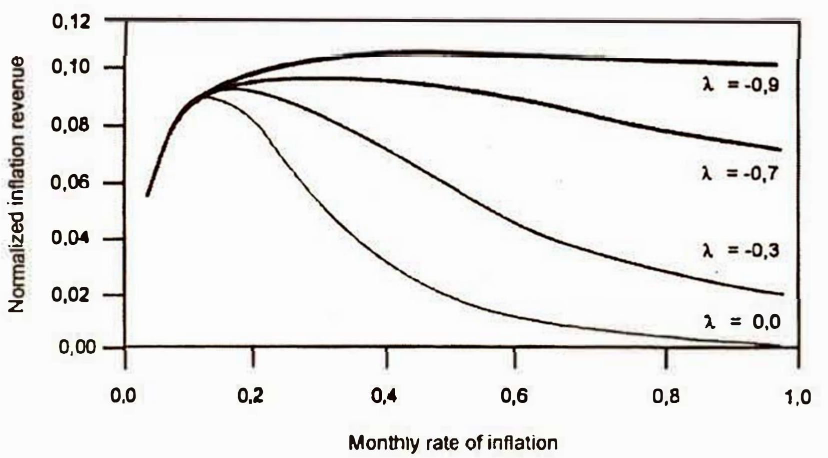
[16] Formally speaking, this extension of the model can be treated as it is in the text (by taking demand for money as given) only if it is assumed that economic agents ignore the dependence of the convenience return on money in relation to the inflation rate and the estimate of the expected value of κ is taken as given at each moment in time when resolving the problem of dynamic programming in equations (5)-(7). If the function $\kappa(\pi)$ were known in advance to the representative agent, it would have to have been included in the calculation of optimal demand for money balances.

[17] To distinguish between these possibilities, it may be worthwhile attempting to obtain indirect data for the convenience return on money.

$$\pi^{*} = \frac{1 + \lambda\gamma}{-\alpha(1 + \lambda)} \qquad (22)$$

As expected, when $\lambda=0$ equation (22) is reduced to the familiar expression $-1/\alpha$ derived by Cagan for the optimal inflation rate (to collect inflation tax). Note also that for the inverse function of equation (11) ($\lambda \rightarrow -1$), the optimal inflation rate tends to infinity. Thus the value of λ is the crucial parameter for determining the behavior of the optimal inflation rate and has the potential to resolve the apparent divergence found by Cagan between the mean inflation rate in actual hyperinflation episodes and the optimal rate calculated by the log-linear model.

Figure 4
Inflation revenue in the Box-Cox money demand function



Note also that in Figure 4 the revenue curve for the Box-Cox formulation is flatter than the logarithmic curve, which means any errors made in terms of overestimating the optimal inflation rate would produce significantly lower revenue losses in the Box-Cox equation than in the logarithmic specification. Given the nature of these revenue curves, which extend to the right as $\lambda \rightarrow -1$, the impact of a given absolute error in establishing the inflation rate is less serious if it is made in the direction of "inflating too much" than in that of "not inflating enough". This could lead risk-averse monetary and fiscal decision makers to err in the direction of overestimating the inflation rate required to obtain a given amount of inflation revenue, and therefore to collect more seigniorage than needed to absorb a given volume of real funds. It can only be conjectured whether this would fuel hyperinflation in a given situation.

An analysis ot equation (22) also allows us to restrict still further the acceptable values of the form parameter for the Box-Cox specification, since in order for π^* to be positive it is necessary to require that $\lambda \geq -1$. Although this condition regarding λ is not an implication of the basic properties of the money demand function, it is desirable that it be satisfyed since the optimal inflation rate for maximum collection of the inflation tax must be well defined if Cagan's explanation of the reason for money balances to expand is to be acceptable. Adding to this the restrictions on the Box-Cox parameter derived previously, we obtain inequation (23), which can be tested to verify whether the functional form adopted is an adequate representation of demand for real money balances:

$$-1 \leq \lambda \leq 0 \tag{23}$$

The second-order condition for a local maximum in π^*, for inflation tax revenue, is also satisfied provided the conditions derived above for λ and γ are met. To show this, it suffices to verify whether the sign of the second derivative of Π, which is given by (24), is negative at point π^* defined by (22):

$$\frac{d^2\Pi}{d\pi^2} = \alpha(1+\lambda\gamma+\alpha\lambda\pi)^{1/\lambda-1}\left[2+\frac{\alpha(1-\lambda)\pi}{1+\lambda\gamma+\alpha\lambda\pi}\right] \tag{24}$$

Note that because the term outside square brackets in (24) is negative, it is necessary to show that the term inside square brackets is positive at π^*. After a certain amount of algebra it is easily seen that in order to prove this it suffices to show that (25) is always satisfied:

$$\alpha\pi^*(1-\lambda) > -2(1+\lambda\gamma) \tag{25}$$

Substituting π^* as defined in (22) and recalling that (17) implies $1+\lambda\gamma>0$, (25) is reduced to the expression $1<2$, which is identically true. This completes the demonstration that Π is concave in π^*, and therefore this is the only extreme of this function, and it is the global maximum.

If the behavior of this maximum when λ varies is explored, it is easily seen that $\pi^*>-1/\alpha$ provided $\gamma<1$. This latter condition is a consequence of requiring that $\gamma<(1/\lambda)$, from (17) be satisfied for $\lambda = -1$, which is the most restrictive situation in (23). This means the money demand equation obtained using the Box-Cox transform with $\lambda<0$ will generate inflation rates that maximize inflation tax that are higher than those obtained with the logarithmic transform used by Cagan, precisely as we have been seeking to show. It is also easily seen by examining (26), that if $\gamma<1$ the inflation rate that maximizes inflation tax is an increasing function of the absolute value of λ:

$$\frac{d\pi^*}{d|\lambda|} = \frac{\gamma-1}{\alpha(1+\lambda)^2} \tag{26}$$

Taken as a whole, the properties shown in this section suggest that the Box-Cox functional form can be most useful in the analysis of data for the classic hyperinflations if the parameter λ is appropriately estimated. That flexible form is adopted here to estimate the demand for money in high-inflation processes because it probably performs well when high inflation degenerates into hyperinflation. It is also interesting because it is a functional form that is capable of producing the logarithmic transform, or the inverse function in this section, no matter which is in fact the right form to use.[18]

3. Empirical specification

The approach adopted here is the usual one for the study of this subject. Demand for money is analyzed in isolation and with the use of econometric techniques suited to the treatment of individual equations, thus leaving aside matters of identification and bias in simultaneous equations. A treatment of these broader issues would have required a description of the money supply process, which lies beyond the scope of this paper. Money supply may also be specific to the country and episode analyzed, and may not be susceptible to modeling in the more general framework employed in what follows.[19]

Moreover, it is assumed in this paper that effective and desired money balances are equal, so that it is unnecessary to follow the reasoning provided by the partial adjustment model to justify use of the lagged dependent variable as an explanatory variable. The past behavior of

18 This formulation is also capable of producing the linear function if $\lambda=1$, but this functional form can be eliminated in advance because it would generate negative money balances for sufficiently high inflation rates.

19 An alternative approach consists of using the technique of estimation by maximum verisimilitude of complete information proposed by Sargent (1977) to eliminate the asymptotic bias that can potentially occur in an estimation of Cagan's equation, owing to the existence of simultaneous equations in the correct specificotion of market equilibrium for money. This is not an encouraging approach, however. It produced "loose" estimates for the slope parameter of the money demand curve when applied to data for the classic hyperinflations.

variables influences the equation for the current period only through the mechanism of adaptive expectations operating on the independent variables, as described below. The absence of a lagged dependent variable on the right-hand side of the money demand equation is a key difference between the specification proposed here and the conventional one, as defined by Goldfeld & Sichel (1990, sections 2 and 4). This could possibly be a key advantage of the present specification because it avoids the econometric problems involved in estimating an equation that uses the lagged dependent variable as an explanatory variable in the presence of autocorrelated errors. Moreover, as initially pointed out by Cagan (1956), simultaneous use of the hypotheses of adaptive expectations and partial adjustment of actual to desired money balances could lead to severe identification problems.

3.1 Formation of expectations

It is assumed here that expectations about future price increases are formed adaptively, as proposed by Cagan (1956) for the case of hyperinflation. In Cagan's study a cursory examination of the time series involved was sufficient to establish that at any given time the observed rate at which prices were rising did not satisfactorily explain money balances at the same moment in time. Demand for real stocks of money seemed to depend additionally on the rates at which prices had varied in the past, and for this reason Cagan postulated that it depended on expected inflation rates, which in turn could be calculated as a weighted mean of past rates of price change, with weights given by a negative exponential function. This approach has become the usual formulation for the formation of expectations under high-inflation processes, according to Dornbusch (1992, p. 24), who stresses that there seems to be a significant sluggishness in the adjustment of real money balances in initial stages of the process, and that this seems to be followed by acceleration, thus suggesting precisely this mechanism for the formation of expectations.

The adaptive expectation hypothesis states that the expected rate of price changes is revised in each period proportionally to the difference between actual and expected inflation rates. Let $\dot{C}_t$ represent the effective instantaneous rate of exponential price rises at time t, i.e. a discreet sample of the continuous stochastic process $d \log P$, and let E_t represent the expected logarithmic inflation rate at the same moment in time.[20] Thus the adaptive expectation hypothesis means that E_t can be approximately computed by equation (27):[21]

$$E_t(\beta_e) = \frac{1-\exp(-\beta_e)}{\exp(\beta_e t)} \sum_{x=-T}^{t} C_x \exp(\beta_e x) \qquad \beta_e \geq 0 \qquad (27)$$

The parameter β_e, a coefficient which characterizes the formation of expectations and measures the velocity with which inflation expectations are adjusted, is positive and its unit is the inverse of the time unit (monthly, if C and E are measured on a monthly basis). A high value of β_e implies rapid adjustment and produces exponential weights whose value declines rapidly as actual inflation values further in the past are computed into the weighted mean. A small β_e implies slower adjustment and lower weights for actual inflation values in the recent past than in the previous case. The smaller the expectation coefficient, the longer expected inflation takes to respond to inflation shocks. The mean lag between changes in expectations and effective price changes is measured by $1 / \beta_e$. Its unit is the same as the time unit and indicates the position for the center of gravity of the pattern of exponential weights.[22] In equation (27), the first term after the equal sign is the normalization factor, which is equal to the infinite sum of the weights in the sum contained in the equation.

A possible objection to using the error correction mechanism of adaptive expectations is that it may imply a degree of "irrationality" on the part of economic agents, insofar as it assumes that they do not change their method for forming expectations even though they observe systematic errors in projections. However, as shown by Sargent & Wallace (1973), adaptive expectations may be rational in the sense used by Muth (1961) if expectations about a future increase in the money supply are formed in accordance with the hypothesis that the government is financing an approximately fixed proportion of its real spending by creating

20 Although the model is specified for continuous time, it is estimated on the basis of a series of observations obtained by sampling the continuous process at discrete intervals (one month). The new notation is introduced to emphasize this. Hansen & Sargent (1983) explore the possibility that this aggregation in time might significantly bias the estimation of Cagan's model, concluding that for values of β lower than unity, i.e. in the range of values obtained for the hyperinflations studied by Cagan, there is at most a very small asymptotic bias in the estimator of β proposed by Cagan.

21 Because Cagan specifies his model for continuous time, the precise formula for expected inflation is an integer analogous to the summation in the text, and not reproduced here. For the discrete approximation to be valid, the period T must be chosen so as to ensure that the approximation is sufficiently precise. Cagan shows that for an error to be inferior to 0.05%, T must be computed as follows: $T = (-1/\beta_e) \ln ((1 - \exp(-\beta_e) / 0.00005)$.

22 If the data are collected on a monthly basis, $1/\beta$ measures the mean lag in months. For example, if $\beta=0.2$, the mean amplitude of the weighting pattern is five months, i.e. the sum of the normalized weights between period t-5 and t is equal to 0.5. Moreover, in that case approximately 90% of the weight is contained in the last 12 months.

money. In their empirical analysis, Sargent & Wallace (1973, p. 342), conclude: "Our explanation for the feedback from X to m (inflation to money) tends to confirm the wisdom of Cagan's decision to model expectations from an extrapolation of past inflation rates. This method of forming expectations seems to have been rational." On the other hand, Friedman (1978) argues that the hypotheses used by Sargent & Wallace are equivalent to requiring that inflation follow a random path with a null trend, and concludes that the empirical evidence shows that this stochastic process is not plausible as a description of the hyperinflations studied by Cagan.

A rational expectations version of Cagan's specification, without imposing adaptive expectations but with random shocks to the velocity of money, is formally rejected in tests performed for the German hyperinflation by Engsted (1993), who argues however that there is an element of truth in the model insofar as deviations from it are transitory. This suggests that adaptive expectations may be subject to an attenuation effect even if they are not rational. Taylor (1991, p. 338) also interprets his results as rejecting the rational expectations model for hyperinflation in the cases studied by Cagan. However, the model is supported in several cases when, even without requiring rational expectations, it complies with the property that forecast errors are stationary, which is satisfied by adaptive expectations if the process for the inflation rate is first-order integrated. Thus these studies suggest that the adaptive (but not necessarily rational) expectation hypothesis may be reasonable for modeling money demand under high inflation.

Rational expectations are equivalent, in the deterministic case, to perfect short-term prediction. In this case, actual and expected inflation rates are equal, and systematic forecast errors are avoided. Perfect prediction can be considered a special case of the adaptive expectation hypothesis, as seen by taking the limit in equation (27) when β_e increases. Thus there is little to lose by considering that expectations are adaptive, then estimating the confidence interval for β_e, and testing the perfect forecast hypothesis by examining whether it includes high values[23] for β_e. Moreover, from the empirical standpoint the performance of the money demand equation will probably not be improved by assuming that the relevant variable is actual inflation. This may in fact reduce its explanatory power compared with the formulation including adaptive expectations, because a degree of freedom is lost by assuming in advance that β_e is large.

Tests conducted by Chow (1989) to assess the relative performance of rational and adaptive expectations in present-value models also show that adaptive expectations fit the data better. This author also illustrates the well-known fact that incorrectly imposing the property of

23 Empirically speaking, if the data are monthly, a value equal to five for the expectations parameter implies a mean amplitude of 0.5 per month for the weighting pattern and 99% concentration of the weight in the value for period t.

rational expectations on a model that would otherwise be correct can lead to unsatisfactory estimates of important parameters and argues in conclusion that adaptive expectations can be a useful working hypothesis in econometric practice. The present paper follows his advice and hence does not impose rationality on to the adaptive expectation model for demand for real money balances.

Another line of reasoning which can be pursued is to accept models that do not comply with the rational expectation requirement but adopt an enhanced mechanism of adaptive expectations. Evans & Yarrow (1981) extend the rule for adjusting the basic model to include a second-order term so as to correct errors in estimating the time derivative in the inflation rate. They argue that their error correction mechanism allows for stable equilibria and that they have "normal" comparative statistics parameters in contrast to rational expectations equilibrium models with perfect prediction, which in their view behaves "perversely". Frankel (1975) proposes a model in which agents are assumed to form expectations regarding the entire trajectory of the price level (and hence the mean long-term inflation rate) and also regarding the short-term inflation rate, arguing that this model produces short-term behavior that is more consistent with the evidence. The argument is not empirical, however, but based on simulations of the model's dynamic response to shocks. To justify his treatment of expectations, he argues that when information is costly, it may be "rational" for agents to use a relatively simple mechanism for forming expectations rather than trying (at high cost) to compute rational expectations trajectories. For either of these two models mentioned above, it is an empirical question to determine whether one of these more elaborate formulations of adaptive expectations fits the data better. On the other hand, merely enhancing the adaptive expectation hypothesis to force the expected inflation rate to follow the actual inflation rate more closely may not lead to an equation with a better fit, since at the limit we would have the perfect prediction hypothesis, which as already stated does not produce a better model.

The approach employed here is similar to that used previously, in that it extends the adaptive expectation model so as to deal with the uncertainty produced by inflation variability in a more precise manner. However, the nature of the extension is somewhat different, since instead of altering the expectation mechanism in order to enhance it, while maintaining the expected inflation rate as the only link with demand for money, the risk implicit in the use of inflation projections obtained under the adaptive expectation hypothesis is deliberately taken into account in the specification for the money demand equation. In order to attain this goal, it is natural to include in the equation a term proportional to the expected quadratic error in projecting inflation adaptively, and to estimate this term adaptively on the basis of observed past errors.

Because the strategy outlined in the preceding paragraph is equivalent to including inflation variance in the money demand equation,[24] we arrive by a different route at the result derived in Section 2, i.e. that an estimate of the variance of the stochastic price process should be included in the money demand equation. The value of σ^2 is not known in advance and may vary over time, but it can be estimated at each point in time on the basis of past quadratic deviations between the actual rate of price rises (dp/P) and the expected rate (π), rather than the difference from the mean for the entire period, as would be the case in a stationary process. If it is assumed that the formation of expectations about the value of the inflation variance is also adaptive, for the sake of consistency with the formation of expectations about the inflation rate itself, and considering the possibility that in this case the parameter for the formation of expectations may be different (β_v), the expression in equation (28) is obtained:

$$V_t(\beta_e, \beta_v) = \frac{1-\exp(-\beta_v)}{\exp(\beta_v t)} \sum_{x=-T}^{t} (C_x - E_x)^2 \exp(\beta_v x) \qquad \beta_d \geq 0 \qquad (28)$$

In the empirical application of the model developed in Sections 4 and 5, the parameter for the formation of expectations about inflation (β_e) and the parameter for inflation variance (β_v) were taken as equal and represented by the parameter for the formation of expectations about inflation β_i, since there does not appear to be a convincing reason to expect these two parameters to differ significantly in these cases. This is a hypothesis that enhances the stability of the non-linear routine used to adjust the model and does not bias the estimation, as verified by allowing these parameters to differ in a number of tests.

It is important to note that E_t is an estimate of the expected value of the trend for the stochastic process of log(P), which is equal to $\pi - \sigma^2/2$, as can easily be seen by applying Ito's lemma to the Wiener process in equation (1). Thus the estimate of π, which is the term that appears in demand equation (11), can be obtained by adding to E_t half of the estimated variance ($V_t/2$), as specified in equation (30). The estimate of σ^2 can be obtained from the quadratic difference of the stochastic process for the logarithm of prices (V_t), as in equation (28), because its variance is equal to that of the incremental price process.

24 When using this variable in the equation, however, it is useful to be aware of the stylized fact noted by Barro (1970): inflation-rate variance generally increases with the level of inflation. The direct effect of an increase in expected inflation is to reduce real money balances, but an indirect effect may also occur owing to the effect of the level of inflation on its variance. This second effect, however, is not taken into account here, since it is assumed that the explanatory variables are independent.

3.2 Other explanatory variables

Equation (30) generalizes Cagan's model by including the expected product and the real rate of interest as explanatory variables to capture the effects of the real sector of the economy. These are important in high-inflation episodes because they tend to last several years, thus invalidating the hypothesis usually utilized in studies of hyperinflation that such effects are negligible owing to the period of time involved and the magnitude of the impact of other factors.

The expected product is measured as a weighted mean of past income indices with exponentially declining weights, in accordance with a suggestion first put forward by Friedman (1956, p. 19) in connection with the specification of demand for money.[25] This is shown in equation (29), where I_x is the index of the actual real product in period x:

$$Y_t(\beta_y) = \frac{1-\exp(-\beta_y)}{\exp(\beta_y t)} \sum_{x=-T}^{t} I_x \exp(\beta_y x) \qquad \beta_y \geq 0 \qquad (29)$$

The real rate of interest appears in the empirical specification as shown in equation (11). This contrasts with other studies of the demand for money under high inflation which use the nominal interest rate to represent the return on alternative assets.[26] Only one interest rate is listed in (30) for the sake of simplicity, but in general it would be appropriate to include the real return on each alternative asset in which wealth could be held. Last but not least, the use of the real interest rate has the advantage of avoiding multiple co-linearity of the nominal interest rate with the inflation rate.

To summarize, equation (30) synthesizes the general specification for the money demand equation thot has the characteristics derived in Sections 2 and 3. Variables are dated by the subscript t and represented by upper-case letters. Parameters are represented by Greek letters, and ε is error:

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25 The author also used this income index, among others, as a measure of permanent income in his study on the consumption function (see Friedman, 1957, p. 142).

26 If Fischer's hypothesis is true, the use of the sum of the real interest rate and the inflation rate as the explanatory variable in the equation may be rationalized in the conventional empirical specification as being approximately equivalent to including the nominal interest rate in the equation. Phylaktis & Blake (1993) find strong evidence in favor of the validity of that hypothesis for three Latin American countries which experienced high-inflation episodes. This can be seen as supporting the equivalence in the application of the model to Brazil in Section 5.

$$\Phi(M_t/P_t, \lambda) = \Gamma + \alpha_\pi (E_t(\beta_e) + V_t(\beta_e, \beta_v)/2) + \alpha_v V_t(\beta_e, \beta_v) +$$

$$+ \alpha_r R_t + \alpha_y Y_t(\beta_y) + \alpha_s S_t + \alpha_t t + \varepsilon_t \qquad (30)$$

It has been suggested in studies of hyperinflation that the exchange rate may play an important role in money demand in such episodes. Equation (30) could include the premium on currency futures as an additional explanatory variable to measure the importance of foreign exchange as a substitute for local currency,[27] as suggested by Abel et al. (1979). Alternatively, the rate of real return on foreign-exchange holdings could be used, as recommended by the standard practice of including in the equation the return on all alternative assets. However, if the exchange rate is included in nominal terms, care must be taken to control for possible multiple co-linearity with the expected inflation rate. It is an empirical question whether the exchange-rate variable is significant in a given high-inflation process in the presence of the other variables in equatian (30).

A temporal trend is also part of the suggested specification, because the high-inflation episode may last several years, and it is necessary to capture the effect on the demand for real money balances of the technical progress represented by the generalized use of computers and electronic transactions. In this case it is necessary to take the usual care required when using a temporal trend to model these effects. Lastly, the equation also includes a variable to account for seasonal factors that may be present (S_t).

The chief empirical implications of this paper can be summarized in the following suggestions relating to the use of the structure proposed by Cagan far modeling demand for real money balances in high-inflation processes: (a) the linear functional of the Box-Cox transform should be used instead of the log-linear form; (b) the hypothesis that expectations regarding the inflation rate are adaptive should be retained and the actual inflation rate should not be used directly in the equation; (c) inflation-rate variance, estimated adaptively on the basis of the quadratic deviations between the actual and expected inflation rates, should be included as an explanatory variable; and (d) the rate of return on alternative assets should also be included and measured in real terms. In addition to these observations of a general nature, three testable empirical implications derived from equation (11) can be obtained from the

27 The premium on currency futures could also be used as an indirect measure of expected inflation, as proposed by Frankel (1977, 1979).

model in Section 2. They refer to the parameters of equation (30) and are summarized in equations (31) and (32) as follows:

$$\lambda = -1 \tag{31}$$

$$\alpha_{\pi} = -\alpha_{v} = \alpha_{r} = \frac{-1}{\kappa} \tag{32}$$

In the next two sections the performance of the model discussed above is evaluated by applying it to the data for the German hyperinflation and to an analysis of the high-inflation episode that occurred in Brazil in the last two decades.

4. Demand for money during the German hyperinflation

The model presented in Sections 2 and 3 was developed on the basis of several considerations, some of which relate to the behavior of demand for real money balances during hyperinflation. A natural test of the model, therefore, is to estimate it for the data for the German hyperinflationary episode[28] of 1923, using expected inflation and inflationary risk as the only explanatory variables, in order to verify whether it performs significantly better than the model proposed by Cagan.[29] This is done in the following sections, in two stages: the first assesses the enhancement produced by the use of a more flexible functional form, while the second shows the impact of including the variable which measures inflationary risk.

4.1 Equations without the inflationary risk variable

In order to isolate the benefits of using the Box-Cox functional form, the model was estimated without including inflation variance as one of the explanatory variables.[30] The coefficients for four equations, which differ in terms of the period sampled, are shown in Table 1: equation G1 uses the same period as Cagan (Sep. 1920-Jul. 1923), while equations G2, G3 and G4 exclude from the sample observations for which the inflation rate was low or even negative (Sep. 1920-Aug. 1921). Equations G2 and G3 differ in terms of the end-date of the

[28] The original data are taken from Cagan (1956), and the transformed variables are as defined in the preceding section.

[29] The model was also tested for the other hyperinflations tested by Cagan (1956) but the findings are not reported here for lack of space.

[30] Because the correct specification of the model includes inflation variance, the equations in Table 1 are evidently subject to criticism owing to the omission of a key variable.

sample: G2 uses the same date as Cagan, while G3 extends the sample to the last full month of the hyperinflation episode, thus including the observations excluded by Cagan because his equation did not fit them well, as described above. Equation G4 is shown merely for the sake of comparison, since it uses the log-linear formulation for the period extended to October 1923 and shows the nature of the difficulty encountered by Cagan in attempting to adjust the model for observations in periods close to the end of the hyperinflation episode.

All equations were estimated using the procedure described in Appendix A and corrected for heteroscedasticity and autocorrelation of residues. The only exception is G4, which was not adjusted for serial correlation because the Cochrane-Orcutt procedure did not produce satisfactory results. Real money balances were normalized so as to be equal to unity for the geometric mean for the period 1920:8/1923:7, while the inflation rates were normalized so as to be equal to unity for the arithmetic mean for the period 1921:8/1923:11.

In equation G1, the point-estimate of the form parameter for the Box-Cox function ($\lambda = -0.2$) is very similar to the value implicitly assumed by Cagan, and the null value for λ — which corresponds to the logarithmic functional form — is within the 95% confidence interval for that parameter. If the analysis were not detailed further, this would appear to show that he was right to take the log-linear functional form for granted. Moreover, the values of the parameter for the formation of expectations ($\beta = 0.2$) and for the semi-elasticity of demand for money with regard to inflation ($\alpha_\pi = -5.3$) coincide almost exactly with the values obtained by Cagan.

However, excluding observations prior to August 1921 from the sample and estimating equation G2, a very different value emerges for the form parameter: $\lambda = -0.7$. The confidence interval for this parameter shows that the logarithmic formulation can be rejected and that the inverse functional form of equation (11) cannot be rejected, both at the 5% significance level.

TABLE 1
Estimates of demand for real money balances during the German hyperinflation[a]
(Equations without inflationary risk variable)

	G1	G2	G3	G4
Start date	1920:9	1921:9	1921:9	1921:8
End date	1923:7	1923:7	1923:10	1923:10
Degrees of freedom	31	20	23	23
R^2	0,9978	0,9876	0,9464	0,8740
Sum of quadratic residues	0,6867	0,7483	5,6775	11,7677
Standard error of estimate	0,1488	0,1934	0,4968	0,6860
Durbin-Watson	1,1848	1,6999	1,4304	0,2683

(cont....)

(continued)

	G1	G2	G3	G4
Parameter of Box-Cox functional form (λ)	-0,2 (-0,42, -0,04)	-0,7 (-1,16, -0,35)	-0,6 (-1,13, -0,32)	0 (predetermined)[b]
Parameter for formation of adaptive expectations (β)	0,198 (0,167, 0,231)	0,249 (0,215, 0,285)	0,150 (0,089, 0,215)	0,061 (-0,036, 0,168)[c]
Intercept (Γ)	0,834 (0,054)	1,085 (0,071)	0,994 (0,131)	1,183 (0,089)[c]
Coefficient of price process trend (π)	-5,269 (0,310)	-4,375 (0,245)	-4,336 (0,421)	-6,180 (0,543)[c]
Coefficient of residue correlation (ρ)	0,923 (0,061)	0,632 (0,199)	0,535 (0,269)	- -

[a] The values in brackets below the estimates of coefficients Γ and π are standard deviations for the respective parameters. The pair of values shown below the estimate of β is its 95% confidence interval. The estimates for all parameters, as well as their confidence intervals and standard errors, are conditional upon λ. The value for λ and for its confidence interval are unrestricted estimates of maximum verisimilitude. All equations except G4 were estimated with corrections for heteroscedasticity and serial correlation of residues, so as to produce unbiased estimates of standard deviations and confidence intervals. Equation adjustment statistics shown in the upper portion of the table refer to equations as corrected. See Appendix A for details of estimation procedure.

[b] The functional form of this equation is restricted to being log-linear so as to reproduce Cagan's model.

[c] Estimated confidence intervals and the standard deviations of these coefficients are probably biased owing to the high degree of residue autocorrelation, which the Cochrane-Orcutt procedure was unable to correct.

It is not clear why Cagan included these data in his sample, since a theory of demand for money in hyperinflation could hardly be expected to explain demand for real money balances in periods of very low inflation without possibly introducing distortions into the estimation. Exclusion of these observations from the sample is important because they apparently bias the estimation of the functional form in favor of the log-linear formulation, and this has important implications for the way in which real money balances respond to a rise in the inflation rate, as discussed in sub-section 2.2.

In equation G2, the parameter for the formation of expectations is higher (β=0.25), and the value of the coefficient for expected inflation is, in absolute terms, 20% lower than in equation G1. The standard deviation and the confidence interval for the parameters are tighter than Cagan's, which indicates that the more flexible functional form enables the parameters to be identified more distinctly. Moreover, the Cochrane-Orcutt and Box-Pierce statistics do not indicate rejection of the hypothesis of non-autocorrelation of residues at the 5% level, contrary to Cagan's equation, which presents strong serial correlation of residues, as noted by Barro (1970).

The inflation elasticity of money balances that at the inflation rate characterizes the onset of hyperinflation ($\pi=0.5$) can be computed from the G2 coefficients by using equation (20) and is equal to -1.27, which is less than half of -3.18, the value produced by the log-linear model in equation G4 for the same inflation rate. Using the coefficients in equation G2, and using (22), a straightforward computation shows that the monthly inflation rate with continuous capitalization for maximization of revenue from inflation tax[31] is equal to $\pi^* = 14\%$. Thus it would seem from the point-estimate alone that the model does not explain the divergence between the optimal rate and the actual rates observed by Cagan[32] when comparing his optimal rate of 18% with the mean rate for the hyperinflation period, which is equal to 322%. However, this difference can better be put into perspective by taking account of the fact that the optimal rate increases very quickly as the form parameter approaches -1, as illustrated in Figure 4. This raises a key difficulty for obtaining a reasonably accurate estimation of the optimal inflation rate for inflationary financing in situations such as equation G2, where the confidence interval for λ includes a set of values in the neighborhood of -1. In this case the optimal inflation rate may be far higher than the rate computed using the point-estimate of the form parameter if the true value is smaller than the estimated value. In this situation the only precise statement that can be made is that the hypothesis that the optimal inflation rate is in fact infinitely high cannot be rejected at the 5% significance level.

When the model is estimated for the period that ends in October 1923 (equation G3), the estimate for the form parameter can be seen to be stable, since the point-estimate of this parameter and its confidence interval are almost identical to those obtained with equation G2. Moreover, the estimated value of the α coefficient is the same in both equations, showing that the convenience return on money (κ) is also stable. There are some differences in the estimate of β, which decreases from 0.25 to 0.15, possibly as a reflection of some of the other specification problems that led Cagan to end his estimating period in July 1923. Lastly, it can be seen that the standard error in equation G3 is significantly higher than in equation G2, suggesting that the flexible functional form is not sufficient for a full explanation of the poor

31 The fact that the optimal inflation rate is lower than in equation G2, where $\lambda=-0.7$, when compared with the value computed by Cagan (for $\lambda=0$), is not inconsistent with the derivations in sub-section 2.2 because there are other parameters that were considered constant, which is not the case here.

32 The constant optimal inflation rate to maximize revenue from inflation tax can also be compared with the mean monthly inflation rate for the period for which the equation is estimated, which is equal to 23.2%. In this case the difference between the optimal and actual inflation rate is not as great as the difference mentioned in the text. A discussion of which parameter to use for the comparison should focus on two points: (a) when the practice of inflationary financing is assumed to begin, i.e. either when inflation starts to accelerate or not until hyperinflation has set in; and (b) when the period during which the inflation rate is rationally determined by the attempt to levy seignorage is taken to come to an end, i.e. the end of the sample period for which the money demand equation is valid or the end of the hyperinflation process. If the first alternative is preferred as the answer to each of these two questions and July 1923 is considered the end of the sample period, the divergence between the optimal inflation rate and the mean inflation rate is small.

performance of Cagan's equation near the end of the German hyperinflation. However, a comparison of equations G3 and G4 shows that it is highly useful for reducing the specification error for his equation.

4.2 Inclusion of a variable for inflationary risk

The second step in evaluating the model presented here is to include inflation variance as an explanatory variable. A significance test will indicate whether its omission was an important flaw in Cagan's formulation. Equations G5 and G6 in Table 2 show the results of this exercise for the sample periods starting in 1921:8 and ending in 1923:7 and 1923:10 respectively.[33] The sample for equation G7, which starts in 1922:8 and ends in 1923:7, is designed to assess the effect of restricting the estimation to hyperinflation proper, while at the same time avoiding the distortions that can be introduced by consideration of the data for the end of the process.

All equations were estimated using the procedure described in Appendix A and corrected for heteroscedasticity and autocorrelation of residues. The sole exception is G7, in which no adjustment for serial correlation was needed. Real balances and the inflation rate were normalized as in the previous section.

The interpretation of the estimated value for the form parameter (λ) depends on how the convenience return on money (κ) is assumed to behave as hyperinflation develops. There are two possibilities, as discussed in the context of equation (20): it is either constant or decreases as inflation increases. These possibilities are analyzed in what follows.

TABLE 2
Estimates of demand for real money balances during the German hyperinflation[a]
(Equations with inflationary risk variable)

Equation code	G5	G6	G7
Start date	1921:9	1921:9	1922:8
End date	1923:7	1923:10	1923:7
Degrees of freedom	19	22	9
R^2	0,9937	0,9857	0,9797

(cont....)

33 As stressed in the preceding section, it is prudent to avoid starting the sample period on the initial date used by Cagan, owing to the bias this could introduce into the estimation of the form parameter in the Box-Cox money demand equation.

(continued)

Equation code	G5	G6	G7
Sum of quadratic residues	0,3740	1,1286	0,1277
Standard error of estimate	0,1403	0,2265	0,1191
Durbin-Watson	1,7232	1,6009	2,0231
Parameter of Box-Cox functional form (λ)	-0,5 (-0,79, -0,18)	-0,2 (-0,49, +0,10)	-0,8 (-1,76, +0,10)
Parameter for formation of adaptive expectations (β)	0,191 (0,164, 0,219)	0,160 (0,129, 0,192)	0,263 (0,232, 0,294)
Intercept (Γ)	1,158 (0,071)	1,184 (0,109)	1,397 (0,095)
Coefficient of price process trend (π)	-5,519 (0,358)	-5,103 (0,473)	-5,433 (0,218)
Coefficient of inflation variance (σ^2)	6,252 (1,199)	4,632 (0,549)	4,091 (0,573)
Coefficient of residue correlation (ρ)	0,753 (0,185)	0,717 (0,159)	-

[a] The values in brackets below estimates of coefficients Γ, π and σ are standard deviations for the respective parameters. The pair of values shown below the estimate of β is its 95% confidence interval. The estimates for all parameters, as well as their confidence intervals and standard errors, are *conditional* upon λ. The value for λ and for its confidence interval are unrestricted estimates of maximum verisimilitude. All equations except G7 were estimated with corrections for heteroscedasticity and serial correlation of residues, so as to produce unbiased estimates of standard deviations and confidence intervals. Equation adjustment statistics shown in the upper portion of the table refer to equations as corrected. See Appendix A for details of estimation procedure.

In the first case (constant κ), it is possible to test the hypothesis that the true functional form of the demand for real money balances is either Cagan's log-linear specification or the inverse function described in Section 2, by testing for $\lambda=0$ and $\lambda=-1$ respectively. For the period 1921:9/1923:7 (equation G5), the estimated value of λ is –0.5, which is similar to –0.7, the value found in equation G2. Now, however, with inflation variance included in the equation, the hypotheses that the functional form is the logarithm or inverse function can both be rejected at the 5% significance level.

For the sample that includes only the observations for the hyperinflation period (equation G7), the estimated value of the form parameter is –0.8, and neither of the two extreme functional forms can be rejected at the 5% significance level, owing to the very large confidence interval. At the 10% level, however, the hypothesis that $\lambda=0$ can be rejected but not $\lambda=-1$, even at the 25% significance level. This shows that for the latter equation the inverse function is probably very close to the true functional form.

It is also easy to calculate from (20) that the limiting value for the elasticity of real money balances (φ) when inflation increases unlimitedly is equal to -1.25 and -2.0 in G7 and G5 respectively: these values appear far more reasonable than the value $-\infty$ implicit in the log-linear specification.

In equation G6, where the sample period runs from 1921:9 to 1923:10, and which therefore includes the observations left out by Cagan, the estimated form of the money demand function approximates the logarithmic function ($\lambda = -0.2$) and significantly differs from the function found in the equation (G3) for the same period ($\lambda = -0.6$). If the parameter of the function that describes the convenience return on money (κ) is constant, the hypothesis that the functional form is the inverse function can be rejected, but the hypothesis that it is logarithmic cannot. It must be stressed that inclusion of inflation variance significantly enhances equation G3, since equation G6 fits the data far better.

Now consider the second possibility[34] for the interpretation of the estimated value of λ in G6, which is to assume that the demand function has the inverse functional form and at the same time to allow the parameter of the function for the convenience return on money (κ) to decrease as the inflation rate explodes at the end of the hyperinflation process. *If* the estimate of the form parameter is dominated by the behavior of ζ (the inflation elasticity of κ at very high inflation rates toward the end of the hyperinflation process), then according to equation (21) the estimated value of λ in G6 would imply $\zeta = -4.0$. This might explain the increase in the estimated value of λ in equation G6 when the sample period is extended beyond 1923:7, in line with the hypothesis that the true functional form is given by the parameter found in the preceding equations (approximately -0.7).

The estimated value for the expectation parameter (β) decreases from five months in G5 to four in G7, reflecting the pattern observed previously and explained by Cagan (1956, pp. 58-63) when he examines the classic hyperinflations: the mean lag in expectations diminishes when the mean level of inflation increases. This greater sensitivity of expectations to shocks when inflation increases occurs because the cost to agents of not adjusting their expectations fast enough rises swiftly as the inflationary process accelerates and this leads agents to reduce the mean lag in their expectations. The upper limit for the confidence intervals of β in equations G5 and G7 is 0.26, which clearly shows that current inflation cannot replace expected inflation in the money demand equation, since the approximate equality of these two

[34] The estimated value of the expectation parameter in equation G6, which is relatively low, suggests a third possible explanation for the low absolute value of λ obtained for that equation: the expected quadratic error in the projected inflation rate, which estimates variance in the model, may also be correcting for a reduction in the estimated value of the expectation parameter observed when equations G2 and G3, or G5 and G6, are compared. Unfortunately this peculiar interaction may distort the estimate of λ for this sample period, and this shows the need for reservations about its value in G6.

rates would occur only for values of the expectation parameter of the order of 10. This also suggests that use of the adaptive expectation hypothesis to model this hyperinflation episode is justified.

The coefficients estimated for the linear part of the equations in Table 2 are all different from zero at the 5% significance level, showing that omission of the variable that reflects inflationary risk can be a serious specification problem when the data for the German hyperinflation are analyzed. The absolute value of the coefficients of the expected value and variance of inflation are similar (around 5), and the sign of the latter is positive, as expected from the discussion in sub-section 2.1. Moreover, the hypothesis that the sum of the coefficients of the expected values for the level and variance of inflation is null cannot be rejected at the 5% significance level for any of the equations.

To sum up the results of sub-sections 4.1 and 4.2, it can be argued that as a whole they show that the specification proposed here is capable of a better fit with the data for the Germany hyperinflation than the specification proposed by Cagan.[35] It has also been shown that the hypothesis in equation (31) is satisfied to some extent, whereas hypothesis (37) is strongly supported, in general offering evidence in favor of the model in equation (11), with $\kappa \cong 0.2$.

5. Demand for money in Brazil: 1974-92

The modeling strategy proposed here was also applied to Brazilian data for the period between January 1974 and November 1992, when the monthly inflation rate with continuous capitalization varied between about 3% and close to 60%. During this period there were five monetary and income shocks after 1986, causing major changes in the inflation rate in short periods and triggering violent acceleration and deceleration in prices. Real demand for money in months with very high inflation was roughly one-sixth of demand in periods with low inflation (see Figure 5).

Estimation of a function representing demand for real money balances in the full period specified previously is a challenging exercise, especially owing to the shocks that occurred in the period, since no observations were excluded from the estimation. The inclusion in the estimation of a period with relatively low inflation[36] requires that the equation perform well in those situations and allows for an analysis of the changes that occurred in the behavior of agents during the early stage of hyperinflation. On the other hand, several shocks that

35 This comparison with Cagan's model may not be entirely fair, since the model proposed here has an additional explanatory variable, while the Box-Cox functional form is more general and allows for an additional degree of freedom compared with the log-linear specification.

36 Between 1974 and 1983 the rate of price rises remained below 10% per month.

occurred toward the end of the period, while making it difficult to fit the equation to the data, tend to bring out the essential characteristics of demand for money in this economy.

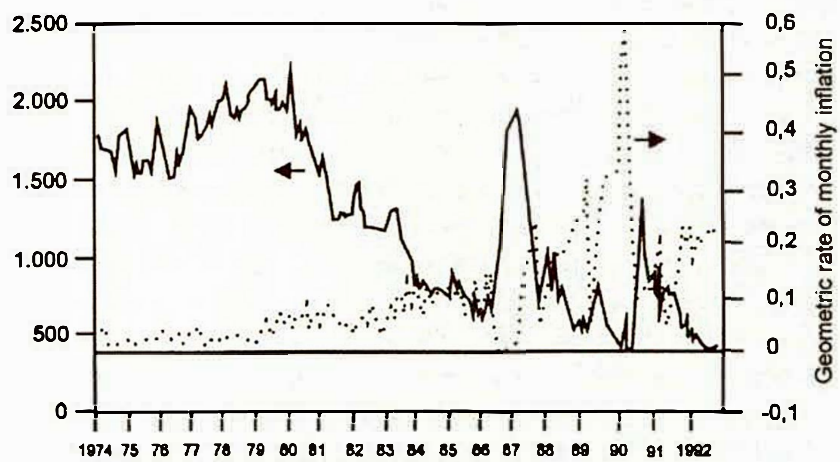
Linear econometric models of demand for money in Brazil that include data after 1974 and use the inflation rate as an explanatory variable can be found in the following studies. Cardoso (1983) uses quarterly data for the period 1996-I/1979-IV in a log-log model and discusses the relative importance of the nominal interest rate and the inflation rate to explain demand for money. The inclusion of lagged money balances as an explanatory variable in the equation is criticized by Gerlach & De Simone (1985), who estimate an autoregressive model of distributed lags with the same variables but also including seasonal factors, and show that the inflation rate is statistically more significant that nominal interest rates in their equation, in contrast with Cardoso's results. They estimate the long-term inflation elasticity of real money balances as –0.08. Darrat (1985), who also criticizes Cardoso's specification for the same reason, uses an Almon lag for the logarithm of income, the nominal interest rate and inflation to solve the apparent instability of Cardoso's equation and finds that the inflation rate is the main explanatory variable in his demand equation, estimating the corresponding long-term elasticity as –0.2. Rossi (1988), who extends Cardoso's data and equations to cover the period 1980-I/1985-IV and argues that the downward shift in the equation occurred in about 1980, also uses the log-log functional form, and concludes that the equation is unstable after 1980. None of these models explicitly deals with the problem of formation of expectations, use alternative functional forms besides the log-log specification or tries to include in the equation a variable to capture inflationary risk.

Rossi (1994), who applies the methodology proposed by Phylaktis & Taylor (1992) and by Engsted (1993) to test the co-integration of money and prices, using monthly data for the period 1980:1/1993:12. This is the only study to include in the analysis the shocks imposed on the economy in pursuit of stabilization after 1985. It finds co-integration for the full period but not for any of the sub-periods into which the sample is divided. In his log-linear formulation, Rossi estimates that the inflation semi-elasticity of demand for money falls between –5 and –8 for periods of high inflation and roughly double that for periods of moderate inflation.

5.1 Estimation

In applying the model described in Section 3 to Brazil, the seasonal adjustment assumed necessary consists of the inclusion of a dummy variable for the periods corresponding to the months of December. This is required because of observed peaks in the demand for money in these months, as can clearly be seen in Figure 5. These exceptional spikes in demand are probably due to the fact that all Brazilian employees receive annual bonuses at that time. The dummy variable is inserted in equation (30) and multiplied by the expected inflation rate, producing a shift in the slope of the function in the months in question rather than a shift in the intercept. This approximately reflects a constant proportional increase, rather than a constant absolute increase, in the demand for real money balances in December, which appears to be the expected result of the increase in nominal incomes that occurs in that month. The technology trend is represented by a time-shift variable equal to the number of months between the start date and the period *t*.

Figure 5
Monetary base and inflation



The model is estimated for the period 1974:2/1992:11 with monthly data as presented in Appendix B. Figure 5 shows real money balances and the inflation rate. Two different concepts of money are used: the monetary base (MB), equal to the net balance of money issued plus bank reserves (on the last day of the month); and M1, including the balance of demand deposits (also on the last day of the month). Only the estimated coefficients for the narrower aggregate are presented here since the results are similar for both aggregates and the empirical findings do not depend heavily on the aggregate used.[37]

The coefficients for the three equations, one for each estimation period, are shown in Table 3: equation B1 refers to the full period, while B2 and B3 refer to the sub-period prior to and subsequent to 1985:1 respectively. All three were estimated to assess the structural stability of the model and to endeavor to identify behavioral changes that might occur on the way to hyperinflation. The first sub-period corresponds to the initial stage of the high-inflation episode,

37 The determination coefficient for the M1 equations is marginally larger, but these equations also have a higher residue autocorrelation and worse Durbin-Watson statistics.

when the exponential monthly rate was below 12% (except for some months in 1983), and the second corresponds to extreme inflation, starting with an acceleration of inflation during 1985, which led to the first attempt at stabilization in February 1986. Five subsequent attempts at stabilization also failed.

5.2 Format of the money demand function and formation of expectations

The estimated values of λ in equations B1, B2 and B3 are –0.9, –0.7 and –1.2 respectively, showing that the shape of the money demand curve is very similar to the shape of the inverse function curve ($\lambda=-1$), as might be expected from the nature of equation (11). Condition (23), which summarizes the theoretical restrictions on the value of the form parameter for the Box-Cox transform, is respected by the point-estimate for λ in equations B1 and B2 but not in B3, where the lower limit of the inequation is violated. In this latter case, however, the estimated confidence interval for λ at the 95% level includes a range of values that satisfies the restriction, showing that the various hypotheses advanced in sub-section 2.2 to derive this condition cannot be rejected at the 5% level for any of the three equations. The confidence intervals for λ also show that the hypothesis that the true functional form of the money demand curve is the inverse function cannot be rejected for equation B2, which corresponds to the low-inflation stage,[38] while Cagan's log-linear form ($\lambda=0$) can be rejected in all three equations. At the 1% level, the log-linear form can also be rejected, but the inverse functional form cannot.

The above analysis is strictly valid only if κ, the parameter for the convenience return on money function in Section 2, is constant. However, a comparison of the inflation-rate coefficient, which is equal to $-1/\kappa$ if the true functional form is the inverse function — equation (14) — in all three equations shows that the convenience return parameter does not significantly change as the mean monthly inflation rate rises from 5.1% to 16.5% in the periods sampled by equations B2 and B3 respectively. This is an indication of the approximate constancy of this parameter, which, in conjunction with the fact that $\lambda=-1$ is supported for the entire period as well as the extreme-inflation period, suggests that the inverse functional form in equation (11) is indeed the true form or that they are highly similar.

38 The low significance of inflation variance in equation B2 is not inconsistent with the development of Section 2 because equation (11), which shows that it must be a significant variable in demand for real money balances, was derived for *high* rates of inflation.

TABLE 3
Estimates of demand for real money balances: 1974-92[a]

Equation code	B1	B2	B3
Start date	1974:3	1974:3	1985:2
End date	1992:11	1985:1	1992:11
Observations	225	131	93
Degrees of freedom	217	123	85
R^2	0,9809	0,9892	0,9356
Sum of quadratic residues	16,5177	2,9765	15,4304
Standard error of estimate	0,2759	0,1555	0,4261
Durbin-Watson	2,1973	2,0885	2,1027
Parameter of Box-Cox functional form (λ)	-0,9 (-1,07, -0,74)	-0,7 (-0,94, -0,46)	-1,2 (-1,55, -0,76)
Parameter for formation of expectations about level and variance of inflation (β_i)	0,180 (0,167, 0,192)	0,11 (0,080, 0,137)	0,20 (0,180, 0,227)
Parameter for formation of expectations about income (β_y)	0,057 (0,046, 0,067)	0,075 (0,048, 0,104)	0,043 (0,001, 0,092)
Intercept (Γ)	-1,685 (0,239)	-0,986 (0,296)	-4,005 (0,9392)
Coefficient of price process trend (π)	-0,975 (0,049)	-1,263 (0,219)	-1,100 (0,057)
Coefficient of inflation variance (σ^2)	1,102 (0,065)	0,897* (0,956)	1,214 (0,074)
Coefficient of normalized short-term interest rate *(R)*	-0,127 (0,029)	-0,146 (0,032)	-0,111 (0,058)
Coefficient of normalized short-term interest rate *(R)*	3,634 (0,373)	2,504 (0,439)	6,903 (1,301)
Coefficient of normalized temporal trend *(t)*	-1,157 (0,133)	-0,545 (0,239)	-1,901 (0,357)
Coefficient of dummy variable for months of December *(S*E)*	0,150 (0,015)	0,112 (0,016)	0,200 (0,031)
Coefficient of residue correlation (ρ)	0,637 (0,053)	0,819 (0,054)	0,419 (0,097)

[a] The values in brackets below estimates of Γ and ρ and of the coefficients π, σ^2, *R*, *Y*, *t* and *S*E* are standard errors. All coefficients are significant at the 5% level, except when marked with an asterisk (*). The pair of values shown below the estimates of λ, β_i and β_y is the respective 95% confidence interval. The equations were estimated with corrections for heteroscedasticity and serial correlation of residues. Equation adjustment statistics shown in the upper portion of the table refer to equations as corrected. See Appendix A for details of estimation procedure.

The estimate of the parameter for the formation of expectations about the level and of variance of inflation (β_i) for the full sample is equal to 0.18, implying a lag between the expected and actual values of 5.5 months on average. This is merely the mean value of the lag for the entire sample, since there is evidence that it is greater when inflation is relatively low and decreases as inflation accelerates. This can be shown by noting that the estimate of the expectation parameter for the initial stage of the process is equal to 0.11, while for the extreme-inflotion stage it is equal to 0.2. The increase in β_i reflects a reduction in the mean log in the formation of expectations from nine months to five months, which occurs in response to the rise in the mean level of inflation associated with the second sub-period. This is the some as the effect that occurred during the German hyperinflation, as stressed in sub-section 4.2, and was first identified by Cagan (1956).

The confidence intervals for β_i are reosonably narrow in relation to the point-estimate, making for the very safe conclusion that the mean period for the formation of expectations decreases substantially as inflation increases. For example, the upper limit for the confidence interval in equation B2 is 0.14, whereas the lower limit in equation B3 is 0.18, indicating a manifest shift in the formation of expectations.

The estimate of the expectation parameter for expected income (β_y) in equation B1 is equal to 0.057, implying a mean lag of 17 months in relation to the actual income index. This lag — which is roughly three times the lag for expected inflation — is consistent with the idea thot expected income should respond more slowly to shocks. The estimate for this parameter in equation B2 is 0.075, corresponding to a mean lag of 13 months, which is shorter than the lag in equation B1. For equation B3, the point-estimate is smaller than for equation B1 but the confidence interval is for greater, so that it is difficult to give much weight to the former value.

5.3 Level ond varionce of inflation, interest rates and income

The other important empirical implication of the model in Section 2 is summarized in equation (32), which specifies that the coefficients for the level ond variance of the inflation rate must be equal to $-1/\kappa$ and $1/\kappa$ respectively. The following paragraphs discuss the results of testing these hypotheses for each of the equations in Table 3.

In equation B1 (for the full sample), the estimated values of the coefficients of π and σ^2 are –0.975 and 1.102 respectively, and their standard deviations show that for $\kappa=1$ neither of the two above hypotheses con be rejected at the 5% significance level. The hypothesis that the sum of the coefficients of π and σ^2 is null, which is a direct test of the theoreticolly imposed restriction, also cannot be rejected at the 5% level. Because the confidence intervals for these parameters are reasonably norrow, the fact that the reduced form of the equation passes this empirical test can be seen as a strong argument in favor of the model proposed in Sections 2 and 3, especially with regard to the sign of the inflation variance coefficient, which is positive, as expected.

In equations B2 and B3, the estimates for the inflation rate coefficient are equal to −1.263 and −1.100 respectively, i.e. less than the value found in equation B1. However, in light of the values of their estimated standard deviations, the hypothesis that $\kappa = 1$ cannot be rejected at the 5% level in either equation, suggesting that this parameter is stable over time, as noted earlier.

For equation B2, the hypothesis that the sum of the coefficients of π and σ^2 is null cannot be rejected at the 5% level, mainly because the standard deviation of the coefficient for the inflation the variance is very large, demonstrating that in fact it is not significant y different from zero. For equation B3, however, the same hypothesis can be rejected even at the 5% level but not at the 2.5% level. The values of the variance coefficients in equations B2 and B3 are as expected: when inflation is relatively low, agents are not concerned about its variability, giving rise to an insignificant coefficient, whereas under extreme inflation they take significant precautions to protect themselves against inflationary risk (especially owing to the various shocks in the period), thus giving rise to a higher coefficient.

A further implication of the model is that the coefficient of the real rate of interest should be equol to $-1/\kappa$ and equal to the coefficient of the inflation rate. Unfortunotely, this condition is not met for any of the equations, since the coefficient in question is around −0.1 in all three. I have no explanation for this at present, but it moy be conjectured that the estimoted value of this coefficient might be subject to the problem of simultaneous equations bias, since the real interest rate could be a channel through which interaction with the money supply equation takes place. As mentioned before, this problem must be dealt with on a later occasion.

To sum up, it can be argued thot the estimates obtoined for λ and for the coefficients of π and σ are strong evidence in favor of the relevance of the functional form derived from the model in Section 2 to the analysis of demand for real money balances in Brazil in the period 1974-92.

Table 4 shows values for the inflation elasticity of real money balances for various typical inflation rates derived from the equations for the full period, and for the initial and extreme stages of the process. For equation B1, the value of the elasticity with respect to expected inflation at the rate that characterizes the onset of hyperinflation is $\varphi\,(0.5) = -1.04$, which is very close to the limiting elasticity when the inflation rate rises indefinitely. This demonstrates that the intensification of hyperinflation would not produce, for this money demand equation, a significant increase in the absolute value of that elasticity compared with the value observed at the onset of hyperinflation. This implication is entirely different from the implication that can be deduced from Cagan's model, insofar as the absolute value of that elasticity would rise unlimitedly as hyperinflation proceeded. The value of the elasticity computed here is only 34%

of the value that would be obtained from the formula derived by Cagan (–3.02) using the value for the semi-elasticity of real money balances estimated by Rossi (1994) for Brazil.[39]

TABLE 4
Inflation elasticity of real money balances[a]

Equation	81	82	83
Reference date	1985:11	1984:1	1992:1
Monthly inflation rate			
∞	1,11	1,43	0,83
50%	1,04	1,26	0,82
10%	0,84	0,86	0,78
2,16%	0,44	0,35	0,65
Intercept of reduced form (γ)	0,784	0,573	0,766

[a] To compute elasticity it is necessary to assume values for the other exogenous variables in equation (30). In this exercise, the expected variances of the inflation rate and the income index respectively are equal to the mean value in the sample for each equation, the real interest rate is null, the computation is performed for the reference date shown under the equation code, and December is not included. The coefficients for the equations were used to obtain the value of γ indicated in the table.

The inflation elasticity of money balances at the mean inflation rate for the period analyzed by Cardoso (1983)[40] is equal to –0.44. This too is higher in absolute terms than the estimates obtained for the same period by Gerlach & De Simone (1985) and Darrat (1985), i.e. –0.08 and –0.20 respectively. Because the elasticity of the demand function specified by these authors is constant, they may have captured up to a point the mean behavior of true elasticity in their sample, since this elasticity is indeed variable if the model proposed here is correct. The value for elasticity obtained here is very close to –0.5, the theoretical value computed by Barro (1970) in his model of optimal periodicity of payments, with a constant fraction of monetarized transactions, for low rates of inflation.[41] It is 50% greater than –0.3, which is the value obtained using the log-linear model with Rossi's estimate of the semi-elasticity of demand for money.

In absolute terms, that elasticity is greater and smaller for equations B2 and B3 respectively than for equation B1, owing to the fact that λ is smaller and greater respectively than for

39 Rossi 91994) estimates an equation for Brazil using Cagan's log-linear specification for the period 1980:1/1993:12 by co-integration methods, and obtains a superconsistent estimate of α=6.04.

40 The arithmetic mean of the *quarterly* inflation rate for the sample period in Cardoso (1983) is equal to 6.7% according to Rossi (1998, note 8). The corresponding mean *monthly* rate with constant capitalization is equal to 2.16%, which produces the desired elasticity based on equation (19).

41 In my view, of all the models proposed by Barro, this one corresponds to the initial stage of the inflation process portrayed in the last computation of elasticity contained in the body of the paper.

equation B1, also in absolute terms (see Figure 3). The smaller absolute value of elasticity for equation B3 compared with the value for equation B2 may possibly be explained as a consequence of the increase in the liquidity of index-linked assets after 1985 owing to economic agents' demand for protection against the capital losses caused by inflation. This could imply that although mean monetary balances are smaller in the period of extreme inflation, an additional reduction in them is costlier than before, leading to a more inelastic demand curve as suggested by the specification of transaction costs in equation (4).

The optimal rate of price rises, with continuous capitalization, from the stanc point of collecting inflation tax is 29.7% per month when computed from equation (22) for the coefficients in equation B1. This figure is far greater than the mean annual rate of around 250% computed by Giambiagi & Pereira (1990) using an equation estimated for the period 1979:4/1988:4, and the monthly rate of 15.2% computed by Rossi (1994) using data for the period 1980:1/1993:12. The optimal inflation rate obtained here is consistent with the possibility that the high-inflation episode which occurred in Brazil in the last decade was caused by an attempt to increase revenue from inflation tax on real money balances, since the figure is higher than the mean inflation rate observed in the period and similar to the rates observed just before the stabilization plans implemented during the sub-period of extreme inflation. It is also consistent with the hypothesis that the acceleration of inflation in Brazil after 1985, which is the reference date for computation of the above-mentioned optimal rate, may have resulted from a rational attempt to collect seigniorage.

For the initial stage of the high-inflation process, in equation B2, $\lambda=-0.7$ leads to an optimal inflation rate $\pi^* = 16\%$ per month. If it is assumed that $\lambda=-1$ in equation B3 for the extreme-inflation stage, the optimal inflation rate is infinitely high. Recalling that as argued above there is no evidence that the other parameters $(1/\kappa, \gamma)$ in elasticity formula (14) are significantly different in the three equations, an alternative explanation can be suggested for the dynamics of the process of inflation acceleration: if demand for money balances becomes more inelastic as the inflation rate increases owing to a rise in the absolute value of λ, this leads to a rise in the optimal inflation rate, which in turn produces a further rise in inflation and a still higher optimal rate. This effect occurs despite the fact that the inflation tax collected at each level of inflation is progressively reduced by the decrease in money balances, on the right-hand branch of the Laffer curve.

In equations B1, B2 and B3, income elasticity at the mean values in the sample of independent variables is equal to 2.68, 1.38 and 3.72 respectively. These values look rather high, particularly the last, but given that the coefficient of expected income in equation B3 has a high estimated standard deviation, its point-estimate should be taken with some reserve.

The effect of the temporal trend can be construed as an effect of technological innovation and reduces real demand for money each month by about 1% on average for the entire period sampled: 0.5% until 1984 and 1.9% after 1985. There is a self-evident interpretation of this in terms of technical progress, since the period in which the reduction is greatest coincides with generalized diffusion of automation in the Brazilian banking industry.

It is also easy to see that the dummy variable for the month of December reduces the total value of the coefficient of expected inflation by approximately 15% during these months for equation B1 and that similar reductions occur for the other equations.

Lastly, when a variable equal to the real dollar exchange rate is introduced into the equations, it is not found to be significant, suggesting that the dollar did not represent a hedge against inflation which was not already available through other instruments in the Brazilian economy during the period.

The equality of the coefficients in the linear portion of the specification for the two sub-periods can be evaluated by performing a Chow test on the estimated values of the form and expectations parameters (λ, and values of β) for stability over the entire period of equation B1. At the 5% significance level this conditional test rejects the hypothesis that the coefficients are equal for the two sub-periods. However, the same test at a 1% significance level cannot reject the stability hypothesis.

6. Conclusions

The paper proposes an empirical specification of the equation for demand for real money balances in high-inflation processes that extends and generalizes Cagan's celebrated hyperinflationary model. The approach developed here derives from a theoretical stochastic dynamic programming model for money demand that captures the idea that the convenience return on money is drastically reduced during hyperinflation owing to the appearance of substitute assets. The solution for the model indicates an inverse ratio between money balances and inflation, and suggests the use of the Box-Cox transform of real money balances to estimate an equation that is linear in the other variables, instead of the logarithmic transform used by Cagan. The theoretical model also shows the need to introduce inflation-rate variance into the equation.

The empirical model is specified with the adoption of an adaptive mechanism for the formation of expectations about the inflation rate, inflation variance, and income. The specification is completed with the introduction of the real rate of interest, of a variable to capture the effects of technical progress, and of a seasonal factor. A non-linear maximum versossimilance procedure is used to estimate the model.

This model of demand for money in high-inflation processes is tested by applying it to the data for the German hyperinflationary episode and to the analysis of Brazil's inflationary experience in the last two decades. The results validate the model proposed here and show that its characteristics are indeed important for an understanding of money demand in high-inflation processes. Generally speaking, they show that the functional form of demand for money in these cases is similar to the inverse function, which corresponds to a Box-Cox parameter $\lambda \approx -1$, in contrast with Cagan's model, which corresponds to $\lambda=0$. This difference has crucial implications for the behavior of inflation elasticity and for the shape of the Laffer curve of inflation tax. In particular, with functional forms close to the inverse function, the optimal inflation rate is extremely high, which possibly justifies the occurrence of episodes of extreme inflation as a consequence of attempts to maximize inflationary financing, in clear contrast with Cagan's model, in which this cannot be found.

The relevance of inflation-rate variance as an explanatory variable in money demand is also established here, and the hypothesis that its coefficient is equal to that of the expected inflation rate but with the opposite sign cannot be rejected in any of the equations.

Further research is required to establish whether the good performance displayed by the model in these episodes of high inflation and hyperinflation is also obtained when it is applied to other cases in other countries.

Appendix A: Estimation of Box-Cox demand for money with adaptive expectations

Equation (30) and definitions (13), (27), (28) and (29) form a non-linear system that can be estimated by a two-stage[42] maximum-verossimilance procedure, similar to the one proposed by Box & Cox (1964):[43]

a) compute normalized money balances z by dividing each *M/P* by the geometric mean of the sample values for real money balances;

b) for each value of λ, estimate the non-linear regression of Φ (z, λ) on the vector of explanatory variables in equation (30), obtaining in the process the non-observable variables *E*, *V* and *Y* from the observed variables *C* and *I* (estimates of the parameters for the formation of expectations are also obtained in this manner); and

c) choose the value of λ for which $RSS(\lambda)$ is minimized.

The standard deviations of the regression coefficients conditioned by λ can be obtained from the results of the usual non-linear regression programs, for the equation with the optimal value for the parameter λ. The standard deviation and confidence interval for λ can be obtained from the reciprocal of the statistic derived for the maximum-verossimilance ratio test. Suppose we are testing the hypothesis $\lambda=\lambda_0$ and define $\theta = [\, RSS\,(\lambda^*) \,/\, RSS\,(\lambda)\,]^{\,n/2}$. The

42 A RATS 386 routine was written to implement this estimation procedure.

43 A reference that is easier to find is Maddala (1977, p. 316).

variable $-2 \log \theta$ is distributed as a chi-squared with one degree of freedom. Thus the 95% confidence interval for λ will include all values such that the following equation is satisfied:

$$n \log RSS(\lambda) - n \log RSS(\lambda^*) < 3.84$$

The λ in item (b) above should be chosen so as to cover the space of possible values, which in our case is given by inequalities (13). The values were chosen between –2 and 0, also at intervals of 0.1, to facilitcte construction of the confidence interval, as described earlier.

Given that the Box-Cox transform produces high negative values for $\Phi(z, \lambda)$ when the inflation rate is very high, and that in this case the measurement error is also probably greater, the variance of the error is assumed to be proportional to inflation ($\sigma_\varepsilon = \sigma E$). This is treated in the usual manner, i.e. by dividing all variables in equation (30) by $\sqrt{E_t}$ before proceeding with the estimation. Moreover, because the residues in the optimal equation may be serially correlated, a Cochrane-Orcutt correction is applied if necessary. These two corrections should ensure that the standard deviations of the coefficient are unbiased estimates of the true values.

Appendix B: Data for estimation of the model for Brazil

Prices (*P*) were measured by the general price index (domestic availability) calculated by Fundação Getúlio Vargas (IGP-DI), which averages prices collected during the month and is therefore centered for the month to which it refers. The instantaneous inflation rate at the *end* of month *t* was then approximated by the rate of exponential growth in the price index between periods *t* and *t*+1: $C_t = \ln(P_{t+1} / P_t)$.

The real monetary base was computed as follows: nominal money balances on the last day of the month, as published by the Central Bank of Brazil, were divided by the price index on the last day of the month, estimated as the geometric mean between the index for the current month and the next: $\sqrt{P_t * P_{t+1}}$

The series for the real rate of interest (*R*) was constructed by deflating the series of mean nominal interest rates for day trades in the open market (*N*). The deflation factor was the mean inflation for the month to which the interest rate refers, calculated as the geometric mean of the instantaneous inflation rate at the beginning and end of the month. The rate of *arithmetic* growth in prices (rather than the rate of *exponential* growth used to calculate C_t) was used to measure instantaneous inflation for the purpose of computing the mean monthly rate of inflation because it was desirable to ensure consistency with the procedure adopted by the Central Bank of Brazil to compute its series of real interest rates in the recent past. Hence the series of real interest rates is computed as $R_t = (1 + N_t) / \sqrt{P_{t+1} / P_{t-1}} - 1.$

The volume of data available for calculating expected income is limited. After 1973, a quarterly series for a real product index[44] (*I*) is available, and its value was repeated for each of the months comprised in a given quarter. Before 1973, given that only an annual series was available, the value was repeated for all months in a given year.

Lastly, it must be stressed that none of the variables was seasonally adjusted and that no observations were excluded from the sample.

Year/Month	Real monetary base	Monthly inflation rate	Real monthly interest rate	Real income index
1970				
1		0,0143		47,32
2		0,0141		47,32
3		0,0185		47,32
4		0,0046		47,32
5		0,0136		47,32
6		0,0223		47,32
7		0,0175		47,32
8		0,0214		47,32
9		0,0210		47,32
10		0,0165		47,32
11		0,0041		47,32
12		0,0081		47,32
1971				
1		0,0160		52,66
2		0,0157		52,66
3		0,0232		52,66
4		0,0152		52,66
5		0,0186		52,66
6		0,0219		52,66
7		0,0143		52,66
8		0,0106		52,66
9		0,0140		52,66
10		0,0104		52,66
11		0,0103		52,66
12		0,0102		52,66
1972				
1		0,0167		58.13
2		0,0197	0.0049	58.13
3		0.0129	0.0079	58.13
4		0.0127	0.0115	58.13
5		0.0094	0.0115	58.13
6		0.0094	0.0087	58.13
7		0.0123	0.0067	58.13
8		0.0152	0.0075	58.13
9		0.0120	0.0098	58.13
10		0.0089	0.0111	58.13
11		0.0088	0.0122	58.13
12		0.0058	0.0082	58.13

(cont....)

44 Quarterly series of real product indices published by Instituto Brasileiro de Geografia e Estatística (IBGE).

(continued)

Year/Month	Real monetary base	Monthly inflation rate	Real monthly interest rate	Real income index
1973				
1		0.0173	0.0056	55.57
2		0.0114	0.0055	55.57
3		0.0141	0.0041	55.57
4		0.0139	0.0059	69.35
5		0.0110	0.0084	69.35
6		0.0108	0.0087	69.35
7		0.0081	0.0082	66.42
8		0.0106	0.0083	66.42
9		0.0105	0.0060	66.42
10		0.0156	0.0050	67.67
11		0.0103	0.0068	67.67
12		0.0127	-0.0008	67.67
1974				
1		0.0269	-0.0127	61.58
2	1.739,32	0.0433	-0.0234	61.58
3	1.673,89	0.0523	-0.0356	61.58
4	1.667,04	0.0343	-0.0307	76.65
5	1.671,01	0.0180	-0.0137	76.65
6	1.670,55	0.0126	-0.0003	76.65
7	1.637,59	0.0125	0.0035	73.15
8	1.663,36	0.0173	-0.0049	73.15
9	1.601,86	0.0145	-0.0022	73.15
10	1.616,93	0.0167	-0.0044	70.34
11	1.735,13	0.0211	-0.0044	70.34
12	1.772,66	0.0229	-0.0048	70.34
1975				
1	1.581,77	0.0224	-0.0049	63.62
2	1.533,99	0.0154	-0.0030	63.62
3	1.564,71	0.0173	-0.0061	63.62
4	1.549,12	0.0212	-0.0074	80.92
5	1.557,59	0.0208	-0.0065	80.92
6	1.597,24	0.0223	-0.0041	80.92
7	1.577,58	0.0277	-0.0086	75.41
8	1.623,38	0.0212	-0.0086	75.41
9	1.618,37	0.0227	-0.0064	75.41
10	1.574,26	0.0222	-0.0031	73.84
11	1.680,70	0.0217	0.0013	73.84
12	1.862,00	0.0300	-0.0061	73.84
1976				
1	1.664,75	0.0408	-0.0120	71.26
2	1.557,80	0.0360	-0.0129	71.26
3	1.511,74	0.0363	-0.0111	71.26
4	1.523,24	0.0336	-0.0052	87.61
5	1.541,31	0.0266	-0.0045	87.61
6	1.655,27	0.0372	-0.0061	87.61
7	1.647,92	0.0400	-0.0056	79.30

(cont....)

(continued)

Year/Month	Real monetary base	Monthly inflation rate	Real monthly interest rate	Real income index
8	1.594,69	0.0345	-0.0096	79.30
9	1.648,71	0.0232	0.0039	79.30
10	1.686,33	0.0190	0.0104	81.44
11	1.767,42	0.0223	0.0087	81.44
12	1.902,41	0.0372	0.0058	81.44
1977				
1	1.879,18	0.0302	0.0002	75.13
2	1.755,37	0.0415	-0.0037	75.13
3	1.726,99	0.0398	-0.0097	75.13
4	1.770,03	0.0352	-0.0114	93.53
5	1.785,96	0.0192	-0.0053	93.53
6	1.821,31	0.0208	0.0105	93.53
7	1.900,92	0.0126	0.0158	84.71
8	1.846,74	0.0172	0.0115	84.71
9	1.886,51	0.0272	0.0122	84.71
10	1.946,96	0.0256	-0.0063	84.52
11	1.962,93	0.0214	-0.0028	84.52
12	2.076,09	0.0261	0.0175	84.52
1978				
1	1.989,48	0.0338	0.0054	77.35
2	1.907,71	0.0319	-0.0039	77.35
3	1.883,93	0.0332	-0.0032	77.35
4	1.915,98	0.0314	-0.0007	94.66
5	1.869,82	0.0356	-0.0087	94.66
6	1.910,83	0.0280	-0.0031	94.66
7	1.910,34	0.0265	0.0091	90.93
8	1.938,40	0.0252	-0.0033	90.93
9	1.965,64	0.0285	0.0086	90.93
10	2.021,36	0.0271	0.0023	90.08
11	2.061,19	0.0151	0.0124	90.08
12	2.125,58	0.0356	0.0196	90.08
1979				
1	2.118,69	0.0368	-0.0003	83.30
2	2.113,20	0.0561	-0.0126	83.30
3	1.970,46	0.0373	-0.0083	83.30
4	1.977,80	0.0231	0.0055	101.31
5	1.964,24	0.0342	-0.0004	101.31
6	1.957,56	0.0426	-0.0110	101.31
7	2.001,66	0.0565	-0.0304	94.94
8	1.928,66	0.0743	-0.0399	94.94
9	1.922,54	0.0509	-0.0277	94.94
10	1.950,56	0.0542	-0.0302	94.98
11	1.912,63	0.0706	-0.0410	94.98
12	2.182,31	0.0627	-0.0304	94.98
1980				
1	1.982,83	0.0401	-0.0221	95.49
2	1.845,86	0.0657	-0.0278	95.49

(cont....)

(continued)

Year/Month	Real monetary base	Monthly inflation rate	Real monthly interest rate	Real income index
3	1.770,31	0.0553	-0.0243	95.49
4	1.834,45	0.0614	-0.0386	103.28
5	1.728,16	0.0550	-0.0384	103.28
6	1.756,30	0.0811	-0.0438	103.28
7	1.707,19	0.0678	-0.0415	102.20
8	1.621,52	0.0520	-0.0288	102.20
9	1.583,57	0.0733	-0.0285	102.20
10	1.535,23	0.0723	-0.0338	99.03
11	1.559,13	0.0580	-0.0251	99.03
12	1.625,00	0.0637	-0.0055	99.03
1981				
1	1.482,41	0.0813	-0.0207	95.37
2	1.380,21	0.0706	-0.0289	95.37
3	1.313,61	0.0531	-0.0127	95.37
4	1.231,99	0.0599	-0.0124	100.60
5	1.237,34	0.0437	0.0035	100.60
6	1.278,55	0.0505	-0.0002	100.60
7	1.272,90	0.0644	-0.0028	96.07
8	1.241,93	0.0496	-0.0000	96.07
9	1.252,03	0.0430	0.0085	96.07
10	1.255,36	0.0513	0.0114	90.97
11	1.353,75	0.0373	0.0091	90.97
12	1.415,94	0.0616	0.0171	90.97
1982				
1	1.440,41	0.0657	-0.0052	91.22
2	1.300,18	0.0696	-0.0162	91.22
3	1.262,55	0.0524	0.0025	91.22
4	1.187,22	0.0597	0.0015	101.39
5	1.179,18	0.0769	-0.0086	101.39
6	1.179,07	0.0585	-0.0082	101.39
7	1.188,30	0.0565	0.0064	99.81
8	1.171,11	0.0361	0.0273	99.81
9	1.162,18	0.0467	0.0244	99.81
10	1.186,94	0.0488	0.0231	94.11
11	1.275,19	0.0596	0.0244	94.11
12	1.310,97	0.0863	0.0109	94.11
1983				
1	1.312,61	0.0634	-0.0072	88.32
2	1.236,95	0.0957	-0.0142	88.32
3	1.110,86	0.0880	-0.0019	88.32
4	1.096,93	0.0649	0.0285	97.24
5	1.055,47	0.1160	0.0141	97.24
6	977,91	0.1248	-0.0119	97.24
7	966,78	0.0965	-0.0094	96.40
8	825,22	0.1204	-0.0120	96.40
9	837,68	0.1245	-0.0343	96.40

(cont....)

(continued)

Year/Month	Real monetary base	Monthly inflation rate	Real monthly interest rate	Real income index
10	788,95	0.0809	-0.0101	93.28
11	798,01	0.0730	0.0129	93.28
12	824,53	0.0935	0.0067	93.28
1984				
1	780,76	0.1156	-0.0067	92.07
2	729,81	0.0950	0.0093	92.07
3	678,56	0.0856	0.0166	92.07
4	742,16	0.0849	0.0110	101.80
5	738,61	0.0884	0.0068	101.80
6	736,63	0.0982	0.0039	101.80
7	724,66	0.1010	0.0142	101.61
8	711,79	0.0999	0.0022	101.61
9	717,55	0.1184	0.0032	101.61
10	693,18	0.0942	0.0150	100.14
11	708,57	0.1002	0.0059	100.14
12	864,17	0.1190	-0.0001	100.14
1985				
1	759,26	0.0968	0.0228	98.43
2	810,80	0.1196	0.0048	98.43
3	722,80	0.0697	0.0288	98.43
4	696,72	0.0749	0.0536	107.66
5	681,91	0.0755	0.0418	107.66
6	598,92	0.0854	0.0217	107.66
7	716,88	0.1310	-0.0126	110.93
8	604,81	0.0874	-0.0188	110.93
9	638,31	0.0866	0.0126	110.93
10	593,46	0.1393	-0.0115	109.98
11	622,86	0.1240	-0.0316	109.98
12	763,91	0.1637	-0.0131	109.98
1986				
	663,24	0.1396	0.0025	105.64
2	675,44	0.0538	0.0399	105.64
3	896,11	-0.0058	-0.0120	105.64
4	1.214,45	0.0032	0.0138	115.84
5	1.390,98	0.0053	0.0078	115.84
6	1.529,22	0.0063	0.0083	115.84
7	1.728,04	0.0132	0.0096	119.87
8	1.809,62	0.0109	0.0134	119.87
9	1.837,12	0.0138	0.0168	119.87
10	1.895,86	0.0242	-0.0003	117.90
11	1.976,15	0.0729	-0.0248	117.90
12	1.867,43	0.1136	-0.0389	117.90
1987				
1	1.591,97	0.1320	-0.0182	113.89
2	1.324,20	0.1397	0.0442	113.89
3	1.160,49	0.1830	-0.0473	113.89
4	1.036,27	0.2436	-0.0685	123.76

(cont....)

(continued)

Year/Month	Real monetary base	Monthly inflation rate	Real monthly interest rate	Real income index
5	806,98	0.2301	-0.0165	123.76
6	633,86	0.0892	0.0060	123.76
7	763,71	0.0440	0.0189	120.54
8	890,46	0.0771	0.0171	120.54
9	973,32	0.1057	-0.0144	120.54
10	725,50	0.1351	-0.0294	117.79
11	897,50	0.1474	-0.0196	117.79
12	988,09	0.1751	-0.0266	117.79
1988				
1	837,65	0.1625	-0.0136	113.88
2	660,03	0.1669	0.0036	113.88
3	796,22	0.1851	-0.0222	113.88
4	713,86	0.1782	0.0029	123.26
5	685,14	0.1892	-0.0126	123.26
6	615,04	0.1951	-0.0084	123.26
7	554,54	0.2062	0.0203	123.35
8	481,29	0.2292	-0.0135	123.35
9	500,35	0.2436	-0.0033	123.35
10	507,90	0.2466	0.0158	115.19
11	469,67	0.2538	-0.0002	115.19
12	586,05	0.3116	-0.0182	115.19
1989				
1	534,65	0.1116	-0.0050	110.75
2	591,91	0.0414	0.1018	110.75
3	669,20	0.0504	0.1502	110.75
4	688,70	0.1200	0.0241	127.49
5	771,00	0.2372	-0.0677	127.49
6	677,00	0.3212	-0.0284	127.49
7	537,50	0.3110	-0.0295	129.77
8	461,34	0.3287	-0.0249	129.77
9	438,15	0.3343	-0.0051	129.77
10	400,14	0.3665	0.0404	122.93
11	441,23	0.4014	0.0109	122.93
12	514,07	0.5417	0.0061	122.93
1990				
1	356,52	0.5404	-0.0243	113.77
2	352,31	0.5951	0.0319	113.77
3	606,45	0.1074	-0.0371	113.77
4	935,59	0.0869	-0.0536	115.84
5	1.358,24	0.0863	-0.0310	115.84
6	1.111,37	0.1220	-0.0200	115.84
7	895,50	0.1216	0.0077	124.90
8	818,19	0.1108	-0.0072	124.90
9	854,11	0.1324	0.0201	124.90
10	736,34	0.1609	0.0058	115.52
11	702,48	0.1524	0.0243	115.52
12	939,03	0.1817	0.0393	115.52

(cont....)

(continued)

Year/Month	Real monetary base	Monthly inflation rate	Real monthly interest rate	Real income index
1991				
1	629,13	0.1915	0.0040	105.74
2	764,13	0.0700	-0.0620	105.74
3	790,25	0.0838	0.0092	105.74
4	735,41	0.0632	0.0189	124.66
5	754,42	0.0940	0.0127	124.66
6	745,52	0.1207	-0.0092	124.66
7	678,54	0.1440	-0.0154	127.69
8	640,62	0.1501	-0.0007	127.69
9	604,71	0.2299	-0.0094	127.69
10	520,90	0.2292	0.0011	117.63
11	537,21	0.2000	0.0685	117.63
12	615,65	0.2378	0.0539	117.63
1992				
1	441,57	0.2215	0.0258	110.79
2	512,07	0.1881	0.0491	110.79
3	440,20	0.1701	0.0605	110.79
4	481,65	0.2025	0.0285	121.88
5	432,90	0.1941	0.0088	121.88
6	409,15	0.1963	0.0224	121.88
7	398,70	0.2274	0.0211	121.17
8	384,23	0.2420	-0.0064	121.17
9	379,47	0.2226	0.0120	121.17
10	384,00	0.2169	0.0289	116.67
11	410,81	0.2127	0.0196	116.67
12			-0.0021	116.67

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CHAPTER 8

THE BRAZILIAN FINANCIAL MARKET DURING 1978-1990: A COINTEGRATION ANALYSIS

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Abstract

The importance of the structure of the financial markets, to study the effect of macroeconomic policies in developing countries, has received growing attention in the literature. This paper tries to investigate how integrated were four of the most important segments of the formal financial market in Brazil, during the period 1978-1990. This investigation was based on correlation and cointegration analyses, using interest rates hat prevailed in each segment. Our results indicate that the integration among those segments was very weak. These results may have important implications for the conduct of monetary and fiscal policies in Brazil

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1. Introduction

The behavior of economic variables such as price level and real growth is directly linked to the effectiveness of macroeconomic policy actions. The institutional arrangement that prevails in each country may have considerable influence on the way macroeconomic policy affects the economy. Institutions not only influence the way a specific macroeconomic policy affects an economic variable, but also determine the political feasibility of alternative policy options. Since the institutional framework is not subject to substantial change in the short run, the influence that these arrangements eventually have on macroeconomic management should be taken into consideration. The view that the economies of the developing countries should behave in the same way as those of the developed countries totally disregards the effects that the institutional environment may have in the functioning of the markets and, consequently, in the responses of economic variables to changes in macroeconomic policy. In a scenario where asymmetric information, high and variable transactions costs, and incomplete markets are widespread, as is the case in the developing world, the institutional framework cannot be overlooked.[1] Several studies have shown that the goals of a given monetary or fiscal policy can only be achieved if those structural factors are correctly identified.[2]

The importance of the structure of the financial market for developing countries has received some attention over the past thirty years. The first comprehensive treatment of the importance of the structure of the financial markets in developing countries came with the studies in the field of development finance which began with the works by McKinnon (1973) and Shaw (1973). They hypothesized that repressing the monetary system through a series of norms and regulations fragments the domestic capital markets with highly adverse consequences to economic growth and inflation. Based on the McKinnon and Shaw tradition many theoretical and empirical studies followed.[3] These studies constructed macroeconomic models with emphasis on the impact of interest rate policy. They linked the interest rate not only to economic growth but also to inflation. Also, those studies have provided a basis for the argument that financial liberalization works as a stabilization device and as an engine for economic development. In raising the real deposit rate of interest to the higher competitive level increases savings and reduces inflation. It pressuposes that this combination will increase the rate of capital formation, and hence, economic growth. The emphasis on liberalization to

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1 See North (1991), for a comprehensive theoretical analysis of the importance of the institutional framework and its effects in changing basic results of the neoclassical theory.

2 For a review of studies stressing the importance of financial structures on macroeconomic variables, see Gertler (1988).

3 See Fry (1988), for a review of studies in the field of Development Finance.

increase economic growth with stability implicitly assumes that markets are perfect and that they would always attain the optimal equilibrium position.

At the microeconomic level, Stiglitz and Weiss (1981) argued that imperfect information in the loan market leads to a disequilibrium situation with quantity adjustment or credit rationing.[4] The implication of this assertion is that the developing countries with more imperfect information in the market would not necessarily improve the performance of their financial systems and, consequently, increase economic growth, if completely liberalized. The foundation for this argument rests in the study of Meade (1955), which indicated that in economies subject to some distortions, removing one distortion may not be welfare enhancing.

At the macroeconomic level, Taylor (1983) and van Wijnbergen (1983) included segmentation between the formal market and the curb market in analyzing the effect of a higher deposit rate of interest on inflation and growth. By assuming that the formal financial market is less efficient than the curb market because of the reserve requirements, and that households substitute mainly out of the curb market when higher rates of interest prevail, their models concluded that financial liberalization may have negative impacts on growth and can lead to more, rather than less inflation, in the short run.

Another important area in which the structure of the financial market has been incorporated into economic analysis is the field of monetary economics.[5] More recently, Cavallo (1977) and, later, others (See Bruno (1979), Taylor (1980), and van Wijnbergen (1982)), considered that the structure of the financial system is a key variable to the explanation of the stagflationary effects of restrictive monetary policy measures in the economies of developing countries. Those authors emphasized the importance of the interest rate on the cost of working capital as a transmission channel between monetary instruments and the supply side of the economy. The high debt/equity ratio, as consequence of the limited role of stock markets in the financial systems of developing countries, indicates that the working capital needs are financed almost entirely by bank or curb market credit. This implies that tight monetary policy would increase the cost of financing working capital into the supply side of the economy and generate a stagflationary bias in the short run.

Recently, new arrangements in the financial market of developing countries have emerged. Calvo and Vegh (1992) have argued that during the second half of the 1980s many high inflation countries in Latin America followed a financial innovation in the interest rate policy

4 For a review of the literature on credit rationing, see Baltensperger (1978) as well as Gertler (1988).

5 The first analysis that related financial markets and monetary policy in developing countries appeared in the work of Gurley and Shaw (1955). They argued that in the early stages of financial development the financial variables like money supply are more important in linking output and financial activity. As the financial markets develop, the institutions with non monetary liabilities arise, and the exclusive focus on money becomes less justified.

that takes the form of paying interest on money,[6] since most of public deficit was financed with interest bearing liabilities with very short maturity. The authors developed an analytical framework in which they showed that the effectiveness of higher interest rate policy in fighting inflation in such an environment is very doubtful. Their analysis suggests that paying higher interest on money will only exacerbate the stop-and-go cycles that often characterize high inflation countries.

The main purpose of this paper is to investigate the hypothesis of the existence of financial market segmentation, as an important structural arrangement of the Brazilian economy, during the decade of the 1980s. We define segmentation as the extent to which the various domestic segments of the formal financial market are not linked to each other in their process of price formation. Those segments include the primary and secondary markets for government bonds, the borrowing market of households and firms from the banking system, and the lending market of the banking system from the public. We expect that a perfectly integrated financial market will maintain a close linkage of the interest rate in all segments of the market, the most elementary reason for the existence of this close linkage being that the possibility of arbitrage sets limits in which the various segments can deviate from one another.

It is important to point out that our analysis is concentrated in the segmentation within the formal part of the financial system, and we will not investigate empirically the existence or importance of the informal part or the curb market because of data limitations. Although there is evidence of the existence of the informal financial sector, the formal part of the market is supposed to manage the great majority of financial intermediation in Brazil.

This article is structured as follows. Section 2 describes the Johansen approach to cointegration which we used to analyze the segmentation of the financial market. The data and some characteristics of the four segments are presented in Section 3. Section 4 shows the results of the statistical and econometric analysis of the segmentation in the short run and in the long run. The implications for policy recommendation and for future research are discussed in Section 5. The paper closes with conclusions in Section 6.

2. Cointegration analysis

2.1 Basic Concepts

Many macroeconomic time series do not present stationarity of mean and variance in their primary form. In regression analysis, first differences of the variables are usually used with the purpose of avoiding the possibility of spurious relationship and inconsistency. In cointegration

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6 The authors mentioned the cases of Argentina, Brazil, and Uruguay. For Argentina and Uruguay, see Rodrigues (1990). For Brazil, see Dornbusch, Sturzenegger, and Wolf (1990) as well as Jorgensen (1990).

analysis, the evidence that the time series are not stationary is used to study the relationship among variables.

Granger (1981, 1983) introduced the idea of cointegration and extended this idea in latter studies (See Engle and Granger (1987)). They pointed out that if variables in a set of time series are stationary of order one, denoted by I(1), but one time series which is stationary of order zero, denoted by I(0), can be generated from linear combination of those variables, then the variables in the original set are said to be cointegrated. They interpreted this linear combination as a long-run equilibrium and asserted that cointegration implies that equilibrium holds, even though the series themselves present short-run components with a flexible dynamic specification.

Engle and Granger developed a cointegration test and an efficient two-step estimator for the cointegrating vector. For two non stationary time series w_τ and x_τ, the first step consists in regressing w_τ on x_τ (or vice versa) to get the linear combination w_τ-αx_τ with the smallest variance. The second step is to test if the linear combination is stationary. According to Dickey, Jansen, and Thornton (1991) the problem with this approach is that to perform the test the researcher has to choose one of the jointly endogenous variables to place in the left hand side. The result of the test may be very sensitive to this choice.

An alternative and superior approach for cointegration was proposed by Johansen (1988).[7] In his approach, all the variables are explicitly endogenous, which avoids the choice bias described above. He derived a maximum likelihood estimator for the set of cointegrated vectors and a likelihood test for the linear hypotheses of cointegration.[8] Johansen expects that the estimators of his process behave better than the Engle and Granger approach, because his process takes into account the error structure of the underlying process that the variables are supposed to follow.[9] In the next section, the Johansen approach for cointegration is briefly discussed.

2.2 The Johansen Approach for Cointegration

We will provide a very brief discussion of the Johansen method along with the main steps that we followed to perform the test. What is described below was based on Johansen (1988),

7 Other approaches have been proposed by Stock and Watson (1988), and Phillips and Ouliaris (1990).

8 Cointegration tests for combinations other than linear have not been proposed yet.

9 MacDonald and Taylor (1991) assert that the Johansen technique is superior because it captures the underlying time series of the data, provides estimates of all the cointegrating vectors that exist within a vector of variables, and offers a test statistic for the number of cointegrated vectors. All those features are not present in the Engle and Granger method.

Dickey and Rossana (1991), and Dickey, Jansen and Thornton (1991). For comprehensive discussions of the method, the reader should refer to those articles.[10]

Consider the κ×1 vector $Y_\tau = (tb_\tau, on_\tau, cd_\tau, lr_\tau)$ of the four I(1) time series of interest rate[11] that we will investigate, and let this vector assume the following autoregressive process (VAR) with Gaussian disturbances ε_t:

$$Y_t = \alpha + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \ldots + \Pi_p Y_{t-p} + \varepsilon_t \quad t = 1,2,\ldots N \tag{1}$$

He considered a simple case where Y_t is integrated of order 1, such that ΔY_t is stationary, and the impact matrix Π has the following representation:

$$\Pi = I - \Pi_1 - \ldots - \Pi_p \tag{2}$$

Expressing Π as $\Pi = \alpha\beta'$, where α and β are κ×υ matrix, we assume that, although ΔY_t is stationary and Y_t is non stationary, the linear combinations expressed by $\beta\, Y_t$ are stationary. Since κ is the number of variables in the vector Y_t, the rank of Π is υ<κ, where υ determines the number of distinct cointegrating vectors that exist among the κ variables.

He then expressed the following hypothesis: $H_0{:}\,rank(\Pi) \leq \upsilon$ or $\Pi = \alpha\beta'$. Johansen (1988) demonstrated that the likelihood ratio test, named Trace Test, for the existence of at most υ cointegrated vectors, is given by

$$\text{TRACE TEST} = -T\sum_{i=\nu+1}^{q} \ln(1-\hat{\lambda}_i), \tag{3}$$

He also demonstrated that if the null hypothesis is defined by $H_0{:}\,rank(\Pi) = \upsilon$, the likelihood ratio statistic, named Maximal Eigenvalue Test, associated with it, is defined by the following expression:

$$\text{MAXIMAL EIGENVALUE TEST} = -T\ln(1-\hat{\lambda}_{\nu+1}) \tag{4}$$

In both tests, $\hat{\lambda}_{\nu+1}, \cdots \hat{\lambda}_q$ are the smallest squared canonical correlation[12] between the two sets of residuals of ΔY_t and Y_{t-p} corrected for the lagged differences defined by the VAR process described in Equation (1). More precisely, the first set of residuals arises from an OLS regression of the first difference of each series on p lagged differences of each series and a constant. The second set of residuals is obtained from an OLS regression of the p+1 lag level

10 For new development of the Johansen method see Johansen and Jaselius (1992).

11 In the vector $Y_\tau = (tb_\tau, on_\tau, cd_\tau, lr_\tau)$, tb=primary market rate, o =overnight rate, cd =borrowing rate, and lr =lending rate.

12 The squared canonical correlations are also called eigenvalues.

of each series upon the same lagged differences of each series and also a constant. If there is seasonableness in the original series, seasonal dummies should be included in the regression. Also, if there exists a trend structure in the original series, a trend variable should be included in the non-stochastic part of the VAR process.[13]

Johansen and Joselius (1990) provided critical values for both tests. They suggested that the Maximal Eigenvalue Test is more powerful than the Trace Test. Kasa (1992) asserted that the Trace Test will tend to have greater power when λ_i are evenly distributed. On the other hand, the Maximal Eigenvalue Test will give better results when λ_i are either small or larger.

3. Data

Any attempt to study the financial market in Brazil will encounter difficulty in gathering data, especially for private financial institutions. Time series for market interest rates have been constructed and made public only recently. For this reason, most of the series used in this paper were construed from data that were not public but gathered from "raw" data obtained from the Central Bank of Brazil. Our analysis covered a period of thirteen years, from 1978 to 1990.

For the primary market of government bonds, we used the index of monthly quotations for national treasury bonds, published by the Ministry of the Economy (see Apecão (1991)). This index is constructed by taking into consideration the yield of government bonds in the primary markets. Since there are several different types of bonds and the denomination of these bonds has changed over time, the use of the official index mentioned above seems to be more appropriate. More importantly, this index is used as the base to index other segments of the financial market. This index is a representation not only of the interest rate paid in the primary market for government bonds, but also in some segments of the financial sector that are subject to monetary correction (i.e., agricultural credit, household savings, and mortgages, among others).

For the secondary market, we used the interest rate paid on the overnight market. This market is a repurchase contract market which pays overnight interest rate. The holders of government securities use this market to obtain capital by using these securities as collateral. The yields for the overnight market were taken from time series available on a data base of the Departamento Economico in the Central Bank of Brazil. The time series for market interest rate were the borrowing and lending rate that prevailed in the banking system through their subsidiaries called "Society of Financing, Credit and Investment." The borrowing rate was the one that the banking system paid on the short-term certificate of deposits. The lending rate

13 For a discussion about the inclusion of a constant, dummy, and trend, see Johansen and Joselius (1988), and Dickey and Rossana (1991).

reflects the short-term cost of money for the private sector (consumption, working capital and investment). It is important to add that the interest rates in these segments are the result of market forces, since the levels of interest rate paid and charged are not subjected to governmental regulation. Moreover, these interest rates are good proxies for other segments of the financial market, like short-term lending rate of investment banks and commercial banks, and also a benchmark for the curb market.

The time series for those market interest rates were constructed from data obtained from the Departamento de Fiscalização of the Central Bank of Brazil. They are weighted means of monthly rate charged and paid for all the banks in ten different regions of the country. The weights were the amount of credit subject to that interest rate that each bank, in each region, borrowed from and lent to their clients.

The maturity of the contracts for the market interest rate was of six months. The average maturity for government securities varied during the period, but remained essentially small and was never greater than one year.[14]

All the interest rates we described above were nominal, and to calculate the real interest rate, the original rates were corrected for inflation. For the period 1978-1985, we used the consumer price index published by the FGV (Índice 2, disponibilidade interna), and for the period after 1985, the one published by IBGE (Índice Nacional de Preço ao Consumidor, INPC).[15] In summary, the interest rates we used in our analysis were short-term ex-post real interest rates.

4. Empirical results

The empirical results will be described in two sub-sections. Sub-Section 4.1 will show some stylized facts regarding the behavior of the real interest rate in the short run, in four segments of the market. Some comparisons are made with similar segments of the financial market in the United States. The United States was chosen as a benchmark since it has a fully integrated financial market. Sub- Section 4.2 will focus on the analysis of the segmentation on the long run, when the results for the cointegration analysis are discussed in more detail.

4.1 The Short Run: Stylized Facts

As reported in the first section, if the segments of the financial market are integrated, we expect that the real interest rate in each segment will maintain a close relationship with one

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14 See Jorgensen (1990), for the average maturity during the eighties, for the primary market and for the overnight market.

15 From Jan./1970 to Oct./1985 the official index for inflation was the Índice 2, FGV. From Nov./85 to Feb./86, the IPCA-AMPLO, from Mar./86 to Feb./91, the IPC, and after Mar./91, the INPC, all published by IBGE.

another in the short run. If the real rate in one segment of the market increases or decreases due to reaction to market forces, the other markets are supposed to react as well. The most obvious reason for this behavior lies in the premise that the possibility of arbitrage will clear the market. The levels of the interest rate may differ due to differences in cost of intermediation and tax structure. Nevertheless, for an integrated financial market to prevail, the upward and downward trends should be common to all segments of the market with similar maturity.

By looking at the Figures 1, 2,3, and 4 we can notice that the behavior of the real interest rate in four segments differs considerably.

Firstly, although the real interest rate is very volatile in all segments of the market, the patterns of volatility differ. The volatility in the primary market for government bonds, and for the overnight market, is caused by variability between positive and negative rates. For both lending and borrowing rates, the volatility stems mainly from variability around positive real rates of interest. This was especially true after 1981, when the market rates became predominantly positive.

Secondly, the levels of the interest rate are much higher for the market rates than for government bonds rates. Indeed, the borrowing rate, and especially the lending rate, have been mainly positive and high during the whole period. After 1988, the levels of the real interest rate have increased considerably, if compared with periods before 1988.

For the primary market for government bonds and for the overnight market, a negative real interest rate was very common during the whole decade. Contrary to the pattern for the market interest rates, the levels of the real interest rate for government bonds have been mainly on the negative side for the period 1988-1990, especially in the primary market.

Low interest rate for government bonds is somehow a surprise, because the financing of higher public deficits during the 1980s would have required higher interest rate.[16] Guidotti and Kumar (1991) have argued correctly that if the domestic public debt is viewed as an interest-bearing component of broad monetary aggregate, the interest rate may be even negative on account of a liquidity premium. Nevertheless, it is worth nating that the liquidity premium would predict lower interest rate in the overnight market than in the primary market, since the former has more liquidity.

An overall picture of the behavior of the real rate of interest in the four markets, for the period 1978-1990, can be seen in the descriptive statistics presented in Table 1. There are some facts that are worth pointing out. Firstly, the means of the real interest rate differed considerably among the various segments. On the other hand, the mean for the real interest

16 With the drying up of foreign borrowing, after the Mexican default in 1982, the Brazilian government had to rely more on debt financing.

rate in the primary market for treasury bills was negative (-1.83% per month) and in the overnight market very close to zero (-0.01% per month). On the other hand, the mean for the market interest rates were both positive (1.54% per month and 5.36% per month, for borrowing rate and lending rate, respectively). This implies that, on average, the monthly spreads between the real market rates and the real rates on government securities were very substantial.

Secondly, the differences in volatility between the four segments, measured by the standard deviation of the ex-post real interest rate, are minor. Although not reported in Table 1,[17] the volatility during the second half of 1980s was, on average, two times higher than during the period 1978-1985, for all segments. The increase in volatility may be associated to more volatile risks, as a consequence of higher inflation rates after 1985.

One interesting feature of the Brazilian financial market can be seen in Table 2. This table shows the contemporary correlation between the real interest rate in four segments.

With the exception of the correlation between the borrowing (CD) and the lending interest rate (LR), the results in the Table 2 demonstrate a very weak interrelationship among the segments of the financial market in Brazil during the period 1978-1990. Even more striking, some segments are negatively correlated.

The results in Table 2 can be compared with correlation analysis for four similar segments of the financial market in the United States, which is summarized in Table 3.

The comparison of the results of Table 2 and Table 3 shows that the contemporary correlations for the real interest rates in Brazil were indeed very low. These results were confirmed by covariance analyses (see Appendix A), which showed negative contemporary covariance between the interest rate of the primary market for government bonds, and the borrowing and lending interest rates. Moreover, correlation and covariance analyses between lagged interest rates demonstrated even weaker results than those of Table 2 (see Appendix A).

In summary, the stylized facts indicated that the formal financial market in Brazil during the period 1978-1990 was not fully integrated. The patterns that the real interest rates followed, in four important segments of the financial market, have demonstrated weak correlation. Although the four segments of the market presented the same degree of volatility, contemporary and lagged correlation and covariance analyses have shown that the integration of the four segments is far from perfect. This conclusion was reinforced when the correlation and covariance analyses, for similar segments of the financial market in the United States, as a means of international comparison, have indicated that numbers for Brazil were indeed very low.

17 See Appendix B.

4.2 The Long Run: Cointegration Analysis

4.2.1 Tests for unit root

As mentioned in the Section 2, before applying cointegration analysis we have to test for the existence of stationarity in all the series of real interest rate, i.e., if the series are I(0). This was accomplished by performing the augmented Dickey-Fuller (ADF) for the existence of unit root. The tests consist of running regressions for all series using OLS for the following equation:

$$\Delta y_t = \alpha + \beta_0 y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad (5)$$

In Equation 5, the ADFtest will check the null hypothesis of unit root I(1), i.e., that the coefficient β_0 is equal to zero, against the alternative hypothesis of stationarity I(0). A linear trend has not been included because the time series have not increased or decreased steadily over time. The results for these tests are given in Table 4, where τ_μ is the result for Equation (5). The critical values were taken from the recent work by MacKinnon (1990).[18]

The column on the upper part of Table 4 shows the unit root tests for the levels of the variables. The reported tests statistics indicate that the null hypothesis

cannot be rejected for any variable. At 5% level of significance, all interest rate series are not stationary.

To confirm the hypothesis of non stationarity we performed the ADFtest for the level of first differences. The column on the middle of Table 4 conveys the results of the ADFtest for the level of first differences of each variable. The high values for the t-statistics, in absolute value, indicate that the hypothesis for unit root for the first differences can be rejected, which allows the acceptance that they are stationary or I(0) processes. These results, though, reinforce the conclusions that the original series are indeed non stationary.

The bottom of Table 4 shows the results of ADFtest for the interest rate differentials or spreads. In all cases, those results indicate that the interest rate differentials are not stationary since the unit root cannot be rejected. This is a first indication that there is not a common trend for the interest rates or that the interest rates are not cointegrated.[19]

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18 See MacKinnon (1990) "Critical Values for Cointegration Tests." Working Paper, University of California, San Diego.

19 An example given by Dickey (1991) is worth mentioning. Consider the bivariate system $\mathbf{w}'_t = [w_{1t}, w_{2t}]'$. If this system is cointegrated with cointegrating vector $\mathbf{b}' = [1 - 1]'$, then $\mathbf{z}_t = \beta \mathbf{z}_t = \mathbf{b}'\mathbf{w}_t = w_{1t} - w_{2t}$ would be stationary time series process. The interest rate differentials are exactly $\mathbf{z}_t$.

4.2.2 Results of the Johansen Test for Cointegration

As described in Section 2, the Trace Test and the Maximal Eigenvalue Test are the two tests statistics for the Johansen method.[20] Before performing these tests, the number of lags in the VAR must be identified. The identification of the best lag for the VAR was conducted in two steps. In the first step, we used F tests for the four equations. Those tests indicated that the VARs with more than eleven lags, in general, provided the best results. In the second step, the residuals of the VARs were tested for Gaussian assumptions using statistical tests for normality and autocorrelation. Those results showed that the VARs of higher order are much closer to the Gaussian assumptions than those of lower order.

We presented the results of those tests for VAR(7), VAR(11), and VAR(15). Indeed, as described above, VARs with less than eleven lags appear to have residuals that are serially correlated, while in VARs with more than eleven lags this problem is not present. The results of the Box-Pierce statistics, in Table 5, confirm these conclusions. The same pattern was found for the Jarque-Bera normality test. The residuals of VARs of higher order are much closer to the normality assumption than those of VARs of lower order. This is confirmed by the smaller values of the Jarque-Bera test for VARs of higher order.

The results for VARs of intermediate lag specification lie in between those of Table 5 and, to avoid redundancy, were not reported. It is important to point out that VARs with order lower than seven presented serious problems of autocorrelation and non-normality.

One noteworthy point is that even the Jarque-Bera statistics for the VARs of higher order rejected the null hypothesis of normality. Nevertheless, the deviation from normality in our data was mainly due to larger kurtosis and not due to skewed distribution. This, according to Johansen (1990), is probably a less serious problem, although the robustness of the ML procedure for deviation from normality has not yet been investigated. Simulations that we undertook with smaller sample size, in order to achieve normality for the residuals, did not affect the results of the Johansen Test that we will report.

Taking into consideration the discussion above, VARs of order superior to eleven are much more appropriate than those of smaller order. In Table 6, we presented the results of the Trace Test and the Maximal Eigenvalue Test for five different lag extensions, VAR(11), VAR(12), VAR(13), VAR(14), and VAR(15) when the four interest rates are analyzed together ($k=4$).[21]

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20 "In the Trace Test, the null hypothesis is that the number of cointegrating vectors is less than or equal to v, where v is 0, 1 or 2. In each case the null hypothesis is tested against the general alternative. The Maximal Eigenvalue Test is similar, except that the alternative hypothesis is explicit. The null hypothesis $v=0$ is tested against the alternative that $v=1$, $v=1$ against the alternative $v=2$, etc." Dickey, Jansen, and Thornton (1991).

21 All the results for the Johansen test were performed by using a SAS program that we wrote in the main frame at Cornell University.

For the Trace Test, the hypothesis that $v \leq 0$ was not uniformly rejected for the five VAR specifications. The results for VAR(11) and VAR(14) rejected the hypothesis that $v \leq 0$, then indicating that there is at least one cointegrating vector. On the other hand, VAR(12), VAR(13), and VAR(15) could not reject the hypothesis that $v \leq 0$. This suggests that there is no cointegrating vector for the multivariate system with four interest rates. This seems to be a much stronger piece of evidence because VAR(11) and VAR(14) indicated the existence of cointegrating vector only marginally. At 2.5% level of significance, the Trace Test for both specifications would fail to reject the hypothesis that $v \leq 0$. Consequently, based on the Trace Test, we can be almost certain that the four interest rates are not integrated in the long run.

For the Maximal Eigenvalue Test, the results were very consistent. None of the VAR specifications could reject the hypothesis that $v=0$, then indicating the nonexistence of cointegrating vectors. The inspection of eigenvalues for all VAR specifications showed that they are not evenly distributed (See Appendix C). Under those circumstances, the Maximal Eigenvalue Test will give better results than the Trace Test. For this reason, the borderline results given by the Trace Test become even weaker. In summary, there is very strong evidence that there is not a cointegrating vector for the four variables, and the respective segments of the financial market may not be in a long-run equilibrium. This suggestion is in line with the results of ADFtest of Table 4 that did not indicate stationarity for the interest rate differentials or spreads.

As described in Section 2, the Johansen test assumes that all variables are jointly endogenous. Consequently, if the variables are cointegrated, there must be an economic force that maintains a long-run equilibrium among these variables. On the other hand, if the variables are not cointegrated, as we found, either those economic forces are lacking, or there are structural factors that allow for the long-run disequilibrium. Short-run disequilibrium is possible but, in the long run, the markets are supposed to clear. In the following section, we will discuss some possible causes and consequences of our findings.

5. Policy implications

The results of the correlation analysis and the cointegration tests may point out a particular feature of the Brazilian financial market, which we named segmentation. Although that this name may be inappropriate, the most important fact of our analysis is that the segments of the financial market deviate considerably from one another with respect to interest rate patterns, both in the short run and in the long run.

The theoretical apparatus to study both the causes and consequences of this phenomenon is still being developed. To understand the functioning of financial markets in developing countries one has to rely on theoretical models for the more advanced and integrated financial markets encountered in developed countries. Although only partially satisfactory, because most of the assumptions that underlie these theoretical models are alien to the economies of the developing world, some progress has been achieved as we pointed out in the introduction.

One class of models that can help to explain the causes of the phenomenon we just described is the one related to the microeconomic consequences of asymmetric information in the credit market. Obtaining reliable information about customers, in an environment of high rates of inflation like that which prevailed in Brazil during the decade of the 1980s, is a difficult task. The lending activity of commercial banks becomes a risky concern.

With high and unstable inflation rates, the overall risks of any economy increase, and the ability to collect reliable information about project profitability and customers' credit-worthiness, deteriorates. As a consequence, the supply of credit reduces considerably with direct impact on market interest rates. The banks are not willing to increase lending to the public at higher risks and favour lending to the government at lower risk. This is feasible as long as the risk of lending to the government is reduced, which is achieved by reducing the maturity on interest bearing assets. The absence of credible indexation, as demonstrated in Figures 1, 2, 3, and 4, is compensated by short-dated securities. In the extreme, very high rates of inflation will require the payment of interest on money, as mentioned by Calvo and Vegh (1990).

Since the lending to the government represents lower risk and higher liquidity, this will result in lower real interest rate on government securities. For the government, this situation has a clear advantage, as far as public finance is concerned. This situation allows the growing public deficit to be financed at lower interest rate that it otherwise would be, in a context of economic stability. The debt becomes interest bearing money, and the optimal finance is not achieved by choosing the optimal rate of inflation that maximize seigniorage, as the Cagan models would argue. Instead, the optimal finance is achieved by setting the real interest rates on fixed-rate government securities that maximize the taxation implicit on those rates.

Even with floating rate notes, market conditions would secure high demand for government securities, which would be translated to low interest rates. Moreover, floating notes are less risky that fixed notes, which would decrease the risk premium component of the interest rate. The higher the risks in the market place, the lower the interest rate on government securities that would maximize the implicit taxation.

Ironically, the more unfavorable the economic situation, the lower the interest rate that maximize implicit taxation. This may help to provide some economic rationale for a negative interest rate in government securities coupled with very high market rates, especially under the presence of expectations of higher rates of inflation.[22] It is important to develop new analytical frameworks that would include these hypotheses.

For the banking system, lending to the government has a much lower operational cost. Even if higher interest rates in the market suggest that the banking system is not maximizing profit in the pure economic sense by lending to the government, it makes sense to do so if cost and risk are considered.[23] This process of aggregate disintermediation may have profound implications for the Brazilian economy.[24]

The macroeconomic implications of credit market asymmetries and financial market innovations cannot be ignored. The analytical frameworks to study the extreme inflationary process in many developing countries have incorporated the financial market innovations that have been adopted in those countries ((see Dornbusch, Sturzenegger, and Wolf (1990) and Calvo and Vegh (1992)). The implications of financial market segmentation for the conduct of monetary policy should be well understood in any stabilization program.

Although financial market segmentation may offer some economic rationale to the conduct of the best fiscal policy, as we briefly analyzed above, the same may not be true with regard of the monetary policy. The flight from money accompanied by increasing velocity and demonetization, as a consequence of the shift into interest bearing domestic assets, may undermine any monetary policy to control inflation. Besides, reduction in the extremely high market interest rates may not be achieved with a loose monetary policy. With higher rates of inflation, the drain of savings from the market place to government securities will make money for the private sector even more costly.

One important point not yet investigated in the Brazilian economy relates to the role that the overnight repurchase market for government securities has played in the liquidity of the economy in the short run, and in absorbing private savings, and consequently reducing credit to the private sector, in the long run.[25] It seems that the amount transacted in this market has been growing exponentially and may have constrained lending in other segments of the

22 For the period of moderate rates of inflation (1981-1985), the average monthly real interest rate were the following (in %): TB=-0.32, ON=0.48, CD=1.00, and LR=3.52. For the period of high rates of inflation (1986-1990), the average monthly real interest rate changed to the following values (in %): TB=-3.39, ON=0.56, CD=3.39, and LR=10.12.

23 By the end of 1989, 50% of holders of federal debt stock in Brazil were the ten largest banks. See Jorgensen (1990).

24 The total debt stock and the debt stock outside the Central Bank, as a percentage of M3, increased from 20% and 17%, in 1980, to 73% and 34%, in 1990, respectively. During the same period, the total market notes (time deposits, certified of deposit, and "poupança") decreased from 49% to 20%.

25 The influence of asset substitution on the credit effect was mentioned by Cagan (1972), and by Friedman and Schwartz (1982). Here, the hypothesis is that the payment of interest on money would affect the liquidity effect as well.

market.[26] The reduced quantity of available credit in the banking system, owing to an increasing role played by the repurchase overnight market, may raise market interest rates relative to the overnight rate. The gap would prevail due to the process of segmentation. The causes and consequences of this phenomenon should be subject of further investigation.

The set of results we have encountered may have some bearing on the monetary transmission mechanism. By linking the monetary and the real side of the economy, the interest rate is considered key variables in the monetary transmission mechanism. The effectiveness and nature of the transmission mechanism should be taken into account for the optimum conduct of the monetary policy. The implications of our findings for the monetary transmission mechanism may be sizable. First, the overnight repurchase market represents a close substitute for money. As Tobin and Brainard (1963) argued, "the possibility of substituting intermediary liabilities for currencies offers a partial escape from monetary restriction. But so long as the intermediary liability are an imperfect substitute for currency, the escape is only partial." In the case of Brazil, the overnight market is almost a perfect substitute. The presence of this quasi-perfect money substitute dampens the liquidity effect considerably. Second, the process of investment in the private sector is distorted by the existence of segmentation. Portfolio decisions will reflect concerns only with the short run and capital formation is discouraged. Third, the adjustment of interest rate structure among all segments, which constitutes the core of the monetary transmission mechanism, will also affect wealth allocations between real and financial assets.[27] As we mentioned before, the shrinking pool of loans to the economy due to disintermediation for the overnight market may allocate resources to real assets sub-optimally.

Among remaining questions, one deserves some comment. How could producer and consumers have borrowed money with such a high real rate for such a long period of time? How did the economy survive with such a high level of real rates that prevailed during most of the 1980s? Somehow, the government sector avoided paying high rates as showed by negative real rates of interest for government securities during the whole decade, but especially after 1986. For the productive sector, part of the financial cost could be passed to higher prices for products, since workers were subject to money illusion and/or restrictions on wage increase. Because workers mostly consume, they may have paid twice.

6. Concluding remarks

The importance of the structure of the financial market in economies of developing countries has received growing attention in the recent economic literature. The Brazilian financial market is a fertile ground for such studies, since it has some unique features.

26 See Jorgensen (1990), for some figures about the size of this market.

27 See Brunner and Meltzer (1963), for detailed discussion of this argument.

By using an atheoretical concept coupled with statistical tools and an advanced econometric methodology, this paper tried to show that the integration of several segments of the formal financial market in Brazil is imperfect, both in the short run and in the long run. The combination of negative real rate of interest in some segments, with high positive real rates in others, was constant. We considered that this finding is a key feature to understand the Brazilian financial market. The main intention of our undertaking was that this finding would serve as a starting point for further investigation, both theoretical and empirical.

The microeconomic consequences of asymmetric information in the credit market, in an environment of volatile risk that prevailed in Brazil, especially after 1985, may provide some economic rationale for the phenomenon we have described as segmentation. If risk explains that phenomenon, then we can no longer call it segmentation, because that behavior would be consistent with standard economic theory. This is an open question.

Nevertheless, the implications of such a phenomenon for the conduct of monetary and fiscal policies may be substantial, as some recent studies have shown with regard to other specialised features of the financial market in developing countries.

The main implication of these findings is that the government lost one important policy tool. Monetary policy stances, either by monitoring monetary aggregates or by targeting the interest rate in the overnight market, are ineffective in affecting market interest rates. In this regard, stabilization programs cannot count on monetary policy at least in the short run.

Another important implication is related to the monetary transmission mechanism and, consequently, capital formation and economic growth. Imperfect and slow adjustment in the structure of interest rate coupled with flight from productive real assets may have had substantial effect in diminishing investment over the long run.

Figure 1
Government Bonds. Primary Market. Ex-Post Real Interest Rate Monthly (%)

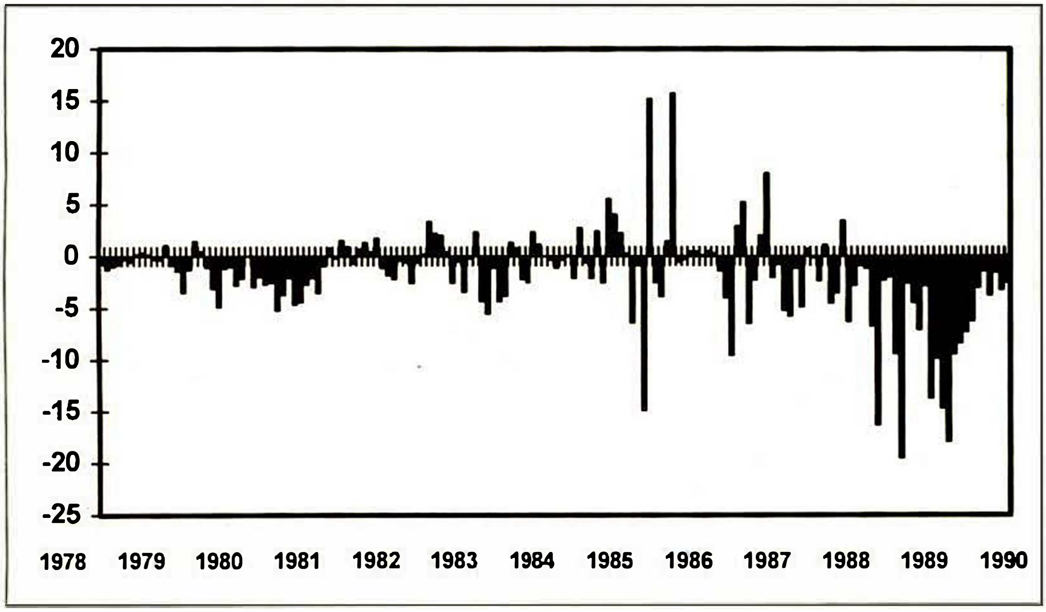

Figure 2
Overnight. Ex-Post Real Interest Rate. Monthly (%)

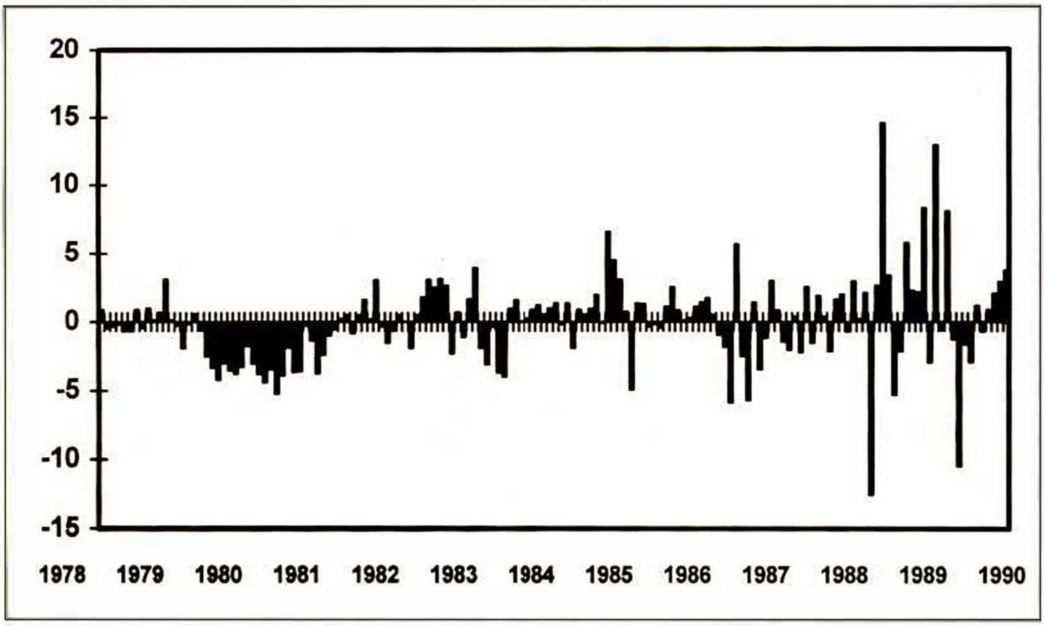

Figure 3
Certified of Deposit. Ex-Post Real Interest Rate. Monthly (%)

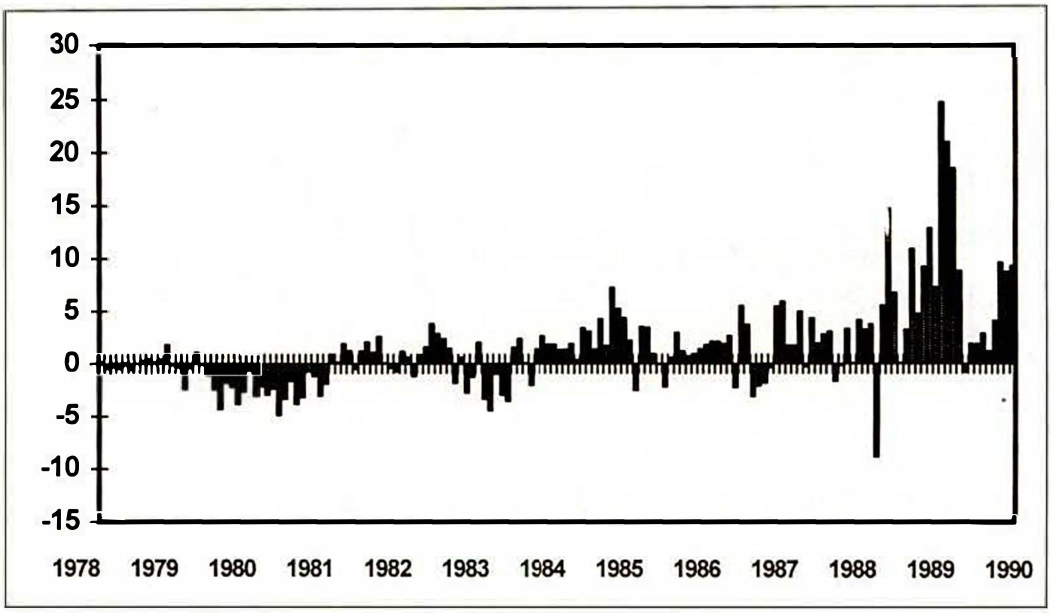

Figure 4
Lending Interest Rate. Ex-Post Real Interest Rate. Monthly (%)

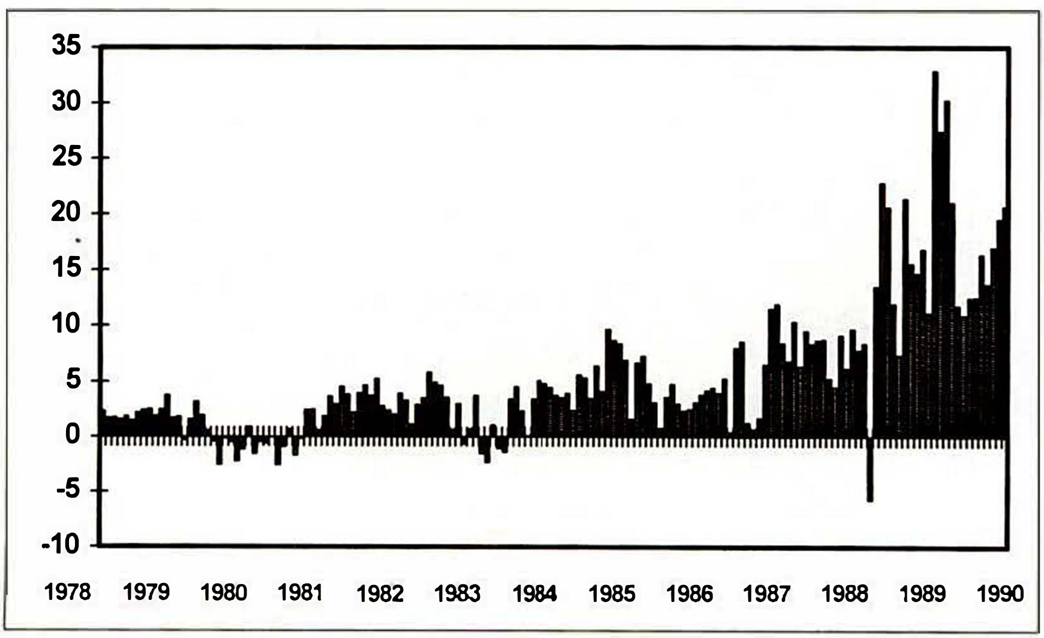

Table 1
Descriptive Statistics for Monthly Ex-Post Real Interest Rates (%) Brazil. 1981-1990

	MEAN	STD. DEV.	MIN.	MAX.
TREASURY BILLS PRIM. MARKET	-1.83	4.50	-19.46	15.69
TREASURY BILLS OVERNIGHT	-0.01	3.22	-12.53	14.52
CERTIFIED OF DEPOSITS	1.54	4.39	-8.77	24.53
LENDING RATE	5.36	6.36	-5.71	32.83

Table 2
Contemporary Correlation. Real Interest Rates. Brazil. 1978-1990

	TB	ON	CD	LR
TB	1.000	0.184	-0.184	-0.294
ON		1.000	0.746	0.590
CD			1.000	0.919
LR				1.000

[a] TB=Primary market, ON=Overnight market,
CD=Certified of deposits, and LR=Lending rate.

Table 3
Contemporary Correlation. Real Interest Rates.
United States. 1978-1990

	TBBP	TTBS	CD	PRST
TTBP	1.000	0.999	0.986	0.987
TTBS		1.000	0.987	0.970
CD			1.000	0.981
PRST				1.000

Source: Citibase. TTBP=3-m treas. bill in the primary market, TTBS=3-m treas. bill in the sec. market, CD=cert. of depos., and PRST=prime rate for short-term business. All deflated by CPI.

Table 4
ADFtest For Unit Root. Interest Rates.
Brazil. 1978-1990. [a]

VARIABLE	τ_μ
TB	-1.41(11)
ON	-2.27(13)
CD	-1.38(13)
LR	-1.26(12)
ΔTB	-6.37(10)**
ΔON	-5.23(12)**
ΔCD	-4.40(12)**
ΔLR	-3.40(12)**
TB-ON	-2.06(12)
LR-TB	-1.94(12)
LR-CD	1.26(13)
CD-TB	-2.16(12)
CD-ON	-1.97(9)
LR-ON	-1.17(11)

[a] * Indicates statistical significance at the 5% level and ** at the 1% level. Critical Values are from MacKinnon(1990).

[b] The number in parenthesis represents the umber of lags necessary to obtain whiteness for ε_t in Eq.(5)

Table 5
Some Test Statistic for the Residuals in The Model of Equation (1) With Various p.[a b]

Eq.	p=7		p=11		p=15	
	τ_1	τ_2	τ_1	τ_2	τ_1	τ_2
TB	113.32	3.26	59.38	2.01	63.60	2.04
ON	258.09	4.86	318.70	2.00	29.86	1.51
CD	251.98	8.90	203.92	3.05	13.30	3.64
LR	262.32	6.51	196.85	2.56	15.48	1.49

[A] $\tau_1 = (n-m)/6\{SK^2 + (EK^2/4)\} \approx \chi^2(2)$ (Jarque-Bera)

$\tau_2 = n \sum_{j=1}^{s} r_j^2 \, (s = 10) \approx \chi^2(10)$ (Box-Pierce Q)

n=number of obs., m=number of regressors, SK=skewness, EK=excess kurtosis, and s=number of autocorrelations.

[b] p=number of lags in the VAR

Table 6

Results of Johansen Test. Multivariate VARs. Four Interest Rates(k=4). [a] [b]

TRACE TEST						
H₀	p=11	p=12	p=13	p=14	p=15	5% CV
v≤3	0.00	1.11	0.07	2.35	1.99	9.09
v≤2	7.85	8.78	9.91	8.55	8.99	20.17
v≤1	28.00	27.40	25.11	27.27	29.94	35.07
v≤0	55.26*	49.44	45.65	54.92*	46.94	53.35
MAXIMAL EIGENVALUE TEST						
H₀	p=11	p=12	p=13	p=14	p=15	5% CV
v=3	0.00	1.11	0.07	2.35	1.99	9.09
v=2	7.85	7.66	9.84	6.20	7.00	15.75
v=1	20.15	18.62	15.21	18.72	15.95	21.89
v=0	27.26	22.04	20.53	27.65	21.99	28.17

[a] Critical Values are from Table A3 in Johansen and Joselius (1990).

* indicates significance at the 5% level.

[b] p stands for the number of lags in VAR.

Appendix A

Table A1
Non Contemporary Correlation. Real Interest Rate. Brazil. 1978-1990

	TB(-1)	ON(-1)	CD	LR
TB(-1)	1.000	0.200	-0.408	-0.473
ON(-1)		1.000	0.228	0.323
CD			1.000	0.919
LR				1.000

TB=Treasury bills in the primary markets, ON=Overnight,
CD=Certified of deposits, and LR=Lending rate.

Table A2
Contemporary Covariance. Real Interest Rate. Brazil. 1978-1990

	TB	ON	CD	LR
TB	20.08	2.89	-3.61	8.34
ON		10.33	10.52	12.03
CD			19.14	25.48
LR				40.14

Table A3
Non Contemporary Correlation. Real Interest Rate. United States. 1978-1990

	TBBP(-1)	TTBS(-1)	CD	PRST
TTBP(-1)	1.000	0.999	0.874	0.876
TTBS(-1)		1.000	0.874	0.879
CD			1.000	0.981
PRST				1.000

Source:Citibase. TTBP=3-m treas. bill in the primary market,
TTBS=3-m treas. bill in the sec.market, CD=cert. of depos., and
PRST=prime rate for short-term business. All deflated by CPI.

Table A4
Contemporary Covariance. Real Interest Rate.
United States. 1978-1990

	TBBP	TTBS	CD	PRST
TTBP	0.77	0.77	0.79	0.84
TTBS		0.78	0.79	0.85
CD			0.82	0.89
PRST				0.99

Appendix B

Table B1
Descriptive Statistics for monthly ex-post real interest rate(%). Brazil. 1978-1985

	MEAN	STD.DEV.	MIN.	MAX.
TREASURY BILLS PRIM. MARKET	-0.86	3.05	-14.87	15.11
TREASURY BILLS OVERNIGHT	-0.38	2.25	-5.19	6.56
CERTIFIED OF DEPOSITS	0.03	2.32	-4.89	7.18
LENDING RATE	2.40	2.54	-2.57	9.65

Table B2
Descriptive Statistics for monthly ex-post real interest rate(%). Brazil. 1986-1990

	MEAN	STD.DEV.	MIN.	MAX.
TREASURY BILLS PRIM. MARKET	-3.39	5.83	-19.46	15.69
TREASURY BILLSOVERNIGHT	0.56	4.32	-12.53	14.52
CERTIFIED OF DEPOSITS	3.39	4.58	-8.77	24.53
LENDING RATE	10.12	6.59	-5.71	32.83

Appendix C

Table C1
Eigenvalues

p=11	p=12	p=13	p=14	p=15
0.1603	0.1624	0.1233	0.1317	0.1315
0.1211	0.1131	0.0929	0.1125	0.0972
0.0490	0.0390	0.0611	0.0479	0.0439
0.0000	0.0150	0.0005	0.0071	0.0127

p= number of lags in the VAR.

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CHAPTER 9

AN ECONOMETRIC MODEL OF AMAZON DEFORESTATION*

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Abstract

Using cross-section municipal data, this paper defines, estimates and simulates an econometric deforestation model for the Brazilian Amazon and how it contributes to CO_2 emissions. The basic model equations are: first, deforestaation – broken down per type of vegetation – is determined by the key economic activities; second, the association between vegetation type and biomass content determines the carbon dioxide emissions caused by deforestatoin; finally, the third equation assumes that the growth rates of population and key economic activities depend solely on their respective spatial densities, and thus forecasts and simulations of the geographic distribution of economic activities and their effect on both deforestation and CO_2 emissions can be developed.

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1. Introduction

Based upon cross section data at municipal level, this paper specifies, estimates, and simulates an econometric model of Brazilian Amazon deforestation and its contribution to CO_2 emissions. The model consists of three blocks of equations: in the first, deforestation - distinguished by vegetation types - is determined by major economic activities; in the second, the relationship between vegetation type and biomass content determines carbon dioxide emissions caused by deforestation; finally, in the third, the growth rates of population and of major economic activities are assumed to depend only of their respective spatial densities, thus allowing projections and simulations of the geographic distribution of economic activities, and their effects on deforestation and C_2 emissions.

The paper improves Reis and Margulis (1991) in three major aspects. Firstly, in the theoretical specification of the model. Secondly, in the data base which was enriched by better information on agricultural output, vegetation cover, transportation conditions, as well as on the spatial characteristics of data like the structure of municipal contiguity. Thirdly, in the regression analysis which takes into account the spatial autocorrelation phenomena, thus allowing a better the diagnosis and treatment of problems resulting from the omission of variables, measurement errors, and improper specification. (Cliff and Ord 1981, Miron 1984)

The paper is organized in seven sections. After the introductory remarks on the contribution of Amazon deforestation to CO_2 emissions, the second section surveys early econometric results on tropical deforestation. The third section derives the basic equations of an economic model of Amazon deforestation. The fourth section discusses estimation issues, with particular attention to spatial autocorrelation. The fifth section describes the data base used and is followed by the presentation of the estimation and simulation results. The concluding section suggests research extensions and further developments of the model.

Table 1
Amazon Deforestation and Carbon Dioxide Emissions

Year	Area km²		Annual increase		Annual CO_2 emissions	
		%	km²	%	in 10^9 t	% of world
1978	152,910	3,1	-	-	-	-
1988	377,633	7,7	22,472	9,5	0,31- 0,45	4,4 - 6,2
1989	401,433	8,2	23,800	6,3	0,33 - 0,48	4,6 - 6,6
1990	415,251	8,5	13,818	3,4	0,19 - 0,27	2,7 - 3,8
1991	426,351	8,7	11,100	2,7	0,15 - 0,22	2,2 - 3,1

Source: INPE 1992; carbon dioxide emissions estimated by the author.

The climatic and ecological consequences of Brazilian Amazon deforestation are among today's leading global environmental concerns. The main reasons for concern are the contributions of tropical deforestation to CO_2 emissions and to the loss of biodiversity. In what follows we address only the first of these issues.

Evidence on the importance of Brazilian Amazon deforestation to CO_2 emissions are presented in Table 1.

The contribution of Amazon deforestation to global emissions is specially significant if one considers that agricultural activities in the region represent less than 1 percent of Brazilian GDP. That makes the slowdown of Brazilian Amazon deforestation one of the most cost-effective ways to reduce carbon dioxide emissions, (Nordhaus 1991, Hoeller et al. 1991, Mors, 1991) though this kind of estimation tends to underestimate the costs of implementing incentives schemes to compensate local population for the losses in economic opportunities. (Almeida 1992, Reis 1992 and Reis and Margulis 1991)

2. Early econometric results on tropical deforestation

Despite the importance of tropical deforestation to the greenhouse effect, econometric analysis of demographic and economic factors are remarkably lacking. Projections are usually based upon naive extrapolations of past trends, often leading to significant overestimates (INPE 1990, Schneider 1990). As a consequence, considerable uncertainty exists with regards to both future rates of deforestation and the costs of halting it.

To take an authoritative example, in the IPCC (1991) the driving mechanism of the projection model is the simple assumption of a unit elasticity of deforestation in relation to population (lagged by 20 years). Moreover, the distribution of deforestation between closed broadleaf and other kind of forests is made in proportion to the area covered by each kind of forest. In both cases, it is only the lack of knowledge concerning relevant parameters that justify the simplistic assumptions adopted.

Econometric results on elasticities of deforestation are scanty. Table 2 provides an incomplete survey of them, which shows major differences of specification, sample, variables, geographic aggregation, and measurement of data. Furthermore, in most cases, parameters were not explicitly derived from theoretical models, thus making comparisons even more difficult. Note also that equations are underidentified. Thus, population elasticities reflect both effects of the supply of labor and of the demand for output.

Despite the aforementioned problems, results seem reasonable at first sight. Thus, comparing Latin America and Southeast Asia, population growth and logging exert greater pressure on deforestation in the latter, while road elasticities are bigger in the former; the impact of agriculture is practically the same in both regions, if cattle raising elasticity is not taken into account.

These differences can be justified by the lower population densities and the more recent settlement of tropical forests of Latin America. As a caveat, however, note that the larger geographical unities of Latin American samples tend to weaken the relationship between population and deforestation introducing a downward bias in the value of elasticities.

Table 2
Survey of econometric results for elasticities of deforestation in relation to major economic activities

Author	Panayotou	Southgate	Kummer	Kummer	Reis and Margulis
Region	Thailand	Latin America	Philippines	Philippines	Brazil Amazon
Dependent variable	Deforestation	Agricultural area	Deforestation	Deforestation	Deforestation
Geographical unit	Municipality	Country	Province	Province	Municipality
Period	1973-82	1970-80	1970-80	1970	1985
Data	Panel	Panel	Cross-section	Panel	Cross-section
Method	OLS	OLS	OLS	OLS	OLS
Specification	Log-Log	Growth rates	First diferention	Log-Log	Logistic
Variable	Elasticity estimates (t values in parentheses)				
Population	1.51(9.7)	0.25(3.8)		0.54(na)	0.30(2.7)
Roads	0.11(1.4)		0.23(2.4)	0.28(na)	0.28(4.7)
Agriculture	0.32*(1.7)		0.41(4.2)		0.40(3,6)
Logging	0.41*(4.1)		0.32(3.2)		0.04(1.0)
Productivity	-0.38(1.9)	-0.20(6.0)			
Cattle herd					0.11(1.83)
R^2	0.80	0.67	0.49	0.58	0.84
D.F	55	18	64	66	165

Note: * assuming a supply price elasticity equal to 1.
Sources: Panayotou & Sungswan 1989, Southgate et al. 1992, Kummer 1991, Reis & Margulis 1991.
The results surveyed suggest that the IPCC (1991) assumption of a unit elasticity of deforestation in relation to population is probably a bit exaggerated. Indeed, most of the remaining tropical forests are in Latin America where population elasticities seems to be significantly lower than unit.

In any case, the lesson to be derived from this brief survey points out to the precarious state of art of the economics of tropical deforestation, and to the contribution which could be brought by econometrics. In this way, it indicates the urgent need for further research efforts on data gathering, model specification and estimation techniques.

3. An economic model of Amazon deforestation

Three blocks of equations compound the model. The first one relates deforestation to economic activity; the second block links deforestation to vegetation cover and to CO_2

emissions; and the third one specify generating functions for the spatial growth of population and economic activities.

The first block is based upon an aggregate production function for major agricultural activities - supposedly, the main source of deforestation in Brazilian Amazon. The derived demand for cleared land in agriculture is determined by profit maximization. Output prices are considered exogenous to the model; wages are determined by demand and supply of labor, and land prices by clearing costs. A logistic function relates deforestation to land cleared in agriculture and to the land requirements of other economic activities.

A Cobb-Douglas production function relates agricultural output *(Q)* to the inputs of labor *(L)* and cleared land *(C)*. Profit maximization - given output prices, wages (w), and clearing costs *(k)* - leads to the following derived demand for cleared land (C_d) and labor (L_d), respectively:

$$C_d = ((1-a)/a)^a . w^a . k^{-a} . Q \tag{1}$$

$$L_d = (k.a/(1-a).w)^{1-a} . Q, \tag{2}$$

where $0<a<1$.

Output *(Q)* is a long run concept defined as a composite index of cattle herd *(H)* and trend output for temporary and permanent crops *(Y)* as follows:

$$Q = H^h . Y^{1-h}, \tag{3}$$

where $0<h<1$

The supply of labor *(L_s)* is assumed to increase with population *(N)* and wages, and to decrease with transport costs proxyed by a vector of variables specified as spatial discount factors which includes the distances to local and national *(M)* markets, and the networks of roads and rivers *(R)*:

$$L_s = w^b . N^g . \exp(e_1 . R - m_1 . M), \tag{4}$$

with $b, g, e_1, m_1 <0$

Equilibrium in the labor markets leads to:

$$w = (k.a/(1-a))^{j.(1-a)} . Q^j . N^{-j.g} . \exp\{-j.(e_1 . R - m_1 . M)\}, \tag{5}$$

where $j = 1/(1+b-a)$.

Furthermore, the free availability of land in the region makes it legitimate to assume that deforestation decisions are short sighted. (Panayotou and Sungsuwan, 1989) Accordingly, land prices are assumed to depend solely on clearing cost which, in turn, are assumed to depend only on the vegetation cover as proxied by the density of forest (F/A), and transport cost which is specified in the same way as in (4):

$$k = \exp(f.(F/A)+m_2.M-e_2.R), \qquad \textbf{(6)}$$

with f, e_2, $m_2 < 0$

where A = geographic area of municipalities.

Substituting (5), (6) and (3) in (1), and taking logarithms, the reduced form of the derived demand for cleared land in agriculture is:

$$C = a/(1-a)^{a.(j.(1-a)-1)Qj.(a+1)} .N^{j.a.g}. \qquad (7)$$

$$\mathrm{Exp}\ \{j.(e_2.(1-a)-e_1).R+j.(m_1+m_2.(1-a)).M)\}.$$

$$\exp(a.(j.(1-a)-1).f.(F/A)\}$$

or

$$C = B_0.Q^{B}1.N^{B}2.\exp(B_3.(F/A)+B_4.R+B_5.M), \qquad (7')$$

where:

$B_0 = ((1-a)/a)^{ab/(1+b-a)} > 0$

$B_1 = (b+1)/(b-a+1) > 0$

$B_2 = -a.g/(b-a+1) < 0$

$B_3 = -a.bf/(b-a+1) < e$

$B_4 = a(be_2-e_1)/(b-a+1) > 0$ if $e_2.\ b > e$

$B_5 = -a(bm_2-m_1)/.(b-a+1) > 0$ if $m_2.b > m$.

Finally, the extent of deforestation *(D)* is determined by land clearing in agriculture, logging activities *(W)* for timber and firewood production, and by all kind of urban activities as proxyed by urban population *(U)*. (Panayotou e Sungsuwan, 1989) The specification adopted is a logistic function relating density of deforestation *(d)*, defined as the relation between deforested area and total geographic area, to the economic activities described above:

$$\log(d/(1-d)) = B_0 + B_1.c + B_2.u + B_3.w + B_5.a \qquad \textbf{(8)}$$

where small letters refers to logarithms.

The logistic is used to describe deforestation as a process which tends toward saturation within a given geographic area. In other words, in the early stages of settlement and deforestation, the effect of economic activities on the density of deforestation is high. As the remaining forest area dwindles, the impact of economic activities on deforestation diminishes, eventually dying out in totally deforested areas.

Mathematically, this is shown by the fact that the elasticity of density of deforestation is equal to $A.(1-d)$, and therefore, in absolute value it decreases monotonically from A, in areas with no deforestation, to zero, in areas where the density of deforestation is one.

According to the above model Amazon deforestation is the result of profit maximizing behavior in a static framework. Dynamic considerations related to the role of land as an asset, to land price speculation and to wealth maximization were completely ruled out by the assumptions embodied in equation (6).

Institutional considerations related to the open access to land and to the weakness of government institutions in Amazonia are ruled out from the model. These motivations make deforestation a mean to secure property rights in land, and as consequence, cleared land tends to exceed land requirement for agricultural purposes, specially in areas where land conflicts are pervasive. (Alston et al. 1990, Sawyer 1986, Southgate 1989). An ad hoc test to the institutional hypothesis would be to include proxies for tenure conditions like population of squatter farmers (S) and land area in public domain (V), as additional variables in equation (8).

A reduced form specification of the model is obtained by substituting (7) in (8) to obtain:

$$\log(d/(1-d)) = A'_0 + A'_1.\mathrm{u} + A'_2.\mathrm{n} + A'_3.\mathrm{q} + A'_4.w + A'_5.\mathrm{a} + \quad (9)$$

$$+ A'_6.(F/A) + A'_7.M$$

where, again, small letters refers to logarithms.

The second block of equations uses an identical logistic specification to estimate the distribution of deforested areas by major types of vegetation. Thus:

$$\log(d_j/1-d_j) = D_0 + D_1.\mathrm{q} + D_2.\mathrm{n} + D_3.R + D_4.M + \quad (10)$$

$$+\Sigma_j(D_{5j}.F_j) + D_6.D$$

where j denotes the 6 main types of Amazon vegetation - namely, dense forest, seasonal forest, savanna, campinarana, wetland, ecological transition - and d_j = deforested share in vegetation type j.

Based upon the biomass content of each major type of vegetation, CO_2 emissions are determined, as follows:

$$CO_2 = \Sigma_j\, q_j\, c_j\, (b_j-b_0)\, D_j \quad (11)$$

where

CO_2 = CO_2 emissions (in tons)

q_j = percent of biomass which is burnt in vegetation *j*

b_j = biomass content (t/ha) of vegetation *j*

b_0 = biomass (t/ha) content in deforested areas (converted or abandoned)

c_j = percent of CO_2 in vegetation *j*;

Estimates of the biomass content in major types of vegetation cover of Brazilian Amazon are presented in Table 3. For estimation and simulation purposes, they were aggregated in two types: forests (which includes dense, seasonal and ecological transition) and savannas (including campinarana and wetlands). Inside each of these two types, deforestation was distributed in proportion to areas of each type of vegetation in the municipality. Finally, for all kinds of vegetation it is assumed that the biomass is completely burnt, that is:

$$q_j = 1 \text{ for all } j \qquad (12)$$

Table 3
Estimates of above ground and total biomass for major types of vegetation covers of Amazonia (ton/ha)

Vegetation type	Area %	Above ground		Roots[a]		Total	
		min.	max	min.	max	min.	max
Dense rain forests	69,53	188	300	54	100	242	400
Open forests	3,03	112	186	37	62	160	247
Ecological transition[b]	5,11	75	112	25	37	100	148
Savanna	13,97	6	75	6	32	12	107
Campinarana	6,34	6	120	6	45	12	165
Wetlands	2,01	6	115	6	38	12	153
Average[c]	100,00	139	240	-	-	180	322

Source: Author estimates for areas and various sources for biomass
Obs.: a) Assumed to be 1/3 of aboveground biomass b) Biomass content assumed to be between the maximum for savannas and seasonal forests c) Weighted by area

The third block of equations consists of the generating functions for the spatial distribution of major economic activities. For population, crop output, cattle stock, logging, and roads, the assumption is that rates of growth in municipality *i* and time *t* depends only on the spatial density of the respective activity at time *t*-1. Thus:

$$_{kit} = C_{0k} + C_{1k}.\log(x_{kit-1}) \qquad (13)$$

for *k* = population, agriculture, cattle, and logging,

and $\hat{x}$ is growth rate, and x is the spatial density, that is, the relation between activity level and geographic area.

Equations (13) describe the patterns of spatial concentration of economic activities over time. An activity k will show increasing spatial concentration if C_{1i} is greater than zero, whereas it will show increasing spatial dispersion if C_{1i} is less than zero.

4. Estimation issues: Spatial Autocorrelation (SAC) and Seemingly Unrelated Regression (SURE)

The model is designed to make secular projections and simulations of the ecological and climatic consequences of tropical deforestation. Reliable estimates of long-run elasticities of deforestation in relation to major economic activities are crucial for this purpose. A major obstacle, however, is the lack of time series sufficiently long to characterize long run equilibrium solutions. This is particularly true for deforestation data.

Fortunately, cross section data for Brazilian Amazonia are especially suited to estimate long run elasticities. The sample includes more than 300 municipalities in very diverse stages of demographic and economic settlement, thus encompassing a wide range of configurations concerning the geographic densities of deforestation, population, and economic activities. Metaphorically speaking, the data mimics long run equilibria situations where differences between counties represent decades or centuries (Pindick, 1979). On top of that, the availability of panel data for major economic and demographic variables allows more rigorous dynamic analysis.

Deforestation, population settlement and economic activities are simultaneous processes taking place in the same geographic space. This brings the possibility of two major econometric problems, namely residual covariance across different equations and spatial autocorrelation of residuals in each equation - both of them deserve careful consideration since, otherwise, estimates of long run elasticities are likely to be biased and inconsistent.

The simultaneity and interdependence of economic decisions give rise to Seemingly Unrelated Regression problems. Thus, equations describing population settlement, forest clearing, cropping, cattle raising, and logging are likely to show stochastic dependence, and therefore, residual covariance across them. The stochastic dependence can result from common generating mechanisms, latent variables and/or adding up restrictions not explicitly recognized in the model. Techniques to deal with these problems are well known (Zellner 1962).

In its turn, spatial or geographic contiguity give rise to phenomena like contagion and/or spatial inertia across observations (neighboring municipalities in this case) which can lead to the presence spatial autocorrelation of residuals in each equation.

Spatial autocorrelation is usually a signal of missing variables, improper structural form, or measurement error. Therefore, its diagnosis can be a strong tool for improving model specification. Its identification requires a contiguity matrix, and usually, its correction is made by the use of Generalized Least Square (GLS) or Maximum Likelihood (ML) methods. (Miron 1984, Cliff and Ord 1973, 1981) Moran (1950) and Geary (1954) coefficients are the usual statistics to test the presence of spatial autocorrelation. For a variable X, with normal deviates z, the Moran coefficient (M) is:

$$M = (n/1.W.1).(Z'.W.Z/Z'Z), \qquad (14)$$

and the Geary coefficient (G) is:

$$G = ((n-1)/2(1'.W.1)).(Ew_i.p_i/Z'Z), \qquad (15)$$

where

n = number of observations (municipalities in this case)

W = contiguity matrix ($n^x n$) with elements w_{ij} equal to 1 if i and j are spatially contiguous observations, and equal to zero otherwise

1 = column vector with all elements equal to 1

Z = matrix ($n^x n$) with elements $z_{ij} = (x_i - x_j)$

pi = ith line of matrix P ($n^x n$) where $p_{ij} = (x_i - x_j)^2$

It is possible to demonstrate that both M and G are asymptotically normal under weak assumptions (Cliff and Ord 1981). Both coefficients can also be used to test residual autocorrelation in regression equations. For more than two independent variables, however, test statistics are not straightforward.

Table 4 presents both the Moran and Geary coefficients for the main variables of the model. Standard errors were calculated under the normality assumption. Spatial autocorrelation for the logarithms of densities of deforestation, population and major economic activities are about the same and significantly higher than the coefficients obtained for growth rates. Figures 1 and 2 give a visual perception of the presence of spatial autocorrelation in the spatial distribution of of deforestation and population densities.

Table 4
Spatial Autocorrelation for Logarithms of Geographic Densities of Main Variables

	Moran		Geary		
	Value	Standart error[a]	Value	Standart error[a]	Simple size
log(dt-1)	0.717	0.049	0.266	0.070	153
log(ct-1)	0.740	0.032	0.226	0.048	336
log(nt-1)	0.700	0.033	0.267	0.048	336
log(ht-1)	0.706	0.032	0.289	0.048	336
log(qt-1)	0.724	0.032	0.259	0.048	335
log(wt-1)	0.487	0.032	0.432	0.048	335
log(qt-1)	0.400	0.033	0.658	0.048	336
log(wt-1)	0.079	0.033	0.886	0.048	336
log(nt/nt-1)	0.350	0.033	0.718	0.048	335
log(ht/ht-1)	0.282	0.035	0.705	0.052	295

Variable St.er. Value St.er. Size

Obs.: 1. St.er: standard error assuming a normal distribution
2. Small letter refer to geographic densities: d = deforestation, c = agricultural land, n = population, h = herd, q = crop output, w = logging. 3. Period t is 1985 and t-1, 1980, except for logging where they refer to 1982 and 1987, respectively.

In the model, problems of spatial autocorrelation as well as of residual covariance across equations are likely to be specially severe for equations (13). The reason for that is the parsimonious and naive specifications used for the generating functions of spatial distribution of population, agriculture, cattle raising, and logging.

For equations (7-9), specifications are supposed to be theoretically more rigorous and to include a good number of the relevant spatial factors. To that extent, the damages caused by improper specification or omitted variables are smaller. Moreover, since the specification of deforestation and deforestation by vegetation type are practically the same, SURE techniques are not likely to make significant improvements compared to OLS results. Therefore, in these cases, it is fair to neglect the problems posed by spatial autocorrelation and residual covariance across equations.

A general specification for the presence of spatial autocorrelation in a model is (Case, 1991):

$$Y = p.W.Y + Z.B + u \qquad (16)$$

$$u = r.W.e + e,$$

where Y = vector (nx1) of dependent variable, Z = a matrix (nxk) of explanatory variables, B = a vector (kx1) of coefficients, u = vectors (nx1) of residuals, e = vectors (nx1) of residuals,

p = intensity of spatial autocorrelation in the dependent variable r = intensity of spatial autocorrelation in the residuals

The three possible cases of spatial autocorrelation and their respective implications are: (a) if $p \neq 0$ and $r = 0$, spatial autocorrelation occurs in the dependent variable but not in the residuals and least square estimators will be biased and inconsistent. (b) If $p = 0$ and $r \neq 0$, spatial autocorrelation in the residuals but not in the dependent variable and OLS estimator of B will be unbiased but inefficient; and (c) if $p \neq 0$ and $r \neq 0$, spatial autocorrelation occurs both the in the dependent and in the residuals, and in this case maximum likelihood methods are suggested for estimation.

When spatial autocorrelation in residuals combines with seemingly unrelated regression, the specification of equation (16) becomes:

$$Y_{(m.nx1)} = Z_{(m.nxm.k)}.B_{(m.kx1)} + u_{(m.nx1)}$$

$$u_{(m.nx1)} = (p_{(m.xm.)}.{}^{(.I_n)}W_{(m.nxm.n)}$$

$$= W._{(m.(.n)}.U_{(m.nx1)} + E_{(m.nx1)}$$

$$E(E) = 0, E(E.E') = H(m.(.n) \qquad (17)$$

where subscripts in parenthesis indicates the number and rows and columns of respective matrices, ox is the kronecker product, and m = number of dependent variables or equations in the model n = number of observations k = number of independent variables or coefficients p = diagonal matrix with elements p_i ($i = 1, 2, \ldots, n$)

5. The data

Deforestation *(D)* data were derived from the Landsat satellite images plotted at municipal level. They are available for a reduced sample of municipalities, and in a single point in time. The images are from 1983 for some observations, 1985 for others, and 1987 for the remaining. Dummy variables for 1983 (DU83) and 1987 (DU87) were included in regressions to reduce bias introduced by these measurement errors.

Geographical areas of major types of vegetation cover *(V_j)* - closed forest, seasonal forest, savanna, wetlands, campinarana, and ecological transition - as well the extent of deforestation in each of them *(D_j)* come from estimates of IBDF-IBGE also based upon Landsat images.

Cleared land and output in agriculture come, respectively from the 1985 Agricultural Census, and the Annual Agriculture Production Municipal Surveys available from 1977 to 1987. Cleared land *(C)* is a stock variable, the area allocated to various economic uses (excluding natural pastures) at Census data. For cattle raising, output *(H)* is also measured by a stock variable: the size of herds at Census date. Since temporary and permanent crop outputs are annual flows, to make time dimensions less disparate, the variable used in the estimations was trend output *(Q)*, defined as the average quantities produced in the five-year periods centered on Census year. This concept smoothens the yearly fluctuations in crop output, and accounts for leads of deforestation in relation to output, particularly relevant for permanent crops.

Rural *(R)* and urban *(U)* population come from the 1980 and the 1991 (preliminary data) Demographic Census. Figures for 1985 are geometric interpolation assuming the same rural/urban composition as in 1980. Urban population is used as a proxy variable for all kinds of urban activities.

Logging *(W)* for timber, charcoal and firewood comes from the Extractive Production Country Surveys available from 1982 to 1987. In equations (8) and (9), the variable used is aggregate cumulative production flows from 1982 to 1987 for timber and charcoal.

In equation (13) rates of growth of logging refer to the 1982-1987 period.

Access and transportation conditions are described by the distance to state capitals and to Bras'ilia - as proxies to local and national markets - an by the extension of major roads and rivers in each municipality. Roads (federal and state, paved and non paved) and rivers (deeper than 2.10 m in 90% of time) come from maps and are available only for 1985/86. For the purposes of the model, it is reasonable to neglect feeder roads since they are simultaneously determined with deforestation and population settlement.

6. Estimation results

Table 5 reports the estimation results for the reduced form in equation (9). Alternative estimation procedures were used: ordinary least squares (OLS), seemingly unrelated regression (SURE), and maximum likelihood (ML) which was applied with the additional assumptions of spatial correlaton in the dependent variable (SACD) or in the residuals (SACR). The statistics of the top of the table are, in that order, the number of observations (N.Obs.), the degrees of freedom (D.F.), the adjusted R^2 (R^2adj.) and the root mean square residual (Rmse), in the OLS equation, replaced by the maximum value of the likelyhood function (LM) and the asymptotic standard errors in the remaining equations; and finally, the Moran coefficient for the residuals, and the spatial autocorrelation coefficient computed by OLS for residuals (Rho) or for the dependent variable (Thau).

Table 5
Estimates for deforestation density (reduced form)

Eq. number	(8)	(9)	(9)	(9)
Dependent	Defor. Dens.	Defor. Dens.	Defor. Dens.	Defor.. Dens.
Specif.	Logistics	Logistics	Logistics	Logistics
Method	OLS	ML	SACD	SACR
N.Obs.	151	151	151	151
G.l.	133	133	132	132
R^2 adj.	0,80	-	-649	-659
Rmse	1,85	1,45	1,41	1,44
Moran resid.	0,21	0,13	0,69	0,54
Rho/Thou	0,72	0,34	0,50	0,70
Variable Coefficient (standard erros in parentheses)				
Population	0,16	0,24	0,10	0,21
	(0,20)	(0,38)	(0,36)	(0,37)
Farming output	0,68	0,38	0,39	0,50
	(0,14)	(0,28)	(0,23)	(0,21)
Herds	0,22	0,22	0,18	0,21
	(0,10)	(0,25)	(0,17)	(0,17)
Logging	-0,42	-0,17	-0,29	-0,36
	(0,13)	(0,28)	(0,23)	(0,24)
Paved roads	1,27	2,22	0,87	0,90
	(1,57)	(4,88)	(2,77)	(2,85)
Unpaved roads	1,43	0,73	0,82	0,70
	(0,49)	(1,10)	(0,73)	(0,75)
Variable Coefficient (standard erros in parentheses)				
Rivers	0,61	-4,20	0,97	0,85
	(1,32)	(5,85)	(0,17)	(1,84)
State dist.	-0,27	-0,13	0,14	-0,40
	(0,66)	(1,89)	(0,91)	(0,94)
Federal dist.	-0,29	-1,03	-0,17	-0,67
	(0,24)	(1,09)	(0,43)	(0,45)
Dense forests	7,35	3,14	4,78	2,92
	(2,67)	(6,60)	(4,81)	(4,93)
Open forests	7,95	4,73	4,99	4,35
	(2,95)	(5,54)	(5,28)	(5,39)
Savanna	6,37	2,16	3,77	1,96
	(6,45)	(5,30)	(3,57)	(3,65)
Ecological stress	7,18	3,84	4,39	3,06
	(2,78)	(5,71)	(5,43)	(5,52)
Invasive species	3,95	1,11	2,85	-0,09
	(2,71)	(6,57)	(4,47)	(4,60)
Scrublands	6,46	-2,77	4,51	2,32
	(3,06)	(35,42)	(5,16)	(5,28)
Geographic area	-1,73	-1,29	-1,03	-1,21
	(0,41)	(0,41)	(0,29)	(0,22)
1983 dummy	-0,30	0,27	-0,40	-0,51
	(1,14)	(2,71)	(2,30)	(2,37)
1987 dumy	1,98	2,67	0,83	1,64
	(1,35)	(4,67)	(2,55)	(2,59)

Note: Rho = spatial autocorrelation of residuals; Thau = spatial autocorrelation of the dependent variable.

Figures for adjusted R^2 and and LM show a good fit for equation (9). With OLS, aproximately 80% of variance in the geographic density of deforestation of Amazonian municipalities is explained by the model. OLS estimation show that most of the coefficient have the expected sign, and are significantly different from zero at the 95% confidence level. With ML procedures, however, the coefficients are not sgnificantly different from zero.

Spatial auto-correlation of residuals is weak, specially if compared to the strong correlation observed for deforestation density which is the dependent variable of the model. Moran coefficients for OLS and ML residuals are 0.21 and 0.13, respectively, and 0.77 for the geographic density of deforestation. Thus, OLS estimates are likely to be biased and inefficient. Maximum likelihood estimates are not significantly affected by the assumptions of SACD or SACR, except for the coefficients of river, the distance, and road variables.

Though not significant, the coefficients of population and logging came out with theoretically unexpected signs. The elasticity of population is expected to be negative if land and labor are substitutes, as is the case in a Cobb-Douglas production function, and if the supply of labor in different municipalities displays a "normal" response to real wages levels. The coefficients, however, are likely show a simultaneous equation bias to the extent that deforestation, population, and major economic activities like cropping and cattle raising are mutually interdependent.

Furthermore, "one should not be surprised to find large wage differences from one district or village to another and apparent disequilibrium in frontier labor markets - especially if one must reside on one's land to retain ownership." (Kazmer:1977:432) In a context of land abundance, high real wages in a given municipality cauld simply mean relatively enlarged possibilities for establishing an independent farm and, therefore, reduced supply of labor. On the other hand, low real wages "may indicate only that new settlers arrive to claim land faster than they can be absorbed into employment." (Kazmer:1977:432)

The above arguments show that the model is underidentified and point the need of more careful specification of the dynamics of labor supply and land settlement. This, however, can only be made with a combination of time series and cross-section for which there is not data at this moment. For the time being, therefore, results will be accepted as they are based upon the assumption that labor will continue to be the binding factor for the expansion of the Amazon agricultural frontier.

Against theory and intuition, the coefficient of logging came out negative and, in OLS estimations, significantly different from zero. The problem seems to be rooted in the use of annual flows of logging to measure the cumulative impact of logging on deforestation. This leads to problems of dynamic specification, since logging flows are at the same time cause and consequence of forest clearing. Thus, they tend to be large in relatively unsettled regions where the agricultural frontier is expanding fast. The suggestion to eliminate this negative bias to specify panel data and to specify a system of equations where logging flows are simultaneously determined with changes in land clearing.

Since equation (9) is a logistic, the elasticity of deforestation density in relation to logarithmic variables, like the density of population, crop output, cattle herd, logging are defined by:

$$E_{d,x} = (1\text{-}d).A'_x \tag{18}$$

where $A'x$ the value of the coefficient of the variable x in case. The absolute value of the elasticity decreases monotonically with the deforestation density of municipalities being equal to A' when there is no deforestation and one when the density of deforestation equals one.

For variables like distance, roads and river, the elasticity of deforestation is defined by:

$$E_{d,x} = (1\text{-}d).A'_x.x \tag{19}$$

The value of elasticity is decreasing with deforestation density and increasing with the value of the variable in the municipality in case. Thus, if deforestation density show a positive relatioship with the vaiable in case, like roads, the value of the elasticity will first increase and later decrease. When the variables has a negative relation, the absolute value of the elasticity will decrease monotonically.

The value of coefficients, though not statistically different, imply that cropping has a stronger effect on deforestation than cattle raising activities. This corroborates results of Reis and Margulis (1991), with the difference that now cropping is measured by the output of crops and not by crop area as was done earlier.

Table 6 report results for the equation (10) which determines the share of deforestation which takes place in forest areas (including dense forests, seasonal forests, and ecological transition) as opposed to areas covered by other kind of vegetation (savannas, wetlands, and campinaranas). The same specification as in equation (9) is used in this case, except for the substitution of geographic area for defoorested area as a normalizing variable.

Table 7 report estimation results for the generating functions of spatial distribution described by equation (12) The specification used is too simple to explain the variances in growth rates of population and economic activities, thus resulting in extremely low correlation coefficients. However, all the activities show small standard errors for the slope coefficients which quantify the relation between its geographic density and subsequent growth rate.

Table 6
Estimates on the extent of forest clearing

Equation n°	10	(10)
Dependent	Forest Clearing	Forest Clearing
Spec.	Logistics	Logistics
Method	OLS	ML
N.Obs.	70	151
D.F.	51	132
R^2 adj.	0,89	
Rmse	0,52	4,55
Rho	-0,09	0,79
Moran	-0,00	0,31
Dependent Coefficients	(standard errors in parenthesis)	
Rural Population	-3,01	-0,05
	(1,74)	(2,51)
Urban Population	1,59	0,16
	(0,96)	(1,23)
Farming output	0,54	0,37
	(0,88)	(1,15)
Herds	1,84	-0,18
	(0,61)	(0,80)
Logging	0,89	-0,42
	(0,81)	(0,99)
Deforested Area	-4,08	0,30
	(0,03)	(2,26)
Dependent Coefficients	(standard errors in parenthesis)	
Paved roads	0,01	0,001
	(0,02)	(0,02)
Unpaved roads	-0,003	-0,002
	(0,005)	(0,006)
Rivers	-0,04	-0,01
	(0,01)	(0,02)
State dist.	-0,009	-0,005
	(0,005)	(0,01)
Federal dist.	0,016	-0,001
	(0,003)	(0,005)
Rainforests	-9,72	-0,45
	(16,9)	(26,5)
Open forests	6,87	4,06
	(15,2)	(22,3)
Savanna	-15,7	-1,67
	(13,2)	(19,2)
Ecological stress	-7,98	2,76
	(13,9)	(20,3)
Invasive species	-23,9	-1,01
	(22,8)	(26,6)
Scrublands	-1,43	-11,3
	(0,63)	(123)

Table 7
Estimates for the generator functions on spatial distribution of population, farming production, livestock breeding, and logging

Model	OLS	SURE	SACD	SACR	SURE+SACR
Dependent: Population growth, 1980/85					
C_{10}	3,412	3,397	1,585	3,218	1,48
	(0,264)	(0,232)	(0,292)	(0,207)	(3,52)
C_{11}	-0,722	-0,752	-0,420	-0,699	-0,625
	(0,111)	(0,100)	(0,114)	(0,101)	(0,16)
Rho/Thou			0,55	0,55	0,95
			(0,059)	(0,059)	
R^2/LM	0,123	0,15	-254,2	-252,4	
Rmse	0,030		0,001	0,001	
N. obs	293	326	336	336	326
Dependent: Livestock breeding growth, 1980/85					
C_{20}	9,245	8,498	7,583	8,427	11,3
	(0,798)	(0,714)	(0,965)	(0,691)	(2,29)
C_{21}	-2,516	-2.341	-1,973	-2,444	-4,47
	(0,332)	(0,282)	(0,356)	(0,306)	(0,45)
Rho/Thou			0,05	0,25	0,74
			(0,083)	(0,076)	
R^2/LM	0,161	0,15	-716,2	-712,5	
Rmse	0,100		0,013	0,012	
N. obs	294	326	335	335	326
Dependent: Forming output growth, 1980/85					
C_{30}	1,396	1,700	0,902	1,073	1,58
	(0,655)	(0,651)	(0,627)	(0,606)	(1,70)
C_{31}	-3,462	-3,786	-2,532	-3,600	-4,46
	(0,315)	(0,307)	(0,440)	(0,330)	(0,47)
Rho/Thou			0,35	0,45	0,70
			(0,077)	(0,066)	
R^2/LM	0,268	0,15	-681,9	-677,4	
Rmse	0,106		0,099	0,097	
N. obs	326	326	335	335	326
Dependent: Logging growth, 1982/87					
C_{40}	-4,325	-4,467	4,277	9,306	15,8
	(2,963)	(2,939)	(2,900)	(2,727)	(19,2)
C_{41}	-0,614	-0,557	-2,334	-5,721	-6,94
	(0,988)	(0,976)	(1,072)	(0,982)	(0,96)
Rho/Thou			0,70	0,75	0,94
			(0,046)	(0,041)	
R^2/LM	-0,002	0,15	-942,8	-932,7	
Rmse	0,295		0,049	0,045	
N. obs	326	326	328	328	326

Note: Rho and Thau respectively refer to the spatial autocorrelation of residuals and dependent variables obtained by ML estimation.

Results show a spatial dispersion of economic activities typical of frontier areas, with growth rates proving lower in areas of less dense economic activity. According to the estimates of C_{k1} obtained by combining spatial autocorrelation of residual and seemingly unrelated regressions (SACR+SURE), this pattern is stronger for logging, followed by cropping and cattle raising, and much lower for population. This is a reasonable finding if one consider that, in the case of population, centripetal forces related to frontier expansion are offset by agglomeration phenomena such as urbanization ond industrialization.

Comparing the different estimotion procedures, OLS values for the slope coefficient are significantly lower than value obtained assuming spatial autocorrelation in residuals (SACR), especially when it is combined with seemingly unrelated regressions (SURE+SACR). Differences are specially significant in the case of logging growth but for population growth they are not significant. Finally, note that SURE+SACR make the slope coefficient for crop and cattle almost identical, suggesting that they are subject to the same determinants.

7. Simulation results

Table 8 presents assumptions, projections and simulations of Brazilian Amazon deforestation and its contribution to CO_2 emissions for 1990-2090. Needless to say, secular projections should be taken cum grano salis. As Theil said, "models are to be used, not to be believed." In any case, they are surely better than the naive extrapolations usually made.

Table 8
Simulations for Brazilian Amazon deforestation – 1990/2090

	A Basic Scenario	B Growth Plus 1% high	C Livestock Plus 1% high	D Farming Plus 1% high	E Roads Plus 1% high	F OLS Coefficients
Assumptions on avarage annual growth rates for 1990/2090 (%)						
Population	1,4	2,5	1,4	1,4	1,4	1,4
Farming	2,9	4,0	2,9	4,0	2,9	2,9
Herds	6,7	7,8	7,8	6,7	6,7	6,7
Logging	6,8	7,8	6,8	6,8	6,8	6,8
Paved roads	3,3	4,4	3,3	3,3	4,4	3,3
Unpaved roads	2,0	3,1	2,0	2,0	3,1	2,0
Annual growth rate of deforested area(%)						
1990/2025	4,8	5,5	4,9	5,0	5,3	3,9
2025/90	0,3	0,6	0,3	0,3	0,6	0,4
1990/2090	1,9	2,3	1,9	1,9	2,2	1,6
Percentage of geograpfhic area deforested						
1990	7,3	7,3	7,3	7,3	7,3	7,1
2025	37,2	46,8	38,3	40,0	43,8	26,6
2090	45,9	67,6	47,6	50,0	62,8	34,5
Cumulative carbon dioxide emissions in 10^9t						
1990/2025	18,2	23,9	18,9	19,8	22,1	11,7
2025	3,5	8,7	4,0	3,8	8,0	5,8
1990/2090	21,7	32,6	22,9	23,6	30,1	17,4

Source: Authors' estimates.
Note: Projections made with coefficients estimated by maximum likelihood, assuming SACR for equation (9) and SACR+SURE for equation (12).

Projections were made using the maximum likelihood estimations of equations (9) and the SACR+SURE estimations for equations (13). The benchmark year for projections was 1990. The Basic Scenario, presented in column A, assumes a secular slowdown in population growth which declines from an average 3.1% p.a., in 1980-990, to 2.1%, in the 1990-2025, and 1.1%, in the 2025-2090. In per capita terms, agricultural GDP (including crops, cattle raising and logging) is assumed to grow at an average rate of 3.0% p.a. in all subperiods. These high rates for secular growth characterize an optimistic economic scenario which is broadly comparable to Scenario E in the IPCC(1991).

It also assumes that, in per capita terms, paved and non-paved roads, grow at constant rates of 1.9% p.a. and 0.5% p.a., respectively, which implies a gradual substitution between them. For the sake of comparison, paved and non-paved roads in the first half of the eighties increased 4.7% p.a. and 3.5% p.a., respectively, while population grew 3.5% p.a. during the eighties.

Finally, it assumes that the patterns of spatial dispersion of economic activities in the next century is the same as the one observed for the estimation period, 1980-1985. In other words, in the projections, the slope coefficients (C_{k1}) in equations (13) were kept constant. Note that constant coefficients (C_{k0}) were adjusted to make growth rates of municipalities compatible with the aggregate rates assumed above.

From an environmental perspective, the result of projections are alarming, though still far from the catastrophic scenarios usually depicted for Amazon. According to the projections, approximately 45% of the geographic area of Brazilian Amazon will be deforested, by the end of next century. For the greenhouse effect, the consequences will be to push cumulative carbon dioxide emissions to something around 21.7 billion tons, which by itself means an increase of 6.8% in the current level of concentration in the atmosphere. Assuming that in the absence of drastic policies carbon dioxide concentration in the atmosphere will grow at around 0.5% to 1.0% p.a., the Amazon's cumulative contribution would stay somewhere between 3.7% and 2.6% of global emissions, respectively.

Most of the deforestation takes place in the 1990-2025 period, reflecting, on the one hand, the higher rates of growth assumed for this sub-period and, on the other, the saturation effect in deforestation implicit in the logistic functional form.

The trade-offs between growth and deforestation are roughly estimated by comparing the Basic Scenario with the alternative scenario presented in column B, where secular rates of growth of population, economic activities, and roads are all increased by 1%.

One percent more growth leads to a 0.4% increase in the average rate of growth of deforestation for the 1990-2090, an additional 20% more in the share of deforested areas in 1990, and and addition of 11 billion tons in CO_2 emissions. Growth has a significant impact on deforestation and high rates of growth, without changes in land uses and/or technologies, are unsustainable.

Columns C, D, and E present comparative dynamic exercises were secular rates of growth of herd, crop output and roads in the are increased by 1%, ceteris paribus. They show that road expansion is, by far, the most important single factor for deforestation with an average elasticity close to 0.3. Both cattle raising and cropping have much smaller effects, with elasticities which are close to 0.1. Finally, column F show that projections made with OLS estimates would give much more conservative results.

8. Concluding remarks

The model and the simulations presented in this paper are useful tools for the appraisal of cost and benefits of sustainable development of Brazilian Amazon. Reliable projections, however, require some improvements in the methodology and data base. Concluding, we just point the most critical aspects for research extensions and further developments.

The most disturbing aspect is perhaps the simultaneous equation biases introduced by the fact that population growth, and economic activities are, at the same time, causes and consequences of deforestation. Thus, they should be treated as endogenous variables in the reduced form of the model. This is probably the reason of both the wrong signs obtained for the coefficients of population, and logging, and the large instability of parameter values in estimations.

The proposed solution is to estimate fixed effect and random effect models based upon panel data. Since Census data at municipal level are available every five years since 1970, and since deforestation can be proxied by land uses defined in the Census, road network at municipal level is the crucial missing variable for panel analysis.

Another aspect deserving careful specification is the long run determinants of technical progress in Amazon agriculture, and their relationship to changes in the geographic densities of population and of other economic activities. Panel data analysis is again a crucial requirement to estimate the parameters related to efficiency and technical progress. Furthermore, the analysis should be made at more relevant levels of aggregation like cattle raising, temporary and permanent crops, as well as reforestation and fallow lands.

Finally, two other dynamic aspects need to be modeled. The first is the determinants of population growth, migration and urbanization. The suggestion here is complement econometrics with demographic techniques. The second aspect concerns the specification of dynamic relationships between the fate of carbon stocks and land use changes.

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CHAPTER 10

EXPORTING AND THE SAGA FOR COMPETITIVENESS OF BRAZILIAN INDUSTRY - 1992*

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Abstract

For an entire decade Brazil's economy presented the worst performance indicators ever registered, while at the same time exports grew at a very rapid pace, particularly exports of industrial products. Such indicators have led some analysts to conclude that external markets are becoming increasingly important to Brazil's industrial sector. The concern as to the competitiveness of Brazilian products has become more relevant not only because of the key role played by exports but also because of the greater exposure vis-à-vis imported products observed over recent years. This article presents the principal findings of a study on the topic of competitiveness which analyzes the data from the companies which were surveyed in light of their involvement in export activities.

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1. Introducition

The Brazilian economy has - for a whole decade - presented what have probably been its worst economic indicators ever; by the end of the 1980s, the difficulties were even sharper. Inflation had mounted to 12-month rates as high as 3000% by mid-1990, and averaged more than 800% in the following two years, whereas real per capita GDP fell 15% between 1988 and 1992.

Meanwhile, exports grew at a very rapid pace, with yearly growth rates reaching nearly 5% between 1980 and 1992, thanks mainly to industrial products, exports of which increased until they accounted for 74% of total exports by 1992.

These two sets of figures have led some analysts to see the dynamism of exports as an important source of growth for the industrial sector that partially compensates for the depressed domestic market. According to such views, industrial exports have become important not only as a source of foreign exchange, as most previous analyses of the Brazilian experience have suggested, taking into account, among other things, the relative insignificance of external sales for total domestic production. By disaggregating the sources of growth, one finds that the external market has also become more important as a source of demand for some industrial sectors.

Furthermore, the experience of 1986 - when several exporters diverted products from the external market to meet the overheated domestic demand and very soon found that the cost of losing foreign contracts proved to be too high - has led to expectations that the increasing involvement in export activity is likely to become more permanent than before.

At the same time, the period since 1987 has witnessed an unprecedented movement towards the opening of the Brazilian economy to imports, which has intensified since 1990.

The precondition for domestic producers to operate successfully in a more open context is to improve competitiveness so as to survive the inflow of competing imports and maintain (or increase) their share of international markets. Improved competitiveness has thus become an explicit target for private producers and policy makers in Brazil as never before.

The present study draws on the primary results of a large research project undertaken jointly by the Instituto de Economia - Universidade Federal do Rio de Janeiro, the Universidade de Campinas and the Brazilian Ministry of Science and Technology on the main features of Brazilian industry with regard to its competitiveness. The research sought to portray the basic steps undertaken recently by Brazilian industrial firms in pursuing competitiveness, their views concerning the main trends and their plans for future action in this regard. A total of 1,500 questionnaires were sent to firms all over the country, and firms were selected on the basis of their contribution to sectoral production, according to the 1985 census.

The results reported here represent a partial processing of data from 350 firms that answered the questionnaire. It was assumed that in order to evaluate the peculiarities of the export sector, the sample of firms should be designed in a way that allows for isolating the effects of exports (i.e., sectoral comparability of exporters and non-exporters), firm size sectoral specificities. A sub-sample of 199 firms in 11 sectors[1] was then identified, and forms the basis for the present analysis.

This study is part of a series of papers dealing with a wide range of subjects directly and indirectly related to the basic issue of the competitiveness of Brazilian industry.[2] More specifically, the present paper seeks to: a) identify the basic action undertaken in the last five years with regard to improving competitiveness, as reflected in the answers to the questionnaire, and b) try to relate whatever differences might be found in the behaviour of the firms to the differences in their involvement in export activity.

This study should be seen as only a first approach to the subject, since time constraints did not allow it to: a) take into account all the information[3] available from the research and b) process the data so as to isolate the specific effects due to firm size, sectoral specificities and involvement in export activity.

Furthermore, this paper should not be expected to include here a comprehensive testing of the effects stemming from involvement in the external market. That would require further work, taking into consideration the characteristics of the period of analysis - above all the domestic recession and exchange-rate overvaluation that have affected the export sector - and controlling for firm size and sectoral specificities, among other attributes.

Instead, the aim of this first approximation is to depict efforts made by the firms surveyed in order to foster competitiveness, and to try to identify indications that involvement in export activity might lead to a differentiated approach. As a by-product, it attempts to determine whether these sample results confirm in broad terms some specific procedures that characterize exporting firms elsewhere.

The structure of the paper is as follows. The second section presents a very brief overview of some positive effects that might be expected from increased involvement in exporting, as a reference for a comparative evaluation of the results obtained. The third section presents a description of the sample of firms and the basic structure of the questionnaire. The fourth section summarizes the basic findings and how they compare to previous evidence, and the main conclusions and some policy implications are presented in the last section.

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1 Steel products; power generating machinery; automobile industry; cotton textiles; pulp; paper; cement; producers of television, radio and sound receivers; fertilizers; furniture; and apparel and clothing.

2 A parallel study dealing with broad issues based on the same primary data is Bielschowsky (1993).

3 A number of aspects, such as a detailed account of manpower training, the entrepreneurs' view of the limitations imposed by the physical and technological infrastructure and others, have not been considered here.

2. A brief account of the positive effects to be expected from exporting

Theory - as well as empirical evidence from the experience of several countries - would lead one to expect a positive correlation between exporting and the improvement of competitiveness. Not only is maintaining a certain level of competitiveness a precondition for successful export performance. There is a virtuous circle linking more exports to more efficient production processes, to better identification of international market opportunities, closer contact with technical progress, and so on, all of which feeds back into improving the conditions for exporting more and in a more sustained way.

At the level of firms, it is often found that firms in developing countries have difficulties in collecting rents accruing from new technologies and thus spend relotively limited resources on basic, innovative research and development (R&D) activities; instead, they orient their research activities towards adapting foreign technologies.

But causality is likely to work in both directions. Exports increase the size of the market and might thus encourage a return to innovative activities. Also, the external market might impose more rigorous conditions on exporters, thus reinforcing the demand for these technological change activities.

As far as the *type* of technological improvement activities is concerned, it might therefore be expected that the greater the degree of involvement of a given firm in export activity, the more likely it is to adopt innovations in cost-cutting, quality improvement and product differentiation.

As far as the *way* of acquiring technology is concerned, the classification adopted by Kirim (1990) for modes of transfer of knowledge can be used. These transfers might take place according to "formal" (market-mediated) contracts (direct investment, licensing, management contracts, turnkey projects), or they might be absorbed via "informal" (non-market) mechanisms such as learning by exporting, imitation, keeping up with technical literature, visiting trade fairs, scientific exchange and others.

It is not the purpose of this study to go into an extensive survey of the related literature. Instead, it will merely review some pieces of evidence relative to a developing country which recently moved towards a more liberal trade orientation - information on Turkey provides a basis for comparison - and a few indicators already available for Brazil.

The results reported in Kirim (1990) for 659 firms in 1987-1988 will be used as a reference for the Turkish experience.

Kirim finds no discernible difference between exportes and domestic-market-oriented firms in terms of their relative R&D spending. Export orientation seemed to influence the *direction*, of technological research efforts. The three most important technological change activities for exporters were, in order of importance: 1) cost reduction; 2) capacity stretching (expanding the physical yield of existing plants and equipment without making major investments in new capital equipment); and 3) quality improvement.

For non-exporters, the ranking was somewhat different, with quality improvement in first place, followed by cost reduction and (lastly) capacity stretching.

Since competing with imports primarily requires product quality, and only to a lesser extent price differentials, the technological activity of domestic-market-oriented firms would be expected to focus more on product differentiation and less on cost-reducing technological research activities. Exporting firms, on the other hand, could be expected to uncertake systematic activities involving cost-reducing, quality-improving and product-developing technological change.

There also seem to be differences between exporters and non-exporters, in the way these technological changes take place. Exporting firms not only were involved in more cost-reducing technological activities than domestic-market-oriented firms, but also carried out these activities more systematically.

Furthermore, both exporting and domestic-market-oriented firms usually acquired their technologies through formal, non-equity modes of technology acquisition only in those cases where the products or technologies were new to them. Domestic-market-oriented firms relied predominantly on domestic and informal sources for acquiring technologies, while exporting firms relied on market-mediated transfer mechanisms. The main reason seems to be that "in activities that are new to the country and to the industry the easiest way to gain access to the technologies is by entering into a formal agreement with a foreign supplier; in other areas where domestic firms have been established for some time, it was always preferable to obtain the incremental knowledge without actually paying for it"(p.1354).

There is apparently no corresponding processed information of this kind on Brazil. However, at least three sets of evidence dealing with specific characteristics of exporting firms are available that provide a background for a comparative evaluation of the results obtained in the present enquiry.

First, Braga (1990) reports on data for 4,342 establishments in 13 industrial sectors for 1981.

He finds - as Kirim did in Turkey - that the probability of rationalizing the production process through product quality control methods, control of raw materials and changes in the layout of the production plant increases with foreign ownership, technology imports, exports and size. The probability of using quality control is also positively affected by product diversification. Furthermore, it was found that not only does involvement with exports have an intense impact on all the technological activities considered, but also that firms that export are much more likely to be involved in technological activity than non-exporting firms.

The export/sales ratio, size and foreign capital ownership also increase the probability that a given firm will develop new products and create a manpower training programme.

Willmore (1992) reports on the results for 17,053 Brazilian manufacturing firms in 19B0.

He finds, first, a negative relation between R&D and exporting. The existence of a researach and development programme appears to have no significant effect on the probability that a firm will engage in export or import activities. The causality seems to be in the opposite direction, since Braga/Willmore (1991) found that exporting increases the probability that a Brazilian firm will engage in R&D.

Exporters tend to be much more concerned about advertising. Firms producing highly advertised, hence differentiated, goods are more likely than others to participate in international trade. Also, exporting firms depend more heavily on imports than domestic-market-oriented firms.

Finally, some complementary evidence was obtained by Willmore, and published as CEPAL (1985), from data on 12,435 firms in 1978.

It showed that firm size was the most important factor affecting both the probability that a firm will export and its subsequent export performance. As far as the competitive attributes being considered above are concerned, it was found that advertising expenditures and licence agreements were very strongly and positively correlated with both the probability of exporting and export performance, once again very much in line with the results reported for Turkey.

3. The sample

The analysis is based on data for 199 firms in 11 industrial sectors. In 1992, these firms exported a total of US$ 6.2 billion, or 23% of total Brazilian exports of industrialized products in that year.

In order to evaluate the role of involvement in exporting, the primary data were processed by grouping the respondent firms according to their export/total sales ratios, in five groups arbitrarily defined as:

i) non-exporters (firms with an X/Y ratio of up to 5%);

ii) firms with an X/Y ratio of 6% to 10%;

iii) firms with an X/Y ratio of 11% to 30%;

iv) firms with an X/Y ratio of 30% and 50% and

v) firms with an X/Y ratio of over 50%.

The sample is described according to the number of firms in each category and to their share of the total sample exports as follows:

Export/sales (%)	Number (%)	Share (%) of sample expo	
		1987-1989	1992
0 to 5	54.2	0.93	0.37
6 to 10	8.4	0.83	1.26
11 to 30	22.3	34.25	30.38
31 to 50	9.5	35.16	43.16
Over 50	5.6	28.83	24.83
Total	100.0	100.00	100.00

More than half of the firms have a very low (less than 5%) export coefficient, and are thus considered non-exporters, or domestic-market-oriented firms. The second notable point revealed by these figures is that the group of firms with export coefficients between 30% and 50% presented the most impressive performance in terms of the external market, significantly increasing their share in total sample exports between the two periods considered here.

Most (72%) of these firms are part of economic groups, a characteristic common to all five sets of firms. In all but the last group, about half (48%) of the firms are multiproducers (i.e., produce several items) and (47%) have several producing units (multiplant).

4. Basic results

a. Recent adjustment

The analysis of these data calls for some preliminary remarks about the year they were collected (1992). It is known from previous research that most of the production sector - manufacturing in particular - in Brazil was by that time undergoing a significant change, after some traumatic experiences since 1990, when liquidity was drastically reduced by government policies, national output declined, domestic interest rates went up very markedly, inflation remained at monthly levels of around 25% and an open trade policy pushed domestic producers into an unprecedented exposure to competition from imports. It is therefore expected that these data reflect the firms' efforts to adapt as much as the basic differences between exporters and non-exporters.

Second, the questionnaire was designed to identify the basic features of the production sector insofar as measures to improve competitiveness are concerned. Hence, the questions were not totally tailor-made to deal with the specific subject of export activity. The analysis from the viewpoint of involvement with the external market is therefore a by-product, even though a great deal of information - unprecedented in several respects - is available from the processed data.

Keeping these two points in mind, it is interesting to note that most (59%) of the firms classified as non-exporters or domestic-market-oriented (DMOs) - those with an export/sales coefficient of less than 5% had total sales worth less than US$ 20 million in 1987-1989, while those firms with export/sales ratios of over 30% recorded sales worth over US$ 120 million that year, indicating a positive correlation between size and export/sales ratios in the sample.

In 1992 the correlation between the X/Y ratio and total sales remained positive, but there are clear indications that the exporters were less vulnerable to the domestic recession: among the DMO firms, 70% had sales below US$ 20 million (compared to 59% in 1987-1989), whereas for exporters the impact is inversely proportional to the export/sales ratio, as shown by the following indicators:

X/Y	% of firms with sales over US$ 120 million	
(%)	1987-1989 (average)	1992
10 to 30	44	33
31 to 50	64	57
Over 50	62	62

This would indicate that - as expected - the external market has acted as a "cushion", softening the negative impact of domestic recession on these firms in direct proportion to their involvement in exports.

As a confirmation of the importance of the external market as a buffer against domestic recession, one could add that the proportion of firms with export/sales ratios of 10% to 30% that had total exports worth at least US$ 12 million increased from 58% in 1987-1989 to 74% in 1992, whereas for those firms with export/sales ratios of over 30%, that proportion remained close to 90% in both periods.

The number of employees per firm shows a distribution similar to that of total sales: 63% of DMO firms had up to 500 workers in 1987-1989, while 25% to 36% of the firms with export/sales ratios of over 10% had more than 3,000 workers.

In 1992 there was a clear adjustment process, with significant reductions in jobs. Among non-exporters, the proportion of firms with up to 500 employees increased to 76%, whereas among exporters with export/sales ratios of over 10%, the proportion of firms with over 3,000 workers fell to between 13% and 29%.

This reduction in jobs was accompanied by a corresponding change in the decision-making process within the firms, as reflected in the number of hierarchical levels. In 1987-1989, half of the non-exporters had up to five decision-making levels,[4] and this proportion increased to 67% in 1992. The same occurred in the several groups of exporters, in increasing proportion with their export/sales ratio, as shown below:

X/Y ratio	% of firms with up to 5 hierachical levels	
	1987-1989 (average)	1992
6 to 10	67	75
11 to 30	46	60
31 to 50	15	46
Over 50	12	40

It follows from the previous paragraphs that one set of differences between exporters and DMO firms stem from their capacity to cope with domestic recession and the intensity of their adjustment in the use of production factors.

However, owing either to the feeling that the worst recessive period is over, or to hopes of improved competitiveness as a result of the adjustment process, more than half of the firms in every group - regardless of their export/sales ratio - expected higher profits in 1993-1995 than in 1992, and in 1996-1998 in comparison to 1993-1995.

It is worth noting that improved competitiveness is not necessarily related to more imports. Data show that 60% or more of non-exporters did not import either capital goods or inputs in 1987-1989 or in 1992.[5] Exporting firms are apparently more dependent or imports: more than 25% of the firms with an export/sales ratio of over 10% imported inputs worth more than US$ 10 million in both 1987-1989 and 1992.

This is consistent with the results obtained by Willmore (1992), as reported in section II: there is a greater propensity to import in exporting firms as compared to DMO firms.

Another basic characteristic of the exporting firms in this sample has to do with the market of destination for their exports. There seem to be some differences in the markets of destination, and these differences appear to be linked to the export/sales ratio, and hence to the size of the firms. In the smallest group of exporters (firms with export/sales ratios of 6% to 10%), 75% of the firms made sales to MERCOSUR in 1992, 42% to "other countries of Latin America" and 50% to the United States and EEC. Among those firms with export/sales ratios of over 50%, 87% export to the United States, 62% to the EEC and only 12% to MERCOSUR.

[4] Firms were asked whether they had up to three decision-making levels, four or five levels, six or seven levels, or over seven levels. In 1987-1989 21% of the firms with X/Y ratios of 10% to 30% and 31% of firms with X/Y ratios of 30% to 50% had more than seven levels. In 1992 those proportions fell to 4% and 15%, respectively.

[5] However, that proportion was higher (61%) in 1987-1989 than in 1992 (56%) for inputs, indicating that even in this group there was some increase in the consumption of imported inputs.

It seems, therefore, that all firms export to the United States and the EEC, but only a limited number of them - and not the largest ones - explore the regional market.[6] Needless to say, this generic conclusion must be qualified by information at the sectoral level.

When asked how they channelled their sales, it turned out that by and large all the firms said they used mostly their own sales structures. It is certainly remarkable that only medium exporters (firms with export/sales ratios of 10% to 50%) referred to the use of trading companies and licensed firms, when one would have expected the smaller exporters to be the main customers of those intermediaries.

In sum, the evidence reviewed thus far indicates an overall trend towards adjusting the number of jobs and the hierarchical structure in each firm, and suggests the existence of basic differences between exporters and non-exporters with regard to their capacity to resist the domestic recession and their propensity to import. Also, there are differences among exporters with regard to the market of destination of their external sales and the way they channel their exports.

Table 1
Sample indicators by groups of firms

X/Y ratio (%)	Total sales variation (%)	Export variation (%)	Input imports (%) 1987-89 (average)	Input imports (%) 1992	Employment/sales (%) 1987/89 (average)	Employment/sales (%) 1992
	1987-89/92					
0 to 5	-4.9	-48.6	9.3	9.5	1.1	0.9
6 to 10	-2.2	96.4	3.6	8.1	1.6	1.3
11 to 30	-7.1	9.3	4.8	5.2	0.8	0.7
31 to 50	5.6	44.3	5.5	5.6	0.6	0.5
Over 50	8.4	9.0	8.1	9.6	0.4	0.4

Source: See text.

A comparison of the first two columns of table 1 shows that in all groups of exporters, external sales increased more than total sales between the two periods. Also, growth in total sales was sharper for those groups of firms involved in some export activity. Export performance was particularly intense among firms with export/sales ratios of 6% to 10% and 31% to 50%.

[6] The relative importance of MERCOSUR merits some additional consideration. The percentage of firms in each group that said it was important is as follows:

X/Y	0-5	6-10	11-30	30-50	Over 50
(%)	27.5	75.0	42.9	30.8	12.5

Although the Southern Cone market is considered important for most firms in the 6% - 10%, one must take into account the relatively high proportions indicated by the firms in other groups. For those firms with X/Y ratios of 0% to 5%, this is the market with the highest indicators. For the two groups of firms with X/Y ratios of 11% to 50%, the percentages are significant, although smaller than the corresponding indicators for the United States/Canada. Note, however, that the above-mentioned groups comprise the bulk of the sample exports.

Although these results must be qualified by sectoral information,[7] they suggest that on the whole, *some exporting was better than no exporting*, although it is not clear whether *more exports are better than fewer exports*. That is, one cannot conclude - from these data - that increasing the export/sales ratio above a certain level is in itself an assurance of better overall sales performance. In other words, it seems more reasonable to infer that exports worked as a buffer against domestic recession than that this period was one of export-led growth.

Table 1 also shows that, in general, all groups of firms increased their imported component; however, because the variation in the import/sales ratio was more intense among small exporters (those firms with export/sales ratios of 6% to 10%) and among the largest exporters (firms with export/sales ratios of over 50%), there does not seem to be a linear relation between the export/sales ratio and the import/sales ratio.

Finally, the last two columns of table 1 confirm the overall reduction in the number of jobs in all groups of firms. Once again, however, this is not a major characteristic linked to the export/sales ratio: suffice it to say that among the largest exporters, the employment/sales ratio remained the same in the two periods.

What these indicators imply at is that there actually are differences between exporters and DMO firms, but also that the adjustment process they reflect is apparently more a result of strategies to improve or consolidate the firms' competitive position in the domestic market than of strategies for penetrating the external market. This should become even more clear in the following discussions of market strategies, productive performance and managerial, technological and productive capability.

b. Market strategies

Firms were asked whether they intended to explore specific market segments or several diversified ones, and which would be the main tool in their strategies with regard to the domestic and the external markets.

It is remarkable that between 52% and 63% of the firms in almost all groups revealed an interest in exploring specific market segments. This seems to indicate a wide spread concern with competitiveness via specialization. Only among those firms exporting more than half of their output was that proportion a bit smaller (38%) and similar to the proportion of answers indicating all market segments.

This view that specialization leads to competitiveness is revealed even more clearly by the information related specifically to the competitive strategies of the firms.

[7] Export price variations might help explain some of these results.

Table 2 summarizes information on product strategy and administration of production, showing - for each group of firms - the percentage of firms that gave affirmative answers.

According to table 2, firms target specific market segments; they are also (especially non-exporters) concerned about brand-name identification and specific clients' requirements. Also, a number of exporters of all sizes are concerned about providing technical assistance for their domestic sales, as well as improving the technical specificity of their products.

Technical specificity of p oducts is also an attribute strongly considered for exports; the higher the export/sales ratio of the firms, the more importance it is given. Coupled with the importance given to brand-name identification and delivery time, this would seem consistent with the previous indications of strategies for targeting specific market segments.

Table 2
Competitive strategies of firms (Product and production administration)

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms) (*)				
Product strategy						
Domestic market:	100					
Brand-name identification		45	33	n.s.	n.s.	38
Efficiency of technical assistance		n.s.	n.s.	n.s.	n.s.	38
technical specificity of product		n.s.	33	38	38	38
Specific clients'requirements		38	33	n.s.	n.s.	n.s.
External market:	100					
Low price		n.s.	50	46	n.s.	n.s.
Brand-name identification		n.s.	n.s.	n.s.	n.s.	38
Delivery time		n.s.	n.s.	n.s.	n.s.	38
Technical specificity of product		n.s.	33	36	77	75
Production flow administration:	176					
Reduce inventories		50	80	50	53	n.s.
Improve raw materials utilization		36	47	45	60	70
Reduce emission of pollutants		n.s.	n.s.	n.s.	n.s.	50
Reduce jobs		n.s.	33	38	n.s.	n.s.
Reduce bottlenecks in production		n.s.	n.s.	35	47	n.s.
Production process:	107					
Increase standardization		n.s.	n.s.	n.s.	n.s.	60
Increase flexibility		65	92	65	79	40
Main productive unit:	171					
Outsourcing basic services		40	47	67	73	90
Specialize product line		n.s.	47	47	n.s.	n.s.
Renew product line		59	60	61	73	50

Source: See text.
N.s. - non-significant (less than 33%)
(*) Firms were asked to indicate each attribute as "important" or "very important", and could indicate up to two attributes. Figures show the percentage of firms in each case.

It is also worth noting that low price is an attribute not considered for sales in the external market, and only those firms with low export/sales ratios seem to take it into account. This seems consistent with the assumption that Brazilian exporters are "price-takers"; that is, too small to influence international price levels.

Figures referring to production flows also reveal some clear trends. By and large, firms are trying to reduce their inventories. Note that this is true of all those dependent on the domestic market for most of their operations, and one reason is probably the cost of keeping inventories in a recessive inflationary environment. This might also explain why the largest exporters do not consider this item in a significant magnitude.[8]

There is also a universal concern about improving the utilization of raw materials, in increasing proportion to involvement in exporting. This is due not only to improved competitiveness; for the largest exporters there is also a parallel preoccupation with the emission of pollutants, a probable consequence of barriers imposed by importing countries.[9]

It was shown in previous paragraphs that the adjustment in recent years comprised a significant reduction in jobs. According to table 2, it appears that no further reduction of significant magnitude is to be expected; only some groups of firms indicate an intention to reduce jobs and bottlenecks in production.

Figures at the end of table 2 confirm that the firms aim at increasing the flexibility of production processes, outsourcing basic services in direct proportion to their export/sales ratios and renewing their product line. Once again, this seems consistent with the previous indications of a quest for competitiveness based on specific market segments and more efficient and flexible production processes.

There are also some differences between exporters and non-exporters with regard to their approach to other firms, as shown in table 3.

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8 Note that this approach differs from that previously reported for the Turkish firms.

9 This is confirmed by the indications - to be discussed later in the text - that non-tariff barriers, have a negative impact on the largest exporters.

Table 3
Competitive strategies of firms (Relations with suppliers and other firms)

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms) (*)				
Input purchases:	107					
Lower price		83	75	66	71	88
Technical specifications		54	50	59	79	75
Durability		n.s.	33	33	n.s.	33
Input suppliers:	106					
Preference for lowest number of suppliers		37	67	50	79	44
Joint R&D programmes		n.s.	58	n.s.	50	n.s.
Joint product development		43	75	50	86	44
Information about product quality		63	92	73	93	56
Stable commercial links		38	75	77	79	78
Suppliers certified by the firm		40	67	53	71	56
Suppliers offering the most advantageous conditions		53	33	37	36	44
Links with other firms	105					
Association for specific projects		n.s.	50	52	71	70
No strategy		55	33	n.s.	n.s.	n.s.

Source: See text.
n.s. - non-significant (less than 33%)
(*) Firms were asked to indicate each attribute as "important" or "very important", and could indicate up to two atributes. Figures show the percentage of firms in each case.

All firms (rationally enough) prefer to buy inputs at low prices. It is, however, interesting to note that concern with the technical specifications of the inputs - although significant for all groups of firms - is an attribute far more important for the largest exporters, and might be a reflection of the more demanding external market. However, this is not so in the case of durability.

Firms in general prefer to deal with a limited number of suppliers, and the exporters in particular attach importance to stable, long-term commercial links with their suppliers. Most firms care about product quality and say they exchange information about it with their input suppliers. But while domestic-market-oriented firms often consider buying from suppliers that offer the most advantageous conditions, it would seem from the figures in table 3 that exporters tend to prefer those suppliers certified by the firm, and often carry out joint product development programmes.

Furthermore, exporters tend to strategically associate with other firms for developing specific projects, while most domestic-market-oriented firms say they have no strategy in that regard.

This might be an additional indicator of the more exacting demands and greater stability of the rules required (and barriers imposed) by the external market as compared to domestic sales.

Additional evidence of the firms' approach to modernization and to dealing with specific market segments is found in their investment strategy.

As shown in table 4, a significant share of the firms consulted said they intended to invest both in increasing capacity and (more intensively) in modernizing productive capacity. The figures also reflect an intention to produce new items that are technologically similar to the present production lines. This is particularly characteristic of those firms with higher export/sales ratios, who aim also at explicitly specializing their product lines.

One interpretation of these responses seems to be that exporters are in general more sensitive to the requirements and demands of the external market, and although there is a general trend towards modernizing production processes, common to most of the firms surveyed, the evidence is stronger for the firms with greater involvement in the external market.

Differences are also found in the way firms finance their investment, although at this level of analysis not much can be said about the extent to which the differences are due to the export/sales ratios or to the size of firms.

Table 4
Competitive strategies of firms (Investment policy and determinants of current strategy)

Attributes	No. of firms	Export/sales (%) ratio				
		0-5	6-10	11-30	31-50	50-100
		(% of firms) (*)				
Investment strategy:	110					
Increase capacity in current lines		54	33	74	38	50
Modernization without capacity variation		42	67	58	56	70
New products tech.						

(cont....)

(continued)

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms) (*)				
similar to current production		41	33	45	56	60
Specialize product line		n.s.	58	36	38	40
Financing:	179					
Own resources		79	87	73	71	n.s.
Public credit		n.s.	40	43	71	70
Domestic private financing		n.s.	47	35	53	n.s.
External private financing		n.s.	n.s.	38	65	60
Localization:	110					
Present location		88	75	71	88	100
Latin American countries (non-MERCOSUR)		n.s.	50	50	n.s.	n.s.
Determinants of present strategy	176					
Domestic recession		78	87	85	71	40
Import competition		n.s.	n.s.	n.s.	47	n.s.
Market globalization		n.s.	73	46	59	60
MERCOSUR		n.s.	47	n.s.	65	n.s.
Consumers requirements		54	40	77	71	90

Source: See text.
n.s. - non-significant (less than 33%)
(*) Firms were asked to indicate each attribute as "important" or "very important", and could indicate up to two attributes. Figures show the percentage of firms in each case.

The figures in table 4 suggest that the lower the export/sales ratio (or the smaller the firm), the more it depends on its own resources for financing investment. In fact, it is worth noting that about 80% of the domestic-market-oriented firms and small exporters depend on their own resources, while less than one third of the largest exporters do so. Instead, the figures indicate an increasing reliance on public credit and (as expected) external private financing that is directly proportional to the firms' grouping according to export/sales ratio. Note, furthermore, that the largest exporters rely almost exclusively on public credit and external private financing: the last column shows little (or no) indication of using the firms's own resources or domestic private credit.

Not surprisingly, by and large the firms intend to maintain their productive units in their present location, but half of those firms with export/sales ratios of 6% to 30% (small to average exporters) say they plan to invest in other Latin American countries, out of the MERCOSUR area. This last figure calls for a cautious interpretation, for it might comprise capital movements into some of the region's tax heavens.

A final set of indicators that seem to confirm previous conclusions has to do with the factors that have actually determined the present strategy adopted by the firms.

As shown at the end of table 4, and as might have been expected in view of previous indicators, domestic recession did affect all groups of firms, but especially those that depend most on the domestic market. Import competition, on the other hand, is genera ly not considered as important, except for some medium to large-scale exporters.

Market globalization is particularly relevant for most exporters, and all groups of firms - mainly the largest exporters -care increasingly about consumer requirements.

Interestingly enough, these figures suggest that MERCOSUR has become an important factor for some firms, but that only for those groups of firms with export/sales ratios of 6% to 50% - that is, small to medium exporters - does the subregional market matter, for the definition of both their competitive strategies and their investment policies.

c. Productive performance

The evidence presented so far has shown the increasing preoccupation of firms with consumer requirements, technical specifications of inputs and products, more efficient use of inputs and raw materials and other indicators, all pointing in the same direction of increased competitiveness.

A similar movement can be identified in the changes that have taken place in recent years in the production process.

Tables 5, 6 and 7 show some basic indicators of the adaptation of the production process to the competitive strategy adopted by the firms.

There is an overall tendency to reduce the average production time. Between 1987-1989 and 1992 there has been an increase in the number of firms with production time of less than 10 days, coupled with a simultaneous reduction of the percentage of firms with a production cycle of more than 30 days. A similar movement is observed in the percentage of firms that have reduced their average delivery time.

The indicators relative to the average rate of reprocessing and the average rate of defective units out of total production also show a general reduction - between the two periods - in the percentage of firms in which more than 10% of output has imperfections.

It is, however, worth noting that half of the group of largest exporters had a zero rate of reprocessing in both periods, which might indicate a pre-existing concern with efficiency not found in other firms. On the other hand, this same group shows an increase in the percentage of firms with a rate of defective units/total output of over 10% between periods, which calls for further, detailed analysis.

There is a marked reduction in the average rate of input rejection in all groups of firms between 1987-1989 and 1992 - especially among the smaller exporters and domestic-market-oriented firms - which confirms the concern about making better use of inputs, but could also reflect a policy of reducing costs.

The argument that such changes are in fact related to movements linked to competitiveness is based on indicators that show a general reduction in the rate of returned products/total and a corresponding increase in the efficiency rate of raw material consumption, which would reflect more efficiency in the production process[10].

This is additionally confirmed by a set of data which indicate that in comparison with 1987-1989, 1992 product prices and production costs were relatively lower, firms paid higher wages, brand-name acceptance in the market was similar or higher, firms (mainly exporters) took less time to deliver products, provided relatively more technical assistance, and produced items with higher technological sophistication, closer to technical specifications, with the same durability and increasingly better adapted to clients' specifications.

The possibly negative counterpart of these positive movements is the indication that firms in general increased the share of energy consumption in total costs; this is particularly clear among the largest exporters. But as the question refers to costs, it does not clarify whether this is due to higher energy prices or to actual consumption.

When asked how they view their main competitors (table 8), the firms' overall reaction seems consistent with previous evidence, as it reflects a movement towards increased brand-name acceptance in the market, less time required for product delivery, more efficient provision of technical assistance, etc. The only aspect that is worth noting is the difference between exporters and domestic-market-oriented firms in that the latter tend to reflect the inflationary domestic environment, considering product prices and wages higher in 1992 than five years earlier.

[10] Note that this does not allow one to test the hypothesis advanced by Kirim (1990) that exporters and non-exporters rank differently their efforts with regard to cost reduction and quality improvement.

Table 5
Competitive strategies of firms(Productive performance)

Attributes	No. of Firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms)				
Average production time						
In 1987-1989	145					
Up to 10 days		37	27	19	25	40
Over 30 days		28	18	63	67	40
In 1992						
Up to 10 days		43	36	19	33	40
Over 30 days		28	18	50	50	40
Average delivery time						
In 1987-1989	167					
Up to 10 days		37	27	8	8	25
Over 90 days		23	27	64	62	50
In 1992						
Up to 10 days		44	33	22	31	37
Over 90 days		20	27	42	54	25
Average reprocessing rate	169					
In 1987-1989						
None		18	13	14	14	50
Over 10%		29	20	42	36	25
In 1992						
None		18	13	14	7	50
Over 10%		25	20	19	29	25
Average rate of defective units/ total output	169					
In 1987-1989						
None		17	7	3	7	13
Over 10%		31	27	33	43	25
In 1992						
None		17	7	3	7	13
Over 10%		24	13	19	36	38

Source: See text.

Table 6
Competitive strategies of firms (Productive performance)

Attributes	No. of firms	Export/sales (%) ratio				
		0-5	6-10	11-30	31-50	50-100
		(% of firms)				
Average rate of input rejection	101					
In 1987-1989						
Up to 1%		40	42	46	31	63
Over 10%		33	17	32	31	13
In 1992						
Up to 1%		45	50	56	31	75
Over 10%		30	8	18	23	13
Average rate of returned products/total sales	169					
In 1987-1989						
Up to 1%		59	73	58	64	75
Over 10%		19	0	17	29	13
In 1992						
Up to 1%		69	67	61	64	88
Over 10%		14	0	11	21	13
Energy costs / direct costs	169					
In 1987-89						
Up to 1%		16	27	29	14	0
Over 10%		41	13	28	43	38
In 1992						
Up to 1%		15	13	11	14	13
Over 10%		35	20	25	29	50
Rate of efficiency of raw material consumption (nominal/ effective rate)	101					
In 1987-1989						
Up to 80%		10	25	7	8	13
Over 97.5%		48	25	54	38	50
In 1992						
Up to 80%		10	17	7	8	13
Over 97.5%		58	42	64	46	63

Source: See text.

Table 7
Competitive strategies of firms (1992 compared to 1987-1989)

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms) (*)				
Product price	158					
Lower		46	73	72	64	57
Production costs	158					
Lower		28	67	53	64	71
Average wages	154					
Higher		38	47	48	31	n.s.
Similar		35	n.s.	n.s.	n.s.	71
Market Acceptance of product brand name	155					
Higher		40	47	n.s.	43	57
Similar		52	40	65	50	43
Time required for delivery	154					
Less		40	67	63	50	71
Time for developing new products	135					
Less		33	67	67	50	67
Efficiency in technical assistance	136					
Higher		46	67	54	83	67
Technological sophisticotion	137					
Higher		46	53	48	69	67
Conformity to technical specifications	143					
Higher		40	33	63	43	57
Similar		46	67	n.s.	50	43
Product durability	129					
Similar		57	79	55	56	80
Conformity to clients'specifications	137					
Higher		55	46	71	50	86

Source: See text.
n.s. - non-significant (less than 33%)
(*) Firms were asked to indicate each attribute as "important" or "very important", and could indicate up to two attributes. Figures show the percentage of firms in each case.

Table 8
Competitive strategies of firms - View of the main competitor

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms) (*)				
Product price	152					
Similar		40	43	37	50	71
Production costs	151					
Higher		n.s.	36	n.s.	36	71
Average wages	148					
Higher		n.s.	36	n.s.	n.s.	43
Similar		45	43	35	38	n.s.
Market acceptance of product brand name	150					
Higher		n.s.	64	n.s.	36	n.s.
Similar		41	n.s.	41	36	n.s.
Time required for delivery	150					
Similar		46	57	n.s.	43	57
Time for developing new products	138					
Similar		n.s.	n.s.	n.s.	43	57
Efficiency in technical assistance	135					
Higher		n.s.	64	36	42	43
Similar		36	36	36	42	0
Technological sophistication	136					
Higher		n.s.	53	42	n.s.	n.s.
Conformity to technical specifications	141					
Similar		49	50	46	64	43
Product durability	129					
Similar		51	69	48	78	60
Conformity to Clients' specifications	139					
Higher		n.s.	50	41	n.s.	n.s.
Similar		44	33	37	69	n.s.

Source: See text.
n.s. - non-significant (less than 33%)
(*) Firms were asked to indicate each attribute as "important" or "very important", and could indicate up to two attributes. Figures show the percentage of firms in each case.

d. Managerial, technological and productive capability

Evidence surveyed at the beginning of this study indicates that the approach of exporters to expenditures on technology, technical assistance, etc. differs from that of domestic-market-oriented firms. The information obtained from the present sample of firms tends to confirm this discrepancy.

Table 9 summarizes a number of such indicators, relative to 1987-1989 and 1992.

It is interesting to note, first of all, that about half of the non-exporters spent nothing at all on research and development (R&D) in both periods, whereas a similar proportion of the group of largest exporters spend over 4.5% of their total sales in this activity. This obviously confirms expectations based on the analysis of broader samples (Braga (1990), Braga/Willmore (1991)) mentioned at the beginning of this article. There are, however, indications that there has been a reduction in this item in 1992 in comparison to the previous period, probably owing to the overall cost-cutting policy.

A similar relation is also found with regard to expenditures on engineering, sales, technical assistance and manpower training programmes - exporters spend relatively more on these items - and here again the indicators show a general reduction between the two periods.

The differences between exporters and domestic-market-oriented firms are even sharper with regard to activities associated with the monitoring of the technological standard of production. Table 10 shows some relevant indicators.

As Kirim (1990) found in Turkey, it appears from the figures in table 10 that most services such as projects, product tests, certificates of compliance with technical requirements and consultancy services in marketing, management and quality are acquired in the domestic market, and that there is a concentration of affirmative answers in the group of largest exparters. No significant number of non-exporters said they had purchased those services either domestically or abroad.

Typically, the types of services purchased abroad are associated with product specificities, and consist of tests, certificates of compliance with technical specifications and consultancy services on product quality. This is consistent with the previous reasoning that large exporters are subject to fierce consumer pressures and competitive efforts.

However, the lack of indicators showing the purchase of technological services by non-exporters does not indicate a lack of concern with quality. The evidence presented above - on more efficient technical assistance and closer conformity to technical and client specifications, among others - clearly suggests an increasing preoccupation with quality improvement. What the figures at the beginning of table 10 seem to show is that, first, even domestic-market-oriented firms have not been significantly affected by competition from imports (as indicated in table 4, import competition is not an important issue for the design of the firms' strategies), and second, that (as Kirim (1990) found in Turkey) these firms are more likely to acquire technologies mainly from informal sources in the domestic market.

This is partially confirmed by the figures in table 11. When asked about the origin of the technical norms they use, firms indicated a predominance of their own criteria for raw material handling, machinery operation and product standardization. Domestic-market-oriented firms rely on official norms for input qualification, product specifications, standordization and tests, while large exporters also use international norms for product specifications and tests.

Another important fact indicated in table 10 is that in spite of the continued period of economic recession in Brazil, most firms in all groups - but mainly exporters - feel that their products compare very favourably (last or penultimate generation) with those produced by the main world exporters.

Furthermore, productive capacity is also said to compare positively: between 40% and 70% of the firms indicate that their most important equipment is less than 10 years old and belongs to the last or penultimate technological generation. Domestic-market-oriented firms - harder hit by domestic recession - compared less favourably, as illustrated by the lower proportion of answers, but it is nevertheless remarkable that the corresponding indicators for this group of firms are in the 40%-50% range.

Table 9
Competitive strategies of firms (Managerial, technological and productive capability)

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30 (% of firms)	31-50	50-100
R&D expenditures/ total sales	169					
In 1987-1989						
None		52	n.s.	n.s.	n.s.	n.s.
Over 4.5%		n.s.	n.s.	n.s.	36	50
In 1992						
None		49	n.s.	n.s.	n.s.	n.s.
Over 4.5%		n.s.	n.s.	n.s.	n.s.	37
Engineering / Total sales	169					
In 1987-1989						
None		50	n.s.	n.s.	n.s.	n.s.
Over 4.5%		n.s.	n.s.	36	36	37
In 1992						
None		47	n.s.	n.s.	n.s.	n.s.
Over 4.5%		n.s.	n.s.	n.s.	36	38

(cont....)

(continued)

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30 (% of firms)	31-50	50-100
Sales expenditures/						
Total sales	169					
In 1987-1989						
Up to 5%		39	40	44	43	25
Over 10%		n.s.	n.s.	n.s.	36	38
In 1992						
Up to 5%		35	47	50	43	50
Over 10%		n.s.	n.s.	n.s.	36	n.s.
Technical assistance/						
Total sales	169					
In 1987-1989						
Up to 0.5%		40	n.s.	n.s.	n.s.	n.s.
Over 4.5%		36	33	36	43	50
In 1992						
Up to 0.5%		34	n.s.	n.s.	n.s.	n.s.
Over 4.5%		37	33	n.s.	36	38
Training programmes/						
Total sales	169					
In 1987-1989						
0.3% to 0.8%		n.s.	33	38	n.s.	n.s.
Over 2.5%		35	n.s.	n.s.	n.s.	38
In 1992						
0.3% to 0.8%		n.s.	47	47	36	n.s.
Over 2.5%		35	n.s.	n.s.	n.s.	n.s.

Source: See text.

n.s. - non-significant (less than 33%)

Table 10
Productive capability and technological standards

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50 (% of firms)	50-100
Services acquired in 1991-1992						
a) In the domestic market						
Projects		n.s.	n.s.	n.s.	n.s.	50
Tests		n.s.	n.s.	n.s.	36	63
Metrology		n.s.	40	n.s.	n.s.	50
Certificate of compliance with technical specifications	n.s.	n.s.	n.s.	n.s.	50	
Consultancy in marketing	n.s.	n.s.	n.s.	36	38	
Consultancy in management	n.s.	n.s.	n.s.	71	75	
Consultancy in quality	n.s.	40	n.s.	50	88	
b) Abroad						
Tests		n.s.	n.s.	n.s.	n.s.	50

(cont....)

(continued)

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
				(% of firms)		
Certificate of complionce with technical specifications	n.s.	n.s.	n.s.	n.s.	38	
Consultancy in quality	n.s.	n.s.	n.s.	n.s.	38	
Generation of the main products of the firm						
Compared to the technological standard of the main world exporters						
Last or penultimate		41	73	67	71	75
Age of the most important equipment						
Up to 10 Years		49	67	47	n.s.	37
Technological generotion of the most important equipment						
Last or penultimate		41	60	64	69	63

Source: See text.
n.s. - non-significant (less than 33%)
(a) 169 respondents

Table 11
Origin of technical norms used by firms

Attributes		Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
					(% of firms)	
Input qualification						
Domestic (ABNT/INMETRO)	51	36	35	n.s.	n.s.	
Firms'own criteria		n.s.	n.s.	40	33	75
Raw materials handling						
Firms'own criteria		57	40	50	50	100
Machinery operotion						
Firms'own criteria		43	40	62	56	100
Product specifications						
Domestic (ABNT/INMETRO)	39	n.s.	n.s.	n.s.	n.s.	
International		n.s.	n.s.	n.s.	63	n.s.
Firms'own criteria		n.s.	50	n.s.	n.s.	67
Product standardization						
Domestic (ABNT/INMETRO)	41	n.s.	n.s.	n.s.	n.s.	
Firms'own criteria		41	55	n.s.	n.s.	60
Product tests						
Domestic (ABNT/INMETRO)	47	46	n.s.	n.s.	n.s.	
International		n.s.	n.s.	n.s.	50	n.s.
Gauging						
Domestic (ABNT/INMETRO)	69	67	69	50	50	

Source: See text.
n.s. - non-significant (less than 33%)

e. Technological capability

The counterpart of the movement towards more efficient production, quality improvement and higher product competitiveness is the need to adopt a number of measures related to the automation of production, the control of the production process, human resources policies and other factors. Tables 12 to 15 provide an overview of the main related points identified in the answers to the questionnaire, comparing the evolution between 1987-1989 and 1992 to the firms' plans for 1993-1995.

There was a clear increase in the number of firms using microelectronic devices in their main productive unit between 1987-1989 and 1992. These are mostly medium to large exporters, and the indications are that these groups of firms intend to intensify the utilization of these devices in the next two years.

An interesting difference between exporters and DMO firms is found in their approach to the ISO 9000 regulations. Over half of the non-exporters said they either didn't know or didn't think it was relevant to implement those regulations,[11] while half or more of the exporters were already implementing them. This is consistent with the expectation that exporters are subject to more strict market rules and barriers.

Also consistent with the previous pieces of evidence pointing to an increasing concern with quality and efficiency are the clear indications in every group of firms of a recent increase in the adoption of statistical control of production processes, the use of quality control circles, time-and-motion analyses, production cells, inbound just-in-time, outbound just-in-time, quality assurance activities at all stages of production, quality control activities at all stages of production, and quality assurance and control activities for all inputs. The indications are that the use of these mechanisms is likely to intensify in 1993-1995.

The indicators are in general more intense in direct proportion to the export/sales ratios of the firms, and this (once more) confirms the increasing concern with quality improvement and cost reduction.[12]

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11 However, another 39% of them said that they were already implementing them.

12 However, not much can be said about the ranking of these technological change activities as to the relative importance which exporters attach to them.

Table 12
Automation, process control

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms)				
% Operations by microelectronic devices						
In 1987-1989						
Over 20%		n.s.	n.s.	n.s.	n.s.	n.s.
In 1992						
Over 20%		n.s.	n.s.	33	46	71
Projected 1993-1995						
Over 20%		n.s.	n.s.	56	66	67
With regard to ISO 9000 regulations						
Don't know or don't want		54	n.s.	n.s.	n.s.	n.s.
Being implemented		39	53	51	43	50
Already implemented		n.s.	n.s.	37	43	50
Statistical control of Production process						
In 1987-1989						
Over 20%		n.s.	n.s.	n.s.	n.s.	n.s.
In 1992						
Over 20%		n.s.	42	41	n.s.	n.s.
Projected 1993-1995						
Over 20%		44	44	64	69	71

Source: See text.
n.s. - non-significant (less than 33%)
(a) 169 respondents

Table 13
Organizational procedures

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms)				
Quality control circles (Over 20% of workers involved in this activity)	165					
1987-1989		n.s.	n.s.	n.s.	n.s.	n.s.
1992		n.s.	n.s.	36	n.s.	n.s.
Projected 1993-1995		34	n.s.	66	38	50
Time-and-motion analysis (number (%) of operations)	141					
1987-1989		n.s.	42	n.s.	36	33
1992		n.s.	42	52	54	33
Projected 1993-1995		38	56	65	50	33

(cont....)

(continued)

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms)				
Production cells						
(Over 20% of workers involved in this activity)	140					
1987-1989		n.s.	n.s.	n.s.	n.s.	n.s.
1992		n.s.	42	n.s.	n.s.	n.s.
Projected 1993-1995		n.s.	44	33	33	n s.
Inbound just in time	143					
(over 20% of workers involved in this activity)						
1987-1989		n.s.	n.s.	n.s.	n.s.	n.s.
1992		n.s.	33	n.s.	n.s.	n.s.
Projected 1993-1995		47	67	56	n.s.	n.s.
Outbound just in time	143					
(Over 20% of suppliers involved in this activity)						
1987-1989		n.s.	n.s.	n.s.	n.s.	n.s.
1992		n.s.	n.s.	n.s.	n.s.	n.s.
Projected 1993-1995		n.s.	44	42	46	n.s.
Participation in just in time of clients	140					
(over 20% of shipments)						
1987-1989		n.s.	n.s.	n.s.	n.s.	n.s.
1992		n.s.	n.s.	n.s.	n.s.	n.s.
Projected 1993-1995		n.s.	44	38	n.s.	n.s.

Source: See text.
n.s. - non-significant (less than 33%)

Table 14
Quality control procedures

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms)				
Quality assurance activities (all stages of production)	112					
1987-1989		n.s.	n.s.	n.s.	n.s.	n.s.
1992		n.s.	50	36	54	n.s.
Projected 1993-1995		52	70	76	77	63
Quality control activities (all stages of production)	156					
1987-1989		n.s.	n.s.	47	54	38
1992		n.s.	50	43	62	57
Projected 1993-1995		47	40	71	64	86

(cont....)

(continued)

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50 (% of firms)	50-100
Quality assurance activities for inputs (all inputs)	119					
1987-1989		n.s.	n.s.	n.s.	n.s.	n.s.
1992		n.s.	36	n.s.	42	n.s.
Projected 1993-1995		39	55	63	69	71
Quality Control activities for inputs (all inputs)	158					
1987-1989		n.s.	33	n.s.	62	n.s.
1992		n.s.	n.s.	n.s.	50	38
Projected 1993-1995		58	n.s.	35	55	71

Source: see text.
n.s. - non-significant (less than 33%)

Table 15
Human resources policy

Attributes	No. of firms	Export/sales (%) ratio 0-5	6-10	11-30	31-50 (% of firms)	50-100
Stable contracts with no formal guarantees	175	45	87	70	71	90
Flexibility in broadly defining jobs	177	45	53	56	71	70
Training policy:	177					
External institutions		39	47	65	65	50
Systematic internal programmes		n.s.	73	78	88	100
Non-systematic internal programmes		42	33	38	n.s.	50

Source: See text.
n.s. - non-significant (less than 33%)

Tables 1 and 2 have shown that this movement towards more efficient production had a corresponding adverse effect on employment, as firms began outsourcing basic services, among other measures. The figures in table 15 confirm that all groups of firms - but especially the larger exporters - have adopted as a strategy the practice of making stable job contracts with no formal guarantees, and also use flexibility in broadly defining jobs.

At the same time, however, most firms - again, predominantly exporters - have training programmes (systematically or not) and rely mostly on external institutions to carry them out. Optimistic conclusions should be qualified, however, by the indications (table 9) of a reduction in training programmes/total sales ratios between 1987-1989 and 1992.

f. "External" determinants of competitiveness

A final set of data appears in tables 16 to 21. Firms were asked to isolate which - in their view - were the main determinants of competitiveness, with regard to market characteristics, industrial organization, relations with suppliers and characteristics of raw materials, attributes of equipment, macroeconomic conditions and international elements.

The questions sought to ascertain how entrepreneurs considered each attribute with regard to its importance for the competitiveness of their firms in the market where they compete, as well as its influence on the firm itself. Furthermore, the questions on the effects on the firm referred to the present situation (as of 1992), so that for a given attribute, such as "conformity with client specifications", firms would say whether they considered it important for competing and whether the present degree of conformity had an identifiable positive or negative impact on the firm.

In relation to market characteristics, in general the firms in all groups (not surprisingly) considered as important or very important for competing all of the attributes listed in the questionnaire - low sales prices, knowledge of product brand name, fast product delivery, fast development of new products,[13] efficiency in technical assistance, technical sophistication of products, conformity with client specifications, exploring specific market segments, and the possibility of exploring a large domestic market.

Table 16
Determinants of Competitiveness as Identified by the Firms (Market Characteristics)

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
		(% of firms)				
Low sales price						
Sectorally:						
Important or very important		88	100	94	100	100
For the firm:						
Positive		48	n.s.	n.s.	n.s.	n.s.
Product brand name						
Sectorally:						
Important or very important		88	92	90	79	100
For the firm:						
Positive		64	47	51	n.s.	n.s.
Fast product delivery						

(cont....)

[13] Apparently this was the only atribute more important for small to medium exporters. The answers given by all the others were positively correlated with the export/sales ratio.

(continued)

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50 (% of firms)	50-100
Sectorally:						
Important or very important		95	100	94	94	100
For the firm:						
Positive		55	47	49	53	60
Fast development of new products						
Sectorally:						
Important or very important		54	92	81	81	60
For the firm:						
Positive		n.s.	n.s.	n.s.	n.s.	n.s.
Efficiency in technical assistance						
Sectorally:						
Important or very important		71	92	77	94	100
For the firm:						
Positive		37	40	49	40	40
Technical sophistication of products						
Sectorally:						
Important or very important		71	75	84	75	60
For the firm:						
Positive		n.s.	n.s.	n.s.	n.s.	n.s.
Conformity with technical specifications						
Sectorally:						
Important or very important		80	83	94	94	100
For the firm:						
Positive		39	40	62	59	90
Conformity with client specifications						
Sectorally:						
Important or very important		73	92	94	94	90
For the firm:						
Positive		46	40	62	47	70
Specific market segments						
Sectorally:						
Important or very important		76	100	84	75	100
For the Firm:						
Positive		51	47	56	n.s.	40
Large domestic market						
Sectorally:						
Important or very important		90	100	97	100	40
For the Firm:						
Positive		46	40	53	47	n.s.

Source: See text.
n.s. - non-significant (less than 33%)
(a) 176 respondents

Table 17
Determinants of competitiveness as identified by the firms
(Industrial organization)

Attributes	No. of firms (a)	0-5	6-10	11-30	31-50	50-100
		Export/sales (%) ratio (% of firms)				
Deverticalizotion of production						
Sectorally:						
Important or very important		72	75	50	75	80
For the firm:						
Positive		n.s.	n.s.	n.s.	37	n.s.
Market diversification						
Sectorally:						
Important or very important		55	67	70	94	80
For the firm:						
Positive		n.s.	n.s.	n.s.	44	50
Large-scole production						
Sectorally:						
Important or very important		85	75	78	94	100
For the Firm:						
Positive		n.s.	n.s.	n.s.	n.s.	80

Source: See text.
n.s. - non-significant (less than 33%)
(a) 176 respondents

Table 18
Determinants of competitiveness as identified by the firms
(Intersectoral Relations - Suppliers and Raw Material)

Attributes	No. of firms (a)	0-5	6-10	11-30	31-50	50-100
		Export/sales (%) ratio (% of firms)				
Long, stable relations with suppliers						
Sectorally:						
Important or very important		95	100	97	100	100
For the Firm:						
Positive		76	53	74	53	70
Long, stable relations with clients						
Sectorally:						
Important or very important		100	100	97	100	100
For the firm:						
Positive		85	73	92	82	100
Keeping own distribution systems						
Sectorally:						
Important or very important		68	58	63	50	70
For the firm:						
Positive		42	n.s.	n.s.	n.s.	44
Access to other distribution systems						

(cont....)

(continued)

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
					(% of firms)	
Sectorally:						
Important or very important		61	33	66	81	90
For the firm:						
Positive		n.s.	n.s.	n.s.	n.s.	n.s.
Low price for raw materials						
Sectorally:						
Important or very important		98	92	97	100	80
For the firm:						
Positive		50	n.s.	45	53	70
Rapid access to raw materials						
Sectorally:						
Important or very important		100	100	93	100	100
For the firm:						
Positive		48	33	47	41	60
Technical appropriateness of raw materials						
Sectorally:						
Important or very important		95	100	97	100	100
For the firm:						
Positive		55	n.s.	58	47	70
Durability of raw materials						
Sectorally:						
Important or very important		61	83	70	75	70
For the firm:						
Positive		52	40	n.s.	n.s.	n.s.
Raw materials corresponding to the firm's Specifications						
Sectorally:						
Important or very important		85	100	93	94	100
For the Firm:						
Positive		43	n.s.	41	n.s.	40

Source: See text.
n.s. - non-significant (less than 33%)
(a) 172 respondents

Table 19
Determinants of competitiveness as identified by the firms (Intersectoral relations - equipment)

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
					(% of firms)	
Low price of equipment						
Sectorally:						
Important or very important		83	92	90	94	100
For the firm:						
Positive		n.s.	n.s.	n.s.	n.s.	n.s.
Rapid equipment elivery						
Sectorally:						

(cont....)

(continued)

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50	50-100
				(% of firms)		
Important or very important		73	100	87	100	100
For the firm:						
Positive		n.s.	n.s.	n.s.	n.s.	n.s.
Efficient technical assistance for equipment						
Sectorally:						
Important or very important		83	100	93	100	100
For the firm:						
Positive		35	n.s.	n.s.	41	50
Technical sophistication of equipment						
Sectorally:						
Important or very mportant		78	99	93	94	100
For the firm:						
Positive		41	n.s.	47	41	n.s.
Conformity of equipment to technical specifications						
Sectorally:						
Important or very important		89	100	83	94	100
For the firm:						
Positive		35	n.s.	45	35	44
Durability of equipment						
Sectorally:						
Important or very important		90	100	97	100	100
For the firm:						
Positive		48	n.s.	47	47	60
Opportunities to import raw materials or components						
Sectorally:						
Important or very important		83	82	93	100	80
For the firm:						
Positive		35	n.s.	40	35	60
Opportunities to import equipment						
Sectorally:						
Important or very important		73	100	90	100	90
For the firm:						
Positive		n.s.	n.s.	40	35	60

Source: See text.
n.s. - non-significant (less than 33%)
(a) 171 respondants

Table 20
Determinants of competitiveness as identified by the firms
(Intersectoral Relations - macroeconomic conditions)

Attributes	No. of firms (a)	Export/sales (%) ratio 0-5	6-10	11-30	31-50 (% of firms)	50-100
Labour cost						
Sectorally:						
Important or very important		88	100	97	94	60
For the firm:						
Negative		48	n.s.	n.s.	n.s.	n.s.
Interest rate						
Sectorally:						
Important or very important		100	100	100	100	90
For the firm:						
Negative		79	53	82	94	70
Exchange rate						
Sectorally:						
Important or very important		70	100	87	94	90
For the firm:						
Negative		35	33	44	n.s.	n.s.
Long-term credit						
Sectorally:						
Important or very important		88	92	97	94	90
For the firm:						
Negative		47	40	61	94	50
Short-term credit						
Sectorally:						
Important or very important		78	92	87	94	90
For the firm:						
Negative		45	40	n.s.	41	n.s.
Export financing						
Sectorally:						
Important or very important		53	100	97	100	90
For the firm:						
Positive		n.s.	n.s.	n.s.	n.s.	50
Tax on inputs						
Sectorally:						
Important or very important		98	100	93	100	90
For the firm:						
Negative		82	67	71	77	70
Tax on products						
Sectorally:						
Important or very important		100	100	93	100	90
For the firm:						
Negative		85	67	73	71	70
Fiscal incentives to exports						
Sectorally:						
Important or very important		63	100	90	94	90
For the firm:						
Negative		n.s.	40	42	n.s.	n.s.
Fiscal incentives to investment						
Sectorally:						
Important or very important		75	100	100	88	90
For the firm:						

(cont....)

(continued)

Attributes	No. of firms (a)	0-5	6-10	11-30	31-50	50-100
		Export/sales (%) ratio (% of firms)				
Negative		n.s.	60	63	47	40
Import tariffs on inputs						
Sectorally:						
Important or very important		70	100	93	94	70
For the firm:						
Negative		36	33	53	59	n.s.
Import tariffs on capital goods						
Sectorally:						
Important or very important		55	92	89	94	80
For the firm:						
Negative		n.s.	n.s.	58	47	n.s.
Import tariffs on competing goods						
Sectorally:						
Important or very important		53	92	58	50	n.s.
For the firm:						
Positive		n.s.	33	n.s.	n.s.	n.s.
Social security costs						
Sectorally:						
Important or very mportant		98	92	100	100	90
For the firm:						
Negative		76	53	87	71	n.s.

Source: See text.
n.s. - non-significant (less than 33%)
(a) 175 respondents

Table 21
Determinants of competitiveness as identified by the firms (Intersectoral relations - international conditions)

Attributes	No. of firms (a)	0-5	6-10	11-30	31-50	50-100
		Export/sales (%) ratio (% of firms)				
Access to new foreign technologies						
Sectorally:						
Very important		n.s.	67	63	81	60
For the firm:						
Positive		34	47	34	n.s.	40
Technological links with foreign firms abroad						
Sectorally:						
Very important		n.s.	50	47	69	n.s.
For the firm:						
Positive		n.s.	47	33	n.s.	n.s.
Harmonization of trade policies						
Sectorolly:						
Very important		n.s.	50	53	44	50
For the firm:						
Negative		n.s.	n.s.	41	44	n.s.
MERCOSUR						
Sectorally:						
Very important		n.s.	n.s.	47	38	n.s.

(cont....)

(continued)

Attributes	No. of firms (a)	0-5	6-10	11-30	31-50	50-100
		Export/sales (%) ratio (% of firms)				
For the firm:						
Positive		n.s.	n.s.	34	41	n.s.
Tariff barriers to international trade						
Sectorally:						
Very important		n.s.	33	47	75	100
For the firm:						
Negative		n.s.	n.s.	n.s.	71	56
Technical barriers to international trade						
Sectorally:						
Very important		n.s.	n.s.	n.s.	63	80
For the firm:						
Negative		n.s.	n.s.	n.s.	47	60

Source: See text.
n.s. - non-significant (less than 33%)
(a) 111 respondents

Also, there is no significant indication that any of these attributes would at present have negative effects on the firms. Instead, most of the firms in all groups were satisfied (positive influence) with the present status of product delivery time, efficiency in providing technical assistance, and conformity with technical and client product specifications.

As far as the attributes of industrial organization are concerned, most firms - regardless of their export/sales ratio -consider important or very important the deverticalization of production, market diversification and large-scale production. Only some of the larger exporters, however, indicated that the present situation has positive effects on their firms.

Firms of all groups also praise - as determinants of competitiveness - the maintenance of long and stable relations with suppliers and clients and the possibility of gaining rapid access to raw materials that are also cheap and technically appropriate and that correspond to the firm's specifications. Apparently they are less worried[14] about the distribution system for their products, be it exclusive or belonging to third parties.

Thus, entrepreneurs have in general indicated positive effects on their firms stemming from the present status of their relations with suppliers and clients and rapid access to raw materials.

A very high proportion (nearly all) of the firms in all groups consider (not surprisingly) as very important for competitiveness rapid access to cheap, durable, technically sophisticated equipment with efficient technical assistance and conformity to technical specifications. Also very important are opportunities to import equipment and raw materials and components.

[14] However, they still consider it important or very important for competing in the market.

No significant proportion of firms manifested satisfaction with the present situation with regard to the price or delivery time for acquiring new equipment. A sizeable share (about 40% or more) of the entrepreneurs consider positive for their firms the present level of technical sophistication and durability of the equipment[15], but apparently only the exporters seem satisfied with current terms for importing equipment and raw materials.[16]

In their appraisal of the macroeconomic determinants of competitiveness, the firms are almost unanimous in naming the level of domestic interest rates, the level of taxation of production and social security costs as very important items. Other relevant variables are (as expected) the exchange rate, labour costs, the availability of short- and long-term credit and fiscal incentives for exports and for investment in general.

It is particularly remarkable that import tariffs on competing goods apparently rank last in importance, considering the percentage of firms that classified it as important. One group of firms even indicated that this attribute had positive effects.[17]

The figures in table 20 reflect more explicitly the dissatisfaction of entrepreneurs with some of the most obvious effects of inflation in a context of fiscal deficit: a large number of firms noted the negative impacts of high interest rates, the limited availability of long-term credit, the relatively high tax on inputs and products and (for all but the largest exporters) the level of import tariffs on inputs and social security costs.

The first and last sets of indicators in table 20, taken together, indicate thot labour costs seem relevant mainly for domestic-market-oriented firms, while social security costs affect most groups of firms. The corresponding (non-significant) indicators for the group of largest exporters might be interpreted as a suggestion that the relatively higher intensity of the adjustment that took place in this group (table 1) has made these firms less sensitive to factor costs.

A final set of determinants of competitiveness external to the firms concerns some key factors in international relations. It is worth noting, first of all, not only that a smaller number of firms answered this part of the questionnaire, but also that the percentages in each row of table 21 are smaller than in table 20. This reflects the obvious fact that firms are, on the whole, more concerned about domestic constraints; only exporters care about these international determinants.[18]

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15 In accordance with the evidence provided by table 10, which suggests a relative technological updating of the most important equipment in most firms.

16 This is consistent with the indications (table 1) that only these firms have imported significantly in recent years.

17 This is consistent with the previous indication that import competition is not relevant to the definition of production and marketing strategies.

18 The figures in the first column of table 21 apparently confirm that domestic-market-oriented firms are less interested.

According to table 21, firms consider as very important for competing in their markets access to new foreign technologies - either directly or via links with foreign firms - and mechanisms to avoid barriers that currently affect their exports.

At the firm level, there are indications that the groups of medium to large-scale exporters are at present negatively affected by tariff and technical barriers to trade, and by the present harmonization of trade policies.

This dissatisfaction with the present harmonization of trade policies does not refer to the consolidation of MERCOSUR. In fact, MERCOSUR is considered important by small- and medium-scale exporters (firms with an export/sales ratio of up to 50%) -as shown by the figures in table 4 - and these firms have indicated positive effects.

5. General evaluation

This study is a first attempt to identify - through a partial processing of the data obtained from a survey of industrial firms in Brazil in 1992 - the basic actions recently undertaken by those firms to improve their competitiveness, and to relate the differences among the firms to their involvement in exporting activity.

It should be clear that the results obtained here have to be carefully considered in light of the specific (unusual) period when the firms were surveyed. That was a time when the domestic economy presented recessive conditions, coupled with record inflation and fiscal imbalance. It was also a period when the export sector was starting to recover from the effects of the highest exchange-rate overvaluation since the adoption of the crawling-peg mechanism in 1968.

From the perspective of the participation of domestic products in the international market, the toll taken by these adverse conditions was a significant fall - in the second half of the 1980s -in the market share of Brazilian exports in most geographic areas,[19] In addition, some structural constraints have been of increasing concern to analysts of the Brazilian trade sector. Not only do natural resources-intensive products with low processing still represent an overwhelming share of the country's exports. A large proportion of the non-traditional products exported from Brazil have relatively less dynamic markets; at least in terms of demand in OECD countries, the prospects stemming from the structure of specialization seem to compare poorly with those of competitors.[20]

In such a context - and given the peculiarities of the questionnaire - this study should not be expected to constitute a comprehensive test of the role of exports. Instead, the purpose of this first approximation (not controlling for firm size or sectoral peculiarities) is to depict the efforts

19 For basic data, see BNDES (1993).

20 In this regard, see Fichet (1993).

that have been made by the firms surveyed in order to foster competitiveness, and - whenever possible - to try to identify indications that involvement in the external market might lead to a differentiated approach.

The analysis has shown an overall movement of most producers towards productive efficiency; an intensification of the use of quality criteria in purchasing inputs, using raw materials and managing the production process; a clear concern with product quality and the provision of technical assistance; and a preoccupation with meeting client-determined specifications, in specific market segments.

The results also show that the sampled firms have, as a rule, gone through an adjustment process clearly motivated by the recent recessive inflationary conditions of the domestic market; among other consequences, this has led to lower labour/output ratios.

The evidence surveyed here also tended to confirm in broad terms the results obtained elsewhere with regard to exporters being more concerned with formally (i.e., by means of market-mediated contracts) acquiring technology and adapting themselves to more strict market conditions than domestic-market-oriented firms.

In the external side, the data indicate that the larger exporters are being affected by the barriers importing countries impose on their products. Additionally, there is evidence that MERCOSUR has become a factor taken into consideration by some firms in defining their strategies, although the largest exporters do not seem to be among them.

The inferences one might derive from these indicators for suggesting policy measures should take into account, first, that they refer to a fairly representative set of firms, corresponding to 23% of the exports of industrial products in 1992. Also, one should keep in mind the fact that firms with the highest export/sales ratios are large in size, belong to economic groups and have diversified lines of production. This might be indicative of the importance of inter-industrial relations for the export sector.[21]

This seems to be confirmed by the respondents'concern about maintaining stable commercial relations with suppliers and clients, as well as the preoccupation with meeting client specifications and providing technical assistance in specific market segments.

An optimistic view of these indicators would suggest that this approach of "specialization leading to competitiveness" might have deeper roots in the productive structure than the simple analysis of the export structure would suggest. If so, this would also mean greater capacity to disseminate the benefits of exporting activity into the productive sector and lead to more systemic competitiveness.

[21] As indicated also in BNDES (1993).

A pessimistic view would stress the fact that the external market actually served as a "cushion" against the domestic recession during the period of analysis, and hence export performance might be vulnerable to an upturn in economic activity. This could be confirmed by the indications that firms care most about the domestic market.

The truth probably lies in between. As emphasized earlier, the period of analysis is unusual in that domestic recession influenced most of the outcomes, as reflected in the cost-cutting policies that led to reduced expenditures on engineering, sales, manpower training and other items. But at the same time, the figures presented here point to an increasing concern with the number of operotions by microelectronic devices, with implementing the ISO 9000 regulations and other factors, all of which would indicate a more systematic and careful approach to more demanding markets (firms do not seem to worry much about import competition), where firms feel as technologically updated as their competitors.

One might add that these animal spirits of the export sector might be reinforced by previous experience: in 1986 a domestic boom induced several exporters to redirect their sales, only to learn very soon the costs of losing stable relations with foreign clients, a characteristic specifically praised in the answers to the present survey.

It is hard to derive more definite conclusions from such a broad analysis, without going into details about the role of the firms' size and sectoral specificities. The sample comprises such diverse sectors as the production of power-generating machinery, furniture and apparel and clothing, among others, but the shortage of time for analysis does not allow for more detailed treatment of the information.

Furthermore, it would be interesting to know if there is any significant difference between foreign and domestically-owned firms (especially among the larger exporters) with regard to the variables considered here. Bielschowsky (1993) shows that the movement towards competitiveness has apparently been more intense in subsidiaries of foreign companies than in domestic firms, although the intensity of the changes in the latter are quite impressive. But his sample does not allow for the analysis of performance according to the export/soles ratio, as in the present study. That would require a further processing of the primary data.

The policy implications that follow from these sets of data are numerous. First, the firms surveyed show an overall confidence with regard to their conditions for competing with imports. This would indicate that (possibly with some specific sectoral exceptions) there seems to be, in general, no reason to reverse the policy of low import barriers. The evidence reviewed seems to recommend instead that international negotiators should intensify efforts to reduce the trade barriers affecting exports.

The indications of concern with structural competitiveness might look inconsistent with the reduction of expenditure on related measures such as manpower training, if one does not take into account the short-term peculiarities of the period. It seems, however, that this inconsistency is unsustainable over time, and that firms will sooner or later be forced to resume these activities if they are to maintain or improve their level of competitiveness. But it is also an indicator that there is a case for complementary policy measures to help firms overcome the difficulties that led to that reduction. Such initiatives become even more important in a period of systematic and generalized reduction of employment/sales ratios.

By and large, the firms surveyed point to the levels of domestic interest rates and of taxes on inputs and products as two major constraints they have to face. Needless to say, this affects all the firms, but it is interesting to note that the exporters have been able to gain access to cheaper foreign financing. When considered together with the indications that these firms belong to economic groups, these differentiated conditions might lead to considerations of the likely consequences for the domestic market structure. Measures to ensure fair competition might become even more necessary than before.

The results presented here also suggest other types of policies more directly related to the quest for systemic competitiveness, such as informing a broader spectrum of firms of the importance of adopting mechanisms like those prescribed by the ISO 9000, providing credit and other incentives to help (mainly smaller) firms improve their managerial, technological and productive capability, and several other initiatives.

The range of possibilities for policy suggestions is as varied as the topics covered by this report. It is hoped that this broad picture will prove helpful in identifying the main issues. More specific conclusions would require a more detailed analysis of the enormous amount of information available, at the sectoral level.

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